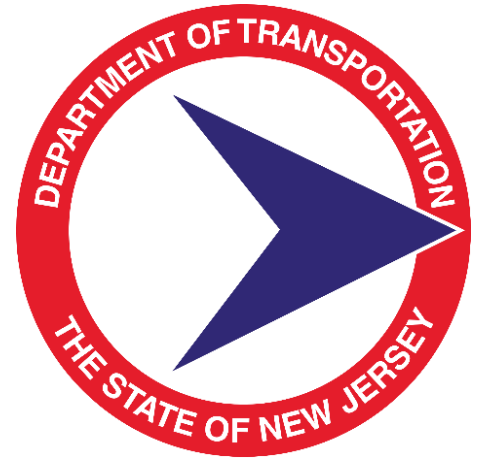
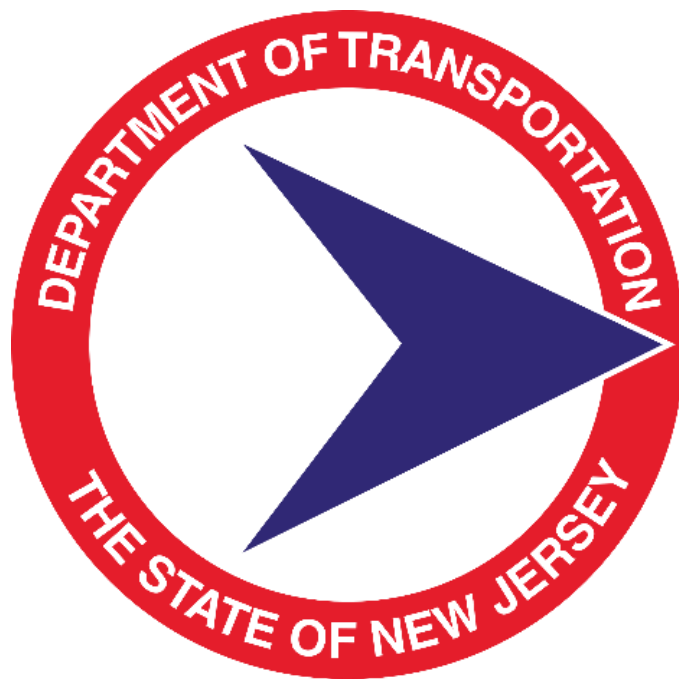


# New Jersey Department of Transportation



## Design Manual for Bridges & Structures Sixth Edition, 2016

New Jersey  
Department of Transportation



Design Manual  
for Bridges and Structures  
Sixth Edition, 2016

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<http://www.state.nj.us/transportation/eng/CADD/v8/>

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- (1) Also see Subsection 25.1 of this Manual.
- (2) These are utility company standard drawings and are intended to be used only as guides in the preparation of Contract Plans.
- (3) Also see Section 40 of this Manual.
- (4) Also see Section 15 of this Manual.
- (5) Also see Subsection 24.20 of this Manual.
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## Section 1 - Introduction

### 1.1 Purpose

This Manual, supplemented by other NJDOT Baseline Documents and operating procedures and policies, is the vehicle by which the design of bridges and structures is implemented. Presented herein is a compilation of NJDOT Structural Design guidance, specification interpretations, standard practices, details and standards.

Good design practice will always require a combination of basic engineering principles, experience and judgment in order to furnish the best possible structure to suit an individual site within reasonable economic limitations, it does not preclude justifiable exceptions, subject to the approval of the Manager, Bureau of Structural Engineering, provided the exceptions are based on sound engineering principles.

While the Design Manual establishes the standards for designing bridge structures in New Jersey, Designers are encouraged to explore innovative methods in providing NJDOT project bridge designs. Discovery of an innovative method and a concurrence for its use should be submitted to the Bureau of Structural Engineering. Sufficient information; such as, history of the method's development, identification of successful use by other States and evidence of adherence to AASHTO LRFD design parameters must be provided.

Use of Prefabricated Bridge systems is also strongly encouraged, along with the use of enhanced materials; such as, High Performance Steel and High Performance Concrete to better assure the attainment of a bridge structure's design service life expectancy.

### 1.2 Reference Publications

A. The following publications, as modified in this Manual, govern the design of bridges and structures:

- AASHTO A Policy on Geometric Design of Highways and Streets
- AASHTO Guide Specifications and Commentary for Vessel Collision Design of Highway Bridges
- AASHTO Guide Specifications for Fracture Critical Non-Redundant Steel Bridge Members
- AASHTO Guide Specifications for Highway Bridge Fabrication with HPS 70W Steel
- AASHTO Guide Specifications for LRFD Seismic Design of Highway Bridges
- AASHTO LRFD Bridge Design Specifications
- AASHTO LRFD Bridge Construction Specifications
- AASHTO LRFD Guide Specifications for Design of Pedestrian Bridges
- AASHTO LRFD Movable Highway Bridge Design Specifications
- AASHTO Manual for Assessing Safety Hardware (MASH) used in conjunction with AASHTO/FHWA Joint Implementation Plan for the AASHTO Manual for Assessing Safety Hardware, 2009
- AASHTO Manual for Bridge Evaluation
- AASHTO Manual on Foundation Investigations
- AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals
- AASHTO/AWS D1.1 Structural Welding Code-Steel

- AASHTO/AWS D1.2 Structural Welding Code-Aluminum
- AASHTO/AWS D1.5 Bridge Welding Code
- AREMA Manual for Railway Engineering

B. The above publications are approved references to be used in conjunction with this Manual. Primarily they set forth minimum nationwide requirements which are consistent with current practice, but require modifications to suit local conditions. In the event of conflict in the requirements, the instructions in this Manual shall govern.

### **1.3 Approval**

Any reference to the following titles throughout this Manual means that the approval is by the Director of Bridge Engineering and Infrastructure Management or State Transportation Engineer:

- Manager, Structural Engineering/Manager of Structural Engineering
- Director of Bridge Engineering and Infrastructure Management

## Section 2 - Bridge Terms

The following is a list of bridge terms usually found in bridge plans or referred to in bridge construction:

### **Abutment**

The portion of the bridge substructure at either end of a bridge which transfers loads from the superstructure to the foundation and provides lateral support for embankment.

### **Alignment Bearing**

A bearing that prevents transverse movement of the superstructure. Normally, one beam on each span has an alignment bearing. However, seismic considerations may warrant provision of more than one alignment bearing.

### **Backwall**

The portion of an abutment behind the bridge seats which extends upward from the top of the bridge seats to the top of the abutment or bottom of the header.

### **Batter**

A deviation from the vertical, commonly found on the back sides of walls and on piles.

### **Bearing**

Usually, a device which supports the end of a girder and distributes superstructure loads to the abutment or pier. Fixed bearings do not provide for longitudinal movement of the superstructure to compensate for expansion and contraction due to temperature changes.

### **Bent**

A row or group of piles in a structure, a row of columns. Piers are also referred to as bents when the piles extend above the ground to the pier cap.

### **Boring**

An exploration of subsurface material. Borings are used by the Design Engineer in determining the types and dimensions of foundations required. Borings are used by Construction personnel to determine the type of materials in which piles are to bear, and to determine suitable bearing strata in foundation excavations.

### **Borrow Excavation, Bridge Foundation (BEBF)**

Select compacted material used for foundations.

### **Bridge Seat**

The horizontal surface on an abutment or pier on which the girders are to be supported.

### **Bulkhead**

1. Usually, bulkheads (timber, concrete, or steel sheeting) are constructed adjacent to railroads or waterways to retain embankments or prevent erosion.
2. A temporary vertical form at a construction, contraction or expansion joint.



**Camber**

A slight parabolic curvature constructed into a girder to:

1. Compensate for deflections in the girder due to the weight of the girder and weight of concrete supported by it.
2. Provide curvature to the superstructure if the roadway profile is on a vertical curve.
3. Provide architectural curvature to the girder.

**Cap Beam**

A steel, timber or concrete beam capping a bent of piles or columns.

**Centerline of Bearings**

A horizontal alignment control line through the centers of the bearings which is used in abutment or pier layout and girder erection.

**Chamfer**

The inclined flat surface formed by removing a square edge or corner; a beveled edge.

**Column**

A vertical compression member usually circular or rectangular in cross section. In piers, columns transfer loads from the superstructure to the footing foundation.

**Construction Joint**

A joint where adjacent portions of the structure are joined together. This is usually roughly finished and has reinforcement steel extending through it. Abbr.: Const. Jt.

**Contraction Joint**

A joint which separates two adjacent portions of the structure and contains a bond break such as a paraffin coating. Abbr.: Contr. Jt.

**Coping**

A projecting course of concrete. Usually, this is a projection on the outside of bridge sidewalks. It is also found on wingwalls of stub abutments and some pier cap beams.

**Cutoff Wall**

A type of concrete header constructed under headwall aprons, culvert invert slabs and culvert wingwall footings to prevent washouts caused by scouring action of the water.

**Diaphragm**

Channel, angle steel or cast-in-place concrete cross bracing between girders.

**Dowel**

A reinforcement bar extending through a construction joint connecting two adjacent portions of the structure.

**Elevation View**

A front or side view.

**Expansion Joint**

A joint which separates two adjacent portions of a structure and contains compressible material to allow for concrete expansion. Abbr.: Exp. Jt.

**Fascia Beams**

The outermost girders on any span.

**Flange**

The projecting portion of a beam or channel. The top or the bottom plate of a steel girder.

**Footing**

Part of a foundation, normally wider than the supported wall or column, which transmits loads from above to the soil below either by direct contact or through piles.

**Foundation**

The part of a structure which is usually placed below the surface of the ground which distributes the load upon the subsoil.

**Girder**

A horizontal supporting structural member. (Beam, Stringer)

**Header**

A concrete wall on the top of an abutment backwall usually found between the end of a deck slab and the roadway approach slab.

**Integral Abutment Bridge**

A bridge whose superstructure is rigidly connected to its abutments.

**Life Cycle Cost**

The total cost of an item's ownership over a specified period of time. For NJDOT Bridge Projects, this period will be 100 years. This includes initial acquisition costs (right of way, planning, design, construction), operation, maintenance, modification, replacement, demolition, financing, taxes, disposal and salvage value as applicable.

**Parapet**

A concrete railing or barrier located on the bridge deck fascia and the tops of retaining walls.

**Pier**

The portion of the bridge substructure which transfers loads from the superstructure to the foundation. Provides intermediate support for multi-span bridges.

**Piles**

Shafts of concrete, timber, or steel which are used to transfer foundation loads through subsurface materials.

**Pitch**

The vertical distance covered by one turn of spiral reinforcement in columns.

**Plan View**

Top view.

**Retaining Wall**

A wall designed to retain embankment and prevent erosion.

**Section View**

An internal view. In Bridge Plans, sections are usually shown through all parts of the structure.

**Shear Connectors**

Usually stud type connectors welded to the top of girders or U type reinforcement protruding from prestressed concrete beams and embedded in the concrete deck slabs.

**Soffit**

The underside portion of a deck slab overhanging the exterior of fascia girders.

**Stiffener**

Longitudinal or vertical plates (welded to structural steel beams) to prevent buckling.

**Substructure**

The part of a structure below the superstructure.

**Superstructure**

In a bridge, the superstructure consists of bearings, girders, decks, sidewalks, etc. (All above the substructure).

**Wingwall**

A wall at the end of an abutment or culvert for retaining slopes and preventing erosion.

**Viaduct**

A bridge made up of multi-spans supported on piers carrying the roadway over streets, highways, railroads and/or streams.

## Section 3 - AASHTO LRFD Bridge Design Specifications with NJDOT Stipulations

### 3.1 Load and Resistance Factor Design (LRFD) Philosophy

The design of new structures and new elements of rehabilitated bridge structures in New Jersey shall be completed with the use of the *AASHTO LRFD Bridge Design Specifications*. Guidance for the Reconstruction or Rehabilitation of existing bridge structures is provided in Section 8 of this Manual.

The LRFD bridge design philosophy is based on the premise that four Limit States are stipulated to achieve the basic design objectives of constructability, safety and serviceability. All Limit States are given equal importance.

The four Limit States are:

**Service Limit State:** Stress, deformation and crack width are limited under service conditions.

**Fatigue and Fracture Limit State:** Fatigue stress range is limited for the expected number of stress cycles due to a single design truck in order to control crack initiation and propagation, and to prevent fracture during the design life of the bridge.

**Strength Limit State:** Strength and stability are provided to resist the significant load combinations that a bridge is expected to experience in its design life.

**Extreme Event Limit States:** Structures are proportioned to resist collapse due to extreme events, such as, major earthquake, flood, ice flow, collision by a vessel, etc.

Equation 1.3.2.1-1 of the *AASHTO LRFD Bridge Design Specifications*, unless otherwise specified, must be satisfied for each Limit State:

Where  $\eta = \eta_D \eta_R \eta_I \geq 0.95$

$\eta$  = A factor relating to ductility, redundancy and operational importance.

$\eta_D$  = A factor relating to ductility

$\eta_R$  = A factor relating to redundancy

$\eta_I$  = A factor relating to importance

$\gamma_I$  = Load factor: A statistically based multiplier

$\phi$  = Resistance Factor: A statistically based multiplier

$Q_I$  = Force Effect

$R_n$  = Nominal Resistance

$R_r$  = Factored Resistance:  $\phi R_n$

Subsection 1.3 of the LRFD Specifications may be referred to for additional commentary concerning the philosophy of the Specifications' development.

### 3.2 Vehicular Bridge Structures

The current Edition of the *AASHTO LRFD Bridge Design Specifications* (with current Interims), with the following stipulations to the respective AASHTO LRFD Sections, shall govern the design of bridge structures in New Jersey.

**Note:** The following Section numbers refer to the Section numbering of the *AASHTO LRFD Bridge Design Specifications*.

## **Section 1 – Introduction**

### 1.3.4 – Redundancy

The following is added:

During concept design, the Designer shall ensure that the bridge is redundant in accordance with the provisions herein.

### 1.3.5 Operational Importance

The following is added:

The Operational Importance strength limit state classification shall be as follows:

NHS Structures -  $n_i = 1.05$

NON-NHS Structures -  $n_i = 1.00$

## **Section 2 - General Design and Location Features**

### 2.3.2 Bridge Site Arrangement

#### 2.3.2.2 Traffic Safety

##### 2.3.2.2.1 Protection of Structures

The following is added:

The *NJDOT Design Manual Roadway* shall be referred to for additional guidance concerning lateral clearance requirements.

### 2.3.3 Clearances

#### 2.3.3.1 Navigational

The following is added:

The guidance provided in Section 42 of this Manual shall be followed in procuring U.S. Coast Guard permits.

#### 2.3.3.2 Highway Vertical

The following is added:

The minimum vertical under clearances that are tabulated in the following Table are based on the provisions of the *AASHTO A Policy on Geometric Design of Highways and Streets*. For Interstate Highways, *AASHTO A Policy on Design Standards Interstate System* will apply. The specified clearances shall control the design of bridge structures in New Jersey.

**Table 2.3.3.2 - Minimum Vertical Clearances for Bridges & Structures**

| Roadway Functional Classification Facility Type         | Vehicular and Railroad Over Crossings | Pedestrian and Bikeway Over Crossings | Overhead Sign Structures | Tunnels | Notes   |
|---|---------------------------------------|---------------------------------------|--------------------------|---------|---------|
| Interstates<br>Freeways<br>Expressways                  | 16'-0"                                | 17'-0"                                | 17'-3"                   | 16'-0"  | 1,2,3,8 |
| Rural Arterials<br>Urban Arterials                      | 16'-0"                                | 17'-0"                                | 17'-3"                   | 16'-0"  | 1,2,3,8 |
| Local Roads and Streets and Collector Roads and Streets | 14'-6"                                | 17'-0"                                | 17'-3"                   | 14'-6"  | 1,2,8   |
| Railroads   | 23'-0"                                | 23'-0"                                | --                       | 23'-0"  | 4       |
| Electrified Tracks                                      | 24'-6"                                | 24'-6"                                | --                       | 24'-6"  | 4       |
| Inter-Coastal Waterway                                  | 55'-0"                                | --                                    | --                       | --      | 5       |
| Navigable Waterways                                     | Varies                                | --                                    | --                       | --      | 6       |
| Other Waterways   | Varies                                | --                                    | --                       | --      | 7       |
| Existing Bridges and Structures                         | --                                    | --                                    | --                       | --      | 8       |

**Notes for Table 2.3.3.2**

1. Design Exceptions are required for proposed clearances that are less than the minimum values shown in this table. The clearance shall apply over the entire roadway width including any contiguous auxiliary lanes and shoulders. Approval of a Design Exception should follow the process in the current NJDOT Design Exception Manual.
2. When an existing vertical clearance is proposed to be reduced, but will still meet or exceed the minimum, written approval for a waiver is required from the Director of Bridge Engineering and Infrastructure Management. For new structures, total replacements, or full superstructure replacements, an additional 6 inches of vertical clearance is required for future resurfacings or a waiver is required from the Director of Bridge Engineering and Infrastructure Management.
3. In highly urbanized areas where a 16'-0" vertical clearance is required, a minimum clearance of 14'-6" may be provided if there is a route within the approximate location of the bridge in question that provides an existing 16'-0" minimum vertical clearance. In such instances, signing to the alternate route should be called for in the Contract Plans. A Design Exception is still required.

4. The 23'-0" clearance above the top of rails (24'-6" for electrified tracks) includes an allowance of 1'-0" for future ballasting of the railroad tracks and minor structure encroachment during construction or maintenance operations. Exceptions to the clearances may be approved when ordered by the State regulatory agency having jurisdiction over such matters. A greater vertical clearance may be required at individual locations where necessary and when justified on the basis of extraordinary site conditions.
5. Exceptions to the standard 55'-0" clearance (above M.H.W.) may be approved if justified by marine traffic and cost studies or ordered by the U.S. Coast Guard.
6. Clearance contingent on marine traffic and cost studies. Clearance subject to approval by the U.S. Coast Guard.
7. Freeboard clearance contingent on hydraulic and hydrologic studies. Subject to approval by N.J. Division of Water Resources.
8. State Laws, N.J.S.A. 27:5G-1 through 27:5G-4, require that every bridge or overpass carrying municipal, county, or state roads, including railroads, with a vertical clearance of less than 14'-6" from the roadway beneath shall have a minimum clearance marked or posted thereon in accordance with the current standards prescribed by the "Manual of Uniform Traffic Control Devices for Streets and Highways". All bridges over State owned roadways with a minimum vertical clearance of less than 14'-9" shall also be posted.

Signs, warning persons operating motor vehicles that they are approaching a bridge or overpass with less than 14'-6" clearance, shall be placed at the last safe exit or detour preceding the bridge or overpass. The minimum clearance of the bridge or overpass shall be indicated on these signs.

The signs required by this section shall be maintained by the appropriate government entity which has jurisdiction over the roadway underneath the bridge or overpass. The above provisions do not apply to toll road authorities.

### **General Vertical Clearance Provisions**

If it is anticipated that future lanes will be required for the lower roadway, the clearance stipulated in this policy shall be applied to the future lane.

The clearance for ramps shall be that of the connecting highway. In the case where a ramp connects highways with different vertical clearance criteria, the higher clearance shall be used.

For spans between 120'-0" and 150'-0", the need for a bolted splice (located near one quarter-point) should be anticipated in calculating the minimum vertical clearance. An allowance of  $\frac{3}{4}$  inch (fastener head) plus thickness of bottom flange splice plate shall be considered.

For spans over 150 feet, two splices located near each quarter-point should be anticipated. An allowance of  $\frac{3}{4}$  inch (fastener head) plus thickness of bottom flange splice plate shall be considered.

#### 2.3 Location Features

##### Highway Horizontal

The following is added:



Lateral clearances shall conform to Section 5-11 of the *NJDOT Design Manual – Roadway*.

#### Railroad Overpass

The following is added:

Refer to Table 2.3.3.2 of this Manual for Minimum Vertical Clearance requirements.

### 2.5 Design Objectives

#### 2.5.2.2 Inspectability

The following is added:

For all bridge structures, to assure inspectability access, the design details shall be reviewed and certified by an Engineer who meets NJDOT NBIS requirements for qualification as a team leader.

#### 2.5.2.3 Maintainability

The second sentence of the 1<sup>st</sup> paragraph is changed to:

When the climatic and/or traffic environment is such that the bridge deck may need to be replaced prior to the required service life, provisions shall be shown on the plans for replacement of the deck and/or bearings.

#### 2.5.2.4 Rideability

The last paragraph is deleted and the following is added:

A thickness of ½ inch shall be provided to compensate for surface wear. The ½ inch of the concrete deck slab thickness shall be considered as a wearing surface. Consequently, it shall be considered as dead load, but shall not be considered effective in carrying secondary dead loads (except future overlay wearing surface) or live loads and impact.

#### Deformations

##### 2.5.2.6.2 Criteria for Deflection

The following is added:

The criterion stated within this Subsection is required for design of New Jersey bridge structures. The structural analysis shall be based on service limit state load combinations and the criteria in Article 2.5.2.6.2. of the AASHTO LRFD Specifications. The following specified deflection limits shall be used for steel, aluminum and/or concrete bridge construction:

- |  |           |
|--|-----------|
| • Vehicular load, general                                | Span/1000 |
| • Vehicular and pedestrian loads                         | Span/1000 |
| • Vehicular load on cantilever arms                      | Span/400  |
| • Vehicular load and pedestrian loads on cantilever arms | Span/400  |

The following additional criteria shall be followed:

Although the design of continuous beams will not consider the combination of the reinforcement steel in the negative moment region, the reinforcement steel contribution will be considered in determining deflections.

##### 2.5.2.6.3 Optional Criteria for Span to Depth Ratios

The following is added:

The use of the optional criteria, including Table 1, studied within this Subsection, should be studied to verify acceptable ranges of bridge deformations for curved girder designs.

#### 2.5.2.7 Consideration of Future Widening

##### 2.5.2.7.2 Substructure

The paragraph is changed to:

When future widening can be anticipated, the substructure shall be designed for the widened condition. The design shall satisfy all widened and un-widened condition design requirements.

### **Section 3 - Loads and Load Factors**

#### 3.4 Load Factors and Combinations

##### 3.4.1 Load Factors and Load Combinations

The last paragraph is changed to:

The load factor for live load in Extreme Event Load Combination I,  $Y_{EQ}$  shall be taken as 0.50.

The following is added:

For Integral Abutment Jointless Bridge designs, the maximum Load Combination and Load Factors under the "TU, CR, SH" column of Table 3.4.1-1 shall be used and the maximum permanent load factors listed in Table 3.4.1-2 shall be used.

#### 3.5 Permanent Loads

##### 3.5.1 Dead Loads: DC, DW and EV

The following is added:

Superstructure designs for bridge structures that utilize one course deck slab construction shall include an additional (25 p.s.f.) dead load. The 25 p.s.f. shall be considered as a secondary dead load.

#### 3.6 Live Loads

##### 3.6.1 Gravity Loads: LL and PL

###### 3.6.1.1 Vehicular Live Load

###### 3.6.1.1.2 Multiple Presence of Live Load

The following is added:

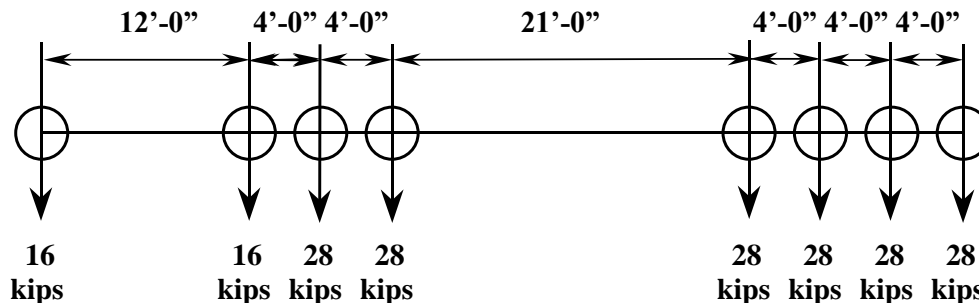
When analyzing for the NJDOT Permit Vehicle configuration, its presence shall only be considered to occur once on a bridge structure. Additional design lanes shall be considered to be occupied by the HL-93 loading.

###### 3.6.1.2 Design Vehicular Live Load

###### 3.6.1.2.1 General

The following is added:

In addition to the HL-93 analysis a Strength II Limit State calculation shall be made for the following permit vehicle configuration:



### LRFD Permit Vehicle, NJDOT

Also, when designing for prestressed concrete components, a Service III Limit State calculation shall be made for the above permit vehicle configuration. However, in lieu of the changes stated under Subsection 5.9.4, Table 5.9.4.1.2-1 (in this section), specified Stress Limit limitations stated in the *AASHTO LRFD Bridge Design Specification* shall be accounted for in the permit vehicle check.

For non-NHS (National Highway System) bridge structures, permit vehicle may not be considered.

#### 3.6.2 Dynamic Load Allowance: IM

##### 3.6.2.1 General

The following is added:

When analyzing the permit vehicle configuration, the IM factor shall be 25% for "All Other Limit States" conditions.

#### 3.6.5 Vehicular Collision Force: CT

##### 3.6.5.1 Protection of Structures

The following is added:

For projects which involve only resurfacing, restoration or rehabilitation (3R) of roadway, the protection of existing bridge structures may be exempted as determined on a project to project basis. This shall be based on assessment of heavy vehicle impact history, roadway conditions, traffic condition, and bridge importance at the bridge site. Designer shall obtain approval for the exemption from the Director of Bridge Engineering and Infrastructure Management.

#### 3.10 Earthquake Effects: EQ

##### 3.10.1 General

The following is added:

Refer to Section 38 of this Manual for guidance concerning the Seismic analysis of New Jersey bridge structures.

#### 3.11 Earth Pressure: EH, ES, LS, and DD

### 3.11.5 Earth Pressure: EH

#### 3.11.5.1 Lateral Earth Pressure

The second paragraph is changed to:

Unless otherwise specified, the resultant lateral earth loads due to the weight of the backfill shall be assumed to act at a height of  $0.33H$  above the base of the wall, where "H" is the total wall height measured from the surface of the ground to the bottom of the footing.

#### 3.11.5.5 Equivalent-Fluid Method of Estimating Rankine Lateral Earth Pressures

The first paragraph is changed to:

The equivalent fluid pressure shall not be less than 35 pounds per cubic feet.

### 3.12 Force Effects Due To Superimposed Deformations: TU, TG, SH, CR, SE

#### 3.12.2 Uniform Temperature

The following is added:

For rigid frame concrete piers on typical highway grade crossings that are on continuous footings, the temperature differential shall be 15 degrees F for rise in temperature and 20 degrees F for fall in temperature. The temperature values established for "cold climate" in Table 3.12.2.1-1 shall be used for all other cases.

#### 3.12.3 Temperature Gradient

The following is added:

The temperature gradient shall be neglected for multi-beam bridge structures.

## **Section 4 - Structural Analysis and Evaluation**

### 4.6 Static Analysis

#### 4.6.2 Approximate Methods of Analysis

##### 4.6.2.2 Beam Slab Bridges

##### 4.6.2.2.2 Distribution Factor Method for Moment and Shear

The following is added:

The distribution factor for the HL-93 loading shall also be used for the permit vehicle in performing Strength II calculations. However, the guidance provided under Subsection 3.6.1.2.1 shall be followed.

## **Section 5 - Concrete Structures**

### 5.4 Material Properties

#### 5.4.1 General

The first paragraph is changed to:

Designs shall be based on the use of materials and concrete classes that conform to the construction materials as specified in the *NJDOT Standard Specifications for Road and Bridge Construction*.

#### 5.4.2 Normal Weight and Structural Lightweight Concrete

### 5.4.2.3 Shrinkage and Creep

#### 5.4.2.3.2 Creep and 5.4.2.3.3 Shrinkage

The following is added:

The average relative humidity (percent) (H) should be assumed to be 70% throughout the State.

### 5.4.3 Reinforcing Steel

The following is added:

Reinforcing steel properties shall conform to the requirements of the *NJDOT Standard Specifications for Road and Bridge Construction*.

### 5.4.4 Prestressing Steel

#### 5.4.4.1 General

The first paragraph is changed to:

Prestressing steel properties shall conform to the requirements of the *NJDOT Standard Specifications for Road and Bridge Construction*.

The following is added:

Low relaxation strands shall be used and accounted for in the design of prestressed concrete beams.

### 5.9 Prestressing and Partial Prestressing

#### 5.9.4 Stress Limits for Concrete

The following is added:

Generally, the design strength for prestressed concrete shall be  $f'_c=5,000$  psi (Class P concrete). The Engineer may use an optional, higher design strength of  $f'_c = 5,500$  psi (Class P-1 concrete) or  $f'_c = 6,000$  psi (Class P-2 concrete).

If a Designer wishes to use a higher design strength than stated above, it is permitted. However, the provisions of the *NJDOT Standard Specifications* must be studied and suitably amended to account for the control and acceptance testing requirements in the fabrication of the higher strength concrete.

#### 5.9.4.2 For Stresses at Service Limit State After Losses – Fully Pretensioned Components

##### 5.9.4.2.2 Tension Stresses

**Table 5.9.4.2.2-1 is changed to:**

| <b>Bridge Type</b>   | <b>Location</b>  | <b>Stress Limit</b> |
|--|--|---------------------|
| Other Than Segmentally Constructed Bridges                                     | Tension in the Precompressed Tensile Zone Bridges, Assuming Uncracked Sections   |                     |
|  | For components with bonded prestressing tendons or reinforcement that are subjected to not worse than moderate corrosion conditions.   | No tension *        |
|  | For components with bonded prestressing tendons or reinforcement that are subjected to severe corrosive conditions.  | No tension *        |
|  | For components with unbonded prestressing tendons.   | No tension          |
| Segmentally Constructed Bridges  | Longitudinal Stresses Through Joints in the Precompressed Tensile Zone   |                     |
|  | Joints with minimum bonded auxiliary reinforcement through the joints sufficient to carry the calculated longitudinal tensile force at a stress of $0.5 f_y$ ; internal tendons.   | No tension          |
|  | Joints without the minimum bonded auxiliary reinforcement through joints.  | No tension          |
|  | Transverse Stresses Through Joints   |                     |
|  | Tension in the transverse direction in precompressed tensile zone.   | No tension          |
| Stresses in Other Areas  | For areas without bonded reinforcement.  | No tension          |
|  | In areas with bonded reinforcement sufficient to resist the tensile force in the concrete computed assuming an uncracked section where reinforcement is proportional using a stress of $0.5 f_y$ , not to exceed 30 ksi. | No tension          |
|  | Principal Tensile Stresses at Neutral Axis in Web.   |                     |
| All types of segmental concrete bridges with internal and/or external tendons. | $0.110\sqrt{f'_c}$<br>(ksi)  |                     |

\* Refer to Subsection 3.6.1.2.1 in this Manual for additional guidance on assessing the permit vehicle effects when designing prestressed concrete components.

#### 5.9.5 Loss of Prestress

##### 5.9.5.4 Refined Estimates of Time-Dependent-Losses

#### 5.9.5.4.2 Losses: Time of Transfer to Time of Deck Replacement

The following is added:

The average ambient relative humidity (percent) (H) should be assumed to be 70% throughout the State.

#### 5.10 Details of Reinforcement

##### 5.10.8 Shrinkage and Temperature Reinforcement

The following is added after the 2<sup>nd</sup> paragraph:

Concrete deck slab temperature - distribution steel shall not be less than #16 reinforcing bars spaced @ 15 inches.

#### 5.11 Development and Splices of Reinforcement

##### 5.11.5 Splices of Bar Reinforcement

###### 5.11.5.2 General Requirements

###### 5.11.5.2.1 Lap Splices

The following is added to the first paragraph:

The splice design length shall be based on the use of Grade 60 reinforcement. The dimensions of all laps shall be detailed on the plans.

#### 5.12 Durability

##### 5.12.4 Protective Coatings

The last sentence is deleted and the following is inserted:

Cover to corrosion protected reinforcement steel shall conform to Table 5.12.3-1 denotations. Also, the reinforcement steel cover shall be 2½ inches for riding surface deck slabs on prestressed concrete slab or box beam superstructures.

Also refer to Subsection 20.2 of this Manual for additional deck slab requirements, to Subsection 17.1 for abutments/retaining walls requirements in corrosive conditions, to Subsection 19.2.1 for concrete piers requirements in corrosive conditions, and to Subsection 19.6 for requirements concerning pile bents in a marine environment.

#### 5.13 Specific Members

##### 5.13.2 Diaphragms, Deep Beams, Brackets, Corbels and Beam Ledges

###### 5.13.2.2 Diaphragms

The 4<sup>th</sup> paragraph is deleted and the following is inserted:

Diaphragms shall be provided as stated in the first three paragraphs above.

The following is added:

###### 5.13.5 Mass Concrete

Mass Concrete is defined as any large volume of cast-in-place or precast concrete with dimensions large enough to require that measures be taken to cope with the generation of heat and attendant volume change so as to minimize cracking.



When the minimum dimensions of a concrete component exceed 3 feet and the ratio of volume of concrete to surface area is greater than one foot or 12 inches, then Mass Concrete requirements shall be applied. The surface area will include all of the cumulative area of all surfaces of the concrete component being considered including the full underside (bottom) surface of footings, caps, etc. Volume and surface area calculations shall be in units of feet. Therefore, the volume shall be measured in units of cubic feet and the area in units of square feet.

The Designer shall consider the consequences of Mass Concrete requirements in selecting member sizes and shall avoid Mass Concrete whenever practicable. However, when Mass Concrete is unavoidable, the Designer shall indicate on the plans those portions of the concrete elements in the bridge that are Mass Concrete.

Seal Concrete or concrete deck slabs shall not be considered to be Mass Concrete.

Also, refer to Section 25 of this Manual for additional criteria concerning Precast/Prestressed Concrete.

## **Section 6 – Steel Structures**

### 6.6 Fatigue and Fracture Considerations

#### 6.6.2 Fracture

The following is added:

Refer to the NJDOT *Standard Specifications for Road and Bridge Construction* for Charpy V-Notch Impact requirements.

### 6.7 General Dimension And Detail Requirements

#### 6.7.2 Dead Load Camber

The following is added:

An additional 8 p.s.f. shall be included in the camber computations to account for the dead load of permanent stay-in-place forms and 5 p.s.f. shall be included to account for the average 3/8 inches additional thickness of deck concrete which fills the forms. Also, refer to Section 20 of this Manual for additional dead load requirements when S.I.P. forms, in conjunction with the main reinforcement not in alignment, are used.

#### 6.7.3 Minimum Thickness of Steel

The first paragraph is changed to:

Structural Steel shall not be less than 3/8 inches in thickness.

### 6.7.4 Diaphragms and Cross Frames

#### 6.7.4.1 General

The first sentence is changed to:

Diaphragms or cross frames shall be placed at the end of the structure, across interior supports and intermittently along the spans.

### 6.10 I Section Flexural Members

#### 6.10.1 General

The following is added:

Compact Sections are desirable throughout a bridge structure.

In continuous spans, the design of the shear connectors in the negative moment portion shall consider the contribution of the longitudinal reinforcement steel.

#### 6.10.10 Shear Connectors

##### 6.10.10.1 General

The following is added:

Welded studs shall be used for shear connectors. Refer to Guide Plate 3.9-2 of this Manual for guidance.

Composite sections shall be designed without consideration of the contribution of the reinforcement steel in the negative moment region of continuous spans. This is except as noted for design of shear connectors and for deflection calculations.

#### 6.10.11 Stiffeners

##### 6.10.11.1 Transverse Stiffeners

###### 6.10.11.1.1 General

The following is added:

Whenever possible, a thicker web should be used to minimize the number of or eliminate the need of transverse stiffeners.

##### 6.10.11.3 Longitudinal Stiffeners

###### 6.10.11.3.1 General

The following is added:

The use of longitudinal stiffeners shall be limited to spans greater than 200 feet.

The following note shall be added to Plans whenever a longitudinal stiffener is used:

A maximum of 2 splices will be permitted for longitudinal stiffeners. Under the requirements for Quality Control Inspection, prior to welding the stiffener to the stringer, the butt welds shall be radiographed.

#### 6.10.12 Cover Plates

##### 6.10.12.1 General

The following is added:

Welded cover plates shall be narrower than the flange to which they are attached. Research indicates that when cover plates are wider than the flange, fatigue strength is significantly reduced. If fatigue strength is reduced edge cracks may occur in the flange.

#### 6.13 Connections and Splices

##### 6.13.3 Welded Connections

###### 6.13.3.1 General

The first paragraph is changed to:

Welding shall conform to the requirements of the current edition of the *ANSI/AASHTO/AWS Bridge Welding Code D1.5*, except that electro-slag weldments on main structural tension and reversal stress members will not be permitted.

Also, refer to Section 24 of this Manual for additional criteria concerning Structural Steel.

## **Section 9 - Decks and Deck Systems**

### 9.4 General Design Requirements

#### 9.4.3 Concrete Appurtenances

The following is added:

The guidance of Subsection 20.12 of this Manual concerning provision of open deflection and contraction type joints in parapets, barriers and sidewalks shall be followed.

### 9.7 Concrete Deck Slabs

#### 9.7.1 General

##### 9.7.1.5 Design of Cantilever Slabs

The following is added:

The maximum effective deck overhang shall be maintained at 4'-6". The effective slab section, in maintaining this distance, shall be based on the following limits:

For prestressed concrete girders, whose top flange width is greater than its bottom flange width, and for structural steel members, the effective slab section shall be the distance that is from  $\frac{1}{4}$  the flange width to the edge of the deck slab.

For other prestressed concrete girders, Concrete T beams and prestressed slab and box beams, the effective slab section shall be the distance that is from the edge of the flange to the edge of the deck slab.

#### 9.7.2 Empirical Design

##### 9.7.2.1 General

The following is added:

The provisions of 9.7.3 - Traditional Design shall primarily be followed for concrete deck slab designs. The Tables provided in Section 20 of this Manual may be referred to for uniformity of reinforcement detailing. If the bridge structure configuration entails straight longitudinal superstructure members, then the Empirical Method may be used.

Also, refer to Section 20 of this Manual for additional criteria concerning concrete deck slabs.

## **Section 10 – Foundations**

### 10.5 Limit States and Resistance Factors

### 10.6 Spread Footings

### 10.7 Driven Piles

### 10.8 Drilled Shafts

## 10.9 Micropiles

Also, refer to Section 16 of this Manual for additional criteria concerning Foundation designs.

## **Section 11 – Walls, Abutments and Piers**

### 11.5 Limit States and Resistance Factors

### 11.6 Abutment and Conventional Retaining Walls

### 11.7 Piers

### 11.8 Nongravity Cantilevered Walls

### 11.9 Anchored Walls

### 11.10 Mechanically Stabilized Earth Walls

### 11.11 Prefabricated Modular Walls

## **Section 13 - Railings**

### 13.4 General

The last sentence of the third paragraph is changed to:

On high speed urban expressways where a pedestrian walkway is provided, the walkway area may be separated from the adjacent roadway by a traffic railing or combination railing.

### 13.7 Traffic Railing

#### 13.7.1 Railing System

##### 13.7.1.1 General

The following is added:

Railing system dimensions shall preferably conform to those systems detailed in Section 23 of this Manual. The *NJDOT Roadway Design Manual* should also be referred to so that proper geometry between the roadway and bridge section is maintained.

##### 13.7.2 Test Level Selection Criteria

The following is added:

Refer to Section 23 of this Manual for guidance in determining bridge railing crash tested level selection.

### 13.11 Curbs and Sidewalks

#### 13.11.2 Sidewalks

The existing text is changed to:

Where curbing is used on a bridge, the curb height shall conform to Subsection 5.6.4 of the Roadway Design Manual and the linear curb height transition shall conform to Standard Roadway Construction Detail CD-607-2.5.

## **Section 14 - Joints and Bearings**

### 14.5.2 Selection

#### 14.5.2.1 Number of Joints

The following is added:

With design and construction technologies being available, consideration of Simple-for-Dead-Load and Continuous-for-Live-Load concept is encouraged on project-to-project basis to reduce the number of joints over bridge piers at fixed-fixed bearings.

#### 14.7 Special Design Provisions For Bearings

##### 14.7.10 Other Bearing Systems

The following is added:

Only those bearing systems that are discussed in Section 24 of this Manual are permitted.

**Note:** End reference to AASHTO LRFD Section Number Designations

### 3.3 Overhead and Cantilever Sign Support Structures

The 2007 Edition of the *NJDOT Sign Support Structure Standard Drawing* designs are in accordance with the 2009 (5<sup>th</sup> Edition) of the *AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals*. Instructions and overall notations provided on these drawings should be referred to for use of the drawings.

For additional information and for structural design criteria concerning Variable/Dynamic Message Sign (VMS/DMS) structures, refer to Section 30 of this Manual for guidance.

Also, refer to Section 31 for criteria on bridge mounted sign support structures.

### 3.4 Pedestrian/Bicycle Traffic Bridge Structures

A. *The AASHTO LRFD Bridge Design Specifications* (with current Interims) and as modified throughout this Manual shall govern the design of bridge structures for use specifically by pedestrian or bicycle traffic. Also, the *AASHTO LRFD Guide Specifications for Design of Pedestrian Bridges* and the *AASHTO Guide for the Development of Bicycle Facilities* may be referred to for additional guidance.

Additionally, NJDOT has issued a publication titled "*Bicycle and Pedestrian Planning and Facilities Design*" that may also be referred to for guidance.

B. In accordance with the provisions of Subpart 3.6.1.6 of the *AASHTO LRFD Bridge Design Specifications*, bridges that only carry pedestrian and/or bicycle traffic shall be designed for a live load of 0.085 kips per sq. ft.

C. When vehicular access is not physically restricted, the potential for the use of a pedestrian bridge by an occasional maintenance vehicle should be considered in the design of the bridge. According to the provisions of Subsection 3.6.1.6 of the *AASHTO LRFD Bridge Design Specifications*, the following vehicular loads should be used for the indicated lane widths:

Clear deck width: 6 ft. to 10 ft. – 10,000 lbs (H-5 Truck)

Clear deck width: over 10 ft. – 20,000 lbs (H-10 Truck)

D. Vertical underclearances shall be as established in Subsection 3.2 of this Manual.

- E. Ramp type approaches together with auxiliary stairways and fencing shall be used. Ramps shall be a minimum of 8'-0" wide with a maximum grade of 8.33 percent. Stairway width shall be 6'-0", with 11 inch treads and 7 inch risers. Non-slip nosing shall be provided on stairs. Intermediate level platforms shall be provided in all cases.
- F. Walkway width on the span(s) shall equal the width of the approach that includes graded shoulders but, shall not be less than 8'-0".
- G. Chain link fence (enclosed type) shall be provided on the portion of the bridge which spans the roadway, including shoulders. Use of chain link fence on ramps and/or stairways of the pedestrian bridges will be determined on a project to project basis. See the Type 7 Clearance Diagrams in Section 23. Also, refer to Section 23 for additional fencing provision criteria.
- H. Simple or continuous spans members shall be designed so that the deflection due to service live load shall not exceed the limits that are specified in Subsection 2.5.2.6.2 of the *AASHTO LRFD Bridge Design Specifications*.

### **3.5 Movable Bridge Structures**

The design of movable bridge structures shall be in accordance with the *AASHTO LRFD Movable Highway Bridge Design Specifications*. (It is intended that these specifications be used in conjunction with the requirements of Subsection 3.1 of this Manual).

When the design of a Movable Bridge involves the design of approach bridge sections, the approach bridge sections shall be designed in accordance with the *AASHTO LRFD Bridge Design Specifications* and as modified within this Manual.

The inspection, evaluation and maintenance of movable bridge structures shall conform to the requirements of the current *AASHTO Movable Bridge Inspection, Evaluation and Maintenance Manual*.

### **3.6 Alternate Design Criteria of Non-NHS Roadways**

- A. Bridge geometry shall conform to the guidance of the *AASHTO Policy on Geometric Design of Highways and Streets*, Chapter 5, Local Roads and Streets.
- B. Design live load of the Permit Truck may not be applied to Non-NHS bridge structures.
- C. The operational importance factor specified in *AASHTO LRFD Specifications* Article 1.3.5 may be reduced to 0.95 for strength limit state.

## **Section 4 - Railroads**

### **4.1 Design Criteria**

- A. Railroad bridges shall be designed in accordance with the *AREMA Manual for Railway Engineering*.
- B. All rail-carrying bridges and structures shall be designed for the AREMA E-80 loading with diesel impact instead of the AREMA E-72 loading.

### **4.2 Vertical Underclearances**

Vertical underclearances shall conform to the table shown in Subsection 3.2 of this Manual.

### **4.3 Lateral Clearances**

Lateral clearances shall conform to Guide Sheet Plate 3.14-1.

### **4.4 Protective Shield**

A protective shield is required during the construction of spans over electrified tracks. Details shall be shown on plans and shall be subject to the approval of the appropriate Railroad Company. See Guide Sheet Plate 3.14-2.

### **4.5 Railroad Utility Agreement Plans**

Procedures to be followed by the Design units concerning Bridge sketches, preliminary plans, agreements and final plans shall conform to Department guidelines.

## Section 5 - Bridge Type Selection and Geometrics

### 5.1 Bridge Type Selection

1. Engineering, architectural (when warranted), and cost studies shall be prepared for each structure or group of structures. Where several structures are in close proximity with each other, studies may be prepared to show possible interaction with each other.

In the consideration of the need for a movable bridge structure, the long term investment associated with machinery maintenance, liabilities associated with navigation hazards and staffing the structure with operators should be considered. Also, the impact of traffic congestion due to openings should be considered. These issues should be addressed in assessing the cost and practicality of a movable bridge versus a fixed bridge.

2. These initial studies should be developed from a careful appraisal of the site, foundation, drainage conditions, highway limitations, and environmental impact, both present and future. The structural types proposed as a result of these studies must be based on the highest standards of creativity and engineering technique.
3. For a group of bridges in a contract, structure types should be similar so that similarity of construction details may result in economy of costs.
4. New materials and developments may be incorporated in the design of the proposed structures. This is provided that approval has been given by the Manager, Bureau of Structural Engineering.
5. Economy, aesthetics, maximum safety and infrastructure security are compatible in the design of structures. For grade separation structures, in urban as well as rural areas, the absence of shoulder piers allows for possible future widening of the lower roadway while removing sight line restrictions and minimizing safety hazards. The resultant "open" structure usually results in a more pleasing appearance.
6. In planning new bridges, the list of available structure materials and types of construction should be considered. The use of High Performance Steel and High Performance Concrete is encouraged. At any given location, the ultimate selection should be based on suitability and aesthetics. This is with consideration of the bridge and its site as an entity and also as part of the surrounding environment.

The character and coloration of the terrain and the form of nearby structures should all be influences on the aesthetics proposed for the structure.

7. Superstructures of shallow proportion shall be strived for; however, stiffness requirements and other design considerations must be balanced against those of aesthetic appeal. Ordinarily, the superstructure should be of uniform depth from end to end. Unsightly details, which present abrupt discontinuities in the bridge profile, should be avoided.
8. In arriving at span proportions, substructure elements should be positioned well clear of travelled roadways. For lateral clearances to substructure elements, refer to the *NJDOT Roadway Design Manual*. Minimum lateral clearances are



illustrated therein. Where considerations of economy permit, abutment faces should be at least 30 feet from roadways. Planning along these lines should result in proportions which are economical, aesthetic, and that provide maximum safety for the travelling public.

9. Abutments and wingwalls should be made as inconspicuous as possible by limiting the exposed height of the abutment (preferably stub to semi-stub). An appropriately aesthetic type treatment shall be proposed for all large exposed surfaces.
10. Concrete piers which are built near roadways should generally be of open-type construction (i.e. column bent piers). When supporting a multitude of closely spaced stringers, a common and simple frame consisting of a uniform depth cap beam on circular columns may be suitable. Often times, frame proportions are enhanced by allowing the cap beam to cantilever over the exterior columns with a variable depth that tapers to a minimum beyond the fascia stringer bearing. The slender tee-pier should not be overlooked for the support of high crossings or narrow structures.
11. New designs, as well as major rehabilitation work for high level or complex structures, should include permanent provisions for inspection, such as catwalks, in order to make bridge members accessible. Bridge design engineers should ensure that easy and adequate access can be achieved, especially to pin-hanger assemblies, fatigue prone details and fracture critical members.

## **5.2 Geometrics On Bridges**

1. It is generally accepted that the use of machine finishing for deck slab construction produces more durable and better quality bridge decks. Adverse geometrics, however, sometimes preclude the use of machine finishers. Highway and bridge designers shall make every effort to eliminate or minimize adverse geometrics on bridge decks during the design phases.
2. The magnitude and complexity of modern highway bridges are often characterized by the introduction of certain features; such as, horizontal curves, vertical curves, variable bridge widths for on and off ramps, variable cross-slopes and many others. These features are often incorporated in bridge designs without a rational analysis during the initial design stages of the project and evolve as an outgrowth of the adjacent approaches. Justification for the inclusion of adverse conditions should be prepared by the highway designers. Such justification should be included in the Design Appraisal. These features should be avoided where possible.
3. The number of curved bridges is increasing. If properly planned for at the project inception, horizontal curves could frequently be included in the contiguous approach roadways, especially in rural areas where the right-of-way might not be a determining cost factor. Curved bridges are generally more costly than straight bridges. For steel girder superstructures, heat curving the girders or cutting flange plates to meet the curvature will add to the steel cost. Superelevation and additional labor could increase the overall project cost by about 10 to 15 percent.
4. Wherever possible, vertical curves, both crest and sag, should be located away from the bridge. It is economically advantageous to place a bridge on a tangent

grade rather than on the vertical curve. Cambering girders for vertical curvature is more costly than tangent girders since excessive camber may entail cutting the web to the required curvature, thus wasting steel and increasing fabrication costs. Increased construction costs will result from forming a bridge deck on a curve in view of the additional labor required to achieve the plan precision in forming the deck.

5. Except for major interchanges, it may not be necessary to include the geometrics for the on and off ramps on the bridge. These could be designed to clear the bridge in the interest of economy. When an off ramp is made part of a bridge, the gore area including its supports should include crash cushions. This will also increase costs.
6. A comprehensive and diligent analysis should be made of the entire project at the preliminary design stage. This should be the basis for designing curves and ramps away from the structures to the maximum extent feasible since they generally increase the bridge cost. Locating curves and ramps on the approach highways rather than on bridges results in simpler construction, is more economical, and reduces future maintenance requirements. Although it is more desirable to avoid curves and ramps on bridges, their absolute elimination is not proposed. Rather, it is believed that there are locations where alignment of bridges on curves is unable to provide the much sought highway geometry. Determination of the final design of straight versus curved bridges, constant or variable width, should be based on comparative cost estimates of the alternatives.
7. If site conditions permit, in order to avoid the design and construction of skewed bridges, abutments that are ninety degrees to the upper roadway shall be developed. This may be accomplished by increasing one side of the span and not placing the abutments parallel to the lower roadway.

### **5.3 Alternate Designs**

Studies during the Preliminary Design may conclude that alternate designs may be warranted for major bridges. The decision as to whether or not to proceed with an alternate design will be made, as recommended by the Manager, Bureau of Structural Engineering, by the Assistant Commissioner, Capital Program Management. On Federal Aid Full Oversight projects, this decision will be made in conjunction with FHWA. The decision will be made on a project to project basis at the scoping phase of the project.

### **5.4 Life Cycle Cost Analysis**

Life Cycle Cost Analysis (LCCA) is defined as the total cost of an item's ownership over a specified period of time. This includes, as applicable, initial acquisition costs (right-of-way, planning, design, construction), operation, maintenance, modification, replacement, demolition, financing, taxes, disposal, and salvage value.

A LCCA shall be made in studying alternate design concepts to compare the benefits and costs that arise at different times in a bridge structure's life span. Future benefits and costs over the proposed time span of each alternative should be considered. A long term perspective should be considered in programming

improvements and selecting among alternative design, maintenance, rehabilitation and reconstruction strategies in designing bridge structures.

In New Jersey, an important factor to consider in this process, especially in urban areas, is highway congestion. Investment decisions must consider the impact that is imposed on the traveling public in constructing bridge structures on congested highways. The LCCA will help the Department to identify and explain the real costs that it must bear in maintaining its bridge structures. Also, the LCCA will assist the Department in making the best use of available funds. The FHWA recognizes that a LCCA may result in proposals that call for potential allocation of significant funds.

The following paragraphs provide guidance in developing the principals for a good LCCA. These principals will allow the Department to identify its investment alternatives.

1. **Analysis Period.** Generally an analysis period should be considered for LCCA of bridge structures. This is due to the realization that future Department and user costs, that are associated with maintenance of a bridge structure, will be high. For a bridge structure on the National Highway System (NHS) an analysis period of 100 years should be considered. This will require a longer analysis period. All project alternatives should consider this length.
2. **User Costs.** The costs and lost productivity to the public because of traffic delays should account for a high cost range consideration. Increased vehicle operating costs, accident costs and delay related costs should be considered in the LCCA.
3. **Discount Rate.** Future agency and user costs should be discounted to net present value or converted to equivalent uniform annual costs using appropriate discount rates. The selected discount rate should be based on guidance that is provided in the Office of Management and Budget (OMB) Circular A-94, *Guidelines and Discount Rate for Benefit Cost Analysis of Federal Programs*.
4. **Other Factors.** Budgetary, environmental and safety considerations will influence the investment decision. These factors should be considered along with the results of the LCCA in evaluating the investment alternative.
5. **Department Costs.** Traffic control costs, during a maintenance or rehabilitation project, should be considered in the LCCA.

## **5.5 Value Engineering**

The use of Value Engineering (VE) in the planning, design and/or construction of structural work is encouraged. Consideration of life cycle cost shall be the primary purpose in applying VE to structural work.

1. Value Engineering is an effective tool for both product improvement and cost reduction. It should not be confused with the typical design review process nor should it be applied in a routine manner without warrant. Value Engineering should be employed when there is potential for a significant ratio of savings to the cost of the VE study or substantial improvements in program effectiveness. Value Engineering should be considered on all major structural projects, and on obviously high cost projects as well as standard details that are used repetitively on many projects.

2. For maximum benefit, VE should be employed as early as possible in the project development process so that valid VE recommendations can be implemented without delaying the progress of the project.
3. The *NJDOT Standard Specifications for Road and Bridge Construction* includes a VE specification which encourages the Contractor to propose changes in contract requirements which will accomplish the project's functional requirements at less cost. The net savings of each proposal should be shared with the contractor, or through the Contractor with subcontractors and suppliers, at a stated reasonable rate. Reimbursement for such share is eligible for pro-rate reimbursement of Federal-aid funds. The Department retains the right to accept or reject all proposals and acquire all rights to use the accepted VE proposals in current and future projects without restriction.

## **5.6 Retaining Walls**

1. The Designer will analyze site conditions during preliminary engineering and make recommendations regarding which wall system may be used.

Retaining wall can be Rigid Gravity and Semi-Gravity (Conventional) wall, Nongravity cantilevered wall, Anchored walls, Mechanically Stabilized Earth Wall (MSE) or Prefabricated Modular Wall.

2. Conceptual wall plans, hereafter referred to as Control Plans, shall be provided in the final Contract Plans. The Control Plans shall be prepared by the Designer and shall include project specific details. Complete detailed proprietary wall drawings are not to be included in the contract documents. After the award of the contract, complete proprietary wall plans for the selected wall will be prepared and submitted as working drawings in accordance with the *NJDOT Standard Specifications for Road and Bridge Construction*. A set of original drawings will be added to the record set of the contract documents after approval of the working drawings.
3. When special site conditions only permit construction of certain type proprietary walls, design and preparation of detailed proprietary drawings for the permitted wall types shall be done and included as part of the contract documents. Special site conditions shall include, but not be limited to, the following:
  - excessive height of wall (more than 30 feet)
  - poor foundation conditions (low bearing pressure)
  - constructability
  - noise barriers mounted to wall
  - longitudinal drainage in the common structure volume
  - obstructions such as sign support structures

## **5.7 Context Sensitive Design**

Context Sensitive Design is a comprehensive and balanced approach that considers social, natural and physical aspects, for all transportation actions. It fully assesses impacts of an improvement on the community, exploits design flexibility and involves all stake holders in developing solutions to project concerns. This design approach should be followed for all bridge structure work.

## Section 6 - Preliminary Bridge Plans

These provisions generally govern submissions for the design of new bridges and structures. Refer to Section 8 of this Manual for provisions governing submissions for Reconstruction and Rehabilitation Contracts.

### 6.1 General

1. In the submission of Preliminary Plans, the submission should, as applicable, contain the following information:
  - a. Plan and elevation of a structure showing the following:
    - elevation grades of the structure and immediate approaches
    - span lengths
    - skew
    - controlling minimum horizontal and vertical clearances (also show the actual vertical clearance obtained)
    - type of superstructure
    - location of expansion and fixed bearings
    - proposed elevations of bottom of footing shall be indicated together with the original ground line, finished ground line, and assumed rock line (if any)
  - b. Typical section of bridge showing the following:
    - type, spacing and arrangement of beams
    - widths of median
    - traveled roadway
    - shoulder (or curb offset) and curb or sidewalk
    - type of railing or chain link fence
    - type of parapet
    - cross-slopes or superelevation

A preliminary drainage design and layout arrived at through accepted means, as described in Section 22 - Deck Drainage of this Manual, shall be included in these documents.
  - c. Typical section of approach roadway showing median, roadway and shoulder dimensions, and location of guide rail, if any.
  - d. The plan sheet should include Notes about design loading, design allowable stresses, etc. and the specifications under which the structure is to be designed (see Subsection 6.3).
  - e. Profiles of roadway on the bridge and lower roadway should be shown.
  - f. Location of bridge mounted signs shall be shown if information is available at the time of submission.
  - g. Location of subsurface utilities and proposed utilities in the superstructure should be shown.
  - h. Hydraulic and hydrologic data shall be noted on plans for waterway structures.
  - i. If a railroad crossing, show existing tracks, profile on tracks, proposed horizontal and vertical clearances and topography along the railroad. (A

separate Railroad Agreement Plan is to be prepared in accordance with Subsection 1.4.5 of this Manual).

- j. Where water crossings are involved, horizontal and vertical clearances selected should be covered in the submission. Any special inlet-outlet treatment should be shown. A copy of required permits should be included.
  - k. In designing the rehabilitation or reconstruction of existing bridges, substandard underclearances and load carrying restrictions are to be suitably addressed.
2. The Preliminary Submission shall include an evaluation of the proposed superstructure to determine if the structure warrants provision of an access mechanism whereby maintenance activities or inspections may be performed. If deemed warranted, the Designer shall recommend for approval to the Manager, Structural Engineering, installation of an under bridge access mechanism.
  3. The Preliminary Submission shall consist of the following items:
    - Preliminary Bridge Plans
    - Design Recommendation Summary
    - Preliminary Foundation Report and Recommendation (Refer to Section 34 of this Manual)
    - Construction Cost Estimate
    - Seismic Retrofit Report (if applicable) (Refer to Section 38 of this Manual)
    - Hydraulic and Scour Report (if applicable) (Refer to Section 39 of this Manual)
    - Vessel Collision Report (if applicable) (Refer to Subsection 19.9 of this Manual)
  4. Preliminary bridge plans shall be on 22 inch by 36 inch sheets and be in bound sets.

## 6.2 General Notes

The following notes (as applicable) shall be provided to indicate the design and construction criteria for a project. The notes shall be shown in the right hand corner of the General Plan and Elevation Sheet for each structure. Note 10 shall be deleted from the plan sheet at the time of the final submission.

### 1. Design Specifications

The *AASHTO LRFD Bridge Design Specifications*, with current interims, as modified by Section 3 of the NJDOT Design Manual for Bridges and Structures. The year of the current *AASHTO LRFD Bridge Design Specifications* should be inserted.

### 2. Construction Specifications

The *NJDOT Standard Specifications for Road and Bridge Construction* with current Supplemental Specifications, as modified by the Special Provisions. This note may be modified to insert the current year and to refer to any updated specifications.

### 3. Live Load

AASHTO LRFD HL-93 Vehicular Live Loading or NJDOT Permit Vehicle, whichever governs.

## 4. Concrete Compressive Stresses

Design Compressive Strength -  $f'_c$ 

Class A..... 4,000 psi

Class B..... 3,000 psi

(Insert other designations, as required, for specific project requirements.)

## 5. Reinforcement Steel

ASTM A615 (Grade 60)

## 6. Superstructure

a. Dead load includes a 25 lbs. /sq.ft. provision for a future 2 inch thick concrete overlay protective system on the bridge deck.

b. Structural Steel: AASHTO M 270, Grade \_\_\_\_\_

(ASTM A 709), Grade \_\_\_\_\_) with Supplementary Requirements for Notch Toughness for all member components marked (T).

(Refer to Section 24 of this Manual for permitted structural steel designations.)

c. See Structural Steel Plans for Cleaning and Painting Systems, and Finish Coat Color.

d. See Structural Steel Plans for any member or member components designated FCM's under the Fracture Control Plan.

e. See Precast/Prestressed Concrete Beam Plan Sheets for details and notes.

## 7. Seismic Design Notes

Seismic Design Category = \_\_\_\_\_

Site Class Definition = \_\_\_\_\_

(Section 38 of this Manual should be referred to for guidance in providing this information.)

8. Estimated Cost \$ \_\_\_\_\_ Based on (Insert Year) prices.

## Section 7 - Final Bridge Plans

These provisions generally govern submissions for the design of new bridges and structures. See Section 8 for guidance on Reconstruction and Rehabilitation Projects.

### 7.1 General

1. Contract drawings shall be on 22 inch by 36 inch sheets.
2. Preferably, plans, sections, and elevations should be drawn to a scale not less than  $\frac{1}{4}'' = 1'-0''$  and details to a scale not less than  $\frac{3}{8}'' = 1'-0''$  except on the General Plan and Elevation Sheet.
3. Two (2) sets of the Design and Quantity Calculations shall be submitted as part of this submission.

### 7.2 Plan Submission Criteria

#### 7.2.1 Key Plan To Structures

This is usually the first sheet in the bridge plans in contracts that have two or more structures. It usually includes:

1. Relative location of new bridges, culverts, retaining walls, cantilever sign structures, overhead sign structures and bridge mounted signs.
2. Relative locations of existing bridges to be altered or demolished

The plan is intended as a quick reference for all the structure work in the contract plans. A scale of  $1''=100'$  or  $1''=200'$  is desirable. Use of bridge numbers, overhead sign structure numbers, wall numbers, culvert numbers, etc. in addition to names, is required.

#### 7.2.2 General Plan and Elevation

This is usually the first sheet for each structure. It includes:

1. Index of Drawings
 

This lists the Bridge Sheet titles and numbers for the structure.
2. Summary of Quantities
 

This lists each item and its estimated Contract Quantity for the structure.
3. General Notes
 

This lists the criteria used in designing the structure.

Hydraulic and hydrologic data are shown for waterway structures.
4. Profiles
 

These show proposed profile lines, vertical curve information, tangent grades, original ground line, stationing and proposed finished grade elevations.
5. Plan
 

The plan view of the entire structure indicates:

  - Relative position of the structure
  - Skew of the structure



- Certain dimension, such as:
  - Lane widths
  - Lengths of spans from center to center of bearings
  - Sidewalk and parapet widths
  - Proposed slope protection location
- Point of minimum vertical clearance
- Location of borings
- Stationing
- Bearings of baselines
- Locations of subsurface and above ground utilities and complete information thereof
- Geometrics
- Working and control points
- Beginning and end of Structures (stationing)
- Temporary sheeting limits

## 6. Elevation

This is a pictorial illustration of the structure. It indicates:

- General appearances of the completed structure
- Approximate original ground line and approximate rock line
- Minimum vertical clearance (actual and required)
- Locations of fixed and expansion bearings
- Approximate clearances (actual and required)
- Type of foundation
- Temporary construction clearances

## 7. Section

This is usually a section taken through the plan view. It indicates:

- Transverse deck grades (cross-slopes)
- Transverse dimensions of the superstructure
- Number of girders and spacing dimensions
- Approximate original ground line and approximate rock line
- Approximate foundations (spread footing, pile, drilled shaft, and micro pile) positions
- Location of utilities
- Finished grade line

### 7.2.3 Foundations Layout

#### a) Pile Plan and Elevation

The plan and elevation view of footings and the piles includes:

- Stationing
- Bearings of baselines
- Relative position of footings
- Location of test piles and/or load tests
- Pile tip elevations
- Pile cut-off elevations
- Batter of piles
- All dimensions required to construct piles and footings

- Number of piles in each footing unit and total estimated length of piles in each footing unit
- Numbering system of piles for identification purposes as per Guide Plate 3.4-6.
- Notes indicating types of pile
- Notes concerning any special requirements; such as, removal of unsuitable materials, minimum tip penetration, or any other special considerations, shall be included on this sheet

#### **b) Drilled Shaft Plan and Elevation**

The plan and elevation view of the drilled shaft includes:

- Stationing
- Bearings of baselines
- Location of the Demonstration/technique shaft
- Diameter of the drilled shaft elevation
- Top of the drilled shaft elevation
- Bottom of the drilled shaft elevation
- All dimensions required to construct drilled shafts and footings
- Number of Shafts in each footing unit
- The estimated length of drilled shaft in soil and in rock
- The estimated length of temporary or permanent casing
- The estimated length of Reinforcement steel
- Numbering system of drilled shafts for identification purposes as per Guide Plate 3.4-6.
- Notes concerning any special requirements; the special considerations shall be included on this sheet

#### **c) Micropile Plan and Elevation**

The plan and elevation view of the micropile includes:

- Stationing
- Bearings of baselines
- Location of the micropile proof load test
- Tip Elevation of the micropile
- Bottom of the drilled shaft cap
- Numbering system of micropiles for identification purposes as per Guide Plate 3.4-6.
- All dimensions required to construct piles and footings
- Number of piles in each footing unit and total estimated length of piles in each footing unit
- Numbering system of piles for identification purposes as per Guide Plate 3.4-6.
- Notes indicating types of pile
- Notes concerning any special requirements; special considerations shall be included on this sheet

#### **7.2.4 Abutment**

These sheets include:

1. Plan

A plan view of the abutment which includes:

- Bearing line
- An outline of the abutment footing
- Location, spacing and clearances of horizontal reinforcement steel in the footing
- Footing and abutment dimension
- An outline of the abutment wall
- Locations of section view
- Bearing location

## 2. Elevation

A front view of the abutment and walls which includes:

- Pertinent dimensions and elevation
- Typical reinforcement steel locations, spacing and clearance
- Locations of horizontal construction joint
- Foundation locations
- Batter of walls and pile

## 3. Section

Typical sections through abutment walls which include:

- Pertinent dimensions and elevation
- Typical reinforcement steel locations, spacing, cover and clearance
- Locations of horizontal construction joint
- Batter of walls and pile
- Foundation locations

These sheets also include:

- Estimated quantities of items incorporated on the sheet
- Details of bent reinforcement bars
- Reinforcement bar lists - These are used in computing net theoretical weight.
- Details of foundation and bridge excavation pay limits
- Details of epoxy waterproofing pay limits
- Details of concrete slope protection
- Details of joint and joint sealing

### **7.2.5 Pier**

These sheets include:

#### 1. Plan

A top view of the pier which indicates:

- Pertinent dimension
- Bridge seat elevation
- Column spacing
- Bearing location
- Locations of section view
- Bearing line

#### 2. Elevation

A side view of the pier which usually indicates:

- Pertinent dimensions and elevation
- Locations of section view
- Reinforcement steel location, spacing, cover and clearance
- Spiral reinforcement pitch
- Foundation locations

### 3. End Elevation

An end view of the pier. It may indicate:

- Reinforcement steel location, spacing, cover and clearance
- Architectural details (rustication strips, chamfers, etc.)
- Epoxy waterproofing pay limit
- Pertinent dimension
- Foundation locations

### 4. Section

Sections taken through the columns and cap beams to better indicate dimensions and reinforcement steel locations.

### 5. Estimated Quantities

Estimated quantities of the items incorporated in the pier.

This sheet may also include:

- Detail of foundation excavation pay limits in the pier area
- Details of bent reinforcement bars
- Reinforcement bar lists - These are used in computing net theoretical weight.

## 7.2.6 Superstructure

### 7.2.6.1 Structural Steel Sheets

These sheets may include but not be limited to:

#### 1. Framing Plan

A top view of the centerlines of the steel girders. This view may indicate:

- Lengths of stringers from centerline of bearings to centerline of bearings
- Locations of and spacing between diaphragms
- Identification of individual stringers
- Bearing lines
- Angle between centerline of bearings and stringers
- Elevations of the tops of the stringers at the centerline of bearings
- Skew of bridge
- Sizes of diaphragm channels
- Location and identification of utilities

#### 2. Elevations

Side views of the different girders. These views may indicate:

- Shear connector spacing
- Transverse intermediate stiffener spacing
- Flange dimension
- Length of plate

- Depth of web plate
  - Splice
3. Shear Connector Detail
  4. Diaphragm Detail
  5. Sections at pertinent location
  6. Schedule of Cambers and Deflection
  7. Shear Lock Device Detail
  8. Estimated Quantities

Estimated quantities of structural steel and shear connectors.

9. Notes

These might include the size of bolts or rivets, type of steel, weld symbols and sizes, structural steel paint system designation and finish coat color, notes concerning Notch Toughness, Fracture Control Plan, and welding inspection testing symbol requirements.

#### **7.2.6.2 Structural Steel Bearings**

Refer to Section 24 of this Manual for guidance.

#### **7.2.6.3 Precast/Prestressed Concrete Beams**

These sheets may include:

- Framing plan
- Centerline of bearings
- Top view of the centerlines of the beams and diaphragms. This may indicate:
  - Spacing between beams and between diaphragm
  - Identification of individual beam
  - Spacing of utility support
- Estimated quantities
- Details of Beams and reinforcement
- Details of diaphragm
- Construction note
- Design criteria
- Location and identification of utilities

#### **7.2.6.4 Deck Slab**

This sheet may include:

1. Plan

A top view of the deck slab. This usually indicates the size and location of reinforcement steel and joints.

2. Sections

A typical section through the deck slab may indicate:

- Deck thickness
- Haunch thickness

- Typical reinforcement steel location
  - Location of profile line, transverse grades
  - Pertinent dimensions
  - Utilities location and identification
  - Overlays
  - Sections through deck joints may indicate:
    - Pertinent dimensions
    - Reinforcement locations
    - Notes pertaining to joints and sealers
3. Small scale schematic diagram showing the following minimum information:
- Baseline and other control lines - Stations at 25 feet intervals
  - Cross-slope percentages
  - Elevations at 25 feet intervals
  - Horizontal curve layout information
  - Contours at 10 feet intervals between variable cross-slopes

This information is used by the Review Engineer and Designer to determine if adverse geometrics precludes the use of machine finishing of the bridge deck.

4. Details
- Copper waterstop
- Preformed joint sealer and installation
5. Reinforcement Steel Bar List - These are used in computing net theoretical weight
6. Estimated quantities
7. Small scale diagram showing concrete placing sequence for continuous spans.

### **7.2.7 Detail Sheets**

There may be one or more sheets under this heading. The details may be typical or specific. These may indicate:

- Parapets
- Chain link fence
- Bridge railings
- Junction boxes
- Abutment form panel arrangement and scoring
- Anchor bolts
- Joints, waterstop, sealing
- Abutment drainage
- Pay limits for epoxy waterproofing and
- Pay limits for foundation and bridge excavation (Note: the quantity will be added up with roadway excavation for total excavation pay item.)
- Rigid metallic conduit sleeves
- Sidewalk and parapet joint location
- Lighting standard foundations
- Deck joints
- Utilities

- Granite masonry or Stainless Steel Pier Protection
- Scour countermeasures
- Fender systems
- Seismic details
- Navigational lighting and access

Conglomerations of "Typical Details", such as Foundation Excavation, Structural Details, Wall Sections, etc. all on the same sheet, should be avoided. Typical structural details should be shown with the structural steel drawings, foundation excavation payment limits should be shown on the abutment and pier drawings, etc.

### **7.2.8 Standard Drawings/Bridge Construction Details (BCDs)**

The use of Standard Drawings, included in Appendix 2 of this Manual and BCDs, may be studied for use with bridge plans. BCDs are contained in the "Standard Roadway Construction – Traffic Control – Bridge Construction Details" package of drawings. For contracts that contain more than one bridge, a Standard Drawing detail sheet is to be provided with each structure. BCDs do not have to be reproduced on a project to project basis. They may be referred to for their inclusion as an item of a project's construction.

Reference to the Standard Drawings should be included in the Index of Drawings shown on the General Plan and Elevation Sheet.

### **7.2.9 Culverts**

This is a sheet showing culvert type structures. They may include:

#### 1. Plan

This is a plan view of the entire structure. It indicates:

- Length of culvert section
- Overall dimension
- Reinforcement steel
- Station
- Skew to base line
- Stage construction

#### 2. Elevation

This is a front view of the culvert which indicates:

- Pertinent elevation
- Types and locations of wall joint
- Invert elevation
- Reinforcement steel
- Location of section view
- Location of utilities
- Cut-off wall
- Type of foundation

#### 3. Section

Typical sections through culvert and retaining walls which indicates:

- Pertinent dimensions and elevation

- Reinforcement steel
- Location of joint
- Batter of wall

These sheets also include:

- Estimated quantities of items incorporated on the sheet
- Details of bent reinforcement bars.
- Reinforcement bar lists.
- Details of foundation and channel excavation payment limits.
- Details of epoxy seal coat payment limits.
- General Notes indicating design criteria and hydrologic data.
- Foundation data, as required.

### **7.2.10 Retaining Walls**

Refer to Section 17.3 of this Manual for criteria concerning the design and details of the retaining wall Structures.

1. Conventional Retaining walls
2. Nongravity Cantilevered Walls
3. Anchored walls
4. Mechanically Stabilized Earth Walls
5. Prefabricated Modular Walls

- a. Plan View

A top view of the wall and footing which indicates:

- Pertinent dimensions
- Location of piles or shafts (if not shown on the footing and pile/shaft location plan)
- Reinforcement steel location, cover and spacing in footings
- Boring locations and identification
- Back of wall drainage details

- b. Elevation View

A side view of the wall which may indicate:

- Pertinent dimensions and elevation
- Location of section view
- Reinforcement steel location, cover and spacing
- Foundation type and pile or shaft locations in the finished structure
- Wall identification number
- Back of wall drainage and flow line elevation

- c. Section View

Sections taken through the wall to better indicate dimensions, reinforcement steel locations, concrete cover for rebars, pile locations, elevation

- d. Estimated Quantities

Estimated quantities for the items incorporated in the wall

This sheet may also include:



- Detail of foundation excavation pay limit
- Details of bent reinforcement bar
- Reinforcing bar list

e. Proprietary Retaining Wall

Based on the engineering study of a project, the Designer will recommend the proprietary walls that can be utilized.

This information should be provided in the Design Recommendation and listed on the contract documents. The following methodology shall be followed in presenting a Final Submission in which construction of proprietary retaining walls is planned. Also, refer to Sections 3 and 17 of this Manual for design guidance.

1. The Designer shall prepare a Control Plan that provides sufficient information to the proprietary wall supplier, for the design of the wall system. Refer to 4. below for information that is to be provided on the Control Plan. Refer to Subsection 5.6 of this Manual for governing site conditions that may limit the wall type selection.
2. The Standard Specifications should be referred to for fabrication and construction requirements of approved proprietary wall systems.
3. If it is determined that only one type proprietary wall system is suitable for a specific site, then the Control Plans may be developed with the intent that only that wall system is to be constructed. However, if it is determined that only one particular MSE wall system or modular wall system is suitable for a project site, then a waiver must be obtained for use of the identified sole proprietary wall system.
4. The Sample Plans package of drawings provides an illustration of a Control Plan presentation. Standard Drawings within this Manual are to be used to provide these plans in a project. The guidance provided in Subsection 17.3 of this Manual is also be followed in completing the Control Plan. The Control Plans are to include, but not be limited to, the following information:
  - a. Plan and elevation views of the wall(s)
 

Show the Elevation view of wall(s), existing and proposed ground lines, elevations at 25 foot intervals at the top of wall and proposed ground line (used to compute quantities), wall embedment (maximum elevation at top of levelling pad) and beginning and end of wall stations.
  - b. Control data for horizontal and vertical alignment
  - c. Specific/nominal limits of the wall(s)
  - d. Locations of existing and proposed utilities
  - e. Boring locations
  - f. General Notes
  - g. Right of Way limits / construction easements

- h. If warranted, construction sequence requirements, traffic control, access, and stage construction sequence
- i. Work Item Quantities table
- j. Estimate of Quantities Table
- k. Limits of Common Structure Volume
- l. Limits and requirements for drainage features within the Common Structure Volume, limits and requirements which will affect the construction or stability of the wall beneath, on top of, and behind the retaining wall.
- m. At stream location, high water and normal water levels and scour protection
- n. Design parameters to establish External Stability factors, which are to include, but not be limited to, the following:
  - Nominal Bearing Resistance, Factored Bearing Resistance and Sliding Resistance Factor
  - Soil Unit Weight of Porous Fill
  - Soil Unit Weight of Foundation Subgrade, Retained soil, and soil within the Wall system
  - Angle of Internal Friction for the Foundation Subgrade, Retained Soil, and the Soils within the Wall System
  - Anticipated settlement
  - If required, Foundation Subgrade Treatment
- o. Magnitude, location and direction of external loads due to bridges, sign structures, traffic surcharge, etc.
- p. Seismic criteria
- q. Sections through wall showing offset control point, pay area, ditches, sidewalks, superelevation and any unusual features
- r. General details showing:
  - End of wall interfaces
  - Wall/coping/barrier or barrier interfaces
  - Drainage pipe and inlet details, slip joint details
  - Compatibility with roadway plans
  - Excavation, temporary sheeting, cofferdam requirements
  - Architectural details (such as dimensional requirements, special wall features; such as facing finish, texture, color or planting)
  - Location and size of any existing or proposed structures
  - Location of overhead signs or roadway lighting
  - Location and height of noise barrier, if applicable

Guide Plates 3.4-7 through 3.4-12 may be used in presenting this information.

## 5. Foundation Report and Recommendation

- a. When proprietary retaining walls are to be included in a project, the Foundation Report shall provide complete detailed information as to

- the reason for recommendation of proprietary retaining wall systems. The Designer shall evaluate global external stability, sliding, overturning, slope stability, bearing resistance and settlement.
- b. The Report shall indicate the maximum elevation at the top of leveling pads or footings and the design foundation pressures at those elevations.
  - c. If soil subgrade treatment, soil enhancements and/or unsuitable material removal is required, the Report shall clarify such recommendations along with potential effects that the recommendations may have on the various alternates.
  - d. In order to permit the availability of the Report to the Contractor, the Designer shall assure that the most current Report is provided to the Project Manager. The Designer must verify that the copy of the Report that is to be provided to the Contractor does not include calculations.
6. When construction of proprietary walls is planned, Control Plans are required in the final contract documents.
- a. The Contractor shall be responsible for providing the design calculations and construction plans for the proprietary retaining wall systems as Working Drawings. Refer to Section 17 of this Manual for design submission criteria. The NJDOT Standard Specifications should be referred to for guidance in the submission of working drawings.
  - b. The Designer will sign and seal the drawings noting that the walls have been checked for external stability and for conformance with the design concept of the project. Also, he will modify the Index of Drawings on the Contract set of plans.
7. When project site conditions limit the wall type system selection (refer to Subsection 5.6 of this Manual) complete proprietary wall designs shall be provided in the Contract set of plans.
- a. All calculations shall be provided. Appropriate information shall be stated on the contract plans.
  - b. Complete information as to the proposed method of fabrication and erection of precast units and related components shall be provided. Working drawings shall be prepared and submitted in accordance with the requirements specified in the Standard Specifications and as modified herein.
8. As per Subsection 6.2 of this Manual, when only one type proprietary wall system manufacturer can be used, a waiver must be obtained from FHWA.
9. The Department reserves the right to reject any proprietary wall system or wall systems details which do not conform to the control plans, pre-approved NJDOT Design Manuals or AASHTO Specifications.

### 7.2.11 Demolition of Existing Bridge

This sheet is a schematic outline with general information necessary to assist bidders in determining the extent of the work

The minimum information is:

- Plan, elevation and typical sections with key dimensions and elevation
- Extent of removal and staging
- Estimate of the quantities of the principal item to be removed
- Route and Section number under which the bridge was built
- Microfilm file reference number (7 digits)
- Any other information which, in the judgment of the engineer, will be of value to all concerned

The following note shall be indicated on this sheet:

The information presented hereon is for informational purposes only and is not guaranteed to be correct. Bidders shall visit the site before submitting bids to ascertain the extent of the work

If the original bridge plans are available, a half-tone reproduction of the General Plan and Elevation sheet, modified to suit, should be considered for inclusion in the above Plans.

### 7.2.12 Sign Support Structures

1. Refer to Section 30 of this Manual for criteria concerning the design and installation of Variable/Dynamic Message Sign (VMS/DMS) Support Structures.
2. Contract plans for sign support structures shall include, but shall not necessarily be limited to, the following:

a. Key Plan to Structures:

Location of overhead, cantilever and bridge mounted sign structures will be shown on the Key Plan to Structures sheet.

Boring locations and numbers in conjunction with subsurface and overhead utilities may be shown on this sheet.

b. Elevation of Structures:

This plan sheet is a single line diagram showing the sign structures in elevation and including the following information:

- Principal dimensions
- Total sign design area limits
- Sign location on structures
- Sign identification
- Stations
- Roadway dimensions
- Vertical and horizontal clearance dimensions
- Guide rail locations
- Bottom of footing elevations
- I-9 or I-10 Soil Aggregate limits
- Foundation plan (if other pile types used)

- Temporary sheeting (if necessary)
  - Utilities adjacent to footings
  - Estimated quantities
- c. Plan View of Structures
- Roadway Lane Width
  - Roadway Station of Structure
  - Boring locations
  - Direction of Traffic Flow
  - Footing Schematic Outline
  - Location of Foundation, Temporary Sheeting (if applicable)
  - Location of Utilities Adjacent to Footing
- d. Standard Contract Plans:
- Overhead**
- Standard Contract Plan Plates completed in accordance with Standard Design Instruction Drawing Plates.
- Cantilever**
- Standard Contract Plan Plates completed in accordance with Standard Design Instruction Drawing Plates.
- e. Detail plans for other type sign support structures, such as bridge mounted sign structures, developed on an individual structure basis.
- f. Electrical and Lighting Plans (usually included with Roadway Plans).

### 7.2.13 Specialty Sheet

These sheets can include:

- Fender systems
- Modifications of railroad electrification facilities
- Protective shield over electrified railroad track

### 7.2.14 Temporary Bridge Structures

This sheet is a schematic outline of the temporary bridge to provide bidder with minimum criteria. Prefabricated element/system is encouraged for the purpose of reducing traffic interruption.

The information includes:

#### 1. General Notes

This identifies the criteria used in designing the structure; such as, applicable specifications (AASHTO, AREMA), minimum design loading and other minimum design requirements.

Soil boring data shall be provided for foundation design.

Hydraulic and hydrologic data are shown for waterway structures.

#### 2. Profiles

These show proposed profile lines, vertical curve information, tangent grades, original ground line, stationing, and proposed finished grade elevations.

### 3. Plan

This is a plan view of the entire structure. It indicates:

- Skew of the structure.
- Certain dimensions; such as,
  - Lane Width
  - Sidewalk Width
  - Location and identification of boring
  - Location of subsurface and above ground utilities

### 4. Elevation

A schematic elevation to illustrate the following:

- Original groundline and approximate rockline
- Minimum vertical clearance
- Minimum lateral clearance

All of the documents and procedures required shall apply to temporary structures. All certificates and permits required shall be obtained during the design phases. Any changes in the plan during advertising or construction will necessitate application for amendments to the permit.

Approach roadways for temporary structures shall be detailed in the roadway plan portion of the Contract Plans.

#### **7.2.15 High Tower Lighting**

Contract Plans for tower lighting footing details shall include, but not necessarily be limited to, the following:

##### 1. Key Plan to Tower Lighting Footings

If the contract is exclusively a lighting contract, a Key Plan Sheet shall be provided.

##### 2. Tower Lighting Footing Details

- Plan
- Elevation
- Pedestal Section
- Reinforcement Steel Bar List
- Rebar Bending Details
- Existing Ground Line Elevations
- Bottom of Footing Elevations
- Tower Lighting Identification Numbers
- Location by Station and Offsets
- Boring Locations and Identification Numbers
- Estimated Quantities
- Design Criteria
- Wind Pressure Diagram
- Light Tower Diagrams
- General Notes
- Foundation Excavation Details
- I-9 or I-10 Soil Aggregate limits
- Foundation Plan

### 7.3 Plan Revisions

1. No revisions shall be made to contract drawings between the time of advertising and award of contract. During the advertising period, additions, deletions or corrections to contract plans shall be accomplished by addendum. Revisions to plans, in compliance with addenda, shall be made immediately after award of contract.
2. Revisions to contract drawings shall be made in accordance with the illustration shown on Guide Sheet Plate 3.2-1. Erasures are not allowed.
3. Where revisions are necessary on a Consultant's contract plans, the Consultant shall mark, in red, changes in accordance with the illustration shown on Guide Sheet Plate 3.2-1. The same drawing shall be submitted for approval with a transmittal letter detailing the changes. Drafting work shall be done by the Consultant.
4. Where changes are so extensive that new drawings are necessary, the following procedure shall be used:
  - a. Mark original contract drawing:  
"Void - See Supplementary Sheet B\_\_\_\_S"
  - b. Mark new drawing:  
"Supplementary Sheet B\_\_\_\_S"
5. If contract plans have been submitted in an electronic media, a submission should be provided to include the original submission and all changes.

## Section 8 - Reconstruction and Rehabilitation Projects

### 8.1 Concrete Bridge Decks

In the processes that are involved in construction, rehabilitation and reconstruction of concrete bridge decks, with special emphasis on overlay protective systems, the following terminology shall apply:

1. Construction means the initial construction of any specific bridge deck.
2. Maintenance means routine or incidental work necessary to keep a bridge deck functioning in a safe and efficient manner.
3. Overlay Protective System means a system used to protect bridge decks from deterioration induced by highway deicing chemicals, salt water, or other hostile environments.
4. Reconstruction means the restoration of the structural integrity of a concrete bridge deck by complete removal and replacement of the existing deteriorated bridge deck.
5. Rehabilitation means the work necessary to restore the structural integrity of portions of the original bridge deck as well as the installation of an overlay protective system.

The following policies are established for all bridge decks to be constructed, rehabilitated or reconstructed with Federal-aid funds.

1. Standard Specifications. Criteria that is included in the *NJDOT Specifications for Road and Bridge Construction* shall be adhered to.
2. High Performance Concrete (HPC). HPC deck slabs that are designed for reliability and durability shall be the primary protective system for bridge deck construction.
3. Overlay Protective System. When planning roadway resurfacing projects or bridge rehabilitation projects, a cost effective Overlay Protective System should be evaluated.
4. Eligible Work. Reconstruction and rehabilitation procedures necessary to assure acceptable performance of existing structures are set forth below and are eligible for Federal-aid participation from the appropriate category. Reconstruction and rehabilitation shall include all work required to assure satisfactory performance of the concrete deck, as well as supporting superstructure and substructure units.
  - a. This may include the removal of existing overlays, removal and replacement of all deteriorated components or the complete removal and replacement of the entire bridge deck.
  - b. This work may also include repair or removal and replacement of deteriorated concrete curbs, sidewalks, parapets, deck joints, bearings or similar incidental items which are associated with proper functional restoration of the structure.
  - c. Safety improvements should be undertaken when such improvements eliminate an established hazardous condition. Such safety improvements may include widening, elimination of hazardous walks and substandard



safety hardware, removal of hazardous fixed objects or the installation of energy absorbing barrier system and any other features that are consistent with current safety standards.

5. Projects that include the replacement of a bridge deck or complete superstructure replacement shall utilize the *AASHTO LRFD Bridge Design Specifications* to design the deck slab or entire superstructure. Also, refer to 8.6, herein, for additional guidance.

## **8.2 Field Condition and Appraisal Survey**

1. Where an existing bridge or structure is to be widened, altered, reconstructed or rehabilitated, the Evaluation Survey Report for the bridge shall be studied to verify component conditions, rating analysis and recommended repairs.
2. In conjunction with the review of the Report, a limited Field Condition Survey shall be made to update the original inspection report. A Supplementary Report shall be written and include recommendations for additional work together with a preliminary cost estimate. The Supplementary Report shall be submitted prior to Preliminary submission.

The Department will determine and authorize the extent of the work to be included in the Contract Plans.

3. Consistent with the definitions established in Subsection 8.1 above, safety improvements shall be considered for all reconstruction and rehabilitation projects. Recommendations shall be included in the Supplementary Report. If not already included in the Scope of Work, the Department will determine and authorize the extent of work to be included in the Contract Plans.
4. The minimum vertical underclearance shall be verified. If the underclearance is substandard, a commentary about the extent of work that is needed to improve the situation, together with a preliminary cost estimate, shall be provided. The Department will determine if a detailed retrofit study is warranted.

## **8.3 Deck Slab Reconstruction (Replacement)**

1. Deck slab replacements shall be designed in accordance with the *AASHTO LRFD Bridge Design Specifications* and other applicable provisions of this Manual. Existing stringers and/or beams must be analyzed to determine if additional Dead Load stresses may be introduced. Secondary Dead Load design requirements may also be a factor.
2. If the deck slab reconstruction work should impact bridge approach areas, the Design Engineer should refer to Subsection 20.10 of this Manual for guidance concerning provision of approach slabs.
3. If calculations indicate that the existing stringers and/or beams may become significantly overstressed, the matter, together with recommendations, should be brought to the attention of the Manager, Bureau of Structural Engineering.
4. Special measures such as requiring the use of removable deck forms, retrofitting stringers with shear connectors, shear connector replacement, design criteria exceptions, etc. may be required.

Additionally, the height of shear connector studs on the existing stringers should be considered. Additional studs may have to be added in order to conform to the design criteria under Subsection 24.6.

#### **8.4 Special Conditions**

Any changes in the condition of the bridge superstructure, current at the time of the Final Plan Processing for the receipt of construction bids, which influence previous design decisions, should be considered. Special Provisions may be required in the Plans and Special Provisions for the following (if not already included in the contract documents):

- Construction Staging.
- Traffic controls and diversions.
- Authorized detours.
- Restricted working hours or days.
- Load restrictions for construction equipment.
- Posting for reduced speeds, substandard vertical underclearances and/or load capacities.

#### **8.5 Closure of Movable Bridges**

1. Contracts involving reconstruction or rehabilitation of movable bridges, where closures are expected, shall have suitable provisions written into the Special Provisions to conform to the regulations of the U.S. Coast Guard.
2. Requests for U.S. Coast Guard approval of proposed closures shall be channeled through the Manager, Bureau of Structural Engineering. Approval shall be received prior to advertising the contract for bids.

#### **8.6 Superstructure Replacements or Bridge Widening Projects**

1. **Superstructure** - Superstructure replacements shall be designed in accordance with applicable criteria of the *AASHTO LRFD Bridge Design Specifications* and as may be amended within this Manual. Bridge widenings that will exceed 30% of the deck slab area will similarly be designed according to the *AASHTO LRFD Bridge Design Specifications*. For bridge widening project that does not exceed 30% of the deck slab area, design shall follow AASHTO LRFD criteria or original design criteria.
2. **Substructure** - The existing substructure of a bridge that meets the above replacement or widening criteria shall be analyzed based on LRFD design criteria for Strength I limit state following AASHTO LRFD Design Specifications by applying the design load (HL-93) to the reconstructed conditions, or evaluated for Design Load as per the guidance provided in Section 6 Part A (LRFR) of the AASHTO Manual for Bridge Evaluation to the reconstructed conditions.

## Section 9 - Bridge Deck Rehabilitation Projects

### 9.1 Requirements

Prior to the Preliminary Submission, the following work shall be performed:

- A. Review the Bridge Evaluation Survey Report or any prior Deck Evaluation Survey.
- B. Perform an on-the-site observation to determine if a Bridge Deck Evaluation Survey is warranted.
- C. Perform, if authorized, a Deck Evaluation Survey according to the guidance provided herein.
- D. Perform a Field Survey to determine existing/as-built geometrics and deck profile elevations at 10 foot intervals.
- E. Submit to the Bureau of Structural Engineering a report, in letter form, stating what the substandard conditions are. A determination will be made as to whether further studies are to be done to address the condition(s).

Adhere to the following criteria in developing contract documents:

- A. Pavement surface removal should be scheduled for existing bridges with Hot Mix Asphalt (HMA) Overlays. Determine if waterproofing was also included and detail plans accordingly. Specifications in the Special Provisions should require that the existing waterproofing be removed and replaced with a new waterproofing membrane. Use of Bridge Deck Waterproofing Surface Course (BDWSC) does not require a waterproofing membrane.
- B. When a bare concrete deck is scheduled for an overlay, plans should be based on a detailed deck evaluation survey and outline the Repair Areas, Repair Material, etc.
- C. Provisions for reinforcement steel quantity should be scheduled if it is determined that a reasonably large amount will be required. If not scheduled, the Special Provisions should be modified accordingly.
- D. When a precast deck system or a prefabricated superstructure and deck system is the chosen structural solution for a rehabilitation project, an HMA overlay is permitted.

#### 9.1.1 Resurfacing projects:

Polymer concrete thin overlay or other types of concrete overlay may be scheduled for resurfacing projects, based on existing conditions and allowed overlay thickness. The Manager of Structural Engineering will approve the overlay system to be applied for the particular project and will verify that the additional dead load does not cause an overstress condition.

HMA overlays shall not be allowed unless bridge deck slabs are in all following conditions:

- 1) Very short remaining life, e.g. temporary overlay prior to planned deck replacement;
- 2) Minimal or no deck joints;

### 3) Water-proof surface membrane has to be used

When specifying an overlay, the deck joints and approaches may have to be reconstructed due to the elevation change.

#### A. HMA overlays (when applicable):

When installation of HMA is approved, the existing condition of the deck concrete shall be documented by referencing the current Bridge Evaluation Report findings and updating the findings by a visit to the site. If directed by the Manager, Structural Engineering, a Deck Condition Survey report is to be generated, according to the provisions herein.

The thickness of HMA overlays shall be noted on the Plans.

Installation of a waterproofing membrane shall be planned for prior to placing an HMA. In cases where HMA overlays are already part of the existing deck surface, replacements of such overlays is permitted. Removal of any existing membrane waterproofing is to be planned.

#### B. Concrete Overlays

The standard thickness of concrete overlay varies depending on the system used. This thickness shall be noted on the Plans. This thickness may be used to establish a contract estimated quantity.

An additional 10% to 20% (depending on the concrete overlay area) should be added to the concrete overlay estimated quantity. This is based on the anticipation that additional thickness may be required at some locations to achieve the proposed plan profile elevations and cross-slopes.

### **9.1.2 Bridge Deck Patching and Repairs**

Situations which would produce a concrete layer thickness in excess of 2 inches require special solutions. For example, if substructure settlements have resulted in significant lowering of the original plan/as-built profile elevations, jacking of the superstructure at selected locations may be considered and scheduled as a contract pay item when warranted. The deck surface treatment shall be in accordance with the overlay manufacture's recommendations.

Scarification may not be necessary when an overlay protective system is to be added and when the newly replaced or repaired bridge deck has not been opened to traffic or has been subjected to traffic and deicing chemicals for a relatively short time. Cleaning of the surface by sandblasting or shot blasting may suffice. Provisions should be included in the Special Provisions accordingly.

If new expansion joint assemblies are proposed and approved for scheduling as a contract pay item, a continuous sealer across the full width of the deck slab should be planned.

### **9.2 Deck Deterioration Quantity**

- A. Based on a study of an existing Bridge Evaluation Report and site visit, an approximation of required Type B and C repairs is to be noted on the plans.
- B. To quantify an existing deck condition and required work, the following parameters may be used:

|                                |  |
|--------------------------------|--|
| 1% to 60% deck deterioration   | Deck Patching/Repair with or without Overlay |
| 50% to 100% deck deterioration | Deck Replacement                             |

The overlapping percentages are intended to provide some flexibility in the decision making process. If the deck deterioration percentage falls in the overlapping percentages, then the following factors should also be considered in order to determine the final recommended repair:

- Adjacent Structure – Need to look at the condition of and what repair work is proposed for the adjacent structures in the corridor.
- Upcoming Project – If the bridge is included in a project that is in the pipeline.
- Traffic Volume – ADT in the heavy traffic areas.

### 9.3 NBI Coding

- For decks receiving an overlay, Item 106 (year constructed) of the Structural Inventory and Appraisal will be updated to the year of reconstruction. The highest code that is used for a reconstructed deck is an "8". The coding of Item 58 (bridge deck condition) will be based on the actual condition of the deck in the field, but in no case less than a rating of "7".
- For decks receiving patching, Item 106 will not be revised and the coding of Item 58 will be updated based on the actual condition of the deck in the field.

### 9.4 Machine Finishing For Repaired Concrete Deck Surface

- Rapid set concrete, such as Rapid Set LMC, is permitted by approval of the Manager, Structural Engineering.
- Design the bridge deck to minimize the areas that include small tight areas, unusual transition, or other geometric constraints. These may preclude machine finishing, requiring the use of hand tools, thereby increasing the project cost.
- See Subsection 20.9-1. for criteria which could preclude use of machine finishing for bridge deck slab construction. These provisions shall also apply to concrete overlay protective system construction.
- It shall be the responsibility of the Structural Design Engineer to show the following note on the plans in bridge deck areas where adverse conditions could conceivably preclude the use of machine finishing:

**Note:** Machine finishing of concrete surface not required. See Special Provisions."

Or

**Note:** Machine finishing of concrete surface not required in areas designated. See Special Provisions."

Whichever is applicable.

Unique specifications should be included in a project's Special Provisions.

## 9.5 Construction Document Development

- A. In order to reduce construction costs, repair and resurfacing of deck deterioration of all bridges in a contract shall be accounted for under the single item "Concrete Deck Repair". This item will consist of constructing a modified standard "Type B" repair for all repairs. However, if a "Type C" repair is encountered, it shall be accordingly repaired, but still be included in the item "Concrete Deck Repair". Class A concrete or Type IA quick setting patch material is to be used for concrete deck repairs depending on available traffic windows. For depths more than 4 inches, patch materials and method of construction shall be approved by the RE. Special attention should be made to manufacturer's recommendations regarding application thickness and curing time.
- B. All spall areas to be repaired must be clearly outlined on the plans. All previous spall repairs containing epoxy shall be removed. Engineering judgment should be used to determine if small isolated spalls in the deck should be included as part of an adjacent larger repair. The larger the repair patch, the easier it is for workers to remove the defective concrete and replace it with patch material.
- C. All deck repair shall be finished utilizing a coarse broom finish unless the existing deck is already sawcut. This item is to be included in the price bid for the item "Concrete Deck Repair". Large repair areas such as overall lane widths or decks already sawcut shall be finished with the item "Sawcut Grooved Deck Surface".
- D. Construction joints are often used to limit the size of the repair due to lane closing restrictions. They may be placed at the contractor's option to provide a working edge for concrete finishing, to provide for a continuous joint replacement or to facilitate an end of the work day stoppage point. If warranted, suitable notes should be provided on the plans.

The Designer should outline repair areas that do not form acute angles with the deck joints or other repair areas. There may be cases where new construction joints must be sawcut into the new concrete to provide the proper edge. Notes on the plans should instruct the Contractor to plan his work to avoid placing a construction joint at odd angles.

- E. Notes on the plans should outline repair procedures. All existing reinforcing steel must be sandblasted or hydroblast cleaned prior to placement of patch material. The minimum depth of repair should not be less than 2 inches with a minimum of 1 inch removal of concrete below the bottom of the top mat of the existing reinforcement. In all cases, there should be enough space available for the maximum size of concrete aggregate to "fit" in any location within the volume of the repaired concrete deck.

The plans must be specific about the concrete removal. Hydrodemolition is acceptable as a removal technique. The Contractor must provide necessary sediment control measures so as not to impact any surrounding areas or drainage systems and meet all environmental requirements.

In removing deteriorated concrete, caution must be exercised so that the removal does not progress into sound concrete, or is limited to 1 inch below the top reinforcement.

The Designer shall develop the plans so that this guidance is provided.

- F. Details must be shown for treatment of repair areas which cannot be completed during work hours due to unforeseen conditions. Use of cold patches or steel cover plates are permitted. A time limit of 2 days should be placed on the duration the temporary cover can remain in place. The price for placement, maintenance, and removal of the temporary cover and cold patch during repairs shall be included in the bid cost of "Concrete Deck Repairs".
- G. Deck joints which exhibit leakage and/or edge spalling shall be repaired by replacing the Deck Joint Sealer and/or reconstructing the header and/or deck side of the joint utilizing the non-standard items "Deck Joint Reconstruction", "Sawcut Joint Reconstruction" or "Deck Joint Repairs". These items shall be measured in linear feet with the area to be repaired outlined in the plan view.
- H. Where applicable, hot poured rubber asphalt joint sealer should be used to seal joints. Where possible, bituminized fiber joint filler should be placed below the hot poured rubber asphalt joint sealer.

Where defects due to spalling at joint sealers occur, the joint should be repaired according to appropriate details.

Where abutment deck joints are reconstructed, hot poured sealant should be placed between the abutment header and approach slab.

## **9.6 Safety Upgrades**

- A. For decks that are to have an overlay installed, the following upgrades shall be planned:
  - 1. All geometric standards will be met or, a design exception will be prepared.
  - 2. On NHS bridges, provision of upgraded beam guide rail attachment and transition, installation of guide rail or other crashworthy retrofit barrier system across the structure or replacement of parapets and subsequent guide rail installation will be required.
 

For non-NHS bridges, if full safety upgrades are not practical, as determined by the Bureau of Structural Engineering, and there is no accident history, then attachments and transitions which consist of at least reduced post spacings and connections with a history of satisfactory performance will be considered acceptable.
- B. For decks that are to be patched between 20% and 30% of the total deck areas and/or are to receive an HMA overlay:
  - 1. On NHS bridges evaluate the need to upgrade or retrofit the existing bridge parapets. Factors such as accident data, loading, geometry, cost and impact of an improvement should be evaluated. The evaluation is to be provided to the Manager, Structural Engineering for determination on including an upgrade or retrofit of the existing condition into a project.
  - 2. For non-NHS bridges, if full safety upgrades are not practical, as determined by the Bureau of Structural Engineering, and there is no accident history, then attachments and transitions which consist of at least reduced post spacings are acceptable.
- C. If it is determined that upgrading or retrofitting an existing guide rail connection is warranted, then the method to design an improvement; such as, construction

of an end pylon section, may be based on AASHTO LRFD Bridge Design Specifications, Design Forces for Traffic Railings in Section 13.

## **9.7 Deck Evaluation Survey**

### **A. Description of Survey and Testing**

Testing and evaluation of concrete bridge decks consists of visual observations, delamination or debonding detection, concrete sampling for chloride analysis, and electrical potential measurement (half-cell testing). All of these bridge deck evaluation techniques are used to detect existing defects and actively deteriorating conditions of the deck. The following descriptions are intended to provide information and procedures for these bridge deck evaluation techniques. These techniques should be used in sequence and, if warranted, in combination. By using the combined results, engineers can better evaluate the condition of any bridge deck.

#### **1. Visual Survey**

The first step for deck evaluation is a visual observation to determine the extent of spalling, cracking and scaling. The information from visual surveys is used to determine further deck condition survey needs. Visual surveys are generally expressed in terms of the amount of spalling and patching as a percent of the total deck area.

##### **Concrete Delamination Detection**

A delamination survey provides information on the subsurface condition of concrete bridge decks. A chain drag or GPR can be used to survey concrete bridge decks for delamination.

Ground Penetrating Radar (GPR) or Portable Seismic Pavement Analyzer (PSPA) equipment may also be used to assess delamination reinforcement steel cover and, as permitted by the specific equipment, other deck slab condition information.

#### **2. Chloride Analysis**

Chloride analysis provides a quantitative measure of the chloride ion contamination of concrete at selected levels in the deck. The "threshold" chloride content, or amount of chloride needed to initiate corrosion, is approximately 2.0 lbs. of chloride per cubic yard of concrete.

#### **3. Half-Cell Test**

The purpose of half-cell testing is to determine the areas in the deck in which active corrosion is present.

Research tests have demonstrated that a potential difference more negative than -0.35 volts indicates a high degree of probability of active corrosion of the reinforcing steel. Potential readings not greater than -0.20 volts indicate the probability of inactive or no corrosion, while potential readings between -0.20 volts and -0.35 volts indicate the possibility of active corrosion. Surveys are temperature sensitive and should only be performed if the ambient air temperature has been above 40° F for a minimum of 72 hours immediately prior to the date of the survey.

#### **4. Pachometer Test**



In order to properly establish the deck condition, establishing the depth of cover over the top reinforcement is necessary. This will provide the evaluator with needed information to properly judge the existing condition versus what is the required minimum depth of cover.

## B. Procedures for Performing Deck Evaluation Surveys

### 1. Visual Observations

- a. Study the deficiencies of either the asphalt overlay or the concrete deck wearing surface (e.g. spalling, cracking, scaling, warping, asphalt creep, alligator cracks, etc.). Include the location and size of deficiencies, if any.
- b. Observe the underside of the deck and record the approximate size and location of all areas exhibiting cracks with or without efflorescence. Also, record all areas having concrete spalled from the bottom reinforcing.
- c. If the structure does not have an asphalt overlay over the concrete deck, determine the percentage of spalls and/or patches in the exposed concrete deck. Decks covered with asphalt should be similarly inspected, with a general condition statement made about the asphalt surface.
- d. Record the percentage of noted deficiencies for use in the final deck condition determination.

### 2. Concrete Delamination Detection

Chain Drag or GPR

Plot delaminated deck areas on a scaled map of the bridge deck.

### 3. Chloride Analysis

- a. Select random sample locations for chloride testing using statistical methods and plot the locations on a plan view of the deck. As a minimum requirement, 10 locations per every 6000 square yard area should be tested.
- b. After the lab has analyzed the samples taken, calculate the percentage of the samples with a chloride content greater than or equal 2 lbs./cu.yd. from:

$$\frac{\text{No. of Samples with Cl. greater than or equal to 2 lbs/cu.yd.} \times 100}{\text{Total No. of Samples}} = \underline{\quad}\%$$

### 4. Half-Cell Test

Calculate the percentage of possible corrosion affected deck area from the results by counting the number of tests points equal to or more negative than -0.35 volts.

$$\frac{\text{No. of Samples More Negative than -0.35 volts} \times 100}{\text{Total No. of Samples}} = \underline{\quad}\%$$

### 5. Pachometer Survey

Perform a Pachometer Survey to determine the depth of the concrete cover over the reinforcement steel. The equipment shall be calibrated according to the equipment manufacturer's specifications.

## **9.8 Determining Deck Condition And Extent Of Work**

### Evaluation of Field Survey Results

If a detailed study as described in Section 9.7 is not available, use Section 9.2. When a detailed study has been performed, use the following categories to establish the condition of a bridge deck:

#### **9.8.1 Category 1 - Extensive Active Corrosion**

5% or more of the deck area spalled

**Or**

40% or more of the deck area deteriorated or contaminated as indicated by any nonduplicating combination of the following:

(1) spalls, (2) delamination, and (3) corrosion potentials more negative than - 0.35 volts (CSE)

**Or**

40% of the area of the bridge deck indicated by random chloride sampling to contain greater than 2.0 pounds of chloride per cubic yard of concrete at the level of the top rebars.

#### **9.8.2 Category 2 - Moderate Active Corrosion**

0 to 5% of the deck area spalled,

**Or**

5 to 40% of the deck area deteriorated or contaminated as indicated by any nonduplicating combination of the following: (1) spalls, (2) delaminations, and (3) corrosion potential more negative than -0.35 volts (CSE),

**Or**

5 to 40% of the area of the bridge deck indicated by random chloride sampling to contain greater than 2.0 pounds of chloride per cubic yard of concrete at the level of the top rebars.

#### **9.8.3 Category 3 - Light to No Active Corrosion**

No spalls,

**Or**

0 to 5% of the deck area deteriorated or contaminated as indicated by any nonduplicating combination of the following: (1) delaminations, (2) corrosion potentials more negative than -0.35 volts (CSE),

**Or**

0 to 5% of the area of the bridge deck indicated by random chloride sampling to contain greater than 2.0 pounds of chloride per cubic yard of concrete at the level of the top rebars.

## **9.9 Recommended Restoration Procedures**

Based on the foregoing categorization of the condition of the bridge deck, Table 9.1, which details rehabilitation and reconstruction alternates, has been developed.

**Table 9.1 Restoration Procedures**

| <b>Category</b>                         | <b>Procedures</b>            | <b>Restoration</b><br>(Considered Permanent)   | <b>Restoration</b><br>(Estimated extended life 10 to 15 yrs)   |
|---|------------------------------|--|--|
| Structurally Inadequate                 |                              | Complete Deck Replacement (Unless restorable)  |  |
| <b>1.</b><br>Extensive Active Corrosion | Required Restoration Work    | Complete Deck Replacement  | Removal of all deteriorated concrete. Follow the repair procedure approved for the protective system selected.               |
|   | Testing Steps (see below)    | Steps 1 through 4 as necessary. (Probably only step 1)   | Step 1 only, except all the testing steps on the first five (5) bridge decks (spans) plus 10% of the remaining bridge decks. |
|   | Suggested Protective Systems | Membrane with HMA overlay*; Concrete Thin (less than 1") Overlay Protective System. *  | Membrane with HMA overlay**; Concrete Thin (less than 1") Overlay Protective System. **                                      |
| <b>2.</b><br>Moderate Active Corrosion  |                              | Same as Category 1 above<br>or<br>Same as Category 3 below, as determined by the State.  | Same as Category 1   |
| <b>3.</b><br>Light To No Active         | Required Restoration Work    | Removal and Replacement of all areas of deterioration and chloride contaminated concrete as determined by corrosion potentials and/or chloride sampling. (Less than 5% of the deck area is bad). | Same as Category 1<br>Note: For this category of condition, permanent restoration is recommended.                            |
|   | Testing Steps                | Steps 1 through 4.   | Same as Category 1   |
|   | Suggested Protective System  | Membrane with HMA overlay*; Concrete Thin (less than 1") Overlay Protective System. *  | Membrane with HMA overlay**; Concrete Thin (less than 1") Overlay Protective System. **                                      |

\* When approved prior to Preliminary Plan      \*\* Submission on a project to project basis

Testing Steps:

|    |                   |    |                 |  |  |
|----|-------------------|----|-----------------|--|--|
| 1. | Visual            | 3. | Half-Cell Test  |  |  |
| 2. | Chloride Analysis | 4. | Pachometer Test |  |  |

## Section 10 - Estimated Quantities/Design Calculations

### 10.1 Plans

1. Estimated quantity tabulations shall be shown on plans.
2. Each bridge plan detail sheet shall have the following type of tabulation, which represents the quantity of contract pay items shown on that sheet:

| <b>Quantities</b> |          |             |      |                   |
|-------------------|----------|-------------|------|-------------------|
| Sequence No.      | Item No. | Description | Unit | Contract Quantity |
|                   |          |             |      |                   |
|                   |          |             |      |                   |
|                   |          |             |      |                   |
|                   |          |             |      |                   |

3. The General Plan and Elevation sheet shall have the following type of tabulation which represents the total quantities of the individual plan sheets and, consequently, the total quantities for the bridge or structure.

| <b>Summary of Quantities</b> |          |             |      |                   |
|------------------------------|----------|-------------|------|-------------------|
| Sequence No.                 | Item No. | Description | Unit | Contract Quantity |
|                              |          |             |      |                   |
|                              |          |             |      |                   |
|                              |          |             |      |                   |
|                              |          |             |      |                   |

4. Each bridge design unit shall obtain from the roadway design unit the last roadway sequence number to facilitate the bridge item sequence numbering.
5. Quantities on these sheets shall be listed on an individual bridge or structure basis. Retaining walls shall be summarized on a total quantity for all walls in the contract. However, the quantities for the individual walls shall be included in a separate tabulation.
6. Overhead and Cantilever Sign Structures shall be listed on an individual lump sum basis; however, the items for clearing site, foundation excavation, concrete for footings, temporary sheeting and reinforcement steel shall be listed as the total summary for all sign support structures in the contract.

### 10.2 Calculations

1. Estimated quantity calculations are required as part of the Final Plan Submission. They shall be on 8½ inch by 11 inch sheets bound in a separate folder (from the design calculations). Each sheet shall be initialed by the estimator and the checker.

2. The required submission of bridge quantity calculations at the Final Submission shall also include schematic drawings of all concrete structures.
3. The volume of concrete in each individual unit shall be noted on the schematic drawings. The sheets shall be bound into the folder following the index. This will facilitate pinpointing any mistakes or errors during construction when Quantity calculations are made for purposes of monthly payments.

### **10.3 Guidance On NJDOT Standard Specifications Pay Item Usage**

The *NJDOT Standard Specifications for Road and Bridge Construction* provide Pay Items for work on bridges and structures. The following guidance may be followed for pay item selection:

1. The item Clearing Site Bridge is used when a "bridge" is involved, either partial or total removal.  
  
The item Clearing Site Structure is used when a "structure"; such as, culverts, walls, etc. is involved, either partial or total removal. In addition, when it is determined that certain components are to be salvaged and remain the property of the State, provisions in the Plans and/or the Supplementary Specifications are required.
2. Hot Mix Asphalt (HMA) overlays with membrane waterproofing may be used in bridge deck rehabilitation projects.
3. An item for porous fill is usually listed with the roadway items of work.
4. Payment line limits for Excavation Work shall be shown on the Plans in accordance with Guide Sheet Plates 3.15-1 to 3.15-5 of this Manual.
5. See Section 33 of this Manual for guidance concerning Cofferdams, Sheet Piling Left in Place and Sheet Piling.
6. For Structural Steel use the lump sum method of payment. A per pound pay unit method may be considered for the occasional project where there is a possibility that significant changes can occur during construction; such as, on repair or rehabilitation projects.
7. See Section 34 of this Manual for guidelines as to when Prebored Holes should be scheduled.
8. Schedule Pile Load tests on a project to project basis only if required in the Foundation Report.
9. Pneumatically Applied Mortar is usually scheduled under the square foot pay unit method. Per bag pay unit method should be considered for rehabilitation projects where there is the possibility of significant changes in the extent of repair areas.
10. See Section 30 of this Manual concerning sign support structure work.
11. The estimated quantity for utility conduits shall be the total length of all conduits in the bank.
12. See Section 7 of this Manual for Temporary bridge presentation criteria.
13. Items are listed (for each bridge and/or structure in the Contract) in the order in which the items of work appear in the Standard Item listing of the

Contractor Payment Listing. Any additional bridge items which may be required (but which are not included in the provisions of the Standard Specifications) shall be included in the listing by the same criteria.

14. See Bridge Construction Details for details of RMC Expansion Sleeves and Junction Boxes.
15. An Underdeck lighting item is to be listed with electrical items of work.
16. Hand Power Tool Cleaning may be used for those projects where Epoxy Mastic surface preparation with Hand/Power Tool Cleaning is warranted and the effective steel is confined to limited areas.

#### **10.4 Design Calculations Criteria**

1. Design calculations shall be on 8 ½" x 11" sheets.
2. For both Consultant and In-House design projects, a single set of calculations will be included with the Project Files. Checker's corrections shall be made directly on the original set of calculations. Each sheet shall be signed by the designer and the checker.
3. Computer interpretation information shall be included in the design calculations in accordance with Subsection 14.1.
4. If changes are necessary in the Standard Contract Plan Plates for Sign Support Structures, half-size copies of the Plates shall be included with the calculations in accordance with Subsection 30.5 item 2.
5. The design calculations shall be bound in separate folders by individual bridges and structures. The front cover shall identify the contents with the following minimum information:

Route \_\_\_\_\_ Contract No. \_\_\_\_\_ County \_\_\_\_\_

Design Calculations For: \_\_\_\_\_

Design Unit \_\_\_\_\_

Structure No. \_\_\_\_\_

## **Section 11 - Submission Guidelines For Plan Reviews**

### **11.1 Design Development (Preliminary Structural Documents)**

This submission provides for a review of the preliminary plans of an entire project. During this review, interested parties look at all aspects of preliminary development of a project to develop the Department's final scope of work.

The structural preliminary plans may be submitted after the Preliminary Design Submission Date only with prior approval of the Department's Project Manager.

Bridge designers are reminded that inclusion of any unique structural concept; such as, alternate abutment types must be approved by the Manager, Structural Engineering prior to including the concept in the Preliminary submission.

A Preliminary Submission is not considered complete until Preliminary Plans for all structures in the contract have been approved. If the structural plans are submitted for Preliminary Bridge Plan approval as part of the Preliminary Submission, the NJDOT Project Manager should be contacted just prior to the scheduled submission to determine the exact number of documents to be submitted.

It is preferred that all bridges and structures in the contract be submitted at the same time; however, it is recognized in large contracts that interchanges and sections of roads are sometimes approved in a "piecemeal" fashion. Consequently, preliminary bridge plans will be accepted on an individual basis.

### **11.2 Design Development (Final Structural Documents)**

This submission, in effect, is the submission of 100% complete contract documents. Submission of all bridge documents shall be included in the total contract documents.

## Section 12 - Footprint Program

### 12.1 Policy

1. Under the Highway Bridge Replacement and Rehabilitation Program (HBRRP), bridges with a sufficiency rating of less than 50.0 are eligible for Federal Bridge Replacement (BR) funding for replacement or rehabilitation while those with a sufficiency rating of 80.0 or less are eligible for Federal Bridge Rehabilitation (BH) funding for rehabilitation.
2. The following Parameters and Guidelines are intended to facilitate the replacement or rehabilitation of structurally deficient and/or functionally obsolete structures by utilizing a "Footprint Program" that will limit the scope of these projects. The intent is to limit the right-of-way and environmental impacts that normally occur when upgrading both the bridge and the approach roadways to desirable geometric standards and to classify these projects as a categorical exclusion.
3. The Parameters and Guidelines apply to both National Highway System (NHS) bridges as well Non-NHS bridges. All bridge projects must be designed to the *AASHTO LRFD Bridge Design Specifications* and to the stipulations that are stated within this Manual.

### 12.2 Design Parameters

1. A bridge may be replaced on the same line and grade or be relocated offline approximately one bridge width to the side if this better facilitates stage construction. The profile may also be changed as necessary to improve vertical underclearances. However, the shallowest superstructure feasible should be designed for the bridge in order to minimize changes to the roadway profile.
2. The profile and horizontal alignment shall transition back into the existing roadway as quickly as possible without creating substandard conditions or degrading existing substandard conditions. Design Exceptions for transition areas are to be in compliance with the current Design Exception Manual. In addition, provided that the historical crash data does not warrant the upgrade, it is not necessary to correct existing substandard profiles or horizontal sight distance conditions adjacent to or within the limits of the bridge.

If feasible, a bridge may also be lengthened or widened as needed to meet standards.

3. A Tier II environmental screening shall be performed. A determination shall be made during the Tier II process whether or not the project can be classified as a categorical exclusion and be delivered under the Footprint Program.

### 12.3 Guidelines

1. Prior to the beginning of Design, a report discussing the following guidelines, the recommended bridge improvement and the construction document conditions shall be submitted for concurrence with developing the project under the Footprint Program. This report should also state the design ADT, the design speed, the posted speed, and the geometric standards (controlling design elements information).



2. For bridges that are classified as structurally deficient and/or functionally obsolete the following conditions and remedies will apply:
  - a. If the bridge is structurally deficient only, the proposed improvements must remove it from the structurally deficient category.
  - b. If the bridge is both structurally deficient and functionally obsolete, the proposed improvements must remove it from the structurally deficient category and, ideally, remove it from the functionally obsolete category. However, if this cannot be achieved without major environmental, right-of-way or utility impacts, the project may still be considered for the Footprint program.
  - c. If the bridge is functionally obsolete only, the proposed improvements will remove the bridge from the functionally obsolete category. OR, the proposed improvements must significantly reduce deficiencies in elements such as vertical and horizontal clearances.

**Notes:**

The current and projected traffic volumes should be considered to avoid designing a structure that is or will be inadequate due to capacity.

If the proposed bridge work involves a major rehabilitation or replacement, it will not be eligible for any Federal funds for 10 years after construction is completed. The decision to rehabilitate the structure must be based on the cost-effectiveness of rehabilitation versus new construction and considerate of this funding stipulation.

3. It shall be determined if the existing bridge is either on or eligible for the National Register of Historic Places or a contributing element of an historic district. If this is the case, the method of preservation is to be evaluated and a corresponding rehabilitation scheme must be considered. Also, if the bridge is on the National Register then Sections 106 and 4(f) requirements are to be considered in the project development.
4. Vehicular crash records at and near the existing bridge site are to be reviewed to determine whether geometric design improvements on the approach roadway may be necessary. If geometric improvements are warranted, the design speed shall be in accordance with the appropriate AASHTO/NJDOT standards.

If such improvements require major Right of Way, environmental or utility impacts, then the project should be removed from the Footprint Program. However, if minor safety features such as improved warning signs, permanent pavement markings, guide rail and new highway lighting satisfy the safety concerns, a project will still be eligible for the Footprint Program.

**Note:** Under this Program, major right of way, will be considered to be total acquisition, relocations and significant revisions to internal traffic circulation of a roadway.

5. The Footprint Program may include a structure that requires only minor right-of-way, environmental and utility impacts.
6. The minimum roadway width shall conform to the appropriate AASHTO/NJDOT standards or meet the approach roadway width, whichever is greater (provided the approach roadways are not excessively wide).

7. Context Sensitive Design elements may be considered (such as pedestrian and bicycle accommodations or lighting).

If warranted, sidewalks and/or wider lanes may be provided. Aesthetic enhancements may be considered on all projects consistent with the comments obtained from the meetings.

8. Rapid bridge construction techniques and /or prefabricated bridge elements and systems should be utilized wherever possible to reduce construction duration. In addition, innovative structural designs should be considered when conventional methods create one or more of the following:
  - excessive ROW impact
  - undesirable sight distance condition
  - other undesirable design element or costly mitigation effort

## **Section 13 - Bridge Attachment Permits**

### **13.1 General**

The Department allows utility attachments to crossframes of an existing bridge. This is if the proposed addition is "a practical arrangement and considered to be in the public interest". Bridges, overhead sign support structures or other highway structures should not be used to support utilities where their support will impede the Department's ability to perform future work on the structure without relocation of the utility.

As a guide for the preparation of plans and for the review of plans for proposed attachments, the following information has been established:

### **13.2 Location**

1. The location of a utility crossing in a structure should be selected to avoid conflict with existing utilities or future utilities for which provisions have been made. Adequate access for maintenance and inspection of the planned installation and of the structure itself must be kept in mind.
2. Placement of utilities on bridge decks or sidewalk areas, or attachments to railings or parapets, are not permitted. Also prohibited are exposed installations at the outside faces of the structure.
3. Existing underclearances must be preserved. Section 32 of this Manual may be referred to for policy regulations concerning utility installations. Familiarity with the structural framework is necessary to avoid conflicts with bearing seats, crossframes, intermediate and end diaphragms and lateral bracing.
4. Structural integrity of the bridge components shall be preserved. The dead load of the proposed utility attachment shall not cause undue stresses.

### **13.3 Installation and Plan Requirements**

1. Joints in bridge decks usually define locations where differential movements can occur between adjacent spans resulting from temperature changes and traffic loads. Appropriate devices must be provided at these locations to accommodate similar movements in bridge attachments.
2. Galvanized structural steel should be utilized for supports where existing structural elements cannot be used to carry loads. Sizes of proposed structural shapes should be provided.
3. Specify the type, size and location of connections. High strength bolts (7/8 inch diameter preferred) shall be used. For existing structures, welding to existing structural appurtenances is prohibited. Welding to bottom flanges or lower one third of web of simply supported stringers is not permitted. Welding will also be prohibited in areas of negative moment area for continuous beams. Placement of anchor bolts or other inserts into deck slabs is also prohibited.
4. Pipes installed through abutment backwalls should be placed in galvanized steel sleeves that are set in non-shrink grout. The opening between the pipe and sleeve is to be packed with jute or similar material to prevent leakage through the backwall.
5. Ducts for electrical and communication cables are to be used.

6. Pipes carrying liquids under pressure in trenches should be sleeved within 10 feet of abutments, walls and piers.
7. All pipelines carrying liquids or gasses under pressure shall extend through the supporting structure without changes in alignment. Changes in alignment shall be outside the structure limits. Reactions developed at these locations should be carried by thrust blocks or other means completely independent of the bridge's structural elements.
8. The project location should be defined on a small scale location map on which the site can be seen in relationship to major points of reference; such as, highways, municipalities, bodies of water, county lines, etc.
9. Identification of the route, municipality, county, applicant, and proposed bridge attachment should be placed in the title block located in the lower right hand corner.
10. Provide a plan view with a North reference arrow, an elevation and a cross section of the structure and detailing and necessary dimensions to identify and locate existing and proposed structural members that are in relationship to the bridge attachment and to verify clearances. Additional sections should be shown, as required, to completely convey the extent of the work and/or modifications proposed.
11. The outside diameters and thickness of pipes, and weights of pipe or conduit and materials carried should be shown on the plans. If manufactured fittings, connectors, supports, etc. are used, their identity and spacing should be indicated on the plans and catalog cuts with dimensions should be traced on to the plans.

## Section 14 - Computer Programs

### 14.1 Design Calculations (Consultants)

1. The use of computers as a tool in the performance of design computations and other applications such as determination of dimensions and grades is acceptable provided:
  - All computer work is under the direct supervision of an experienced structural engineer familiar with computer techniques.
  - The Designer assumes responsibility for the logic and results of the program.
2. Documentation of all computer programs written by the Designer or obtained from other sources (including computer services) must be based on the use of the *AASHTO LRFD Bridge Design Specifications* with modification for NJDOT design requirements.
3. In the event that questions arise concerning the use of any software, the following information is to be maintained by the Designer:
  - a. A description of the program, explaining exactly what the program does, what options are available, what methods are used and AASHTO conformance.
  - b. The input required by the program, including a description of each value, an input form (if one is used), and sample input.
  - c. The output given by the program, including a complete description of each value, any keys used in interpreting the output, and sample output from the given input.
  - d. Any constants or parameters used in the program.
  - e. An explanation of how the program was checked, including a copy of computations relative to test.
4. Use of computer software does not relieve the Designer of the responsibility of ascertaining that the program is satisfactory for the use intended.
5. When computer output is included in a set of computations for submission, a copy of the input forms necessary to interpret the data should also be included.

### 14.2 Computer-Aided Drafting (Consultants)

1. Contract Plans prepared with the use of computer aided drafting systems will be acceptable provided that they are consistent with the provisions of this Manual. Guidance provided in the NJDOT CADD Standards Manual should be followed.
2. Changes required on drawings as a result of the Final design review must be made by the computer drafting system.

## **Section 15 - Integral Abutment Jointless Bridges**

### **15.1 Characteristics of Integral Bridges**

Integral abutment jointless type bridge structures are single or multiple span continuous bridge structures that have their superstructure cast integrally with their substructure. Due to the elimination of deck joints, construction and maintenance cost are lowered and fewer foundation piles are required. Also, research has indicated that this type bridge structure will perform better than a conventional bridge structure in a seismic event.

For these reasons, Designers should consider an Integral Abutment Jointless Bridge as the preferred choice when planning for a bridge replacement or new bridge design.

Integral abutment jointless bridges accommodate superstructure movements without conventional expansion joints. With the superstructure rigidly connected to the substructure and with flexible substructure piling, the superstructure is permitted to expand and contract. Relief slabs, connected to the abutment and deck slab with reinforcement, move with the superstructure. At its junction to the approach pavement, the relief slab may be supported by a sleeper slab. If a sleeper slab is not utilized, the superstructure movement is accommodated using flexible pavement joints.

The integral abutment jointless bridge concept is based on the theory that due to the flexibility of the piling, thermal stresses are transferred to the substructure by way of a rigid connection between the superstructure and substructure. The concrete abutment contains sufficient bulk to be considered a rigid mass. A positive connection with the ends of the beams or girders is provided by rigidly connecting the beams or girders and by encasing them in reinforced concrete. This provides for full transfer of temperature variation and live load rotational displacement to the abutment piling.

The connection between the abutments and the superstructure shall be assumed to be pinned for the superstructure's design and analysis. The superstructure design shall include a check for the adverse effects of fixity.

### **15.2 Criteria For Integral Abutment Bridge Design**

The movement associated with integral abutment jointless bridge design can be largely associated with thermal expansion and contraction of the superstructure. By definition, the length of an integral abutment jointless structure shall be equal to the abutment center line of bearing to abutment center line of bearing dimension. This also applies to continuous span structure lengths with expansion bearings at the piers. This length of expansion mobilizes the horizontal passive soil pressure.

Where rock or glacial till is within a distance to the surface that would stipulate the use of piles with an effective length that is less than 15 feet in length, the suitability of the site shall be carefully studied for integral abutment jointless bridge construction. This is based on the understanding that piles with an effective length less than 15 feet may not permit the flexibility that is required to withstand the expected superstructure movement. The Designer shall assure that the effective length of piles is adequate.

Also, soil strata should be studied to assess any potential of soil instability. If existing soils have any potential of instability, the Geotechnical Engineering Unit should be consulted for concurrence before proceeding with development of the Integral Abutment concept.

### **15.2.1 Relief Slab**

1. Relief slabs will always be required for integral abutment jointless bridge structures. Their lengths shall vary from a minimum of 10 feet to a maximum that is based on the intercept of a 1 V to 1.5 H line from the bottom of the abutment excavation to the top of the highway pavement. This length is to be measured along the centerline of roadway. Standard Drawing 2.5-5 within this Manual provides details for Relief Slab construction.

The relief slab detailing provided on Standard Drawing 2.5-5 is to be followed as the basis for its design. Of primary importance is the requirement that the relief slab shall include two complete layers of reinforcement.

2. The end of the relief slab shall be parallel to the skew. A width from face of rail to face of rail shall be provided. Special provisions shall be made to allow free movement of the relief slabs if curbs, barriers or sidewalks are present. Relief slabs shall always be a separate pour from the superstructure slab. However, they shall be joined together. The location of drainage structures in relief slabs is not permitted.
3. Where warranted, as per the Expansion Provisions stated below, to prevent the relief slab from moving excessively, it should rest on a keyed sleeper slab. The excavation for the sleeper slab shall be made after the compacted abutment backfill is placed. The sleeper slab shall be founded on undisturbed compacted material. No loose backfill may be used.
4. The relief slab shall be cast on two (2) layers of four (4) mil thick polyethylene sheets. It shall be designed as a structural slab that is supported at each end. Two layers of reinforcement shall be accounted for in the design and construction of the relief slab.
5. The provision of relief slabs for integral abutment jointless bridge construction will make the use of traditional approach slabs not necessary.

### **15.2.2 Expansion Provisions**

1. For bridge lengths 150 feet or less, provision for expansion at the relief slab ends may be waived if it is determined by the Designer that allowance for expansion at the relief slab end is not warranted.
2. For bridge lengths over 150 feet and up to 300 feet, provisions shall be made for expansion at the end of each relief slab by installation of a sleeper slab.
3. For bridge lengths over 300 feet and up to 450 feet, integral designs shall be approved by the Manager, Bureau of Structural Engineering, on an individual basis. Provision for expansion shall be made at the end of each relief slab by installation of a sleeper slab.
4. For bridge lengths over 450 feet, integral abutments should not be considered.

5. When planning the deck slab construction, the concrete placement must be planned to be a monolithic pour. No joints other than sawcut control joints or construction joints are to be considered for the planned pour.

### **15.3 Design Procedure Guidelines**

The following criteria shall be utilized in providing integral abutment jointless bridge designs:

#### **15.3.1 Hydraulics**

Integral abutment jointless bridge structures provide fixity between the superstructure and substructure and provide greater protection against translation and uplift than conventional bridges. The NJDOT Bridge Scour Evaluation Program and Structure Inventory and Appraisal Inventory records shall be studied to verify scour potential at a project site. To address potential impact of a scour effect on proposed Integral abutment bridge sites, the following areas should be reviewed and analyzed where scour potential exists:

1. Stream Velocity

Any history of erosion or scour at the bridge site should be reviewed and a determination made if the new structure will alleviate any problems (alignment, restricted opening etc.) that may contribute to scour. Where a scour history is determined, the potential positive effects of an Integral abutment jointless bridge should be noted. Scour information may be obtained by researching the NJDOT Bridge Scour Evaluation Program and Structural Inventory and Appraisal coding records referred to above.

2. Bank Protection

Suitable slope protection construction, to provide protection against scour, should be provided. On all integral abutment jointless bridges, geotextile bedding shall be used against the front face of the abutment, under the slope protection and down the slope a minimum of 6 feet.

#### **15.3.2 Skew Angle/Curved Girders**

The maximum skew angle for integral abutment jointless bridge designs shall be thirty (30) degrees. Skew angles greater than this shall preclude the use of integral abutment jointless bridge designs.

Superstructure configurations that require the use of horizontally curved girder schemes shall also preclude the use of integral abutment jointless bridge designs.

#### **15.3.3 Foundation Types and Criteria**

1. The abutment and pile design shall assume that the girders transfer to the piles all moments and vertical and horizontal forces that are produced by the superimposed dead load, live load plus impact, earth pressure, temperature, shrinkage, creep and seismic loads. The transfer of these forces shall be considered to be achieved after the rigid connection to the abutments is made. The rigid connection shall be detailed to resist all applied loads.

Use of pile supported reinforced concrete abutments are required. Alternate or proprietary type abutments are not permitted for Integral abutment designs.



2. All abutment substructure units shall be supported on a single row of piles. Due to the nature of the integral abutment jointless bridge design, flexibility in the vicinity of the pile to pile cap connection is important to help reduce the buildup of stresses which would normally be relieved through the use of expansion bearings and joints. Therefore, pile type selection shall be based on providing this increased flexibility and in accounting for the thermal movement of the superstructure.

Cast-in-place (C.I.P.), steel pipe piles (open-end or concrete filled), or steel H piles may be used for structures with span lengths of 150 feet or less.

In the use of steel pipe piles (open-end or concrete filled) or steel H-piles, the section loss (thickness) of the pile shall be considered due to corrosion that may occur over the life span of the bridge structure. If deemed necessary, additional corrosion protection, such as application of a coal tar epoxy coating or galvanizing of the pipe piles and H-piles may be stipulated.

Only steel H piles should be used for structures with span lengths over 150 feet. When steel H piles are used, the web of the piles shall be perpendicular to the centerline of the beams regardless of the skew. This will facilitate the bending about the weak axis of the pile. Weak axis bending generates less stress in the piles and accommodates bridge displacements better as compared with the strong- axis bending.

3. In order to reduce the stresses in the piles, for bridge span lengths of 100 feet or more, each pile at each substructure unit shall be inserted into a pre-bored hole. The pre-bored hole shall extend a minimum distance of 10 feet below the bottom of the planned finished ground line elevation. Steel casings may be used to shore up the augured hole. All details and notes required by the Foundation Design Report shall be placed on the plans. For bridge lengths under 100 feet, pre-boring may not be required.

The diameter of the augured hole shall be twice the size of the pile. After insertion of the pile, the hole or casing shall be filled with uncompacted I-8 soil aggregate. The uncompacted I-8 soil aggregate shall conform, according to the provisions of the NJDOT Standard Specifications, to designation I-8 soil aggregate.

The cost of pre-boring the holes, use of any casings and uncompacted I-8 soil aggregate shall be included in the Unit Price Bid of the pile item.

4. To provide adequate penetration, all piles shall then be driven to a minimum depth that accounts for a stilt type effect (scour or erosion), provision for loss of lateral support caused by scoured material, lateral loading and provision for sufficient lateral support.
5. The Designer must determine the practical point at which the embedded pile is determined to be fixed. The following steps may be followed to perform such an analysis:

Calculate the thermal movement demand. For a bridge structure with equal intermediate bent stiffness, the movement demand will be equal. The atmospheric temperature range, coefficient of expansion and the structure's length should be considered.

The plastic moment capacity of the embedded length of the pile (embedded in the concrete cap) must be calculated. As stated earlier, the pile shall be oriented for bending about the weak axis.

The column capacity must then be calculated.

The adequacy of the backwall to resist passive pressure due to expansion must be calculated.

6. When CIP or steel pipe piles (open ended or concrete filled) are used, pipe casings conforming to ASTM A252, Grade 2 minimum with a minimum wall thickness of  $\frac{1}{4}$  inches shall be used. This shall be noted on the plans. Higher grades may be used if it is determined that a higher grade meets the design parameters that have been considered in the pile selection.
7. A pile bent configuration should be used for the integral abutment substructure detailing. One pile per girder shall be used. Intermediate piles, as required, may be provided.
8. Pile selection shall be based upon the recommendations that are contained in the Geotechnical Report. The axial loads shall be based upon the reactions from the superstructure design. This shall include the superstructure dead load, live load plus impact and the substructure dead load.
9. As stated earlier, live load impact shall be included in the design of piles. The total length for single span bridges and the end span length for multiple span length bridges should be considered.
10. Steel H-piles may be socketed into a rock strata by means of drilling or boring. After drilling, the piles shall be driven to refusal. This method is permitted with the condition that the remaining effective length of pile is sufficient to permit the required bridge structure flexibility.
11. A pinned connection of the superstructure and abutments shall be assumed for the superstructure design and analysis. The superstructure design should include a check for the adverse effects of fixity.
12. Provision of pile splices shall not be planned. However, if required during construction, splices will not be permitted in the top and bottom 10 feet length of the pile.
13. The following is a flowchart that provides a simple procedure for determining the selection of a pile system.

### **Design Flow Chart for Integral Abutment**

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Step 1. Superstructure Design based on LRFD

Step 2. Design the abutment piles for vertical loads

2.1 Choose the pile that can carry the applied vertical loads

- Choose pile cross section
- Allow 1/16" corrosion around the pile perimeter.
- Calculate the allowable pile stress for the corroded section.
- Check the axial load capacity: If the total pile design load is more than the factored axial resistance, Redesign

Step 3. Design the piles for horizontal loading

3.1 Calculate the total thermal movement demand at the abutment

3.2 Calculate the plastic moment capacity of the section of the pile,  $M_p$

3.3 Check the ability of the surrounding concrete to develop the plastic moment capacity within the embedded length of pile penetrating the abutment.

3.4 Calculate the displaced shape and the bending moment diagram of horizontally loaded pile embedded in soil using the software LPILE, GROUP or FB Multiplier, etc.

- The boundary condition needed to model the pile-abutment system is fixed head + displacement. Using LPILE start modeling using fixed head condition (slope at the pile head = 0) and apply the lateral load that is needed to achieve the horizontal displacement.
- If  $M_{TOP}$  (moment at the top of pile) is less than the plastic moment  $M_p$  then reduce the pile section or the steel grade. Redesign
- If  $M_{TOP}$  is approximately equal to the plastic moment then remodel the system as a free head with an applied  $M_p$  at the top.

3.5 Check the unbraced length section of the pile as a beam column

- Determine the applicable group load cases on the unbraced length ( $L_c$ ) of the pile (unbraced = length of pile between zero moments)
- Calculate the pile capacities using AASHTO LRFD and develop an interaction diagram
- Superimpose the group loading on the interaction diagram
  - If the group loading is under the interaction diagram then, OK
  - If not, then redesign (increase pile cross section or the grade of steel)

### 15.3.4 Superstructure

1. Adjacent precast prestressed box beams, spread precast prestressed box beams, precast prestressed concrete girders and structural steel beams may be used for integral abutment jointless bridge configurations.

When precast prestressed box beams are to be used, thermal movement stresses shall be judged to be critical when the beams act by pulling an abutment with a relief slab. Mild reinforcement shall be added to the ends of the precast prestressed box beams to resist such stresses.

2. Standard Drawings 2.5-1 and 2.5-2 provide detailing for rigidly connecting structural steel type superstructures to the abutments.

As detailed in Standard Drawing 2.5-3, prestressed concrete girders may be connected by doweling them to the abutments. Inserts for the dowels should be planned as part of the fabrication process.

Slotted holes should be used when doweling of prestressed concrete members to the abutments is planned. Placement of prestressed concrete members on plain elastomeric pads should be detailed.

3. As detailed in Standard Drawing 2.5-2, steel girders may also be placed on plain elastomeric pads. Anchor bolts, if used, should pass through both the pad and the bottom flange of the girder. Another method is to use a longer bolt so that nuts may be placed above and below the bottom flange. The grade of the girder may be better controlled this way. Slotted holes should be used to allow better flexibility in aligning the girder.

Weathering steel, subject to the guidance provided in Subsection 24.19 of this Manual, may be used.

According to the NJDOT Standard Specifications, when weathering steel is used in Integral Abutment construction, the ends of the girders shall be painted for a distance that extends to one foot beyond the concrete diaphragm. To facilitate the shop fabrication of the girders, a length, to meet this requirement, shall be provided on the Plans.

### 15.3.5 Abutments

1. In integral abutment jointless bridges, the ends of the superstructure beams are fixed to the integral abutments. Expansion joints are thus eliminated at these supports. When the expansion joints are eliminated, forces that are induced by resistance to thermal movements must be proportioned among all substructure units. This must be considered in the design of integral abutments.
2. The integral abutment jointless bridge concept is based on the theory that, due to the flexibility of piles, thermal stresses are transferred to the substructure by way of a rigid connection. The concrete abutment contains sufficient bulk to be considered a rigid mass. To facilitate the stress transfer, abutments shall be placed parallel to each other and ideally be of equal height.
3. The connection between the girder ends and the abutment shall provide for full transfer of temperature variation and for live load rotational displacement to the abutment piling.

4. To support the integral abutment jointless bridge, a single row of piles shall be used. The piles are driven vertically and none are battered. This arrangement of piles permits the abutment to move in a longitudinal direction under temperature effects.
5. If construction of a Mechanically Stabilized Earth (MSE) wall system is planned and the location of the wall system will be in front of the abutment, abutment piles shall be placed in plastic sleeves while the MSE wall is constructed. After the MSE wall is constructed, the piles, as required, shall be driven to refusal or to a minimum tip elevation. The pile sleeves shall then be filled with un-compacted sand.

### **15.3.6 Piers**

1. Piers for integral abutment jointless bridges have similar design requirements and share common design procedures with the piers of a more traditional bridge. The primary distinguishing features of the piers for an integral abutment bridge involve their ability to accommodate potentially large superstructure movements and the sharing of lateral and longitudinal forces among the substructure units.
2. As with integral abutments, the piers must also be designed to accommodate the movements of the superstructure. Thermal movements are usually the major concern, although superstructure movements, due to concrete creep and drying shrinkage, will also be present to some degree.
3. As part of the overall structural system, integral abutment jointless bridge piers will typically be required to carry a portion of externally applied longitudinal and transverse loads. In addition, thermal movements of the superstructure will induce forces as the piers attempt to restrain those movements.
4. As the superstructure expands and contracts with seasonal temperature changes, and to a lesser extent, creep and shrinkage, the tops of the piers will be forced to undergo displacements relative to their bases. These displacements will produce curvatures in columns that can be closely estimated based on the magnitude of the movements, the fixity conditions at the top and bottom of the columns and the height of columns.
5. Once curvatures are estimated, an effective column stiffness must be considered to compute internal moments and shears. A set of equivalent external forces, in equilibrium with the computed internal moments and shears, must be computed. This set of equivalent forces is used in subsequent analysis to represent the effects of superstructure movements on the piers.
6. Forces induced by the distribution of the superstructure movements must be computed. Also, the distribution of externally applied loads to the substructure units must be estimated.
7. Similar to the design of a traditional pier, piers of integral abutment jointless bridges are designed for load combinations. Often, load combinations involving temperature, creep and shrinkage, as opposed to combinations containing external loads only, control the design. A pier must be capable of undergoing the imposed superstructure movements while simultaneously resisting external forces.

8. A bearing at a pier of an integral abutment jointless bridge structure should only be fixed when the amount of expected expansion from the bearing to both abutments or adjoining pier is equal. All other cases should use expansion bearings.
9. The following guidance shall be followed in determining the type of pier selection in integral abutment jointless bridge designs:

- a. Continuity at Piers.

- 1) The concrete deck slab must be physically continuous, with joints limited to sawcut control joints or construction joints. Distinction must be made between slab continuity and girder continuity at the piers.
- 2) If, in accommodating the load transfer, girder continuity is deemed appropriate by the design, the superstructure shall be assumed continuous for live loads and superimposed dead loads only. Girders shall be erected as simple spans and made continuous by the addition of mild steel in the deck slab.
- 3) Longer span integral jointless bridges; i.e., those with spans over 100 feet shall be detailed to provide a deck slab placement sequence if girder continuity is to be provided.  
Where applicable, casting of concrete diaphragms over the piers should be done concurrently with placement of the slab.
- 4) When slab-only continuity is provided over the piers, girders are to be designed as simply supported for all loads.

- b. Types of Piers.

To design piers to accommodate potentially large superstructure movements, the following options are available:

- 1) Flexible piers, rigidly connected to the superstructure;
- 2) Isolated rigid piers, connected to the superstructure by means of flexible bearings;
- 3) Semi-rigid piers, connected to the superstructure with dowels and neoprene bearing pads;
- 4) Hinged-base piers, connected to the superstructure with dowels and neoprene bearing pads.

- c. Flexible Piers.

- 1) A single row of piles, with a concrete cap that may be rigidly attached to the superstructure, provides a typical example of a flexible pier. This type of pier is assumed to provide vertical support only. The moments induced in the piles due to superstructure rotation or translation are small and may be ignored.
- 2) A bridge constructed with flexible piers relies entirely on the integral abutments for lateral stability and for resisting lateral forces. Passive pressures behind the backwalls, friction, and passive pressures on the abutment piles should be mobilized to resist lateral and longitudinal forces.

- 3) With this type of pier use, temporary lateral bracing may be required to provide stability during construction. Designers must consider a means to account for passive soil pressures in the vicinity of the backwalls.

d. Isolated Rigid Piers.

- 1) Rigid piers are defined as piers whose base is considered fixed against rotation and translation, either by large footings bearing on soil or rock, or by pile groups designed to resist moment. The connection to the superstructure is usually detailed in a way that allows free longitudinal movement of the superstructure, but restrains transverse movements. This type of detailing permits the superstructure to undergo thermal movements freely, yet allows the pier to participate in carrying transverse forces.
- 2) With this class of pier, the superstructure is supported on relatively tall shimmed neoprene bearing pads. A shear block, isolated from the pier diaphragm with a compressible material such as cork, is cast on the top of the pier cap to guide the movement longitudinally, while restraining transverse movements.
- 3) This type pier represents the traditional solution taken with steel girder bridges at so called expansion piers. It offers the advantage of eliminating the stresses associated with superstructure thermal movements. It also provides piers that require no temporary shoring for stability during construction.
- 4) In utilizing this system, additional consideration must be given to the detailing associated with the taller bearing pads and the detailing associated with the shear key. In addition, because the pier and the superstructure are isolated longitudinally, the designer must ensure that the bearing seats are wide enough to accommodate seismic movements.

e. Semi-Rigid Piers.

- 1) These piers are similar to rigid piers. Their bases are considered fixed by either large spread footings or pile groups; however, the connection of the piers to the superstructure differs significantly.
- 2) In utilizing prestressed concrete girders that bear on elastomeric pads, a diaphragm is placed between the ends of the girders. Dowels, perhaps combined with a shear key between girders, connect the diaphragm to the pier cap. Compressible materials are frequently introduced along the edges of the diaphragm, and, along with the elastomeric bearing pads, allow the girders to rotate freely under live load.
- 3) The dowels force the pier to move with the superstructure as it undergoes thermal expansion and contraction and, to a lesser extent, creep and shrinkage. Accommodation of these movements requires careful analysis during the design of the piers. Normally, the stiffness of the piers is assumed to be reduced due to cracking and creep.

- 4) There are several advantages to this type of pier: detailing is simplified, use of thin elastomeric pads are relatively inexpensive, temporary shoring is not required during construction, all piers participate in resisting seismic forces and the girders are positively attached to the piers. In addition, with many piers active in resisting longitudinal and transverse forces, the designer need not rely on passive soil pressures at the integral abutments to resist lateral forces.
  - 5) Design of semi-rigid piers is slightly more complicated because careful assessment of foundation conditions, pier stiffnesses and estimated movements is required. In some situations semi-rigid piers are inappropriate. For example, short piers bearing on solid rock may not have adequate flexibility to accommodate movements without distress.
- f. Hinged-Base Piers.
- 1) This type of pier may be used to avoid the need for an expansion pier in a situation where semi-rigid piers have inadequate flexibility. A "hinge" is cast into the top of the footing to permit flexibility of the column.
  - 2) Temporary construction shoring may be required, and additional detailing requirements at the top of the footing may increase cost; however, the designer should keep this alternate in mind under special circumstances where the other pier types are not feasible.

### **15.3.7 Wingwall Configuration**

1. In-Line or wingwalls that are parallel to the abutment in excess of 12 feet should be supported on their own foundation independent of the integral abutment system. In this case, a flexible joint must be provided between the wingwall stem and the abutment backwall.
2. Flared walls cantilevered off of the abutments may be considered by the Designer on a case by case basis. The use of flared wingwalls should generally only be considered at stream crossings where the alignment and velocity of the stream would make in-line walls vulnerable to scour. Piles shall not be placed under any flared walls that are integral with the abutment stem.
3. U-walls, integral to the abutment, shall preferably not measure more than 10 feet from the rear face of the abutment stem. Refer to Standard Drawing 2.5-4 for conceptual detailing.

If U-walls greater than 10 feet in length are required, the wingwall foundation should be separated from the abutment foundation. A flexible joint between the abutment backwall and wingwall stem should be provided. This type arrangement will maintain the abutment/pile flexibility so that the thermal movement of the superstructure is permitted.

4. The offset distance between the end of the relief slab and the rear face of the U-wall should preferably be a minimum of 4 feet. If the relief slab must extend to the rear face of the U-wall, they shall be separated by a 2 inch joint filled with Prefomed Expansion Joint Filler material.



### 15.3.8 Horizontal Alignment

Only straight beams will be allowed. Provided that the beams are straight, structures on curved alignments will be permitted.

### 15.3.9 Grade

The maximum difference in elevations between abutments shall be 5%. This is meant to facilitate an even vertical alignment between abutments.

### 15.3.10 Stage Construction

Stage Construction is permitted. Special consideration shall be given to the superstructure's rigid connection to the substructure during concrete placement when staging construction. The superstructure should be secured, free from rotation, until all concrete, up to the deck slab, is placed.

### 15.3.11 Seismic Modeling and Design

If the seismic design category (SDC), displacement demand and type of abutment and backfill warrant the seismic design of the integral abutment, design the abutment according to the following:

#### 1. Modeling

Refer to Section 5.2 of *AASHTO Guide Specifications* for seismic analysis.

- a. The general concept behind modeling the seismic response of a bridge structure is to determine a force-displacement relationship for the total structure that is consistent with the ability of the structure to resist the predicted forces and displacements.
- b. Integral abutments shall be modeled to move under seismic loading in both the longitudinal and the transverse directions, thus distributing more transverse forces to the piers.

Be aware that transverse seismic loads may overstress piles in the strong direction. To account for this, the pile tensile capacity may be increased. Otherwise, the integral wingwalls may be designed to resist transverse seismic loads. This will result in lower lateral seismic loads on a pier.

- c. The bridge structure shall be modeled in three dimensions for a stiffness analysis. A multi-mode analysis may be used. For a single span structure, a two dimensional single mode may be used to analyze the structure.
- d. To analyze integral abutment bridges under seismic loads, the stiffness of the abutments must be evaluated. This stiffness should be taken as the function of the abutment height, soil type, abutment thickness and theoretical movement.
- e. The pier type selection should be considered in the seismic modeling. Isolated rigid or semi-rigid piers can participate in resisting seismic loads in the transverse direction. Shear keys and use of dowels with these type piers should be designed to resist transverse forces using the appropriate R-factor for connections.

For isolated rigid piers, the required bridge seat should be accounted for in the modeling.

- f. If necessary, a pinned connection between the superstructure and the abutments should be assumed for the modeling. However, a check for a fixed connection should also be made.
- g. The piles supporting the abutments should be modeled using the length of fixity. The length of fixity can be estimated with the L-PILE program, as an example.

## 2. Design

- a. The abutment walls and piles should be designed for the controlling load case. The abutment walls should be designed by using the proper pressure distribution as determined from a dynamic analysis.

The abutment wall cross section should be designed for the maximum shear and moments that act on them in both the vertical and horizontal direction. Girders can be assumed to act as monolithic supports in the horizontal direction.

- b. Design of abutment walls, piles, and footings shall be based on *AASHTO Guide Specifications for LRFD Seismic Bridge Design*.
- c. The soil pressure behind the abutments should be checked and compared to maximum stress limits and the girders should be checked for the additional axial stress that is imposed by the seismic loads.

### 15.3.12 Utilities

Rigid utility conduits, such as gas, water and sewer, are discouraged with integral abutment construction. However, if required, expansion joints in conduits must be provided at each abutment. Sleeves through the abutment should provide at least 2 inches of clearance around the conduit.

Flexible conduits for electrical or telephone utilities that are properly equipped with an expansion sleeve through the integral abutment are acceptable.

## 15.4 Construction Procedures

The connection scheme of a steel or concrete superstructure governs the procedure that should be followed for the construction of an integral abutment bridge structure. Standard Drawings 2.5-1 and 2.5-2 specify a sequence of steps for integral abutment construction with a steel superstructure and Standard Drawing 2.5-3 specifies a sequence of steps for integral abutment construction with a concrete superstructure.

When constructing a relief slab and sleeper slab, the following procedure should be followed:

1. To permit unhindered longitudinal movement of the relief slab, the surface of the subbase course must be accurately controlled to follow and be parallel to the roadway grade and cross slope.
2. A filter fabric or some type of bond breaker such as polyethylene sheets should be placed on the finished subbase course the full width of the roadway prior to placement of relief slab reinforcement.
3. Pour the relief slab concrete starting at the end away from the abutment, progressing toward the backwall. If it can be so controlled, relief slabs should be

poured in early morning so that the superstructure is expanding. Therefore, the slab is not placed in tension.

4. As shown on Standard Drawings 2.5-1 through 2.5-3, a construction joint between the deck slabs and relief slabs should be placed.

Suitable notes should be provided on the plans to incorporate these construction procedures. Other procedural construction methods, as determined by the Designer and as suitable for the selected superstructure type, may be provided.

The following pay items may be used to account for the respective work:

- Concrete in Superstructure, Relief Slab Integral Abutment
- Concrete in Superstructure, Sleeper Slab Integral Abutment

Abutment backwall and diaphragm concrete may be included in the overall deck slab pay item quantity.

### **15.5 Semi-Integral Abutment Design**

- A. A semi-integral abutment design structure is one whose superstructure is not rigidly connected to its substructure. It may be a single or multiple span continuous structure whose integral characteristics include the following:

- jointless deck
- integral end diaphragms
- compressible backfill
- movable bearings

In this concept, the transfer of displacement due to the piles is minimized. The rotation is generally accomplished by use of a flexible bearing surface at a horizontal interface in the abutment. Horizontal displacements not eliminated in a semi-integral concept must still be considered in the design.

In a semi-integral abutment concept, the girders extend onto the bridge seat and may be embedded into the backwall concrete. However, the girders are not connected to the abutments.

In lieu of conventional deck joint bridges, or where a full integral bridge is not desirable, semi-integral bridges may be considered. The foundations for this type structure shall be stable and fixed. A single row of piles should not be utilized. The foundation piles should be stiffened by inclusion of battered piles or, the foundation may be founded on a spread footing.

- B. The expansion and contraction movement of the superstructure should be accommodated at the roadway end of a relief slab. The geometry of the relief slab, design of the wingwalls and transition parapet, if any, must be compatible with the freedom required for the integral configuration (beams, deck, backwall and relief slab) to move longitudinally.
- C. Refer to Standard Drawing Plate 2.5-6 for conceptual detailing of a Semi-Integral Abutment configuration.
- D. Semi-Integral abutments can be designed as conventional abutments with the following exceptions:
  1. The suspended backwall must be designed for full passive soil pressure.
  2. Wingwalls must be independent from the suspended backwall.

3. Provision for expansion at the ends of the relief slabs must be provided.
4. The top reinforcement in the deck slab at the end of the span should be designed for the negative moment produced from the reaction of half the relief slab dead load and a live load reaction placed on the suspended backwall. The dead load of the suspended backwall should not be considered because the backwall is constructed in a separate placement before the deck and thus will not contribute to tensile stress in the deck slab.

**Note:** Refer to Standard Drawing 2.5-6 for detailing nomenclature.

E. Selection Criteria and Details. The following considerations will preclude use of the Semi-Integral abutment concept:

- Maximum skew -  $30^\circ$
- Maximum expansion length – 200 feet (Distance to nearest Fixed Bearing)
- No restriction on abutment height

## Section 16 - Foundations Design Criteria

Section 10 - Foundations of the *AASHTO LRFD Bridge Design Specifications* shall be followed for the design of foundations.

Additionally, the following guidance is provided to assist Designers in utilizing the AASHTO LRFD Specifications:

### 16.1 Determination of Soil Properties

Subsurface exploration and soil tests shall be performed in accordance with Subsection 10.4 of the *AASHTO LRFD Bridge Design Specifications* (with current interims) and the criteria established in Section 34 of this Manual.

### 16.2 Loads

1. Mass Density (Unit Weight) of Soil ..... 120 lbs./cu.ft
2. Mass Density (Unit Weight) of Concrete .....150 lbs./cu.ft
3. Surcharge loads shall be based on the criteria that is stated in Subsection 3.11.6 of the *AASHTO LRFD Bridge Design Specifications*.
4. To consider the vertical load per foot of approach slabs that react on the abutment backwall, 1/3 of the approach slab length shall be assumed to cause reactions onto the abutment. Also reference Subsection 17.2.7 of this manual
5. Compaction induced additional earth pressures, that are due to construction equipment, shall be considered. Subsection 3.11.2 of the *AASHTO LRFD Bridge Design Specifications* should be referred to for guidance in estimating such earth pressures.

### 16.3 Foundations

In order to prevent damage from frost heave, footings shall be founded at an elevation that is a minimum of 4 feet below the existing ground line or, other than when founded on sound rock, shall be embedded in a minimum 3-foot depth from the ground line to the top of the footing to provide adequate bearing, scour and frost heave protection, whichever is greater.

Also, refer to Section 39 of this Manual for guidance concerning scour considerations.

#### 16.3.1 Spread Footings

- a. The minimum footing thickness shall be 2 feet.
- b. Passive resistance shall be disregarded in sliding failure determination.
- c. Top heel steel shall be designed to support all superimposed loading plus the dead load of the footing. This is without reduction from minimum upward soil pressure that acts beneath the heel.
- d. Toe steel design shall be based upon a cantilever design with earth pressure acting upward and the dead load of concrete acting downward.
- e. Bearing resistance shall be calculated in accordance with AASHTO LRFD Bridge Design Specification, Section 10 for Strength Limit State and Extreme Limit State.

- f. Sliding and Overturning failures shall be checked in accordance with AASHTO LRFD Bridge Design Specification, Section 10 for Strength Limit State and Extreme Limit State.
- g. Eccentricity Load Limitation
  - 1) Strength Limit state
 

The Eccentricity of loading at the Strength Limit state shall be evaluated in accordance with section 10.6.3.3
  - 2) Extreme Limit state
 

Whether the footing is on soil or rock, the eccentricity of loading for Extreme Limit states shall not exceed the limits provided in AASHTO LRFD Bridge design Specification, section 11.6.5 and section 10.6.4.2.
- h. Settlement and overall global stability shall be evaluated in accordance with AASHTO LRFD Bridge design specification, section 10 for Service Limit state and Extreme Limit state.

The following information shall be indicated as Foundation Design Criteria in General Notes on the Preliminary and Final Bridge Plans:

- 1) Nominal Bearing resistance for strength limit state
- 2) Factored Bearing resistance for strength limit state
- 3) Nominal Bearing resistance for extreme limit state

### **16.3.2 Pile Foundations**

In addition to the AASHTO LRFD Bridge Design Specifications, the procedures in the Federal highway administration, Design and Construction of Driven Pile Foundations, workshop manual volume I and II shall be followed.

- a. The minimum pile cap thickness shall be 3 feet.
- b. Material for steel H-piles shall conform to AASHTO M270 Grade 50. Steel H-piles for use in marine environments shall conform to AASHTO M270, Grade 50. All exposed surface areas and those that are within 2 feet of the mudline shall be coated with a 16 mil application of coal tar epoxy as per SSPC Paint Specification 16.

The minimum steel H-pile section for use in pile foundations shall be 12 inches.

In locations where steel piling or steel shells may be subjected to abrasive actions of the bed load of materials, an increased effective section is to be considered in the pile size selection.

- c. Section loss of the pile shall be considered due to corrosion as specified in FHWA-NHI-05-042.
- d. The use of timber piles should be evaluated against current environmental regulations on the use of treated timber. Environmental restrictions may preclude the use of any treated timber product.
- e. Prestressed/Precast Concrete Piles

Class P Concrete

Class P Concrete with corrosion inhibitors shall be required for buried piles.

High Performance Concrete (HPC)

Use of HPC is based on the following conditions:

- a. Prestressed or Precast concrete piles that are to be used in environmentally aggressive conditions (such as exposure to tidal areas). Use of HPC will optimize the expected durability and performance of the prestressed/precast concrete piles. Performance measures such as permeability and abrasion resistance will better assure the expected service life of such pile systems. When such performance is desired, HPC should be used. The strength requirements shall be determined by the Designer based on Section 27 of this manual for class of concrete.
- b. A concrete pile that requires a design compressive strength greater than  $f'_c=6000$  psi should be designed as an HPC element.
- c. Use the following criteria to develop an HPC mix design. Establish the Specific Performance Requirements in the Project's Special Provisions.

| <b>Performance Characteristic</b>                  | <b>Standard Test Method</b> |
|--|-----------------------------|
| Creep @ 180 days<br>(x=microstrain/pressure unit)  | ASTM C 512                  |
| Modulus of Elasticity                              | ASTM C 469                  |
| Chloride Permeability 56 days                      | AASHTO T 277                |
| Shrinkage<br>(x=length change in microstrain)      | ASTM C 157                  |
| 56 Day Compressive Strength                        | AASHTO T 22                 |
| Abrasion Resistance<br>(x= average depths of wear) | ASTM C 944                  |

Notes:

1. Acceptance of HPC pile systems shall be based on achieving the design compressive strength required in a Project.
  2. Chloride permeability testing and Abrasion Resistance testing will only be required when precast or prestressed concrete piles are to be submerged in water as pier bent members.
  3. All tests will be performed on samples that are moist cured for 56 days.
- f. The following criteria, concerning pile foundation design and construction requirements, shall be indicated as Foundation Design Criteria General Notes on Final Bridge Plans and in the Geotechnical report:
- 1) Pile type, size, and the associated material properties
  - 2) Nominal Axial Compression Resistance
  - 3) Factored Axial Compression Resistance
  - 4) Nominal Uplift Resistance

- 5) Factored Uplift Resistance
  - 6) Nominal Driving Axial Compression Resistance (Required Driving Resistance for Determination of the Bearing resistance using PDA and CAPWAP)
  - 7) Maximum Resistance (if exist only).
  - 8) Estimated Pile Tip Elevation
  - 9) Minimum Pile Tip Elevation (only specified if necessary)
- g. The Standard Specifications require that the Contractor submit a completed "Pile and Driving Equipment Data Form" and wave equation analysis using WEAP to demonstrate that piles can be driven with reasonable effort to the ordered lengths and without damage.

Also, the Contractor is to conduct the Pile Driving Analyzer (PDA) tests with the Case Pile Wave Analysis Program (CAPWAP) test piles, or as may be directed by the Resident Engineer (RE).

- h. Designers shall be aware of the Standard Specifications requirements in advancing the design of a pile foundation design. The following guidance shall be followed for pile design requirements:

1) Nominal Axial Compression Resistance

2) Factored Axial Compression Resistance

A resistance factor as specified in Subsection 10.5.5.2.3 of the AASHTO LRFD Bridge Design Specifications should be used to determine the Factored Axial Compression Resistance.

3) Nominal Driving Axial Compression Resistance (Required Resistance for PDA)

Nominal Driving Axial Compression Resistance should be evaluated by adding nominal axial side resistance from scourable soils, soil susceptible for downdrag and other unsuitable materials not used for the determination of Nominal axial compression resistance, to Nominal Axial Compression resistance.

4) Maximum Driving Resistance

If a hard/very dense layer or obstruction is expected in the intermediate layers and requires higher resistance than the nominal driving resistance to drive through such materials, this is considered as Maximum Driving resistance. Perform a Drivability analysis to establish a hammer and driving system that will install the pile in a satisfactory manner. If this is the case, the Nominal Driving Axial Compression Resistance shall be used for the bearing resistance determination during pile driving.

5) Minimum Pile Tip Elevation

If required, a minimum pile penetration should only be specified to ensure that all of the applicable limit states are met; e.g., lateral deflection, uplift, scour, downdrag and pile group settlement.

6) Test piles are required to be monitored with PDA and CAPWAP.

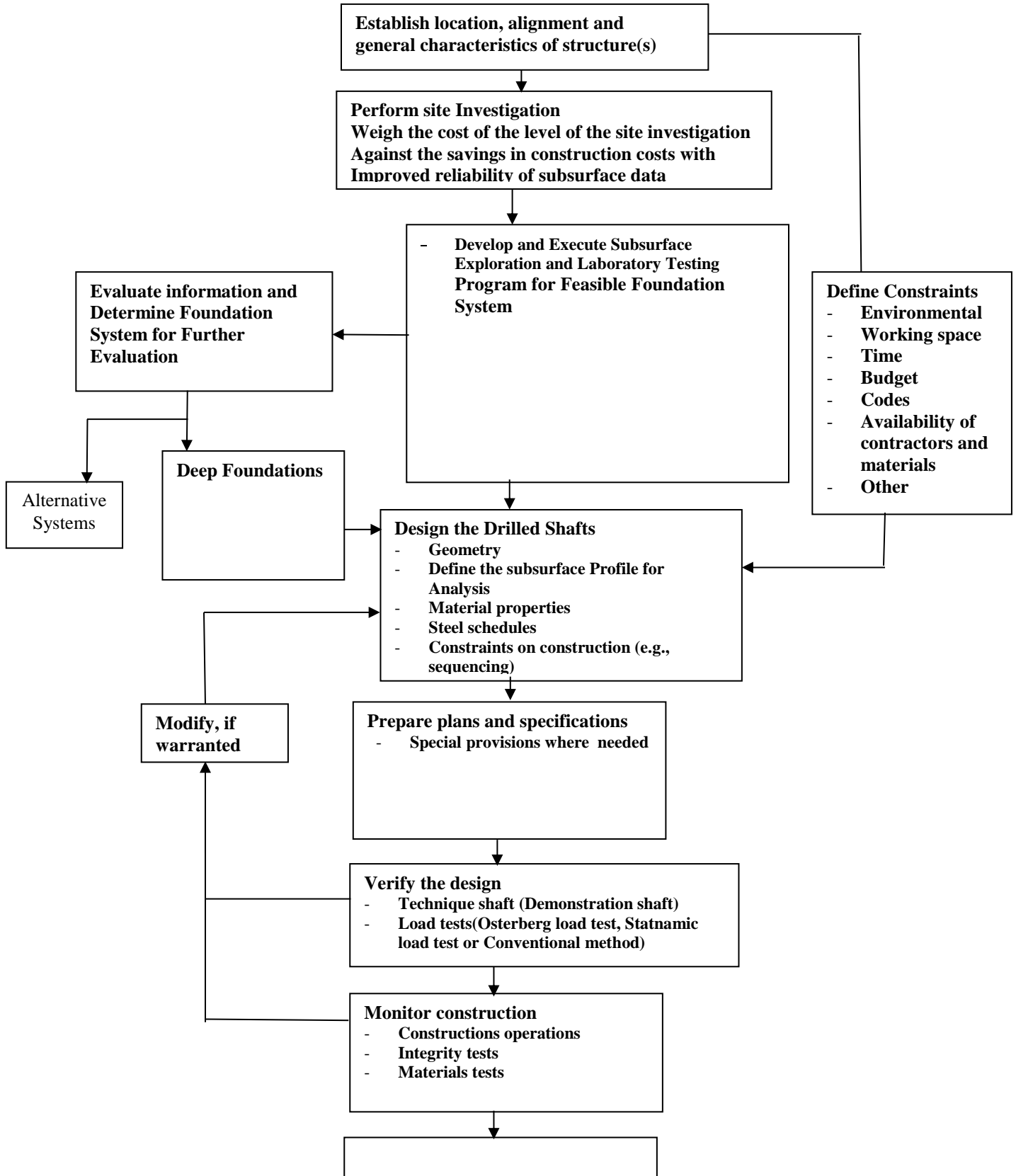


- i. Refer to Guide Plate 3.4-6 for guidance on test pile plan designations. In establishing estimated test pile lengths, the total length that is provided for bidding purposes should be considerate of potential variant lengths of each test pile location. That is, the length of each test pile should not be based on an averaging of length per test pile.
- j. When use of prestressed concrete piles are planned and they are to be constructed in a marine environment, grit impregnated epoxy coated prestressing steel strands shall be used. The grit impregnated epoxy coated prestressing steel strands shall conform to the requirements of ASTM A882.  
Low relaxation prestressing strands shall be used for all prestressed concrete pile applications.
- k. The effects of scour must be considered in addressing pile type selection.
- l. When selecting concrete filled pipe piles, the effective depth of the concrete must be considered in regard to structural capacity.

### **16.3.3 Drilled Shaft Foundations**

In addition to the NJDOT Drilled shaft Specification and AASHTO LRFD Bridge Design Specifications, the Federal Highway Administration Publication Number FHWA-NHI-10-016, titled "Drilled shafts: Construction Procedures and LRFD Design Methods" shall be followed,

- a. The following flow chart illustrates the overall process of designing and constructing drilled shafts:



- b. The Designer shall be cognizant that the initial design may, due to conditions encountered in the field, require modifications. As such, the Designer should be prepared to respond to this requirement.
- c. When drilled shafts, that are constructed in moderately or extremely aggressive environments and that extend through water, are used in bents, they shall be detailed to eliminate construction joints within the Splash Zone. Additionally, it is preferred that such shafts extend to the bottom of the bent cap without a construction joint.
- d. The following criteria, concerning Drilled shaft foundation design and construction requirements, shall be indicated as Foundation Design Criteria General Notes on the Preliminary and Final Bridge Plans:
  - 1) Nominal Axial Compression Resistance
  - 2) Factored Axial Compression Resistance
  - 3) Nominal Uplift Resistance
  - 4) Factored Uplift Resistance
  - 5) Top of the drilled shaft elevation
  - 6) Top of rock socket elevation
  - 7) Tip of drilled shaft elevation

#### **16.3.4 MicroPile Foundations**

In addition to the AASHTO LRFD Bridge Design Specifications, the Procedure in the Federal Highway Micropile Design and Construction FHWA-NHI-05-39 shall be followed,

The following criteria, concerning pile foundation design and construction requirements, shall be indicated as Foundation Design Criteria General Notes on the Preliminary and Final Bridge Plans and in the Geotechnical report:

- 1) Pile size
- 2) Nominal Axial Compression Resistance
- 3) Factored Axial Compression Resistance
- 4) Nominal Uplift Resistance
- 5) Factored Uplift Resistance
- 6) Top of Micro Pile Elevation
- 7) Top of Bond Zone elevation
- 8) Tip of Casing Elevation
- 9) Tip of Micropile Elevation

Design shall be verified by load tests on Micropiles as specified in the Specification.

#### **16.3.5 Foundation Tolerable Movements**

- a. Movements that must be addressed in a foundation's design shall include those of vertical, horizontal and rotational.

- b. As controlling parameters, a foundation is to be designed to provide a total and differential settlement of one (1) inch. If the one inch requirement results in significant cost to the detailing of the superstructure, designing for provision of an efficient total settlement that is greater than one inch may be pursued. The NJDOT Geotechnical Engineering Unit should be contacted for concurrence as to a recommended settlement value.

#### **16.4 Additional Conditions**

Additional conditions to consider for stability of the structure should be checked in terms of:

1. Maximum acceptable post construction settlement.
2. Foundation soil's stabilization for minimum residual settlement.
3. Overall earth mass stability of the foundation soils and/or embankment supporting the structure.
4. Consideration of soil characteristics on the post construction effect on pile foundations (drag and additional lateral pressure).

#### **16.5 Prestressed Concrete Pile Connections**

1. In order to account for the potential uplift of prestressed concrete piles, details to provide for a connection between the pile and pile cap shall be developed and provided in the final plans.
2. The use of mild steel dowels shall be planned for to provide this connection. Details to indicate field drilling and grouting of inserted dowels shall be provided. The size of the dowels and their length shall be as determined by design.

## Section 17 - Abutments and Walls

### 17.1 Design Criteria and Guidance

1. Design of abutments and walls shall be in accordance with Section 11 of the *AASHTO LRFD Bridge Design Specifications*.
2. For contracts with long walls or several walls, design and detailing information may be conveniently presented in a panel-by-panel tabulation.
  - a. Panels should be identified numerically on the General Plan and Elevation and referred to in the tabulation. Similarly, various types of wall sections, reinforcement patterns, etc. should be detailed once and identified for use in the tabulation.
  - b. The tabulation should also indicate footing dimensions for each panel, panel end point elevations and footing elevations.
3. Details such as the placement and arrangement of non-stress reinforcement on wall stems, key construction, I-9 soil aggregate placement, drainage for back of walls and joint construction are common to all panels and should be presented once in a contract set of plans.
4. When "stepped" footings are used for long walls, the step should preferably not be greater than the depth of the footings, except that when the footing is on piles, the step may be twice the depth of the footing. A 1:1 slope of the concrete should be provided at each step.
5. For conventional retaining walls, contraction joints shall be provided at intervals not exceeding 30 feet. Expansion joints shall be provided at intervals not exceeding 90 feet. Abutment joints shall be located approximately midway between the longitudinal superstructure members that rest on the abutment seat.
6. Keyed contraction joints shall be provided in footings. They shall be located under the wall expansion joints.
7. Back of wall drainage shall be provided for all walls including U-Type semi-stub abutments. Weep holes through walls shall not be used where they empty onto pedestrian sidewalks or onto roadways where ponding and freezing could create a safety hazard.

Roadway drainage provisions shall be detailed so that drainage pipes do not empty directly through abutment walls.
8. Wing stems ("elephant ears") shall be shown on the plans for U-Type and flared walls in accordance with the details shown on Guide Plate 3.4-5. The stems of walls shall be designed for combined axial load (including dead load of stem and of backfill acting on stem) and bending due to vertical loads and earth pressure.
9. Designers and detailers should be aware that form work is a substantial part of the construction cost for walls and abutments. Details that permit reuse of forms on as many sections as possible produce economies in the overall construction cost.

10. When battered cross sections are used, the batter of forms should always remain constant and the width of the wall at the top of the batter should be wide enough so the form can extend beyond the top of the batter and still have enough room between the front and rear forms to easily place the concrete.
11. Batters that extend only part way up a wall should be avoided. If partial batters are used, the height of the battered portion should always be made a constant height. If the height of the battered portion is constant with respect to the top of the footing, then the variation in height shall be made up in the upper vertical portion of the wall. This will allow maximum reuse of the battered form.
12. Curved wingwalls should be avoided wherever possible and should not be battered since the shape of the form must be dish-shaped which is extremely difficult to form.
13. If it is absolutely necessary to provide a curved wingwall, it is best to place the footing and the wall on chords and curve only the top portion of the wall.
14. For conventional retaining walls, Subsection 11.6.3.3 – Overturning and 11.6.3.6 – Sliding of the AASHTO LRFD Specifications may be referred to for consideration of these phenomena in Abutment and Wall designs.
15. Due to the non-standardization of design parameters for assessing the use of bridge seat pedestals, planning for the construction of pedestals on abutment bridge seats is not permitted.
16. Use of corrosion protected reinforcement steel shall be scheduled for, initially, all abutment wall grillage reinforcement and the exposed side of retaining walls. Engineering judgment should be used to evaluate the project location toward possibly planning for the use of corrosion protected reinforcement steel for the entire abutment wall or retaining wall construction.

Also, if it is determined that the project site environment is aggressive in nature, then use of a reinforcement steel other than epoxy coated reinforcement steel may be scheduled for the abutment wall or retaining wall construction.

To further offset the potential of corrosion development, concrete mix designs for abutment or retaining wall construction may include a corrosion inhibitor admixture.

## **17.2 Design Parameters**

1.  $f'_c$ .....3000 psi
2.  $f_c$ .....1200 psi
3. Shrinkage and Temperature Reinforcement:

Shrinkage and temperature reinforcement for Abutment walls shall be provided in accordance with Subsection 5.10.8 of the *AASHTO LRFD Bridge Design Specifications*. Minimum reinforcement shall be provided in accordance with Subsection 5.7.3 of the *AASHTO LRFD Bridge Design Specifications*.

Refer to Guide Plates 3.3-1, 3.3-2, and 3.4-1 for more information.

4. The Designer shall verify the need for batter in walls under 10 feet in height. Walls over 10 feet in height shall have a minimum batter of 12:1. The wall height shall be measured from the top of the footing at the rear face of the stem to the top of the wall.
5. The rear face of abutments shall be plumb.
6. The design of sheet pile retaining walls shall be based on a permissible lateral deflection that will be equal to 1% of the exposed height of the wall but not greater than two (2) inches. This limitation shall account for the action on a wall by construction activities and equipment.
7. Vertical load of approach slab reacting on abutment back wall:  
Treat approach slab as a simple span beam, assuming that the one third length of approach slab is uniformly supported on soil at one end and simply supported at the other end on the back wall.

### **17.3 Retaining Wall Systems**

1. Designers are encouraged to use different types of retaining wall systems at select project locations. Conventional Retaining Walls, Nongravity Cantilevered Walls, Anchored Walls, Mechanically Stabilized Earth Wall (MSE) and Prefabricated Modular Walls, should be evaluated for use in a project that involves retaining wall construction.

The design criteria of Section 11 of the AASHTO LRFD Specifications shall be adhered to for the design of the retaining wall systems.

The submission methodology presented in Subsection 7.2.10 of this Manual shall be followed for retaining wall systems.

2. Approved Retaining Wall Systems are listed in the NJDOT Approved Materials Database. Following is a link to this Database:  
[www.state.nj.us/transportation/eng/materials/](http://www.state.nj.us/transportation/eng/materials/)
3. When proprietary retaining wall systems are identified and appropriate for use in a project, unless otherwise directed, a design for the cast-in-place cantilever wall system is not required.
4. As advised in Subsection 7.2.10 of this Manual, based on the suitability of a site for a proprietary Retaining wall System, Control Plans may be developed with the intent that only one type of wall system will be constructed.
5. For those projects where use of proprietary walls are not feasible, a design for another type of retaining wall system shall be provided.
6. Sections 7 of this Manual may be referred to for guidance in providing Final Submission Control Plans for retaining wall presentations. The following guidance shall also be followed:
  - a. For MSE Walls, and prefabricated modular a drainage system consisting of an 8 inch P.C.M.P. and 2' x 2' stone pocket shall be placed parallel to and behind the wall. The area above the stone pocket behind the wall shall be backfilled with I-9 Soil aggregate or Coarse aggregate no. 57. Refer to the Standard Specification for backfill material.

- b. For MSE wall systems that are located adjacent to roadways that may be chemically deiced, to intercept any flows that may contain the deicing chemicals, an impervious membrane shall be placed below the pavement and just above the first row of reinforcements. The membrane shall be sloped to drain away from the wall facing. Refer to the Standard Specifications for the type of material to be used.
- c. The NJDOT Standard Specifications permit the use of I-9 or I-15 soil aggregate or coarse aggregate no. 57 as backfill material. When coarse aggregate is used, geotextile filter fabric material shall be placed at the interface of the aggregate and the regular roadway materials and/or embankments.
- d. In submitting calculations, the wall supplier shall account for the use of the backfill materials within the wall system. The soil unit weight and the frictional angle of the backfill material shall be included in the design calculations.
- e. The minimum unbalanced hydrostatic pressure for design of MSE Wall systems shall be based on a 3 foot lag. This unbalanced hydrostatic pressure shall be considered as a permanent condition when designing MSE Wall systems.
- f. External Stability Design shall conform to the criteria specified in Subsection 11.10.5 of the *AASHTO LRFD Bridge Design Specifications*.

Internal Stability Design shall conform to the criteria specified in Section 11 (11.10.5 and 11.10.7.1) of the *AASHTO LRFD Bridge Design Specifications*. Refer to section 7.2.10 of this Manual.

- g. When designing the moment (anchor) slab for concrete barrier installation, the design of the barrier section shall follow the criteria stated in Subsection 23.3 of this Manual.

The structural capacity of the barrier and concrete moment slab shall be designed using dynamic Loads (TL-3, TL-4, TL-5) in accordance with Sections 5 and 13 of AASHTO LRFD Bridge Design Specifications.

Sliding and overturning stability of the moment slab shall be based on an Equivalent Static Load (ESL) applied to the top of the traffic barrier. For TL-3 and TL-4 barrier systems, the ESL shall be 10 kips; for TL-5 barrier systems, the ESL shall be 23 kips.

For stability analysis, the width of moment slabs shall range between 4.5 feet to 10 feet; the length of moment slabs shall range between 20 feet to 60 feet to counteract sliding and overturning.

The Designer is encouraged to refer to *NCHRP Report 663, "Design of Roadside Barrier Systems Placed on MSE Retaining Walls"* for more guidance.

- h. When site conditions permit the construction of either a Proprietary wall system or a MSE Wall system, a coefficient of base friction shall not be shown on the Control Plan. Soil parameters for the following areas, shall be specified on the Control Plan:
  - Foundation Subgrade Material
  - Fill Material within the wall system



- Fill Material behind the wall system

The specified soil parameters shall be the friction angle of the soil and the unit weight of the soil.

7. Subsections 11.10.1 and 11.11.1 of the *AASHTO LRFD Bridge Design Specifications* establish conditions that preclude construction of respectively, MSE wall and Prefabricated Modular Wall Systems.
8. Use of MSE wall systems that include extensible reinforcements (polymeric reinforcement) is permitted with prior approval from the Manager, Structural Engineering. However, their use is restricted to locations where the maximum height of the wall is 20 feet.
9. Based on the guidance provided in Subsection 2.3.2.2.1 of the *AASHTO LRFD Specifications*, a proprietary wall system may be protected by Guide Rail against a vehicular impact. The Guide Rail installation shall conform to Department standards.

#### **17.4 Proprietary Type Abutments**

1. Sheet pile abutments, or Mechanically Stabilized Earth (MSE), and Prefabricated Modular Walls abutments are considered as proprietary abutments. Their use is subject to the approval of the Manager, Structural Engineering.
2. These types of abutment systems shall be designed based on a 100 service year life.
3. Corrosion protection for steel sheet piles and tie backs shall include the provision of galvanizing, epoxy coating, additional thickness, sheathing of tie backs and/or other methods to assure the 100 year service life.
4. Sheet pile abutments should not be used under the following conditions:
  - a. When tie backs are required and utilities other than highway drainage must be constructed within the reinforced zone.
  - b. When metallic tie bars exposed to surface or ground water that is contaminated by acid mine damage or industrial pollutants, as indicated by low pH and low chlorides and sulfates, are required.
5. Refer to 17.3 and AASHTO LRFD Bridge Design Specifications, Subsection 11.10.11 for MSE abutments, and Subsection 11.11.7 for Prefabricated Modular abutment requirements. Criteria stated therein shall be applied in such Abutment designs.

#### **17.5 Landscape Walls**

1. Retaining walls that are six (6) feet or less in height shall be considered to be Landscape Walls.
2. As discussed in Subsection 11.6.1.2 of the *AASHTO LRFD Bridge Specifications*, the following minimum design provisions shall be considered in designing Landscape walls:
  - a. Lateral earth and water pressures, including any live and dead load surcharge.
  - b. The self-weight of the wall.

- c. Temperature and Shrinkage deformation effects.
- 3. Appropriate drainage provisions shall be provided to prevent hydrostatic and seepage forces from developing behind the wall.
- 4. Dependent on site conditions and type of backfill to be used, consideration should be given to the need to reinforce the backfill zone area.
- 5. Plans for the construction of landscape walls should not be provided with structural plans. Typically, they should be included in a project plan set as part of Landscape plans.

## **Section 18 - Abutment Types**

### **18.1 Design Criteria**

Applicable criteria of Section 11 of the *AASHTO LRFD Bridge Design Specifications*, and as may be amended within this Design Manual, shall govern the design of Abutment Walls.

### **18.2 General**

1. Spill-through abutments may be considered in certain situations; such as, when foundation conditions indicate very short pile lengths.
2. For abutments adjacent to waterways, even though they may not be needed for the foundation design, deep foundations shall be considered where hydraulic or other characteristics indicate the possibility of scour.
3. Reference Subsection 42.3 of this Manual for recommendations for scour protection.
4. For guidance as to the design of Integral Abutments, refer to Section 15 of this Manual.
5. Designers are strongly encouraged to provide enhancements to the appearance of concrete abutments. This may be accomplished through the use of form liners. As a minimum form liners will provide architectural treatment of concrete through the use of standard patterns that may be developed for specific projects. Other aesthetic treatments may be recommended.
6. Refer to Subsection 19.7 of this Manual for guidance on the Abrasion Protection of the abutment concrete.

## Section 19 - Piers

### 19.1 Types

1. Subsection 11.7 of the *AASHTO LRFD Bridge Design Specifications* provides direction on the design of piers.
2. Subsection 5.1 j. of this Manual provides guidance on pier type selections.
3. Designers are strongly encouraged to provide enhancements to the appearance of pier members. This may be accomplished through the use of form liners. As a minimum, form liners will provide architectural treatment of concrete through the use of standard patterns or unique patterns that may be developed for a specific project. Other aesthetic treatments may be recommended.
4. As directed in Subsection 17.1 of this Manual the use of bridge seat pedestals is not permitted.

### 19.2 Pier Locations

1. Use of corrosion protected reinforcement steel shall be scheduled for, initially, all pier grillage reinforcement steel. Engineering judgment should be used to evaluate the project location toward possibly planning for the use of corrosion protected reinforcement steel for the entire pier construction.

Such as, when a pier is located in a marine environment (Zone 3A or 3B, See Subsection 24.18.6) then all reinforcement steel (including footing bars and dowels) shall be corrosion protected. To further offset the potential of corrosion development, concrete mix designs for such pier construction may include a corrosion inhibitor admixture.

If it is determined that a pier or pier element is to be constructed with the use of High Performance Concrete, then the use of a corrosion inhibitor admixture should not be pursued.

The Designer is advised that epoxy coated, galvanized, stainless steel or stainless steel clad reinforcement are equally permitted.

If galvanized reinforcement is designated, all surrounding reinforcement and miscellaneous hardware, that is to be in touch with the galvanized reinforcement, must be galvanized, plastic or PVC coated.

2. Steel sheeting below the top of the seal concrete will generally be left in place. If sheeting is left in place it shall be anchored to the top of the seal concrete. Refer to Guide Sheet Plate 3.13-1 when sheeting is to be left in place. Also, refer to Section 33 of this Manual for guidance on the use of steel sheeting.
3. Section 39 of this Manual may be referred to for information regarding scour design, scour protection and pier protection methods.

### 19.3 Railroads

1. Railroad companies usually require steel sheet piling for excavations adjacent to railroad tracks. The NJDOT Bureau of Civil Engineering should be contacted for specific information regarding these requirements. This information should be obtained prior to the submission of Preliminary Bridge Plans.

2. Piers, that support bridges over railroads and that are located less than 25 feet from the centerline of track, shall either be of solid shaft construction or shall be protected by a reinforced concrete crash wall that extends not less than 7 feet above the top of rail. This will provide an allowance of 1 foot for future ballasting of the railroad tracks and for potential encroachment during construction or maintenance operations.

The crash wall shall be at least 3'-6" thick and shall connect with all the columns. The face of the crash wall shall extend a distance of at least 6 inches beyond the face of the columns on the side adjacent to the track and it shall be anchored to the columns and footings with adequate steel reinforcement.

For more information, reference Chapter 8, Part 2, Section 2.1.5 of the *AREMA Manual For Railway Engineering*.

3. Footing designs within the theoretical railroad embankment line shall provide a 8 foot minimum distance from any point on the rail to the side of the steel sheet piling used for support of tracks during construction.

#### **19.4 Anchor Bolts**

Drilling holes for anchor bolt installation in rigid frame and T-type piers is not permitted. The following steps shall be taken to insure proper construction clearances for anchor bolts (Also see Guide Sheet Plate 3.5-4).

1. Design drawings shall show (in a detail plan and a cross-section view) the relationships between the anchor bolts and the layers of reinforcement steel immediately under each bearing pad. Detail dimensions, locating the centers of the anchor bolts and reinforcement bars shall be indicated.
2. Reinforcement steel adjacent to anchor bolts shall be so spaced as to allow the free installation of 3 inches diameter sleeves for setting anchor bolts.
3. Necessary detail sketches shall be shown to a scale of not less than 1:20. The vertical rows and the horizontal layers of reinforcement steel shall be so spaced as to allow a minimum of 2 diameters clear space between bars to facilitate placing of the concrete.

#### **19.5 Round Columns**

1. Spirals shall be used for reinforcement of pier columns. Generally, for the typical grade crossing, 3 foot round columns will be used with 5/8 inch diameter x 3 1/2 inch pitch bar for spiral reinforcement. The spiral reinforcing shall be full height of column plus extend into the pier cap and the footing by a minimum of 1'-6" and shall end with 1.5 turns at each end.
2. Guide Plate 3.5-2 provides reinforcement detailing for round columns. Refer to 19.2 above for guidance concerning the use of corrosion protected reinforcement.

#### **19.6 Pile Bents**

1. For pile bent type piers, the designer shall establish the minimum pile tip elevation. This elevation shall be shown on the plans.
2. If the structure is located in a severe salt intrusion zone or a salt splash zone, (Zone 3A or 3B as illustrated in the Chart entitled "*Zonal Areas of New Jersey Affected by Salinity*" in Subsection 24.18 of this Manual), all spiral reinforcement

for cast-in-place, precast or prestressed concrete pile bents shall be corrosion protected.

In accordance with Table 5.12.3-1 of the *AASHTO LRFD Bridge Design Specifications*, the concrete clear cover for all substructure units that are located in a severe salt intrusion zone or salt splash zone shall be a minimum of 3 inches.

Refer to 19.2 above for guidance concerning the use of corrosion protected reinforcement.

3. Pile bents located in a severe salt intrusion zone or a salt splash zone, as described above, may be constructed with the use of a corrosion inhibitor admixture.

Refer to 19.2 for guidance concerning the use of High Performance Concrete.

### 19.7 Abrasion Protection

1. To offset the abrasive action of water or ice against a substructure member High Performance Concrete (HPC) shall be used.

The entire member can be constructed with HPC or, HPC may be placed with the use of a form liner to provide a protective facing.

The HPC for pier protection shall meet the performance requirements in the following Table:

| Performance Characteristic  | Standard Test Method                  |
|---|---------------------------------------|
| Abrasion<br>(x = avg. depth of wear in inches)  | ASTM C 944                            |
| Freeze-Thaw Durability<br>(x = relative dynamic modulus of elasticity after 300 cycles) | AASHTO T 161<br>ASTM C 666<br>Proc. A |
| Chloride Permeability<br>56 days (coulombs)   | AASHTO T 277<br>ASTM C 1202           |
| 56 Day Compressive Strength<br>(Design Compressive Strength)                            | AASHTO T 22<br>ASTM C 39              |

**Note:** All test to be performed on concrete samples that are moist or submersion cured for 56 days.

2. The Designer should familiarize himself with the required testing and performance requirements. He should also verify inclusion of appropriate specifications for the development of HPC mix designs for the required work in the Contract Documents.

### 19.8 Fender Pile Systems

In lieu of constructing timber members for fender pile systems, use of FRP composite material may be used for the system components. The increased design life of the composite materials will offset the increased initial cost of the fender system.

The NJDOT Standard Specifications provide criteria for the use of Fiber Reinforced Plastic Lumber (FRLP), Fiber Reinforced Plastic Piles (FRPP) and Fiberglass Concrete Composite Piles (FCCP). A Designer shall verify the availability of composite pile sizes. This verification should establish that a designated size is available from all approved suppliers. This will avoid restricting a designated size to a sole source supplier.

### **19.9 Vessel Collision**

The design of all bridges over navigable waters in New Jersey must include consideration of possible Vessel Collision. Designers shall conduct a vessel risk analysis to assess the presence of any barge traffic and to determine, if warranted, the most economical method for protecting the bridge. The methodology specified in Subsection 3.14 of the *AASHTO LRFD Bridge Design Specifications* shall be followed for this analysis. The Designer shall also comply with the guidance provided below.

1. To provide a historic basis for the design procedure discussed in Subsection 3.14 of the *AASHTO LRFD Bridge Design Specifications*, information and data shall be gathered as follows:
  - a. Data Sources:
    - 1.) U.S. Army Corps of Engineers, Waterborne Commerce Statistics Center, ([www.iwr.usace.army.mil/ndc/csc.htm](http://www.iwr.usace.army.mil/ndc/csc.htm)). Commerce statistics for the subject bridge.
    - 2.) Port Authorities and Water Dependent Industries. Data to document use of the bridge locations by such groups.
    - 3.) Pilot Associations and Merchant Marine Organizations. Data to document use of the bridge locations by such groups.
    - 4.) National Oceanic and Atmospheric Administration (NOAA), Tidal Current Tables; Tidal Current Charts and Nautical Charts. ([www.noaa.gov/charts.html](http://www.noaa.gov/charts.html))
    - 5.) Bridge Tender records for bascule bridge at Regional Offices.
    - 6.) Local tug and barge companies.
  - b. Assembly of Information unless provided by the Department:
    - 1.) Characteristics of the waterway including the following:
      - a.) Nautical chart of the waterway.
      - b.) Type and geometry of bridge.
      - c.) Preliminary plan and elevation drawings depicting the number, size and location of the proposed piers.
      - d.) Navigation channel, width, depth and geometry.
      - e.) Average current velocity across the waterway.
    - 1.) Characteristics of the vessels and traffic including the following:
      - a.) Ship, tug and barge sizes (length, width and height).

- b.) Number of passages for ships, tugs and barges per year (last five years and prediction to end of 25 years in the future).
  - c.) Vessel displacements.
  - d.) Cargo displacements (deadweight tonnage).
  - e.) Draft (depth below the waterline) of ships, tugs and barges.
  - f.) The overall length and speed of tow.
- c. Accident reports
  - d. Bridge Importance Classification
2. Importance Category (IC)
- Generally, the Importance Classification (IC) for bridges crossing a navigable waterway shall be that of "Regular". However, the Designer shall evaluate project specific conditions to determine the Social Survival and Security/Defense requirements of such bridges. If deemed appropriate, the Designer may recommend to the Manager, Structural Engineering, that the bridge be evaluated under an IC of "Critical".
3. Design Vessel
- Subsection 3.14.1 of the *AASHTO LRFD Bridge Design Specifications* specifies the parameters to define the minimum design barge.
- Subsection 3.14.4 of the *AASHTO LRFD Bridge Design Specifications* provides guidance for the selection of design vessels for specific bridge piers. Based on an analysis of the annual frequency of collapse, a design vessel and its associated collision loads can be determined.
4. Design Methodology
- Subsection 3.14.15 of the *AASHTO LRFD Bridge Design Specifications* provides guidance for the design of a substructure protection system. The protection system shall be designed to stop or redirect a vessel so that the substructure member is not impacted.
- NJDOT conducted a research project that identifies Energy Absorbing Fender Systems. The final report should be studied to facilitate identification of such systems. The Report, numbered FHWA NJ 2003-11, dated July, 2003 can be downloaded from the following website link:
- [www.state.nj.us/transportation/refdata/research](http://www.state.nj.us/transportation/refdata/research).
- Bridge piers that are not in the main channel may be designed for a reduced impact. This is considerate of a vessel's ability to attain sufficient water draft to permit it to strike a pier that is not in the main channel. If such an occurrence is not possible, then no impact force shall be applied.
- In addition to utilizing the design specifications presented in the *LRFD Bridge Design Specifications*, the Designer shall also follow the following design methodology:
- a. At least one iteration of secondary effects in columns shall be included; i.e., axial load times the initial lateral deflection.



- b. The analysis must include the effect on adjacent piers from the transfer of lateral forces up to the superstructure. Bearings, including neoprene pads, may transfer lateral forces to the superstructure. Analysis of forced transfer through the mechanisms at the superstructure/substructure interface shall be evaluated by use of generally accepted theory and practice.
- c. The capacity of axially loaded piles shall be limited to the determined compressive and/or tensile loads. For battered pile foundations, load redistribution shall not be permitted when this capacity is reached.
- d. Lateral soil-pile response shall be determined by concepts utilizing a coefficient of subgrade modulus.
- e. Load Combination "Extreme Event II" shown in Table 3.4.1-1 of the *AASHTO LRFD Bridge Design Specifications* shall be used for Vessel Collision. Nonlinear structural effects shall be included and can be significant, particularly for the pier components.
- f. If it is determined that a superstructure member could be impacted by a waterway vessel, the corresponding superstructure span shall be designed for ultimate lateral strength under a ship mast impact force in accordance with the *AASHTO LRFD Bridge Design Specifications*. There shall be no redistribution of the vehicle collision force between piers throughout the superstructure.

## 5. Pile Bents

Bridges in navigable waterways with pile bents shall be designed to remain open for traffic after a vessel collision even if any one pile is lost as a result of the collision. For this design, the load combination for Extreme Event II shall apply; however, the Load Factor for Live Load shall be increased to 1.0.

## 6. Movable Bridges

Movable bridges shall comply with the Vessel Collision requirements stated herein without exception.

## 7. Main Span Length for Barges

The length of the main span between centerlines of piers at the navigable channel shall be based upon Coast Guard requirements, the Vessel Collision risk analysis (in conjunction with a least-cost analysis) and aesthetic considerations.

## 8. Scour with Vessel Collision

The probability of the simultaneous occurrence of a Vessel Collision impact and the presence of scour is a valid concern when planning the design of a substructure's foundation. For this reason, the foundation shall be designed to withstand the following two Load/Scour (LS) combinations:

### A. Load/Scour Combination 1:

$$\mathbf{LS}_{(1)} = \mathbf{Vessel\ Collision} + \mathbf{1/2\ Long-Term\ Scour}$$

Where:

Vessel Collision: Assumed to occur at normal operating speed.

Long-Term Scour: Defined in Section 39 of this Manual.

**B. Load/Scour Combination 2:**

**$$LS_{(2)} = \text{Minimum Impact Vessel} + \frac{1}{2} \text{100-Year Scour}$$**

Where:

Min. Impact Vessel:        Defined in Subsection 3.14.1 of the LRFD Specifications

100-Year Scour:        Defined in Section 39 of this Manual.

When preparing the soil models for computing the foundation strengths, and when otherwise modeling stiffness, the Designer must exercise judgment in assigning soil strength parameters to the soil depth that is subject to Local and Contraction Scour and that may have filled back in.

The soil model shall utilize strength characteristics over the depths that are compatible with the type soil that would be present after having been hydraulically redeposited. In many cases, there may be little difference between the soil strength of the natural stream bed and that of the soil that is redeposited subsequent to a scour event.

**9. Application of Impact Forces**

For long narrow footings in the waterway when the length to width ratio,  $L/W$ , is 2.0 or greater, the longitudinal force shall be applied within the limits of the distance that is equal to the length minus twice the width ( $L-2W$ ).

## Section 20 - Deck and Approach Slabs

### 20.1 High Performance Concrete (HPC) Deck Slabs

1. New construction or the replacement of existing deck slabs of bridge structures that are on the State Highway System shall be based on the construction of a one course deck slab with HPC. HPC is defined as concrete that meets special combinations of performance and uniformity requirements that cannot always be achieved through routine use of conventional constituents and normal placing, mixing and curing practices. The Table below establishes the levels of desired performance for HPC deck slabs.

Sidewalks, parapets and curb lines on bridges shall also be detailed to be constructed with HPC.

An HPC element may be further defined as that which is designed to give optimized performance characteristics for a given set of loads, usage and exposure conditions consistent with the requirements of cost, service life and durability.

2. HPC for deck slabs, sidewalks, parapets and curb lines shall consist of the same properties as Class A concrete with the added stipulation that a pozzalonic material is to be included in the mix design.
3. The Designer should familiarize himself with the following performance requirements and test methods that are to be followed for the HPC mix design development. Refer to the *NJDOT Standard Specifications for Roadway and Bridge Construction*.

| Performance Characteristic  | Standard Test Method                |
|---|-------------------------------------|
| Scaling Resistance<br>(X=visual rating of the surface after 50 cycles)                | ASTM C 672                          |
| Freeze-Thaw Durability<br>(x=relative dynamic modulus of elasticity after 300 cycles) | ASTM T 161<br>ASTM C 666<br>Proc. A |
| Chloride Permeability<br>(x=coulombs)   | AASHTO T 277<br>ASTM C 1202         |
| 56 Day Compressive Strength<br>(Design Compressive Strength)                          | AASHTO T 22<br>ASTM C 39            |

**Note:** All tests to be performed on concrete samples that are moist or submersion cured for 56 days.

4. With the construction of an HPC deck slab, provision of a concrete overlay protective system is not warranted.

### 20.2 Design Criteria

1. Refer to Subsection 20.5 herein for concrete cover requirements and detailing guidance.

Provision of a 1½ inch bottom reinforcement cover must be accounted for in bridge structures that are located in a marine environment.

2. The use of either permanent stay in place (S.I.P.) forms or conventional removable timber forms is permitted for deck slab construction.

For construction over electrified railroad tracks, S.I.P. forms shall always be used.

3. To account for the use of S.I.P. forms, the Concrete Deck Slab Design Table 20.1 in this Section assume that an extra 3/8 inch thickness of concrete is added to the dead load of the slab.

When the S.I.P. ribs cannot be aligned with the bottom main reinforcement steel, and the forms must be dropped to achieve the 1 inch bottom reinforcement cover, Subsection 20.5 herein, for additional dead load considerations, should be referred to.

4. Section 3 of this Manual should be referred to for stipulations to the *AASHTO LRFD Bridge Design Specifications* that concern design of concrete deck slabs. Otherwise, the criteria of Subsection 9.7 of the *AASHTO LRFD Bridge Design Specifications* shall be followed.
5. One-half (1/2) inch shall be deducted from the actual deck slab thickness in the design calculations as an allowance for depth of sawcut grooved finishing and wear.
6. The superstructure design for bridges shall include a 25 psf provision for future maintenance overlay potential.
7. The deck overhang shall be designed according to the provisions of Subsection A13.4 of the LRFD Specifications except that the nominal traffic barrier resistance to the transverse load,  $R_w$ , need not exceed 120% of  $F_t$  as specified in LRFD Table A13.2-1 for the respective test levels.
8. Assume that the effective slab depth is taken from the bottom of the slab to the center of the top main reinforcement steel.

### **20.3 Concrete Deck Surface and Overlay Protective System**

1. Newly constructed decks shall be one-course HPC deck slabs. The concrete deck surface shall be saw cut in accordance with NJDOT Standard Specifications and Construction Details. If overlay system is deemed necessary, HMA overlay system shall be used with the approval of the Manager, Structural Engineering.
2. If any of the concrete bridge slabs are located in areas of significant adverse geometrics (see Subsection 20.9 herein), which could preclude machine finishing of the concrete deck surface, then opinions from construction forces regarding machine finishing capabilities in such cases should be obtained.
3. For a precast deck system or a prefabricated superstructure and deck system, HMA overlay is permitted.

### **20.4 Corrosion Protected Reinforcement In Deck Slabs**

1. All concrete deck slab reinforcement steel shall be corrosion protected. Use of epoxy coated, galvanized reinforcement steel is permitted. However, use of stainless steel or stainless steel clad reinforcement is permitted only with the

approval of the Manager, Structural Engineering and specified in the Special Provisions. When epoxy coated reinforcement is planned, the top and bottom layers of rebars in structural deck slabs shall be epoxy coated. These bars include transverse bars, longitudinal distribution bars, corner, skew and header bars.

In culverts, where the top slab is used as a riding surface, both layers of the top slab reinforcement steel shall be corrosion protected.

2. When galvanized reinforcement is considered, both the top and bottom mat layers shall be galvanized. In addition, chairs, tie wires, nuts, bolts, washers, other devices and miscellaneous hardware that is to be used to support, position or fasten the galvanized reinforcement shall be galvanized. Plastic chairs or plastic coated metal hardware, in lieu of galvanized components may be used.

## **20.5 Deck Slab Design and Construction Detailing**

1. The criteria indicated in the following Table is based on a 2½ inch top cover, a 1 inch bottom cover and placement of rebars perpendicular to traffic with concrete strength of  $f'_c = 4000$  psi and reinforcement steel tensile strength of  $f_y = 60$  ksi. The Table has been prepared in order to establish uniformity in design and details. However, a Designer may develop other deck slab configurations. Calculations shall be included in the design folder.
2. The selection of beam spacings cannot be standardized since this is dependent on beam type selection. Generally, beam spacings of 8 to 10 feet are preferred. The basis for the selection of beam spacings shall include consideration of the necessity of future deck replacement and the maintenance of traffic associated with a deck replacement.
3. The main reinforcement shall be placed normal to the stringers regardless of the skew of the deck slabs. The bars shall be straight, continuous, and of the same size and spacing in both the top and bottom of the slab.

**Table 20.1 Concrete Deck Slab Design**

| <b>Span<br/>ft</b>   | <b>Actual<br/>Slab<br/>Thickness<br/>in</b> | <b>Main<br/>Rebar Top and<br/>Bottom</b> | <b>Long. Dist.<br/>Rebar Top and<br/>Bottom</b> | <b>Additional Top<br/>Main<br/>Rebar in<br/>Overhang with<br/>2'-10" Parapet</b> | <b>Additional Top<br/>Main<br/>Rebar in<br/>Overhang with<br/>2'-8" Parapet &amp;<br/>Sidewalk</b> |
|----------------------|---|--|---|--|--|
| 4'-3" to<br>5'-3"    | 8 ¼   | # 16 @ 12"                               | # 13 @ 12"                                      | # 19 @ 12"   | #19 @ 12"  |
| 5'-4" to<br>6'-3"    | 8 ½   | # 16 @ 11"                               | # 13 @ 11"                                      | # 19 @ 11"   | #16 @ 11"  |
| 6'-4" to<br>7'-3"    | 8 ½   | # 16 @ 9"                                | # 13 @ 9"                                       | # 16 @ 9"  | #13 @ 9"   |
| 7'-4" to<br>8'-3"    | 9   | # 16 @ 8 ½"                              | # 13 @ 8 ½"                                     | # 13 @ 8 ½"  | #13 @ 17"  |
| 8'-4" to<br>9'-3"    | 9 ½   | # 16 @ 8 ½"                              | # 13 @ 8 ½"                                     | # 13 @ 8 ½"  | #13 @ 17"  |
| 9'-4" to<br>9'-10"   | 10  | # 16 @ 8"                                | # 13 @ 8"                                       | # 13 @ 24"   | None   |
| 9'-11" to<br>10'-6"  | 10  | # 19 @ 10"                               | # 16 @ 10"                                      | # 13 @ 69"   | None   |
| 10'-7" to<br>11'-2"  | 10 ½  | # 19 @ 9 ½"                              | # 16 @ 9 ½"                                     | None   | None   |
| 11'-3" to<br>11'-10" | 10 ½  | # 19 @ 8 ¼"                              | # 16 @ 9"                                       | None   | None   |
| 11'-11"<br>to 12'-6" | 10 ¾  | # 19 @ 8 ¼"                              | # 16 @ 9"                                       | None   | None   |
| 12'-7" to<br>13'-2"  | 10 ¾  | # 19 @ 7 ½"                              | # 16 @ 8 ½"                                     | None   | None   |

Notes for the above Table:

- a. Design is based upon the criteria specified in Appendix A4 of the LRFD Specifications.
  - b. Span dimensions shall be based on the distance that is the center to center of girders.
4. Designers should locate stud shear connectors to avoid conflicts with the main bottom reinforcement steel spacing. This is due to the fact that there is little room for field adjustment when the main reinforcement steel must match the rib spacing. Shop drawings for S.I.P. forms should be checked accordingly.
  5. For continuous beam spans additional corrosion protected longitudinal reinforcement steel shall be provided over the interior supports.

6. The main reinforcement steel pattern in the acute corners of skewed slabs and in the deck slabs of curved girder bridges shall be given special consideration. In the acute corners of skewed slabs, a portion of the main reinforcement may have to be placed in a fanned arrangement extending into the corner of the deck slab. On curved girder bridges, the main reinforcement steel should generally be placed radially.
7. When the main reinforcement will not be aligned with the S.I.P. ribs, a 1 inch thickness of concrete shall be added to the dead load of the slab. This is in lieu of the 3/8 inch thickness of concrete that is specified in Subsection 20.2.3.

This extra 5/8 inch thickness of concrete will account for the additional dead load that results from dropping the S.I.P. forms.

Dropping the forms may be needed to achieve the minimum 1 inch bottom rebar cover. A 2 inch nominal form depth shall be assumed. Deeper forms will require additional dead load consideration.

8. When the extra thickness or the dead load is added, the Table 20.1 within this Section is no longer valid. The designer shall develop an independent slab design. The working drawings shall be checked carefully to verify that the intended result is acceptable.
9. In deck slab corners where the acute angle is 65° or less, 7-#16 bars by 15'-0" long shall be placed directly under the top layer of bars. They should be detailed in a fanned arrangement. This reinforcement shall also be corrosion protected; such as, epoxy coated, galvanized or stainless steel.

## **20.6 Deck Joints**

1. Refer to Section 21 of this Manual for the design of transverse and longitudinal joints in deck slabs.
2. Shear locks, as specified in Subsection 24.15 of this Manual, shall be provided with the structural steel work when a longitudinal expansion joint is located in the roadway area.
3. See Guide Sheet Plate 3.8-1 for details of longitudinal joints.

## **20.7 Haunches On Stringer Bridges**

1. All steel stringer bridges with monolithic deck slabs shall be provided with a haunch over each stringer that is to be placed monolithic with the deck slab. The haunch minimum is to be measured from the top of the steel flange to the theoretical bottom of the bottom slab at the center of the web. A deeper haunch may be required when the top flange exceeds 16 inches in width. This is to allow for deck slab cross slopes.
2. The minimum haunch dimension depth shall be one (1) inch and is to be located at the centerline of the span. It shall be calculated to include all factors such as roadway profile, architectural camber, camber for future overlay, camber for future utilities, deck cross slopes, etc.
3. For simple span welded steel girder bridges, the depth of the haunch at the centerline of bearings shall be the minimum depth, that is computed in the Item 2 above, plus the difference in thickness between the maximum and minimum top flange plates.

4. Haunches of fascia beams of multispan bridges shall be set so that the top of the webs of fascia beams in adjacent spans line up.
5. The depth of the haunches shall be labeled on the plans only at the centerline of bearings. The depth of the haunch at the centerline of bearing is necessary on the plans to enable the Contractor to verify the concrete seat elevations. The depth of the haunch at other locations along the span will be computed by the Contractor after the superstructure steel has been erected.
6. Haunches that are greater than 4 inches shall be reinforced with U-stirrups. The minimum reinforcement shall be #16 stirrups at 12 inches.
7. Where field splices in the stringers are shown on the plans or permitted in the Specifications, the haunch shall be a minimum depth of 1 inch over the splice plate. A 1 inch minimum clear cover shall be maintained between the main steel reinforcement and the bolts.

## **20.8 Concrete Placing Sequence**

1. A concrete deck slab placing sequence shall be shown on the plans for deck slabs supported by trusses, arches, continuous and cantilevered design. Other types of structures, such as single span curved girder bridges, may also require special deck placement sequences. The Designer shall evaluate unique situations and provide proper guidance on the plans.
2. Details of keyed transverse construction joints for a deck placing sequence should be developed and shown on the plans.

The transverse construction joint shall be designed as an edge beam. For skewed spans, a skewed-stepped arrangement may be required because of the use of permanent steel stay in place forms.

3. In the construction of Integral Abutment deck slabs, if girder continuity is provided, a deck placing sequence should be detailed for spans greater than 100 feet.

## **20.9 Machine Finishing for Concrete Deck Surface**

1. The following criteria could preclude the use of machine finishing of bridge deck slabs:
  - a. The bridge is on a curve of less than 250 feet radius.
  - b. The acute skew angle is less than 40 degrees.
  - c. The cross slope is variable.
  - d. Variable width occurs with non-parallel machine support rails.
  - e. Variable width is due to internal variable width lane with grade breaks at the edges of this lane.
  - f. Only one structure is in the contract and/or the length is less than 60 feet and curb to curb distance is 24 feet or less.
  - g. Staging of construction is such that machine finisher overhang will interfere with active vehicular traffic lanes.



2. It shall be the responsibility of the Structural Design Engineer to show the following note on deck slab plans where the above conditions could conceivably preclude the use of machine finishing:

**“Note:** Machine finishing of deck slab shall not be required.”

### **20.10 Approach Slabs**

1. Approach slabs are required for all bridges on the State Highway System. This shall also apply to the reconstruction of such bridges.
2. For bridge structures not on the State Highway System, if either of the following conditions exist, provision of approach slabs shall not be considered.
  - a. When the projected Average Daily Traffic (ADT) is less than 2000 vehicles.
  - b. When the Average Daily Heavy Truck Traffic is less than 5% of the ADT.
3. For bridge widening or rehabilitation projects where there was no approach slabs previously, provision of approach slabs shall be subject to the approval of the Manager, Structural Engineering.

Refer to NJDOT Bridge Construction Details for standard approach slab details.

4. For bridges on new alignments, design may require longer approach slabs with other details being the same. In these cases, 45' long approach slabs may be provided unless otherwise approved by the Director of Bridge Engineering and Infrastructure Management. The design of approach slabs shall be considered to be supported in accordance with Subsection 17.2.7.
5. Other design circumstances that vary from the standard plans may require revisions. In any case, the length of approach slabs shall not be less than 25 feet. Refer to Subsection 17.2.7 for approach slab design assumptions.
6. To facilitate an estimation of material quantity that is needed to construct the slabs, a Designer shall provide quantities for approach slabs (reinforcement steel included) and surface treatment specified on plans or in the special provisions.

### **20.11 Medians**

1. Unless precluded by profile and geometric considerations, the median area between parallel bridges shall be “decked over” when the width between curb lines is 30 feet or less. See Guide Sheet Plate 3.6.3.
2. When the median width is greater than 30 feet, cost estimates shall be made for the alternative of “decking over” vs. “open well design”.
3. Decking over is preferred in all cases for safety reasons when the extra construction cost is relatively insignificant.
4. Live load design for the median area shall be similar to the bridge deck slab live load design.

### **20.12 Parapets, Barriers and Sidewalks**

1. Provide 3/16” open deflection joints in parapets at intervals not exceeding 20 feet. Contraction joints at the midpoint between the open joints shall also be provided.

2. Contraction joints shall be provided in sidewalks at the locations of the 3/16" open parapet deflection joints.
3. Provide 3/16" open deflection joints in median barriers at intervals not exceeding 15 feet. There shall be no contraction joints between the open joints and no contraction joints located below the open deflection joints (refer to Bridge Construction Details).
4. Full depth joints shall be provided in parapets, median barriers and sidewalks at locations of transverse deck joints and at a distance not exceeding 20 feet. The full depth joint opening width shall equal the transverse deck joint opening width. (See Bridge Construction Details).
5. All reinforcement steel in parapets, median barriers and sidewalks shall be corrosion protected.
6. Refer to Bridge Construction Details for additional reinforcement that is required to prevent concrete cracking in the overhang portion of the deck slab.

### **20.13 Alternative Deck Slab Systems**

1. Subsection 9.8 of the *AASHTO LRFD Bridge Design Specifications* provides criteria on the design of Metal Decks. Criteria is provided for the use of open, filled and partially filled and unfilled grid decks that are composite with a reinforced concrete deck slab.

Designers are advised that use of metal deck systems must include a fatigue analysis. This analysis should address the installation of the metal deck onto the bridge framing.

2. An example of an unfilled grid deck that is composite with the concrete deck slab is the Exodermic bridge deck system.
  - a. The Exodermic system is comprised of an unfilled steel grid, typically 3 inches to 5.2 inches deep, with a 3.5 inch to 5.2 inch reinforced concrete slab on top of the grid.
  - b. A portion of the grid extends into the reinforced concrete slab. This creates the composite action.
  - c. An exodermic deck system can provide a lighter element to a bridge structure without sacrificing stiffness and strength.
3. Orthotropic Deck systems shall be designed on a project to project basis.
  - a. Orthotropic decks are lightweight and can be easily integrated with an existing bridge superstructure.
  - b. Orthotropic decks may be used to reduce the bridge dead weight and to eliminate deck joints.
  - c. Orthotropic decks consist of steel deck plates that are stiffened by longitudinal ribs and may be of two basic types:
    - With torsionally stiff closed ribs
    - With torsionally soft open ribs

4. The above metal deck systems as well as other prefabricated elements and systems may be evaluated for use in deck replacement projects as well as an overall element of a bridge structure.
5. Such prefabricated deck systems may be used where rapid deployment is a consideration. Concerns for traffic disruption and getting a bridge back into service as quickly as possible can play into the decision making with their use.
6. Use of precast concrete deck panels and prefabricated concrete deck slabs that are built into girder systems may also be considered when rapid deployment is an issue.

## Section 21 - Bridge Deck Joints

### 21.1 General Criteria

Subsection 14.5.3.2 of the *AASHTO LRFD Bridge Design Specifications* provides criteria for surface gap tolerances. These criteria shall be followed for planning deck joint type selection.

1. Transverse deck joints on bridge decks shall consist of either preformed elastomeric joint assemblies or strip seal expansion joint assemblies. The use of bolt down type seal assemblies is restricted only to those locations where bolt down type assemblies currently exist.

Modular expansion joint systems are recommended for joint movements in excess of 4 inches. Joint system suppliers should be contacted to verify movement capabilities prior to specifying a joint assembly type for a project.

2. Standard Drawings provided within this Manual have been developed to facilitate the installation of strip seal joint assemblies and preformed elastomeric joint assemblies. Designers and suppliers are advised that these Standard Drawings should be followed in developing working drawings for the provision of these type joint assemblies.

Typical details for preformed elastomeric joint and strip seal expansion joint assemblies are shown on Bridge Construction Details. The details shown thereon are for typical installations on "new" construction or deck slab replacement projects. The illustrated concepts on the Bridge Construction Details may be used to facilitate the Working Drawing review.

3. Generally, for expected movements of less than or equal to 4 inches, preformed elastomeric or strip seal joint assemblies may be used. However, strip seal assemblies have shown to be more durable from a maintenance perspective. Therefore, strip seal assemblies can be assumed to be the preferred type for Department projects.

### 21.2 Preformed Elastomeric Joint Assembly

1. Payment for structural steel shapes and plates used for Preformed Elastomeric Joint Assemblies will be included under the respective pay item. A separate item for this miscellaneous material is not required.
2. Preformed elastomeric seals smaller than 2½ inches are generally recommended only for fixed end joints. For skewed structures, seals shall be sized such that movements parallel to the joint caused by racking are not greater than 15% of the nominal compression seal width. This is a conservative value utilized by many seal manufacturers.

### 21.3 Longitudinal Deck Joints

The location of longitudinal construction joints shall be provided where necessary for stage construction and for compatibility with a deck slab pouring sequence. When wide structures with many lanes are involved, the Designer should detail where Construction joints can be placed. This will address the potential of concrete placing delays and overall work stoppage. Longitudinal construction joints, if necessary, shall be located over a stringer.

Reference Guide Plate 3.8-1 for details concerning longitudinal construction joints in deck slabs.

#### **21.4 Strip Seal Expansion Joint Assembly**

1. Strip seal expansion dam assemblies shall consist of an extruded neoprene rubber gland locked in the cavities of two parallel steel rail sections. The steel rail material shall conform to AASHTO M 270 Grade 36 or AASHTO M270 Grade 50. The entire joint system shall be hot dipped galvanized after fabrication.

Any galvanized coating of the deck joint system which is damaged during field welding or from other causes shall be repaired by methods outlined in ASTM A780. The damaged area shall be repaired prior to installing the neoprene gland. The neoprene gland shall be continuous for the full bridge width including sidewalks, parapets and median barriers.

Payment for structural steel rails, plates, etc. will be included under the item 'Strip Seal Expansion Joint Assembly'.

2. Strip seal expansion joint assemblies may be used for all bridge applications. However, the following conditions warrant the primary use of Strip Seal Assemblies.
  - a. When the length contributing to expansion is less than 70 feet, and the skew is greater than 35 degrees.
  - b. When the length contributing to expansion is greater than or equal to 70 feet and less than or equal to 250 feet, and the skew is greater than 25 degrees.
3. When a transverse strip seal assembly intersects with a preformed elastomeric seal that is used in a longitudinal joint, the joint subjected to the larger movement shall remain continuous and the other seal shall butt up against it. When longitudinal and transverse strip seals intersect, various factory molded intersections are available as needed. It is recommended that strip seal manufacturers be contacted in order that the most effective details can be specified for these situations.
4. It is essential to the operation of the strip seal that no form of hot or cold applied joint filler be placed over the top of the rubber gland. All sidewalk joints must have steel cover plates. Joints in parapets and median barriers should preferably, if possible, be designed without steel cover plates. In these cases the steel rail sections shall be angled up into the parapet or median barrier and the concrete tapered to the edge of the rail as required.

When approved, steel cover plates may be used if required on highly skewed structures or for specific project requirements.

5. The maximum allowable joint width measured in the direction of travel shall be 4 inches, with 3 inches preferred. The minimum joint widths shown on the construction plans for the superstructure shall be set at 70° F. They shall be set, based upon the project requirements and the minimum installation width of the seal, normal to the steel rail sections.

The minimum joint installation width is generally equal to 1½ inches for smaller size strip seals.

Strip seals with a 5 inch classification are available. However, their use must be carefully evaluated against the AASHTO LRFD Uniform Temperature factoring.

6. The designer should closely analyze and provide details and configurations in problematic areas; such as, sidewalks and parapets. The potential for joint leakage is usually greater in these areas, and they are often difficult to construct and maintain.

Joint details at sidewalks, parapets and median barriers shall be shown on the plans.

## **21.5 Modular Bridge Joint Systems (MBS)**

1. MBS consist of a modular, multiple seal joint system. The configuration of a modular system consists of preformed neoprene strip seals mechanically held in place by steel edge and separation beams. Each separation beam is supported by an independent support bar, which is welded to the separation beam. The support bars are suspended over the joint opening by sliding elastomeric bearings. An equidistant control system is incorporated which develops its maximum compressive force when the joint is at its maximum opening. The expansion joint system does not incorporate any bolted connections between the separator beams and support bars.

The expansion joint system is continuous across the full width of the roadway and continues into traffic barriers.

2. Working drawings shall include but not be limited to the following:
  - a. Plans, elevation and section of the joint system for each movement rating and roadway width showing dimensions and tolerances.
  - b. All ASTM, AASHTO or other material designations.
  - c. Method of installation including but not limited to sequence, setting relative to temperature, anchorage during setting, and installation at curbs.
  - d. Galvanizing of steel members.
  - e. Details of temporary supports for shipping and handling.
  - f. Design calculations for all structural elements. The design calculations shall include a fatigue design and a strength design (when appropriate) for all structural elements, connections, and splices. All welded centerbeam splices shall be shown on the shop plans.
3. The design of MBS shall generally conform to the following design parameters and to criteria stated in Subsection 14.5.6.9 of the *AASHTO LRFD Bridge Design Specifications*:
  - a. It is preferred that the system be designed and fabricated as one continuous unit without field splices. The maximum expansion joint assembly length will be controlled by practical shipping limits. If site and/or construction requirements dictate the need for field splices, the splices shall be located in areas outside the main traffic lanes and consist of a bolted separator beam.
  - b. The expansion joint system shall be appropriately designed to accommodate all expected longitudinal movements (i.e. thermal, creep, shrinkage, elastic shortening, etc.) as well as vertical and horizontal rotations.

- c. Verify by fatigue testing the fatigue resistance of transverse separation beams, support bars, and other structural elements. Design these elements according to the guidelines provided in NCHRP Report 402 – *Fatigue Design of Modular Bridge Expansion Joints* as well as the provisions specified in Subsection 14.5.6.9 of the *AASHTO LRFD Bridge Design Specifications*.
- d. The expansion joint assembly seals shall not protrude above the top of the joint.
- e. The elastomeric springs, bearings and strip seals shall be designed so that they are removable and replaceable.

## Section 22 - Deck Drainage

### 22.1 Hydraulic Criteria

1. In the design of drainage for bridge decks, the criteria specified in the *NJDOT Roadway Design Manual* shall be used.
2. Bridge deck drainage requirements shall be determined on a project to project basis.
3. Detailing of Scupper spacing shall be according to criteria contained in the *NJDOT Roadway Design Manual*.

### 22.2 Cross Slopes

The minimum cross slope on driving lanes and shoulders on bridge decks shall be according to criteria contained in the *NJDOT Roadway Design Manual*. The approach roadway geometry shall be matched.

### 22.3 Grades

1. Bridge decks require adequate grade for proper drainage. This will ensure that chlorides drain off the bridge deck and will prevent ponding and freezing of water. In addition, proper drainage prevents hydroplaning on decks with little surface texture.
2. Sag vertical curves should be avoided on bridge decks wherever possible for aesthetic reasons. However, when used, the requirements of the *NJDOT Roadway Design Manual* shall apply. In order to have adequate longitudinal drainage near the high point of vertical curves, the grade shall not be flatter than required for sight distance requirements and shall be in accordance with the *NJDOT Roadway Design Manual*. Vertical curves on bridge decks should provide a minimum grade of 0.5 percent. If the longitudinal grade is less than 0.5 percent, additional drains or special sloping of the gutters may be required.

### 22.4 Inlets and Downspouts

1. Generally, the number of inlet bridge drains should be kept to a minimum. Bridge drains complicate the deck slab and/or parapet details and generally become a maintenance problem in future years.
  - a.) Since complex drainage systems are more susceptible to blockage by debris, these systems should be avoided and the most simplistic alternative should be utilized.
  - b.) Bridge drains are generally not recommended on structures less than 400 feet long if they have full width shoulders, adequate cross slopes and have adequate catch basins on the bridge approaches, unless adverse geometric considerations dictate.

Structures which do not have full shoulders or have sidewalks (i.e., the design spread is much smaller than above) will require bridge deck drains at more frequent intervals as determined by design calculations. From a practical standpoint, deck drains should be placed near and up slope from expansion joints on the bridge deck to keep storm drainage out of the joints and away from bridge members.

2. Bridge drainage systems over streams shall be located midway between diaphragms or crossframes. Runoff shall be disposed of in a manner consistent



with environmental regulations and safety requirements and shall be directed away from bridge superstructure elements or the substructure. Drainage directly onto unpaved embankments or natural ground where erosion could undermine structural elements will not be permitted.

3. Bridge drainage systems over land shall avoid horizontal runs of drain pipe if a reasonable modification to the design scupper spacing permits the placement of drains adjacent to piers at the low end of spans. Scuppers shall not be discharged on embankments or any traveled way (either vehicular or pedestrian). When applicable and feasible, drain pipe shall be hidden from the view of oncoming traffic.
4. Long runs of outlet pipe on flat grades shall be avoided. Where horizontal runs of drain pipe cannot be avoided, the minimum pitch shall be 8 percent.
5. Drainage from bridge superstructures or embankments shall not discharge on or across a railroad right-of-way without the approval of the railroad company.
6. Downspouts, where required, shall be fabricated from galvanized steel alloy pipe or fiberglass pipe and shall have a minimum diameter of 8 inches. No painting of the galvanized steel alloy pipe is required. Pipe shall be provided with readily accessible cleanouts and shall be located such that no water is discharged against any portion of the structure. The pipe shall preferably discharge into a drainage system which conducts the water away from the structure.
7. Downspouts shall be located so as to facilitate their discharge away from traffic. Downspouts shall not be cast in the inside of or within any substructure limits.
8. Bicycle grates shall be used for all inlets.

## **22.5 Catch Basin System At Bridge Ends**

1. Unless cross-slopes or superelevation preclude flow on one side of the roadway, any bridge that is on a grade or in a sag, where it may collect highway drainage, should have catch basins provided just off the upgrade end of the bridge in each gutter.

Inlets placed up slope of the bridge must be designed and placed to intercept 100 percent of the approach flow using the return period selected for the roadway system. Most bridge drainage systems are marginal, and additional water from the approach roadways should not be imposed on them.

Water should be prevented from running down a crack at the paving notch and undermining an abutment or wingwall. A similar nuisance is created when water runs down a median strip, between parallel roadways and parallel bridges, and washes out the slope paving underneath.

2. This guidance will apply to new bridge designs, bridge replacements, and reconstruction projects.
3. Catch basins and inlets shall be designed so that they lead to drainage outfalls that do not pass through abutment walls.

## **Section 23 - Parapets, Railings, and Chain Link Fencing**

### **23.1 Fencing Warrants**

The following conditions warrant provision of chain link fencing on bridge structures:

1. Highway carrying, grade separation or high level bridges with facility for pedestrian traffic.
2. Expressed concern due to recorded incidents of vandalism from a structure.
3. Consistent with Item 1. above, existing or potential for pedestrian traffic nearby
  - a. Schools, churches, etc.
  - b. Built up areas
  - c. Shopping areas, malls
4. Compliance with formally published federal guidelines, if applicable.
5. Locations where existing railing or parapet conditions are substandard with regard to pedestrian safety.
6. Fencing to preclude unsafe acts or conditions; such as, snow passing through railing, pedestrian access.
7. Where any local regulations, laws or ordinances require protective screening.
8. On overpasses where property is subject to damage, such as buildings or power stations located beneath the structure.
9. Where the above conditions are not clearly present, the Designer shall judge the specific location and submit, if deemed warranted, a request to install fencing. The request shall be directed to the Manager, Bureau of Structural Engineering.

### **23.2 Pedestrian Bridge and Ramp Fencing And Railing Criteria**

#### **1. Handrails**

Handrails shall be provided for all stairs and for ramps with grades greater than 5%. The rail height shall be 34 to 38 inches (per ADA guidelines) as measured from the tread at the face of the riser for stairs and from the ramp surface for ramps.

#### **2. Chain Link Fence**

Portions of pedestrian bridges or walkways over traffic shall be provided with chain link fabric or other approved fencing. The maximum size opening for chain link fabric shall be 1".

Where warranted due to pedestrian volume or where there are recorded incidents of objects thrown from overpasses, pedestrian bridges or walkways shall be fully enclosed with chain link fabric. The enclosure shall conform to the Type 7 detailing presented herein.

At highway crossings, chain link fencing shall extend a minimum of 30 feet beyond the outside shoulder line of the traveled way below the bridge.

#### **3. Bicycle Railing**

A bicycle railing shall be provided on bridges where the presence of bicycle traffic is known to exist. The minimum height of railing used to protect a bicyclist shall be 42 inches, measured from the top of the surface on which the bicycle rides, to the rail. If a concrete barrier is used, smooth rub rails shall be attached to the barriers at a handlebar height of 42 inches minimum.

Chain link fence may be used in lieu of bicycle railing. However, smooth rub rails shall be attached to the fence posts at the prescribed 42 inch minimum height.

There are some locations where higher railing should be considered for high speed high angle impact with a railing or site-specific safety concerns. Refer to Subsection 5.2.10 of *AASHTO Guide for Development of Bicycle Facilities*, and Chapter 2 Section 3 of *NJDOT Bicycle Compatible Roadway Design Treatments*.

#### 4. Steel/Aluminum Picket Railing

Use of steel or aluminum picket railing is permitted to accommodate pedestrian or bicycle traffic. Height of the railing shall meet pedestrian or bicycle traffic limitations stated herein. Design of the picket railing system shall be based on achieving a 75-year design service life. The *AASHTO LRFD Bridge Design Specifications* shall be used for the design.

The maximum clear opening between pickets shall be two (2) inches. The maximum clear opening under the bottom rail of the railing system shall also be two (2) inches. Warrants for installation of chain link fencing stated above shall be adhered to when a picket fence railing system is constructed.

### 23.3 Types of Bridge Railings

1. Illustrated herein are crash tested bridge railing systems. NCHRP Report 350, "Recommended Procedures for the Safety Performance Evaluation of Highway Features", has established criteria; such as, speed, vehicle type and angle of impact by which bridge railing systems are categorized as meeting Test Level (TL) designations.

The illustrated systems meet Test Level 4 criteria (TL-4). For all NHS classified roadways other than Interstate highways, TL-4 type systems shall initially be considered as the minimal acceptable system for use on New Jersey bridge structures.

For those bridge structures that carry Interstate traffic, a TL-5 bridge railing system shall be utilized. Bridge Construction Detail standard drawings provide details for a 4 feet – 2 inches high heavy truck parapet (Texas Type HT railing) and 3 feet – 6 inches high "F" Shape railing respectively. These railings are classified as TL-5 systems. With the exception of the following stipulations, either of these systems may be used on an Interstate Highway.

- a. The "F" shape barrier is recommended as a better choice where heavy vehicle containment is a significant consideration. Accordingly, for those bridge structures that are located on a segment of Interstate roadway with a horizontal curve of less than 1000 feet or incorporate an Exit/Entrance ramp with a horizontal curve radius that is less than 800 feet, the "F" shape barrier shall be used.

- b. When a noise barrier is to be installed behind a bridge railing to address the concern of a large vehicle; such as, a tractor trailer or bus, overtipping and damaging the noise barrier, the Texas Type HT system shall be used.
  - c. Designers must study the location of a specific bridge site when designating which of the two above TL-5 systems should be used. If the bridge parapet is essentially a continuation of the roadway barrier, then the Texas Type HT railings should be used. This will provide a uniform transition. If the bridge location is independent of a roadway barrier, then the "F"-Shape system should be used.
2. On non-NHS classified roadways, either State owned or non-State owned, the use of Test Level systems lower than the TL-4 systems are permitted. The Designer shall evaluate the roadway classification, design speed and truck traffic data for this determination. The above referenced NCHRP Report should be used for identification of the design speed and truck type which were used in establishing the Test Level ratings.

If a bridge structure, located on a non-State-owned, non-NHS roadway, meets the applicable Test Level test data for design speed and truck type usage, designation of a TL-1, TL-2 or TL-3 system is permitted.

3. With the use of the following type bridge railing configurations, in considering the height of the parapet/railing configurations, a 4 ft. 6 inch height, from the riding surface, for bicycle traffic and a 3 ft. 6 inch height from the walking surface, for pedestrian traffic, as warranted, should be provided.

Type 1. The 4 - bar tubular open steel bridge railing system, for traffic and pedestrian use, provides better driver visibility because of its see through feature. Refer to Bridge Construction Detail Drawings for detailing of this system.

Type 2. Concrete parapets, 6'-6" high and integrated with a sidewalk are used for spans over electrified railroad tracks.

Type 3A. The 2'-8" concrete parapet surmounted by a 6'-3" high chain link fence is used on local roads or land service roads which require pedestrian sidewalks. This system is used only where Type 3B cannot be used.

Type 3B. Same as Type 3A, except it has a curved top.

This system cannot be used on narrow sidewalks unless a 2'-6" minimum horizontal clearance between curb and tip end of curved chain link fence post is provided.

Type 4. A 2'-8" high parapet surmounted with an ornamental railing. Ornamental one-rail railing or two-rail railing is considered on an individual bridge basis depending on overall aesthetic considerations. This system is used on low level, short span bridges over a shallow stream or drainage area.

Type 5. Concrete parapets, 2'-10" minimum height, with NJ barrier curb configuration are generally used on bridges which do not have sidewalks. Ornamental one-rail railing may be considered on an individual bridge basis.

Type 6. Concrete parapets, 6'-8" high, integrated with NJ barrier configuration are used on spans over electrified railroad tracks where sidewalks are not required.

See Guide Sheet Plate 3.7-1

Type 7. A curved-top, totally enclosed chain link fence system, is used on pedestrian bridges. Enclosed fence shall be used for the full span length including shoulders.

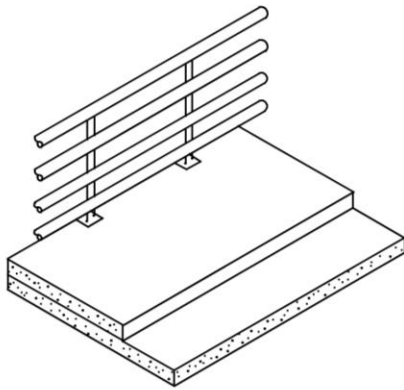
In accordance with the provisions of Subsection 13.7.3.1.1 of the *AASHTO LRFD Bridge Design Specifications*, railing systems that have been previously crash tested may be used without further analysis. Therefore, the systems identified in this Section, as detailed in Bridge Construction Detail standard drawings, may be used in a project without further design.

FHWA has developed a website that provides conceptual drawings of crash tested bridge railing systems. Designers may utilize this resource when involved in a project where railing systems, other than those identified in this Manual, are desirable. The website is: [www.fhwa.dot.gov/bridge/bridgerail](http://www.fhwa.dot.gov/bridge/bridgerail)

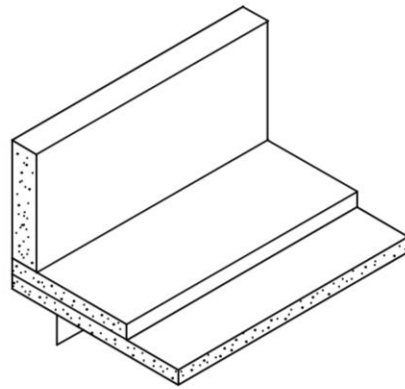
4. In order to enhance the physical appearance of bridge railings, architectural treatments to crash tested bridge railing configurations are permitted. However, the configuration (shape and size) and reinforcement detailing of crash tested systems cannot be changed. Accordingly, architectural treatments to bridge railings shall be submitted to the Bureau of Structural Engineering for review before their adoption into a project.

Any provision of recess patterns to a crash tested configuration shall be limited to a one (1) inch maximum depth. The recess patterns shall also be detailed to require a 45 degree chamfered or beveled edge.

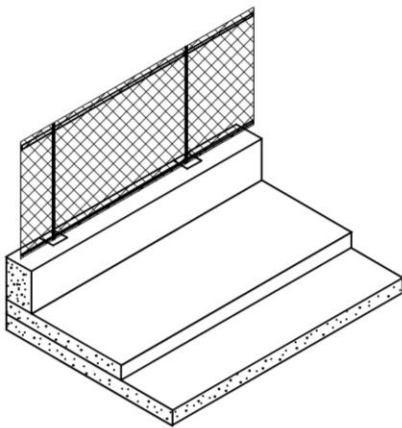
It is understood that any aesthetic treatment to a bridge railing will increase its cost. Therefore, inclusion of aesthetic treatments should be evaluated against anticipated benefits and overall project goals.



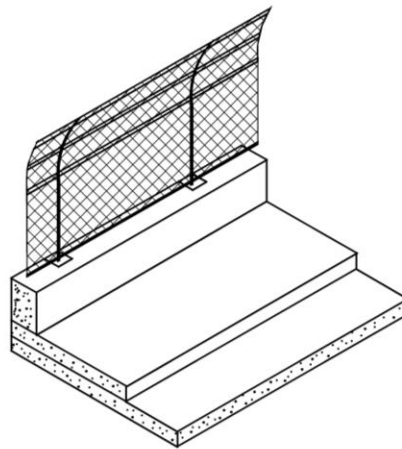
Type 1



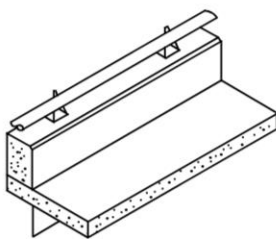
Type 2



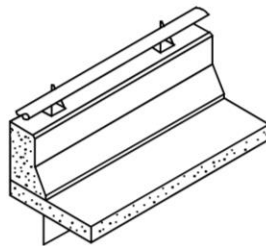
Type 3A



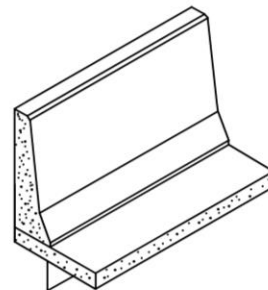
Type 3B



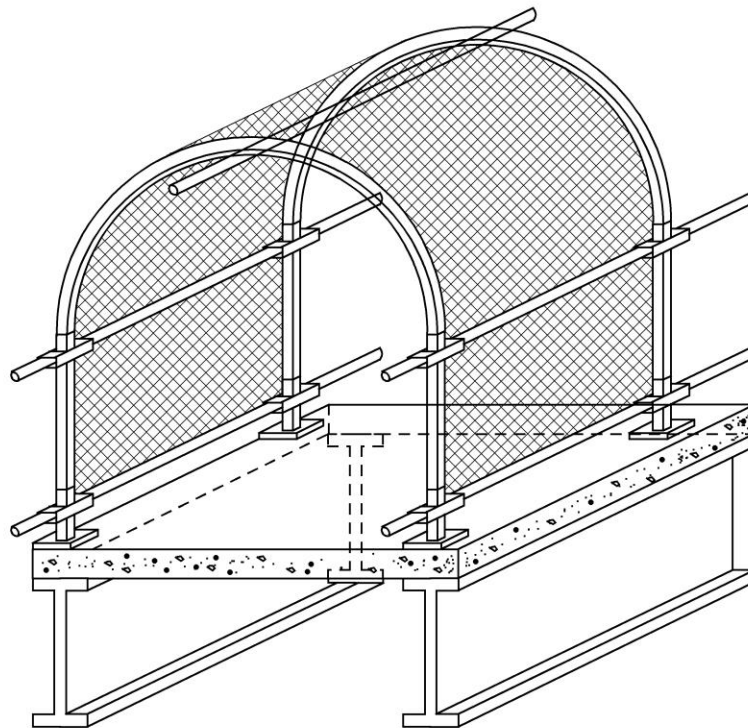
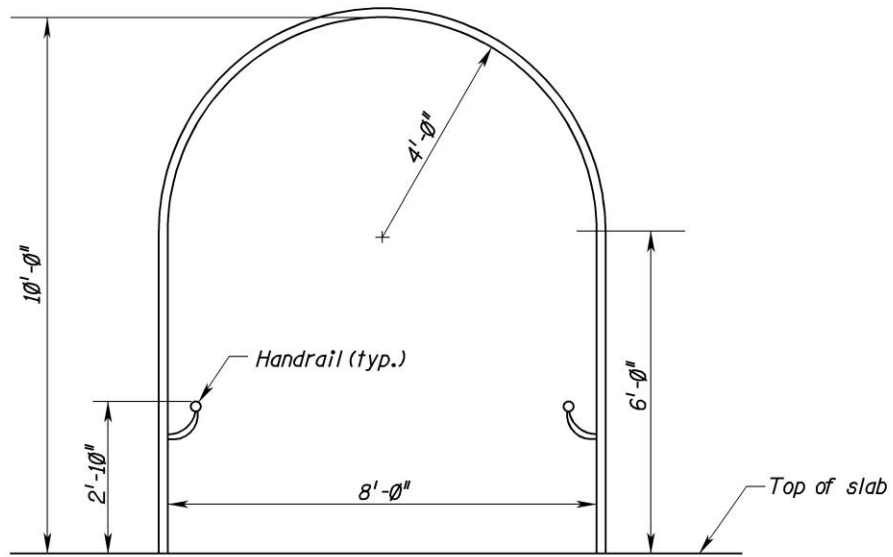
Type 4



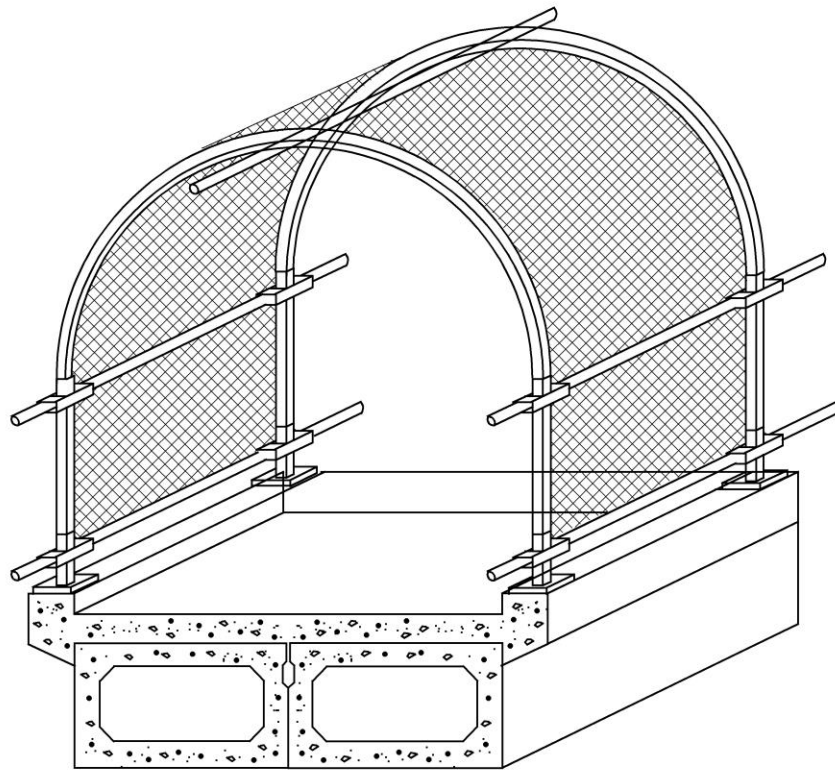
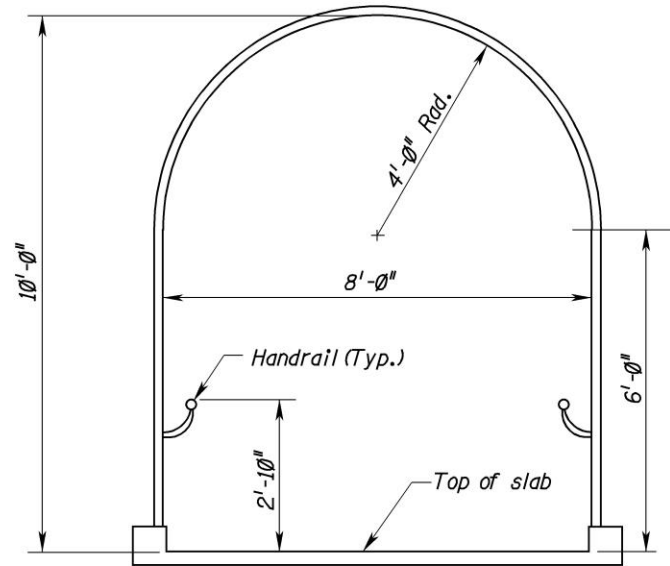
Type 5



Type 6



Type 7



Type 7 (Concrete Superstructure)



## Section 24 - Structural Steel

### 24.1 Design

1. Section 6 of the *AASHTO LRFD Bridge Design Specifications for Highway Bridges* (with current interims), with modifications specified under Section 3 of this Manual, shall govern the design of structural steel members. This will also include the design of curved girder structures.
2. Acceptable Structural Steel superstructure types for New Jersey bridge structures may include rolled beams, welded plate I-girders and steel tubs. Use of truss and thru girder systems are subject to the approval by the Manager, Structural Engineering.
3. The AASHTO/NSBA Steel Bridge Collaboration has published documents that provide guidance on designing for constructability, fabrication detailing as well as other structural steel usage aids. These documents may be referenced and used in preparing contract documents.

Most notable is the document titled "*Guidelines for Design for Constructability*". Criteria is provided to address designing for member sizes, deflections, stiffener requirements and steel box fabrication.

### 24.2 Type of Steel

1. Structural steel grades shall conform to the AASHTO M 270 (ASTM A 709), Grades. Table 6.4.1-1 of the *AASHTO LRFD Bridge Design Specifications* provides a listing of designated Grades.

The use of Grades 36, 50, 50W and HPS designated Grades are permitted. The HPS prefix designates High Performance Steel Grades.

Grade 50W and HPS Grades are weathering steel grades. Subsection 24.19 of this Manual may be referred to for guidance on the use of weathering steel.

The use of High Performance Steel (HPS) is strongly encouraged. Economic studies indicate that furnishing of hybrid girders is generally the most economical choice when using HPS for continuous spans. Therefore, girder webs and positive moment top flanges consisting of Grade 50W with negative moment top flanges and all bottom flanges made up of HPS 70W should initially be considered as the ideal girder section.

The grade or grades of steel to be furnished shall be designated on the plans.

2. All structural steel that is to be used in main load-carrying member components that are subject to tensile stresses shall conform to the applicable Charpy V-notch Impact Test requirements of AASHTO M 270 (ASTM A 709).  
Welded girders made of High Performance Steel (HPS), steels shall be fabricated in accordance with the AASHTO "*Guide for Highway Bridge Fabrication with HPS70W Steel*" which supplements the ANSI/AASHTO/AWS D1.5 Bridge Welding Code.
3. The use of Grades 50W and HPS Grades, given to be weathering steel grades, are subject to the cleaning and painting requirements that are specified in the NJDOT Standard Specifications.
4. All structural steel plans shall have the following note shown thereon:

Structural Steel: AASHTO M 270 Grade \_\_\_\_ (ASTM A 709 Grade\_\_\_\_ ) with Supplementary Requirements for Notch Toughness for all member components marked (T).

5. It shall be the responsibility of the Structural Design Engineer to designate the main load carrying member components that are subject to tensile stress. For this purpose, the designation (T) shall be noted on the contract plans.

The components to be designated (T) shall include flanges, webs, and splice plates of the welded stringers, girders, or rolled beams (also see Guide Sheet Plate 3.9-21.) The above note and designations shall be verified on the shop drawing plans.

### **24.3 Span Type Selection**

1. Simple and continuous stringers are within the range of span types that can be considered for the majority of structures. The choice should be made on the basis of judgment, economy, appearance and serviceability.
2. Bridges shall be designed to satisfy minimum levels of superstructure redundancy such that the failure of one member would not lead to the collapse of the bridge. Subsection 1.3.4 – Redundancy of the *AASHTO LRFD Bridge Specifications* specifies that multiple load path or continuous structures should be developed.

Accordingly, redundant type (multiple load path) systems shall always be used. To satisfy this requirement, bridge structures in New Jersey shall be designed and constructed with a minimum of four (4) girder lines.

Should the need for non-redundant (single load path) systems be unavoidable, their use shall be subject to approval, in writing, by the Manager, Bureau of Structural Engineering. A request for an approval shall include substantial justification why a non-redundant structure is the only structure that will meet the project requirements.

The approval shall be obtained prior to the Preliminary Plan submission and before beginning final design development. Such approval will be subject to the special design, fabrication, and plant inspection provisions of the AASHTO/AWS Section 12 "*Fracture Control Plan for Non-Redundant Members*" (see Subsection 1.24.5).

3. Structures containing pin and hanger connections for suspended/cantilever spans are not permitted. If somehow deemed necessary, suspended/cantilever span design shall be subject to approval, in writing, by the Manager, Bureau of Structural Engineering prior to the Preliminary plan submission.

Pin and hanger connections may only be utilized on redundant (multiple load path) systems. Members shall be restrained against lateral movement on the pins and against lateral distortion due to bridge skew or curvature. Pin and hanger connections shall be designed in accordance with the *AASHTO LRFD Bridge Design Specifications*.

### **24.4 Economics of Stringer Design**

1. In the design of welded plate girders, consideration should be given to minimizing the number of transverse intermediate stiffeners.

This guidance is based on principal for the following reasons:

- a. Welding to the parent metal in itself introduces a discontinuity and should be avoided as much as possible.
  - b. Elimination of projections and obstructions and the resulting flat surfaces optimize the chances of improved quality of workmanship in the cleaning and painting of the structural steel both in the fabricating shop, initial field coating and future maintenance painting.
  - c. Fabrication cost differentials between welding stiffeners versus use of additional material in the main components of girders; such as, additional web thickness, are not overwhelmingly significant. This should be considered during design.
2. Consideration shall also be given to minimizing the number of butt welded flange plate transitions. Plate size transitions may be located at the field splice so that butt welding requirements are either reduced or eliminated. It is the Designer's responsibility to check the availability of plate sizes in order to determine the location of shop splices for flange plates.
  3. Reduction of material mass is not necessarily the ultimate factor in determining span type selection. Material mass of the stringers may represent about 25% of the completed, in-place cost. The bulk of the cost is in fabrication, delivery and erection.
  4. Guide Plates contained in Section 3 of this Manual, for Structural Steel fabrication, are based on economical fabrication detailing. These details should be studied in project development.
  5. Due to the limited availability of rolled beam sections, their use should be carefully studied before their selection as bridge superstructure members.

#### **24.5 Fracture Critical Members**

1. Steel bridge members or member components designated as Fracture Critical Members (FCM's) shall conform to the provisions of the most current edition of the AASHTO/AWS D1.5 Bridge Welding Code.
2. Fracture critical members or member components (FCM's) are tension members or tension components of members whose failure would be expected to result in collapse of the bridge.
3. The responsibility for determining which, if any, bridge member or member component is in the FCM category shall rest with the Structural Design Engineer.
4. If it is determined that any member or member component is in the FCM category, the following note shall be shown on the structural steel plans:  

Fracture Critical Members: Members or member components designated as FCM shall be subject to the provisions of the most current Edition of the AASHTO/AWS D1.5 Bridge Welding Code, Section 12.

Working drawings shall be reviewed by the Structural Design Engineer accordingly.
5. When planning for the rehabilitation or reconstruction of bridges that include the presence of FCM's, an analysis to verify the capacity of gusset and splice plates

shall be made. The analysis shall also consider the potential application of additional dead load or live load, which could result in increased stresses to any member; such as, construction loadings or other temporary conditions.

## 24.6 Composite Design

1. Steel stringers with a concrete deck slab shall normally be designed as composite structures, assuming no temporary supports will be provided for the beams or girders during placement of the permanent dead load.
2. Shear connectors shall be 7/8 inch diameter end welded studs. Height of studs depends on concrete haunch dimensions. Shear connectors shall penetrate at least 2 inches into the bottom mat of the deck slab, but the top of the stud head shall be 3 inches minimum below the top of the deck slab. Use of the same height stud on any one bridge is preferred.
3. See Section 3.2 of this Manual (AASHTO Section 6.10.1) for criteria concerning the negative moment area of continuous spans.

## 24.7 Camber

1. Simple Spans. The various conditions of dead load deflection and camber for each simple span stringer shall be tabulated on the structural steel plans as shown below:

**Table 24.1 Dead Load Deflection and Camber for Single Span**

| Dead Load Deflections (Inches) |           |                  |                                    |   |                             |                         | Camber (Inches)        |                         |                      |                       |
|--------------------------------|-----------|------------------|------------------------------------|---|-----------------------------|-------------------------|------------------------|-------------------------|----------------------|-----------------------|
| Stringer Number                | Location  | Structural Steel | Concrete Slab (Including Haunches) | Stay In Place Form And Added Concrete Thickness | Sidewalks Parapets Barriers | Future Paving Allowance | Total Dead Load Camber | Vertical Curve Ordinate | Architectural Camber | Total Camber Required |
|                                | Mid-Span  |                  |                                    |   |                             |                         |                        |                         |                      |                       |
|                                | 1/4 Point |                  |                                    |   |                             |                         |                        |                         |                      |                       |

The column headed "Vertical Curve Ordinate" shall be used exclusively for simple span stringers located within the limits of a crest vertical curve, provision for its ordinates must be made within the concrete haunch. Consequently, the tabulation of its ordinates is unnecessary.

Total dead load camber is equal to the sum of the dead load deflections. An architectural camber of  $L/100$  inches, where  $L$  is the span length in feet, shall be provided for all simple span stringers unless the vertical curve ordinate meets this, in which case the architectural camber may be omitted. When establishing the depth of the concrete slab and haunch in composite design, the following items shall be considered:

- Total camber required.
- Girder dimensional tolerances per Section 3.5 of the *ANSI/AASHTO/AWS Bridge Welding Code D1.5*.
- A minimum cover of 3 inches over the shear connectors.

When total camber is less than minimum that can be maintained in a beam (W Section) no camber is required but a note stating "Beams shall be placed with any mill camber up" shall be shown on the drawings.

2. Continuous and Cantilevered Spans. The various conditions of dead load deflections and cambers for each stringer shall be tabulated (in the following Camber Table Form) at the tenth point of spans and at the field splice points (at dead load points of contraflexure if field splices are not provided).

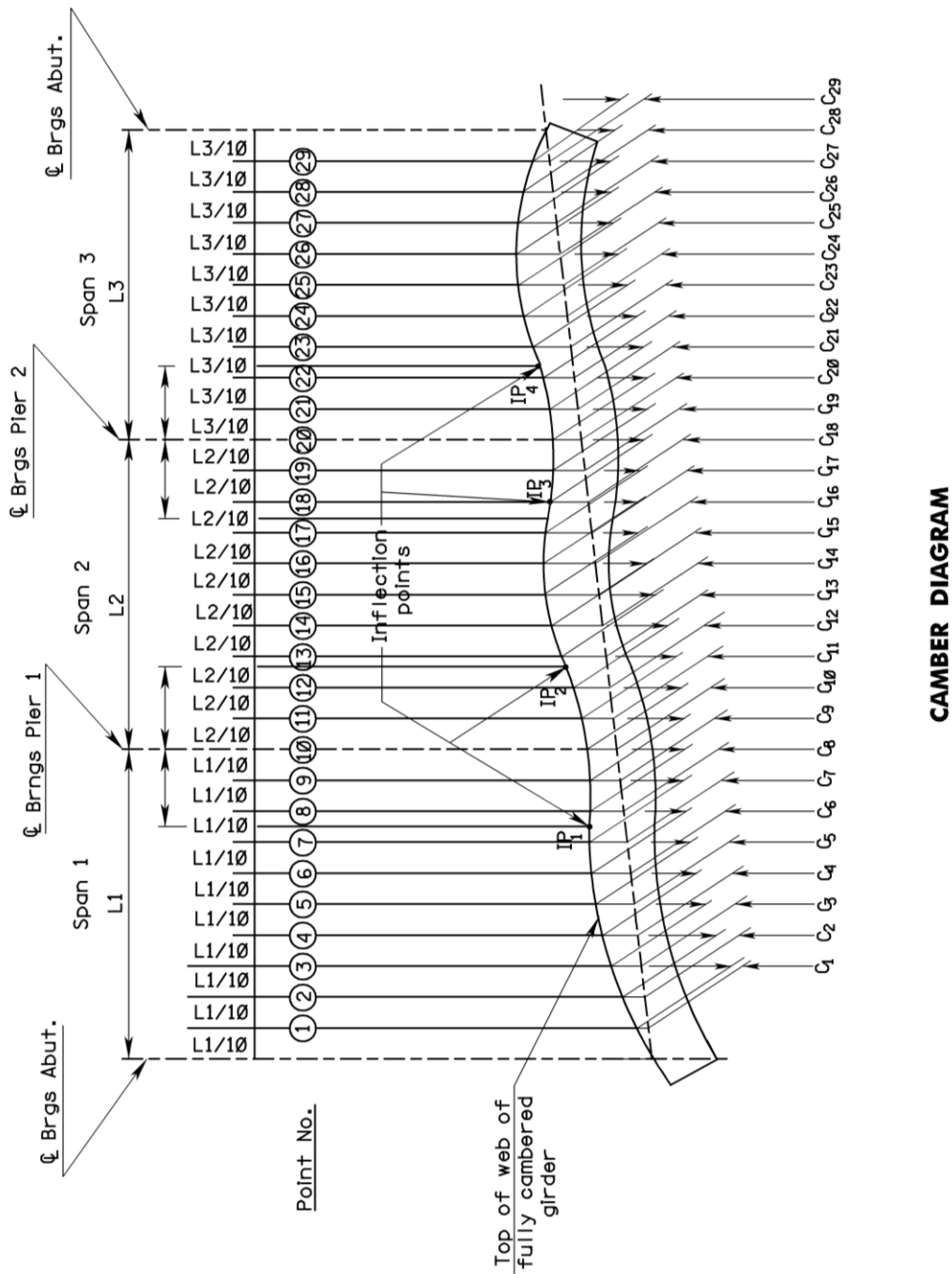
Complete the Camber Table (Table 24.2) and use the example in Figure 24.1 to create the Camber Diagram.

**Table 24.2 Camber Table for Continuous and Cantilevered Spans**

| POINT NUMBER  |  | CAMBER TABLE            |     |     |     |     |     |     |                 |     |     |      |      |      |                 |        |      |      |      |      |                 |      |                        |      |      |      |                 |      |      |      |      |      |      |      |
|---------------|--|-------------------------|-----|-----|-----|-----|-----|-----|-----------------|-----|-----|------|------|------|-----------------|--------|------|------|------|------|-----------------|------|------------------------|------|------|------|-----------------|------|------|------|------|------|------|------|
|               |  | SPAN 1                  |     |     |     |     |     |     | SPAN 2          |     |     |      |      |      |                 | SPAN 3 |      |      |      |      |                 |      | Centerline Brgs. Abut. |      |      |      |                 |      |      |      |      |      |      |      |
|               |  | 1                       | 2   | 3   | 4   | 5   | 6   | 7   | IP <sub>1</sub> | 8   | 9   | 10   | 11   | 12   | IP <sub>2</sub> | 13     | 14   | 15   | 16   | 17   | IP <sub>3</sub> | 18   | 19                     | 20   | 21   | 22   | IP <sub>4</sub> | 23   | 24   | 25   | 26   | 27   | 28   | 29   |
|               |  | Centerline Brgs. Pier 1 |     |     |     |     |     |     |                 |     |     |      |      |      |                 |        |      |      |      |      |                 |      |                        |      |      |      |                 |      |      |      |      |      |      |      |
|               |  | Centerline Brgs. Pier 2 |     |     |     |     |     |     |                 |     |     |      |      |      |                 |        |      |      |      |      |                 |      |                        |      |      |      |                 |      |      |      |      |      |      |      |
|               |  | Centerline Brgs. Abut.  |     |     |     |     |     |     |                 |     |     |      |      |      |                 |        |      |      |      |      |                 |      |                        |      |      |      |                 |      |      |      |      |      |      |      |
| CAMBER        | Steel                                  | 0                       |     |     |     |     |     |     |                 |     |     | 0    |      |      |                 |        |      |      |      |      |                 |      |                        | 0    |      |      |                 |      |      |      |      |      |      | 0    |
|               | Concrete Slab                          | 0                       |     |     |     |     |     |     |                 |     |     | 0    |      |      |                 |        |      |      |      |      |                 |      |                        | 0    |      |      |                 |      |      |      |      |      |      | 0    |
|               | SIP Forms and Addl. Concrete Thickness | 0                       |     |     |     |     |     |     |                 |     |     | 0    |      |      |                 |        |      |      |      |      |                 |      |                        | 0    |      |      |                 |      |      |      |      |      |      | 0    |
|               | S.D.L.                                 | 0                       |     |     |     |     |     |     |                 |     |     | 0    |      |      |                 |        |      |      |      |      |                 |      |                        | 0    |      |      |                 |      |      |      |      |      |      | 0    |
|               | V.C.                                   | 0                       |     |     |     |     |     |     |                 |     |     | 0    |      |      |                 |        |      |      |      |      |                 |      |                        | 0    |      |      |                 |      |      |      |      |      |      | 0    |
| Architectural | 0                                      |                         |     |     |     |     |     |     |                 |     | 0   |      |      |      |                 |        |      |      |      |      |                 |      | 0                      |      |      |      |                 |      |      |      |      |      | 0    |      |
| TOTAL         | 0                                      | C1=                     | C2= | C3= | C4= | C5= | C6= | C7= | C=              | C8= | C9= | C10= | C11= | C12= | C=              | C13=   | C14= | C15= | C16= | C17= | C=              | C18= | C19=                   | C20= | C21= | C22= | C=              | C23= | C24= | C25= | C26= | C27= | C28= | C29= |

### **Camber Table Notes**

- The total camber as tabulated is assumed to be measured vertically to the top of the fully cambered web from a straight line drawn from the intersection of top of web and centerline of bearing at one end of the girder to the intersection of top of web and centerline of bearing at the other end of the girder.
- The camber labeled "Steel" in the table is the camber required in the girder to offset the deflection due to the dead load of the steel in the girder plus all necessary diaphragms, cross frames, etc.
- The camber labeled "Conc. Slab" in the table is the camber required in the girder to offset the deflection due to the dead load of the concrete slab.
- The camber labeled "SDL" in the table is the camber required in the girder to offset the deflection due to the superimposed dead load, that is, the curb, sidewalk, railing and future wearing surface.
- The camber labeled "Stay-in-Place forms and added concrete thickness" is the camber required in the girder to offset the deflection due to the weight of the stay-in-place forms and due to the weight of added concrete that is needed to meet the deck grades.
- The camber labeled "VC" in the table is the camber required in the girder to follow the vertical curve. The Vertical Curve value shall be used exclusively for stringers located within the limits of a crest vertical curve. Where such stringers are located within the limits of a sag vertical curve, provision for its value must be made within the concrete haunch. Consequently, the tabulation of its values is unnecessary.
- The camber labeled "Architectural Camber" shall be a value of  $L/100$  inches, where "L" is the span length in feet. If the vertical curve value provides this camber value, the architectural camber may be omitted.
- Cambers listed in the table as positive are upward cambers.
- Cambers listed in the tables as negative are downward cambers.
- The cambers are tabulated in inches.



**Figure 24.1 Camber Diagram**



### 3. Sag Cambers

Because of the objectionable appearance of a sag camber in a stringer, sag or negative cambers should be avoided. The following are a few guidelines on possible means of avoiding negative camber in a stringer.

- a. Avoid sag vertical curves on bridges.
- b. Never begin or end a superelevation transition or runoff in the middle of a span. Always begin or end transitions off the structure or, if this is impossible, begin or end the transition at a centerline of bearing or a centerline of pier.
- c. Never place a sag camber in a straight stringer on a curved roadway in order to accommodate the variation in the theoretical bottom of slab elevation. The variation should be taken up in the haunch.
- d. Upward dead load deflection may occur in some areas of continuous girders when the ratio of maximum to minimum span lengths becomes significant. There always is a possibility that computed camber built into the girder is not completely removed with the application of dead load. Camber due to a future wearing surface will remain when construction is completed. Additional camber may remain due to differences between design assumptions and actual girder performance.

#### **24.8 Multiple Span Structures**

1. It is desirable that, from an aesthetic viewpoint, a uniform depth of concrete fascia be kept for the full length of the exposed fascia. All fascia beams shall be set so that the bottom of the top flanges will be aligned.
2. Stringers, beams, and girders shall generally be of uniform depth for the full length of the structure, except where changes in depth are absolutely necessary to meet underclearance requirements or where a change in depth is desirable to enhance the appearance of the structure. Changes in depth shall not normally be made in structures with varying spans. Interior stringers shall be made the same depth as the fascia stringer.

#### **24.9 Diaphragms and Crossframes**

1. The criteria of Subsection 6.7.4 – Diaphragms and Cross frames of the LRFD Specifications and Section 3 of this Manual shall be followed in analyzing the need for their provision.
2. The structural steel layout should be examined to determine if the location of relatively stiff intermediate diaphragms placed normal to the stringers introduce detrimental stresses in diaphragms and stringers due to twisting. If this condition exists, the spacing of the diaphragms should be staggered.

Also, the following note should be included on the plans:

“Intermediate diaphragm connections to stringers shall be limited to finger-tight bolts in oversized holes until the dead loads are in place. The bolts shall be tightened after the deck is in place.”

3. Generally, the above note should be provided on final plans for most structural steel erection applications. Especially, final plans that are for those projects where stage construction is involved in the construction process.

### **24.10 Transverse Intermediate Stiffeners**

1. Refer to Subsection 24.5 for Fracture Control Plan criteria.
2. See Guide Plate 3.9-6 for intermediate Stiffener details.

### **24.11 Bearing Stiffeners**

See Guide Plate 3.9-5 for Bearing Stiffener details.

### **24.12 Connector Plates For Interior Diaphragm X-Frames**

See Guide Plate 3.9-14 and 3.9-15 for Connector Plate details.

### **24.13 Stability During Transportation And Erection**

The stability of the stringers and girders during transport and erection is normally the responsibility of the Contractor. However, wherever possible, the design should be such that temporary bracing or diaphragms are not required. In reviewing working drawings, Engineers shall satisfy themselves that the Contractor has properly met his contractual responsibilities in this respect.

### **24.14 Welded Details**

1. Field Welding to stringers, plate girders or any major component of the structure shall not be permitted unless approved by the Manager, Structural Engineering, prior to the submission of working drawings.

Field welding in such cases shall conform to the following Sections of ANSI/AASHTO/AWS Bridge Welding Code D1.5. The following parameters shall be included in the Special Provisions:

- Pre-qualification of the proposed welding procedures shall be in accordance with Section 5, Part A.
  - Qualifications of the welding operator shall be in accordance with Section 5, Part B.
  - The Quality Control Inspector shall meet the qualifications specified in Section 6 and 12.16.
  - All full penetration welds shall be inspected according to AWS D1.5 and NJDOT Standard Specifications requirements.
  - All fillet welds shall be 100% Magnetic Particle (MT) tested in addition to Visual Inspection.
2. The ANSI/AASHTO/AWS Bridge Welding Code D1.5 promulgates the following concepts of inspection, which, in effect, are separate functions:
    - a. Fabrication/Erection Inspection and Testing (Quality Control) is to be performed by the Contractor or Fabricator as a mandatory requirement.
    - b. Verification Inspection and Testing (Quality Assurance) is the prerogative of the State.

Provisions in the ANSI/AASHTO/AWS Bridge Welding Code D1.5 requires that contract documents identify main members and also that contract documents identify groove welds in these members as to category of stress (tension, compression or reversals of stress). Both of these identifications are needed to define the extent of non-destructive testing required by the Contractor as a minimum level under QC inspection specifications.

Identification of the nondestructive inspection required for all welds included in the ANSI/AASHTO/AWS Bridge Welding Code D1.5, shall be accomplished by providing symbols and notes as per paragraph (b) above. This essentially fulfills the requirement of the Bridge Welding Code.

For main member components in structure types such as trusses, bents, towers, box girders etc., it shall be the Structural Design Engineer's responsibility to identify such members and welds as part of the details on the contract drawings with the appropriate welding and NDT symbols.

3. Certain miscellaneous details (supports for screed rails, steel deck forms, miscellaneous connection plates, gussets, etc.) shall normally not be welded by the use of fillet welds (regardless of the direction of weld), plug welds, or tack welds to members or parts subject to tensile stress. At locations where welding cannot be avoided, the maximum stress at the point of attachment shall not exceed nominal fatigue resistance as defined in Subsection 6.6 of the AASHTO LRFD Bridge Design Specifications.

The attachment of these details shall not be allowed where the stress exceeds the nominal fatigue resistance.

4. The contract plans and shop drawings shall clearly show the flange areas where no welding is permitted and the areas on continuous girders where the stiffeners are to be connected to the top or bottom flanges.
5. In the fabrication of HPS girders, the AASHTO Guide Specifications for Highway Bridge Fabrication with HPS 70W steel recommends that filler metals for Grade 50W base metal be specified for all fillet welding. When the use of HPS is planned, this criteria should be stated on the Plans.

#### **24.15 Shear Locks**

Shear locks shall be provided when a longitudinal expansion joint is located in the roadway area as guided in Subsection 20.6 b. of this Manual. The shear locks shall be located at intermediate diaphragms within the middle half of the span. A minimum of three shear locks shall be provided per span. The shear locks are intended to eliminate differential deflections due to live load and impact.

#### **24.16 Flared Decks**

Beams should be laid out parallel as much as practicable. Non-parallel beams shall be kept to a minimum.

#### **24.17 Field Splices**

1. To facilitate the fabrication, shipping and the erection of steel girders, one optional field splice will be permitted in spans between 120 and 150 feet in length. This field splice shall be located between the 1/3 and outer 1/4 points of the span length.

When the span exceeds 150 feet, optional field splices may be located between each of the 1/3 and outer 1/4 points.

In continuous spans, the bolted field splice shall preferably be made at or near the points of dead load contraflexure.

2. Locations and details of the optional field splice shall be shown on the plans. The Contractor may request modifications subject to approval by the Engineer.

3. Field splices shall be designed and detailed using AASHTO M 164 (ASTM A 325) high strength bolts. The flanges should have sufficient excess area at points where splicing is anticipated to permit a bolted splice to be made.
4. Splice locations are generally selected near transitions in flange thickness or width where there is sufficient flange area to permit hole drilling while still maintaining the required net area.
5. When rolled beams are used for continuous structures, the field splices should be located in areas where no cover plates are required. Consideration should be given to the fact that the fatigue strength of the section adjacent to the bolted connection (Category B\*) is less than the fatigue strength of the base metal in areas where there is no splice (Category A\*).
6. See Subsection 20.7 g. of this Manual concerning depth of concrete haunch at location of field splices.

#### 24.18 Paint Coating Systems

1. Environmental Zones. Past studies of air pollutants and sea salt and their effects on structural paint has resulted in establishing the State of New Jersey into four environmental zones. These zones are listed herein. The current structural steel paint systems used by the Department are acceptable for use in all four environmental zones.
2. High Pollutant Level Zones. When planning the rehabilitation of structural steel, there is no evidence to show that repainting schedules are adversely affected in areas where, due to the bridge structure's location, pollutant levels may be higher. Thus industrial and rural areas should normally be considered comparable with regard to the use of current structural steel paint systems. Unusual situations such as structures over or near factories may require individual study to assess the quality and the extent of required removal of the existing coating system.
3. Salt Splash Zones. The effect of salt splash water on the deterioration of structural paint is dependent upon its salinity. It has been established that waters with salinity high enough to initially require use of paint coating system specifications include all coastal waters (Bays, Harbors, etc.) and coastal parts of tidal rivers. The limits of salt splash zones of tidal rivers in New Jersey are delineated by the following table:

| <b>River:</b>          | <b>Salt Splash Zone Limit</b>           |
|------------------------|---|
| Delaware               | Bridgeport, NJ                          |
| Mullica                | 14 <sup>th</sup> mile of River's Length |
| Hudson                 | New York Border                         |
| All other tidal rivers | 15 <sup>th</sup> mile of River          |

**Note:** Salt splash zones are defined as areas that are 15 feet or less above the high water level.

4. Salt Intrusion Zones. Certain areas of the State due to their geographic configuration are subjected to high concentrations of sea salt suspended in the

air. These areas are designated to be in salt intrusion zones. As illustrated herein salt intrusion is generally limited to a 2 mile coastal region.

5. Steel bridge structures that are located in areas where pollutant levels may be high, or in salt splash zones or in salt intrusion zones will initially require use of a paint coat system. However, as per the guidance provided in Subsection 24.19 the use of weathering steel may be considered. Subsection 24.19 contains guidance on evaluating the use of weathering steel.

ZONAL AREAS OF NEW JERSEY AFFECTED BY SALINITY

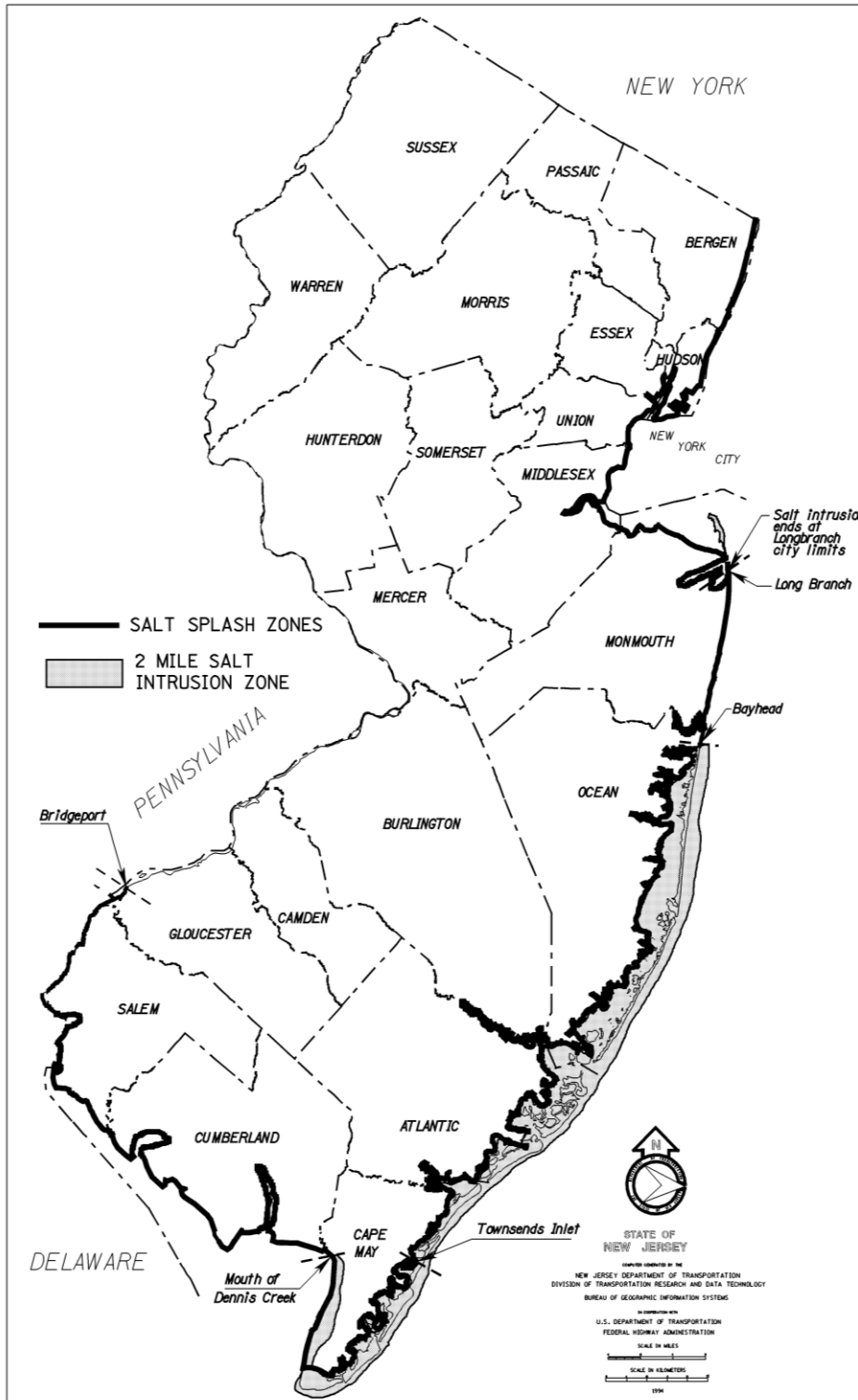


Figure 24.2

The following notes are included to clarify the map on the previous page:

- a. A river's point of measurement is to start where the mouth noticeably changes into a bay or ocean.

Examples:           Hackensack and Passaic Rivers - Newark Bay  
                         Mullica River - Great Bay  
                         Raritan River - Line parallel from South Amboy to opposite  
                         coastline  
                         Shrewsbury River - Sea Bright Bridge

- b. Sea salt intrusion areas are surrounded on three sides by salt water (peninsula, protrusion) such that at least one side faces open ocean or, are those land masses completely surrounded by salt water.

- c. Except for the Delaware and Hudson Rivers, designated splash zones are only approximations of splash zones on rivers.

- e. Dashed lines denote transition points from splash zones to 2 mile intrusion zones.

6. Listed below are the four environmental zones identified in the State of New Jersey:

Zone 1 - Rural or industrial, mild exposure. Where severe corrosion is not a problem.

Zone 2 - Industrial, severe exposure. Area where corrosion is a serious problem. Progressively aggressive industrial locations.

Zone 3A - Marine, mild exposure. Structural steel more than 15 feet above mean high water. Structure located in less severe coastal salt intrusion zone.

Zone 3B - Marine, severe exposure. Structural steel less than 15 feet above mean high water. Structure located in severe coastal salt intrusion zone.

The cleaning and painting systems for new structural steel shall be based on specifications that are contained in the NJDOT Standard Specifications.

For the painting of existing structural steel a written request shall be submitted to the NJDOT Bureau of Maintenance Engineering for direction as to the coating system (Organic Zinc or Epoxy Mastic) that is to be specified for use in the project.

The guidelines listed in the Table 24.3 can be referred to for guidance in planning the work.

Also, as required in the Standard Specifications, a request should be submitted to the Bureau of Project Support to request an EPA ID number. The EPA ID manifest number shall be listed on the manifest for processing of the waste. A minimum of two (2) weeks is required to obtain this information.

The Bureau of Maintenance Engineering and the Bureau of Project Support should be given the structure number, location (highway route number or road name and milepost), municipality, zip code and County.

**Table 24.3 Coating Systems**

| <b>Coating System</b>                              | <b>Paint System</b>   | <b>Surface Preparation</b>   | <b>Acceptable Environmental Zones</b> | <b>Selection Criteria</b>   |
|--|---|--|---------------------------------------|---|
| IEU  | P: Inorganic Zinc Rich<br>I: Epoxy Polyamide<br>F: Aliphatic Urethane         | Near-White Blast Cleaning, SSPC-SP-10  | All                                   | Use for the painting of all new structural steel.   |
| OEU  | P: Organic Zinc Rich<br>I: Epoxy Polyamide<br>F: Aliphatic Urethane           | Near-White Blast Cleaning, SSPC-SP-10  | All                                   | Use for all existing structural steel with an ASTM D610 Rust Grade of 6 or less and when no major structural work involving steel replacement is scheduled in the near future.  |
| EU   | P: Aluminum Epoxy Mastic<br>I: Aluminum Epoxy Mastic<br>F: Aliphatic Urethane | Hand/Power Tool Cleaning, SSPC-SP-2/3 (with spot commercial blast SSPC-SP-6 if and where directed) | All                                   | Use for the painting of all existing structural steel with an ASTM D610 Rust Grade greater than 6.  |
| Leave Steel Unpainted                              |   |  |                                       | Use this option for all existing structural steel with an ASTM D610 Rust Grade of 6 or less and when major structural work, involving steel replacement, is scheduled in the near future. (Use of this option will depend on site conditions) |
| Key:<br>P=Primer      I=Intermediate      F=Finish |   |  |                                       |   |



7. The Standard Specifications provide color chip numbers for the following finish coat colors:

Foliage Green; Lake Blue; Brown

Brown should be specified only at those locations where a significant aesthetic objective is to be achieved. Brown should not be specified for Non-Redundant (Single-Load-Path) type bridges.

Generally, designation of finished colors should be based on the following considerations: If a bridge is located in an opened area (urban or rural) where it is more exposed to the open sky, then Lake Blue should be designated. If a bridge is located in an area other than this, Foliage Green should be designated.

Other finish coat colors; such as, gray or off-gray may be used. The color chip number for these colors may be obtained by contacting the Bureau of Maintenance Engineering. The obtained color chip number should be provided in the Project Special Provisions.

8. The following notes are required on Structural Steel plans to compliment the requirements of the Standard Specifications.

Coating System: \_\_\_\_\_

Finish Coat Color: \_\_\_\_\_

#### **24.19 Weathering Steel**

1. Uncoated weathering grade steels have been available to the bridge engineering industry for many years. The cost-effectiveness of using this material has been demonstrated in both short and long-term savings. The additional cost of this steel is offset by the elimination of the need for initial complete painting. As stated earlier, these steels are currently supplied under AASHTO Specification M270 (ASTM A709) "W" and "HPS W" Grades.
2. The conditions stated below shall render a site not suitable for use of weathering steel.
  - a. Grade Separations in "Tunnel-Like" Conditions. Refer to 3.a. below for additional clarification.
  - b. Low Level Water Crossings; such as,
    - 1.) 10 feet or less over stagnant, sheltered water.
    - 2.) 6 feet or less over moving water.
3. If a proposed structure is to be located at a site with any of the characteristics noted above, the use of uncoated Weathering Grade steel shall not be contemplated. The guidance provided below, shall be considered in analyzing these conditions.
  - a. Grade Separations. The so-called "tunnel effect" is produced by the combination of narrow depressed roadway sections between vertical clearances and deep abutments adjacent to the shoulders as are found at urban/suburban grade separations. These roadway/bridge geometrics combine to prevent roadway spray from being dissipated by air currents and can result in excessive salt in the spray being deposited on the bridge steel.

In such locations, the use of uncoated weathering steel should be avoided as deicing salts may result in adverse conditions.

- b. Low Level Water Crossings. Sufficient clearance over bodies of water must be maintained so that spray or condensation of water vapor does not result in prolonged periods of wetness of the steel. Clearance to bottom flange of at least 10 feet over sheltered, stagnant water and at least 6 feet over running water is recommended.
4. Marine or Industrial Environment. When the project site is located in a marine or industrial environment, a more precise technical evaluation of the suitability of uncoated weathering steel may be obtained from a corrosion consultant, from conducting standardized environmental tests or from both. If serious doubt remains after such an evaluation, then engineering judgment should lean towards coated steel.
  5. If weathering steel is approved for use, the following items should be studied in detailing the construction of a bridge:
    - a. Elimination of bridge joints where possible.
    - b. Expansion joints must be able to control water that is on the deck. Consider the use of a trough under the deck joint to divert water away from vulnerable elements.
    - c. When addressing parallel bridge conditions, the distance between the bridges must be assessed to determine if the adjacent fascia girders should be completely painted. If the fascia girders are close together, possible snow accumulation from plowing or debris accumulation could cause a situation where the steel does not completely dry.
    - d. Do not use welded drip bars where fatigue stresses may be critical.
    - e. Elimination of details that serve as water and debris "traps".
    - f. "Hermetically seal" box members when possible, or provide weep holes to allow proper drainage and circulation of air.
    - g. Cover or screen all openings in boxes that are not sealed.
    - h. Protection of pier caps and abutment walls to minimize staining.
    - i. Seal overlapping surfaces exposed to water (to prevent capillary penetration action).
    - j. Provide drip plates (bars) only on fascia girders at the low end(s) of appropriate spans as detailed in Guide Plate 3.9-23.
    - k. Paint weathering steel as specified in Section 906.04.03A of the NJDOT Standard Specifications for certain areas. Designer shall show the limits of painting on the plans for the ends of girders and exposed surfaces of fascia girders accordingly.
    - l. If non slip-critical bolted joints are used, the faying surfaces should be painted or sealed to prevent the capillary penetration.

## 24.20 Bearing Devices

The following guidance shall be considered for the design of new structures or for those projects that involve, as applicable, a superstructure replacement. For decision making guidance as to the seismic retrofit of existing bridges, Section 38 of this Manual should be referred to for guidance.

### 24.20.1 Bearing Selection Evaluation

a. The bearing type selection should be based on achieving the most economical solution that will support all required movements. An initial evaluation will reveal that reinforced elastomeric bearings or elastomeric bearing pads will often be the lowest maintenance and most economic solution as a bearing selection.

b. The use of HLMR bearing systems should be based on satisfying loading conditions that elastomeric bearings cannot.

Accordingly, economics shall not be the sole category in selecting bearing types. Accommodating longitudinal, transverse and rotational movements as well as consideration of skew conditions should be evaluated in the bearing selection.

c. Subsection 14.6.2 of the AASHTO LRFD Specifications provides a Table that tabulates bearing suitability. This Table can be referred to in determining bearing system selection.

d. Seismic isolation bearings perform all of the service load functions of other bearing types. Also, they will reduce and distribute seismic forces.

### 24.20.2 Requirements for Bearings

Standard Drawings for "Elastomeric Bearing", "Pot Bearing" and "Seismic Isolation Bearing", as contained in this Manual, may be referred to for a conceptual presentation of these type bearing systems.

#### A. General

Structural bearings for use on new bridges or for superstructure replacements shall include use of Steel Reinforced Elastomeric Bearings, Elastomeric Pads, either circular or rectangular, High Load Multi-rotational Bearings or Seismic Isolation Bearings.

High Load Multi-Rotational (HLMR) bearing systems shall include those types that consist of a rotational element of the pot type, disc type or spherical type. When expansion is required, HLMR bearing systems may include sliding surfaces.

Components of such bearings shall include masonry, sole and shim plates, bronze or copper alloyed bearing and expansion plates, anchor bolts, guide devices, polytetrafluorethylene (PTFE) sheets or surfacing lubricants and adhesives.

When load conditions indicate that plain Elastomeric Pads or Reinforced Elastomeric bearing systems are sufficient, detailing shall be provided on the final plans for their use. However, when load conditions indicate that HLMR or Isolation Bearing systems are warranted, then the complete design of these bearing assemblies is not required with the final plan submission. As described

herein, sufficient information is to be provided on the plans to permit the bearing assembly type to be selected by the Contractor.

Bearings shall be supplied as fixed bearings, guided expansion bearings or non-guided expansion bearings. Bearings shall adequately provide, as applicable, for the thermal expansion and contraction, rotation, camber changes and creep and shrinkage of structural members.

The design, materials, fabrication and installation methods shall be in accordance with the *AASHTO LRFD Bridge Design Specifications* and Sections 14 and Section 18 of the *AASHTO LRFD Bridge Construction Specifications*.

#### B. Construction Document Requirements

1. Final Plans shall include a "Bearing Table", as illustrated on the following page that indicates the following information:

- a. A listing of all minimum and maximum vertical and horizontal service loads and transverse and longitudinal rotation requirements for the applicable AASHTO LRFD Load Groups as shown in the following Table.

As discussed in Subsection 14.4.2 of the *AASHTO LRFD Bridge Design Specifications*, bearings must accommodate movements in addition to supporting loads. Therefore, displacements and, particularly, rotations, shall be listed. This will include all longitudinal forces, transverse forces and seismic forces.

- b. Minimum design rotation requirements of the bearing and construction tolerance.

2. The following information shall also be noted or detailed on the plans.

- a. Magnitude and direction of movements at all bearing support points including seismic, thermal, creep and shrinkage movements.
- b. The location, quantity and type of each bearing (fixed, expansion or guided expansion) and the location of all bearing units. An actual bearing layout is preferred or a bearing framing plan to provide this data may be used.

To facilitate selection of a bearing system, Table 24.4 should be provided in the design plans. In order to limit the table size, Engineering judgment should be used to eliminate groups which obviously will not control the bearing design.

Design loads shall be based on the load combinations and load factors that are specified in Subsection 3.4 of the *AASHTO LRFD Bridge Design Specifications*.

**Table 24.4 Displacement/ Rotations**

|                     | Load<br>Combination<br>Limit State | Displacements/ Rotations |     |            |     |              |     |                |     |              |  |
|---------------------|------------------------------------|--------------------------|-----|------------|-----|--------------|-----|----------------|-----|--------------|--|
|                     |                                    | Vertical                 |     | Horizontal |     |              |     | Rotation (RAD) |     |              |  |
|                     |                                    | Min                      | Max | Transverse |     | Longitudinal |     | Transverse     |     | Longitudinal |  |
| Min                 | Max                                |                          |     | Min        | Max | Min          | Max | Min            | Max |              |  |
| Strength I          |                                    |                          |     |            |     |              |     |                |     |              |  |
| Strength II         |                                    |                          |     |            |     |              |     |                |     |              |  |
| Strength III        |                                    |                          |     |            |     |              |     |                |     |              |  |
| Strength IV         |                                    |                          |     |            |     |              |     |                |     |              |  |
| Strength V          |                                    |                          |     |            |     |              |     |                |     |              |  |
| Extreme<br>Event I  |                                    |                          |     |            |     |              |     |                |     |              |  |
| Extreme<br>Event II |                                    |                          |     |            |     |              |     |                |     |              |  |
| Service I           |                                    |                          |     |            |     |              |     |                |     |              |  |
| Service II          |                                    |                          |     |            |     |              |     |                |     |              |  |
| Service III         |                                    |                          |     |            |     |              |     |                |     |              |  |
| Fatigue             |                                    |                          |     |            |     |              |     |                |     |              |  |

### C. Design Requirement

The Designer is advised that he must provide estimated bridge seat elevations with the submission of final plans. The exact elevations will be determined upon submission of the shop drawings that will, of course, designate the bearing height.

The estimated bridge seat elevation heights should be based on the loads that the bearings must be designed to and the required degree of rotation and displacement.

Additionally, the location of anchor bolts and required grillage reinforcement steel size and spacing shall be indicated on the plans. However, it is to be understood that this detailing may have to be adjusted upon the final bearing system type selection.

Accordingly, notes to this affect shall be provided.

The following note shall be provided when designating bridge seat elevations: "Bridge Seat Elevations are based on a bearing height of \_\_\_\_\_".

#### **24.20.3 Permitted Bearing Assembly Types**

The following narrative is provided to familiarize the Designer as to the basic features of the permitted bearing assembly types:

- A. **Elastomeric Bearings.** Elastomeric Bearings shall include unreinforced pads (consisting of elastomers only) and reinforced bearings with steel or fabric laminates. Rectangular or circular types are permitted.

1. Elastomeric bearings have been developed to provide a maintenance free device capable of accommodating expansion and rotation by utilizing the unique characteristics of the elastomeric material.
2. Elastomeric bearings are generally placed between sole plates and masonry plates. In some instances, they can be placed directly between the superstructure member and the substructure unit.
3. Elastomeric bearings are available in three basic types as follows:
  - Plain elastomeric pads
  - Steel reinforced elastomeric pads
  - Fabric reinforced pads (usually a fiberglass composition)
4. Laminations can be created in the elastomer by introducing a layer of steel or fabric between the layers of elastomer. The sheets separating the layers of elastomer are completely encased within the elastomeric material. For vertical loads, each layer of the elastomer behaves like an individual pad, while the horizontal strain is additive to each layer. That is, as layers are applied, the allowable horizontal deformations are increased. Therefore, adding laminations is a convenient way to accommodate larger lateral movements for the same compressive loads.
5. As required by the AASHTO LRFD Bridge Design Specifications, elastomeric materials shall have a hardness of from 50 to 70 durometers.
6. When permitted by design conditions, it is not necessary to bond the elastomeric pads to the superstructure and substructure concrete surfaces. In such cases, restraining lips or keeper plates should be provided around the pads. This will inhibit the potential of the pads walking off the bearing locations. When placed between steel sole plates and masonry plates, the elastomeric material should be bonded vulcanized to the steel plates.

## B. Seismic Isolation Bearings

Seismic bearings are permitted if seismic analysis warrants their use. Refer to Section 38 for Seismic analysis criteria.

1. The basic intent of seismic isolation is to increase the fundamental period of vibration such that the structure is subject to significantly lower earthquake forces.
2. The reduction in forces is accompanied by an increase in displacement demand which must be accommodated with a flexible mount.
3. The following elements describe the basic composition of a bridge seismic isolation system:
  - a. A flexible mounting so that the period of vibration of the bridge is lengthened sufficiently to reduce the force response.
  - b. A damper or energy dissipator so that the relative deflections across the flexible mounting can be limited to a practical design level.
  - c. A means of providing rigidity under low (service) load levels such as wind and braking forces.

4. Rather than resisting the large forces that are generated by earthquakes, seismic isolation systems decouple the bridge deck from the ground motion. When used in combination with a flexible device such as an elastomeric isolation bearing, an energy dissipator can control the response of an isolated structure by limiting both the displacements and the forces.

Standard Drawing number 2.2-3 may be referred to for a conceptual presentation of Seismic Isolation Bearings. This drawing is for informational purposes only and is not to be included in a contract set of plans.

5. Seismic design, performance and testing shall be assessed in accordance with the AASHTO Guide Specifications for Seismic Isolation Design.
6. Seismic Isolation bearing assemblies shall include seismic isolation bearings (isolators), sole plates, masonry plates, mounting plates, lead cores, steel shims, bolts, washers and anchor bolts.
7. The following loads will typically govern the design of the various components of the bearing assembly:
  - a. Vertical Loads will govern the plan size of the assembly and the internal rubber layer thickness.
  - b. Short term loads and damping requirements will govern the lead core diameter.
  - c. Long term displacements and seismic requirements will govern the total rubber height.
  - d. Imposed rotations will govern the internal rubber layer thickness and the total rubber height.

#### C. High Load Multi-Rotational (HLMR) Bearing Systems

##### 1. Pot Bearings

- a. The rotational elements of a pot bearing shall consist of at least a pot, a piston, an elastomeric disc and sealing rings.
- b. Subsection 14.7.4 of the *AASHTO LRFD Bridge Design Specifications* may be referred to for guidance in designing pot bearing systems.

##### 2. Disc Bearings

- a. As defined in Subsection 14.7.8 of the LRFD Specifications, a disc bearing functions by deformation of a polyether urethane disc. The disc must be able to resist vertical loads without excessive deformation and be able to accommodate imposed rotations.
- b. Disc bearings are typically composed of four fundamental components: the load plates, the upper and lower bearing plates, a horizontal load transfer mechanism and an elastomeric disc.

## Section 25 - Precast/Prestressed Concrete

### 25.1 General Design Considerations

1. Subsection 5.9 of the *AASHTO LRFD Bridge Design Specifications* provides criteria on the design of prestressed concrete members.
2. The PCI publication, "*Precast Prestressed Concrete Bridge Design Manual*" also explains and applies major *AASHTO LRFD Bridge Design Specifications* provisions that pertain to prestressed concrete beams.
3. NJDOT stipulations provided in Section 3 of the Manual shall also be followed in the design of prestressed concrete members.

### 25.2 Precast/Prestressed Concrete Sections

Standardization of precast/prestressed concrete sections has simplified design, led to wider utilization of precast/prestressed concrete and has led to a reduction in cost when precast/prestressed concrete is selected. Designers should review the following guidance in evaluating precast/prestressed concrete usage.

1. Prestressed Concrete I-Girders. Details of AASHTO prestressed concrete I beams are illustrated on Standard Drawings 2.1-1 through 2.1-6 of this Manual.

If continuity design for live load (see Subsection 25.9) is selected as a result of the bridge structure selection study, details for the positive restraint moment connection, sole and bearing plates, elastomeric bearing pads, and any other necessary details must be addressed in the design.

2. Prestressed Concrete Voided Slab and Box Beams. Standard drawings for prestressed concrete voided slab and box beams are not presently available. Complete details, including the prestressed strand pattern and bearing details shall be shown in the contract plans for each bridge. Refer to Subsections 25.5 through 25.7 for additional criteria on box and slab beam usage.
3. Prestressed Concrete Bulb Tee Shapes. Studies have concluded that bulb tee shapes are more efficient than I-girder shapes. When compared to the AASHTO Type VI girder an alternative bulb tee shape may lead to reduction in girder weights of up to 35%. Also when compared to the respective I-girder span length capability, a cost savings of 17% may be realized if a bulb tee section is selected. Guide Plate 3.10-26 has been developed to illustrate 3 New England Bulb Tee (NEBT) configurations. Other configurations are available. If a Designer wishes to pursue a NEBT design, he should contact prestressed fabricators to ascertain availability of forms for its casting.

The Federal Highway Administration has initiated an effort to establish measures for the economic fabrication of prestressed concrete members. Toward that end a committee titled Prestressed Concrete Economic Fabrication (PCEF) was formed. The work of the committee has produced a bulb tee shape that they recommend be adopted as a standard shape by State agencies. Guide Plate 3.10-27 details 3 configurations of the PCEF Bulb Tee Shape. Other configurations are available. If a Designer wishes to pursue use of the PCEF shape, he should contact fabricators for availability of forms for its casting.

4. Spliced Prestressed Concrete I-Girders. Spliced concrete I-girder bridges have been shown to be cost-effective for a span range of 120 to 300 feet. A feature of



spliced bridges is the flexibility they provide in selection of span length, number and locations of piers, segment lengths and splice locations. Spliced girders have the ability to adapt to curved superstructure alignments by utilizing short segment lengths and accommodating the change in direction in the cast-in-place joints.

5. Precast Concrete Segmental. Segmental concrete bridges have become an established type of construction for highway and transit projects on constrained sites. Typical applications include transit systems over existing urban streets and highways, reconstruction of existing interchanges and bridges under traffic or projects that cross environmentally sensitive sites. In addition, segmental construction has proved to be appropriate for large-scale, repetitive bridges such as long waterway crossings or urban freeway viaducts or where the aesthetics of the project are particularly important.

Current developments suggest that segmental construction will be used on a larger number of projects in the future. Standard cross sections have been developed to allow for wider application of this construction method to smaller-scale projects. Surveys of existing segmental bridges have demonstrated the durability of this structure type and suggest that additional increases in design life are possible with the use of HPC.

Subsection 5.14.2 of the *AASHTO LRFD Bridge Design Specifications* provides criteria for the design and construction analysis of segmental bridge construction. Section 10 of the *AASHTO LRFD Bridge Construction Specifications* should also be studied for information on post tensioning requirements that must be applied to segmental concrete construction. Also, the American Segmental Bridge Institute (ASBI) provides a forum where owners, designers, contractors and suppliers can gather information on segmental bridge construction.

## **25.3 Materials**

### **1. Strands**

- a. Uncoated seven-wire prestressing steel low relaxation strands, conforming to ASTM A416 (AAHSTO M 203) Grade 270, shall be used. Complete prestressing details shall be provided on the plans.
- b. If determined to be more suitable; such as, to offset the potential of corrosion due to the environmental location, epoxy-coated seven-wire prestressing steel low relaxation strands conforming to ASTM A882/A 882M, Supplements S1, Grade 270 may be used.

### **2. Bars**

- a. Uncoated high-strength steel bars for prestressing concrete conforming to AASHTO M 275, including Supplements S1 and S2 shall be used.
- b. If determined to be more suitable, zinc-coated reinforcing bars conforming to ASTM A767 shall be used or epoxy-coated reinforcing bars conforming to ASTM D3963 (AASHTO M284) shall be used.

### **3. Wire**

Uncoated stress-relieved wire for prestressed concrete conforming to ASTM A421 (AASHTO M204) shall be used.

#### 4. Post-Tensioning Anchorages and Couplers.

Refer to Subsection 5.4.5 of *AASHTO LRFD Bridge Design Specifications* for guidance concerning use of these devices.

#### 5. Ducts

Refer to Subsection 5.4.6 of *AASHTO LRFD Bridge Design Specifications* for guidance concerning use of those devices.

#### 6. Concrete

Generally the design strengths for prestressed/precast concrete shall be based on properties of Class P, P-1 or P-2 concrete. The NJDOT Standard Specifications can be referred to for guidance concerning use of these classes of concrete.

Use of HPC prestressed concrete girders should be evaluated by Designers in their appraisal of alternative bridge structure types. HPC in prestressed girders will optimize their performance with respect to service loads and exposure conditions.

If a design compressive strength greater than 6,000 psi is necessary for the design of precast/prestressed concrete elements, then the use of High Performance Concrete (HPC) should be pursued. The Designer shall familiarize himself with the following HPC performance criteria for the design and fabrication of precast/prestressed concrete beams.

Refer to Section 20 of this Manual for a basic definition of HPC.

| Performance Characteristics                     | Standard Test Method    |
|---|-------------------------|
| Creep<br>(x = inch/pressure unit) @ 180 days    | ASTM C 512              |
| Modulus of Elasticity<br>@ 28 days of age       | ASTM C 469              |
| 56 Day Design Compressive Strength              | AASHTO T 22<br>ASTM C39 |
| Shrinkage<br>(x = length change in microstrain) | ASTM C157               |
| Chloride Permeability (x = coulombs)            | AASHTO T 277            |

**Note:** All tests to be performed on concrete samples that are moist or Submersion cured for 56 days.

The chloride permeability performance criteria will only be required when prestressed concrete beams are constructed at a height that is less than 15 feet above brackish water.

### 25.4 Design/Construction Criteria

1. Drilling for inserts into prestressed concrete members is not permitted.

2. For any pre-tensioning application  $\frac{1}{2}$  inch or 0.6 inch diameter strands shall be used. Minimum spacing of prestressing strands shall be as specified in Subsection 5.10.3.3.1 of the *AASHTO LRFD Bridge Design Specifications*.
3. Stress limits of tendons for pre-tensioning and post-tensioning applications shall be as specified in Subsection 5.9.3 of the *AASHTO LRFD Bridge Design Specifications*.
4. Shipping and handling stresses shall be considered when designing prestressed concrete beams. This is especially important for long span members (over 130 feet) with slender webs and small flanges.
5. Epoxy-coated low-relaxation strands have significantly higher relaxation potential than that of uncoated strands. The use of a relaxation loss value that is equal to doubling the relaxation loss that is calculated for uncoated strands has been recommended by manufacturers. Strand manufactures should be contacted to account for suitable relaxation loss values.
6. Anchorage seating losses are typically higher for epoxy-coated strands than for uncoated strands. This should be considered in stressing and elongation calculations.
7. One of the most important decisions of precast component design is the ability to move the member from the precast plant to the job site. Weight and size limitations for the mode of transportation (truck, rail and barge) should be taken into consideration in the design of precast members. Designers should consult with fabricators on transportation considerations.
8. Various decisions in the design of prestressed concrete members determine the bridge construction cost. The PCI Bridge Design Manual, Chapter 4 describes strategies for economy, and may be referred to as an aid in decision making.
9. When considering prestressed beam layouts, a minimum of four girder lines should be provided to account for redundancy concerns and to account for future repair needs.
10. Standard Drawing 2.1-6 provides detailing for use of steel diaphragms. Steel diaphragms shall be used where intermediate diaphragms are required for prestressed beam configurations. Cast-in-place concrete diaphragms shall be used at end diaphragm locations.
11. Draped, straight and straight/unbonded strand patterns shall be considered as potentially equal solutions for prestressed beam analysis and fabrication. Designers should consult prestressed fabricators to ascertain use of strand patterns in their fabrication process. Alternative patterns, to what is detailed on the plans, subject to the conditions stated herein, may be proposed during fabrication.

## **25.5 Adjacent Voided Slab And Box Beam Design**

1. It is recommended that adjacent slab and box beams not be utilized for bridges with skew angles greater than 30 degrees.

Prestressed concrete box beam bridges shall utilize 4 foot wide box beams whenever possible. All efforts should be made to avoid a mixture of 4 foot and 3 foot wide box beams in satisfying geometrical constraints.

2. Prestressed concrete adjacent slab and box beams shall be surmounted with a minimum 5 inches thick concrete deck slab designed for composite action. Reinforcement steel shall be #16 @ 12 inch centers, both directions, with 2½" cover (see Guide Sheet Plate 3.10-7) and shall be corrosion protected.

In order to achieve a composite connection, Guide Plates within this Manual detail provision of a "camel back" arrangement of the composite reinforcement steel. Designers are advised that an alternate arrangement that eliminates the "camel back" appearance is permitted. The elimination of the "camel back" arrangement has been found to be cost effective.

3. Non-composite design (but with composite details and construction) should also be considered. Additional reserve strength may be gained by adding several strands without a significant increase in the cost of fabricating the slab and box beams.
4. The *AASHTO LRFD Bridge Construction Specifications* allow a tolerance of plus/minus ¼ inch in the width of box beams. Abutment seats shall be detailed of sufficient length to accommodate this possible dimensional overrun in a group of beams.

Abutment seats may be sloped in the transverse direction to conform with the deck cross slope; however, bearing seats shall generally be set level in the longitudinal direction parallel to the direction of the beams. If the bearing seats are not set level in this direction, gravity loads will cause shear in the elastomer.

The use of a tapered sole plate or tapered grout pad may be required so that the bearing surfaces are set level. This will avoid imposing excessive rotation and resulting stresses on the bearing (see Guide Sheet Plate 3.10-9).

## **25.6 Transverse Ties And Keyway Grouting**

1. Construction plans must be consistent with the Construction Specifications. Accordingly, the following criteria shall be followed in the plan development of adjacent prestressed slab and box beam construction:

- a. Transverse ties shall be installed and tensioned before the longitudinal keyways are grouted.
- b. Keyways shall be filled with nonmetallic, nonshrink grout.

2. See Guide Sheet Plates 3.10-13 and 3.10-14 for transverse tie details. Transverse ties shall be high tensile strength steel bars conforming to AASHTO M 275 or one-half inch diameter, Grade 270 strands. Bars should preferably be 1 inch in diameter; however, bars up to 1-3/8" in diameter may be used, if necessary.

The end anchorage hardware shall be galvanized.

3. The force required per transverse tie duct per span is computed by dividing one third of the span superstructure dead load including the beams, deck, sidewalk, utilities and parapets by the number of transverse tie ducts within the fascia beam. The computed value shall be stated on an appropriate contract plan sheet.

Refer to Subsection 5.9.3 of the *AASHTO LRFD Bridge Design Specifications* for the stress limits of Prestressing tendons.

Generally rods are preferred over strands for transverse ties because the end anchorage details are less complicated. If prestressing strands are utilized as transverse ties instead of high strength rods, more than one 7 wire strand may be utilized per transverse duct, if necessary.

Anchorage in prestressed beams shall develop at least 95% of the actual ultimate strength of prestressing steel.

The total force required per transverse duct and the individual strand forces, if applicable, shall be shown on the contract plans.

4. Special design considerations may be required in cases where channel beams are placed next to box beams. Adequate reinforcement shall be designed in the area of the transverse ducts and/or the configuration of the shear key shall be modified such that any allowable beam sweep can be taken into consideration before the beams are tensioned.

## **25.7 Spread Box Beam Design**

1. Spread box beams are particularly useful for structures supporting utilities or where a shallower superstructure is needed than can be provided by Prestressed Concrete I-Beams or Steel Plate Girders.
2. It is recommended that spread box beams not be utilized for bridges with skew angles greater than 30 degrees.
3. Variations on standard spread box beam design (i.e., double spread boxes or a multi-beam structure with spread boxes under sidewalks for utilities) can be considered as alternates where applicable. These arrangements may provide shallower beams and/or a thinner deck slab and may be more economical than standard spread boxes.
4. Spread box beam bridges shall utilize wide beams whenever possible based on cost advantage or other consideration. All efforts should be made to avoid a mixture of 4 foot and 3 foot wide box beams in satisfying geometrical constraints.
5. Prestressed concrete spread box beams and bridge deck slabs shall be designed in accordance with the AASHTO LRFD Specifications and as modified by Section 3 of this Manual. Reference Guide Sheet Plates 3.10-19 through 3.10-25 inclusive, for details on spread box beams.

The maximum spacing center to center of beams shall be 12 feet unless otherwise approved by the Manager, Bureau of Structural Engineering.

6. Prestressed concrete spread box beams shall be designed assuming full composite design between the deck slab and the beams. Deck slab thicknesses, reinforcing steel and haunches shall be in accordance with Section 20 of this Manual.
7. Load distribution factors shall be selected in accordance with Subsection 4.6 of the *AASHTO LRFD Bridge Design Specifications*.
8. Guidance for continuity design for live load shall be in accordance with Subsection 25.9 herein. Continuity design for live load details shall be similar to those for I-beams except that a minimum of three 1¼ inch anchor dowels will be required at the fixed end pier. Corrosion protected reinforcement steel, as

required by design, shall be placed in the top of the deck slab in the negative moment region. For Positive Restraint Moment Connection details, refer to Guide Sheet Plates 3.10-16 and 3.10-17.

9. The Abutment seat slope in the transverse and longitudinal direction, shall be similar to that of adjacent voided slab and box beam specified in Section 25.5 Item 4 herein. Complete details shall be shown on the contract plans. Elastomeric bearing pad selection shall be according to Subsection 25.8 herein.
10. Diaphragms shall be provided at the following points: at the ends of each beam, at midspan for spans up to and including 80 feet and at third points for spans longer than 80 feet.

End diaphragms shall always be placed parallel to the centerline of the bearing. Intermediate diaphragms shall be placed parallel to the centerline of the bearing for skews up to and including 15 degrees and shall be placed perpendicular to the beam for skews greater than 15 degrees.

Threaded inserts shall be cast into the box beams to connect the box beams and the exterior diaphragms.

End diaphragms which are located at fixed bearings shall be the full depth of the box beams and shall be a minimum of 12 inches wide. Reference Guide Plates 3.10-20 and 3.10-21 for more information. End diaphragms which are located at expansion bearings shall be 12 inches above the bottom of the beam and shall be a minimum of 12 inches wide. Reference Guide Sheet Plate 3.10-22 for more information.

Intermediate diaphragms shall be 12 inches above the bottom of the beam and shall be of minimum of 10 inches wide. Reference Guide Sheet Plate 3.10-21 for more information. Pier diaphragms on structures continuous for live load shall be at least 8 inches wider than the positive restraint moment connection.

All dimensions shall be perpendicular to the respective diaphragms. Reinforcing steel size, embedment and spacing shall be by design and shall be shown on the contract plans.

Class A concrete shall be used for the diaphragm work and the quantity shall be included in the Deck Slab pay item.

Use of steel diaphragms is permitted. Standard Drawing number 2.1-6 provides details for intermediate steel diaphragms for prestressed concrete beams. This drawing may be studied for its suitability to the spread box beam concept.

11. When utilities are less than half the depth of the end diaphragm and are approximately centered in the diaphragm, they shall pass through the end diaphragm in a sleeve. Where multiple ducts pass between two beams, it might be necessary to cast a rectangular hole in the end diaphragm. Partial depth end diaphragms at expansion bearings can be lengthened for that purpose.

Utilities which are sleeved through end diaphragms should generally pass through the end diaphragm as close to the center as possible. Other utility arrangements not stated may require the end diaphragm to be shortened to a minimum depth of 18 inches and the utilities be hung from an adjacent support system.

In all cases, the designer shall secure approval from the representative of the utility company and the NJDOT Bureau of Structural Engineering for the location and method of support of all utilities.

12. If Stay-in-Place forms are utilized, weld anchors shall be embedded into each beam for the purpose of attaching the form support angles. Reference Bridge Construction Detail BCD-9 for more information.
13. Standard Drawings provided in this Manual provide details for installing strip seal expansion joint assemblies. Modification to these details or a different design may be necessary to accommodate field conditions or for attachment to a deck slab greater than 8½ inches.
14. For Epoxy Waterproofing Seal Coat limits, refer to Section 25.10.

### **25.8 Bearings**

1. Subsection 24.20 of this Manual provides criteria for bearing systems that satisfy seismic needs. Such type bearing systems should be provided for all new precast prestressed concrete superstructure designs.

In the rehabilitation of existing prestressed concrete I-beam structures, that utilize steel rocker bearings, Section 45 of this Manual should be referred to for guidance in retrofitting such type bearings.

2. The effects of seismic forces shall be considered in the design of bearing systems for precast/prestressed slab and box beam bridges. Elastomeric bearing pads are known to satisfy seismic demands and thus may be used. Elastomeric bearing pads shall be designed in accordance with Section 14 of the current *AASHTO LRFD Bridge Design Specifications*.

For the purpose of bearing design, the bridge site shall be classified as being in temperature Zone C and the elastomer shall be Grade 3.

### **25.9 Continuity Design For Live Load Concept**

1. The concept of continuity design for LL + I + DL2 load moments may be considered for multi-span precast prestressed concrete I-beams and spread box beam designs unless foundation conditions preclude consideration of continuous design (see Subsection 24.3c). This concept shall not be considered for bridges where the skew angle is greater than 30 degrees.
2. Example details of the continuity concept, which illustrate the diaphragm at the pier, continuity rebars in the deck slab, positive restraint moment connection in the bottom of the prestressed concrete I-beam, and use of preformed elastomeric bearings are illustrated on Guide Sheet Plates 3.10-15 to 3.10-18.

However, the results of different research efforts recommend use of other concepts that may be more workable from a design and construction perspective. Accordingly, use of other concepts is permitted. Use of alternate concepts shall be approved by the Manager, Structural Engineering.

3. Design shall be in accordance with Subsection 5.14.1.4 of the *AASHTO LRFD Bridge Design Specifications*.
4. A comparison of the concept indicates the following differences in details when compared to simple span design:

| <b>Simple Span Design For DL Continuous Span Design For LL + I + DL2 Deck Slab:</b>                                  | <b>Simple Span Design for DL + LL +I +DL2 Deck Slab:</b>                |
|--|---|
| N/A  | Preformed elastomeric compression seal or glandular type strip seal     |
| N/A  | Steel joint armor   |
| Concrete placing sequence  | N/A   |
| Continuity rebars  | N/A   |
| <b>Deck Diaphragms at Pier:</b>  | <b>Deck Diaphragms at Pier:</b>   |
| One Diaphragm, _____ inches wide(depends on skew)  | Two Diaphragms, 9 inches wide   |
| <b>PC I-Beams:</b>   | <b>PC I-Beams:</b>  |
| Possible reduction in the beam size-force combination  | N/A   |
| Possible fewer strands   | N/A   |
| Positive restraint moment connection   | N/A   |
| <b>Bearings:</b>   | <b>Bearings:</b>  |
| Refer to Subsection 24.20  | Refer to Subsection 24.20   |
| Width usually greater because of space needed between beams for positive restraint moment connection and bridge skew | N/A   |
| Keeper block   | N/A   |
| N/A  | Corrosion protected rebars (Epoxy coated,Stainless Steel or Galvanized) |
| N/A  | Epoxy waterproofing seal coat   |

5. The same size, number and arrangement of prestressed concrete beams shall be used within a series of spans made continuous for live load. Cut-off points for the continuity rebars in the cast in place deck slab shall be staggered in a minimum of three increments. A concrete deck slab placing sequence shall be shown.
6. The principal reason for the possible use of this concept is the reduction in the number of deck slab joints rather than economy. Continuity design for live load may not be practical or economical for a bridge of a few short spans, but substantial economy could result for multiple (nine or more) spans between 80 and 110 feet.
7. If indicated as a possible alternative for the bridge type, the continuity design for live load concept shall be used for all precast prestressed concrete I-beams. The simple span design concept shall be used if approved by the Manager, Bureau of Structural Engineering, prior to the Preliminary submission.
8. Precast prestressed concrete slab and box beam bridges are generally utilized on short span structures. They are usually designed as simple spans for DL+



LL+ I+ DL2 with transverse deck slab expansion joints. Transverse cracking in the deck slab overlay at the pier is more likely to occur because of the shallow deck if the continuity concept is used in the construction.

Generally, the continuity design for live load concept need not be considered for the typical adjacent slab and box beam bridges, but may be considered for the occasional multi-span bridge where long span/deep box beams are required or where seismic considerations warrant.

### 25.10 Epoxy Waterproofing Seal Coat Limits

Precast prestressed concrete beams shall be treated with an epoxy waterproofing seal coat. The limits for sealer application shall be shown on the construction plans and shall conform to the following:

| Beam Type                                       | Areas to be Treated                             | Application limits (*), (**)  |
|---|---|---|
| I-beams   | Ends, sides bottoms                             | 4 foot length from the beam and end for exterior surfaces and 8" length from the beam end for interior surfaces |
| Beam Type                                       | Areas to be Treated                             | Application limits (*), (**)  |
| Adjacent box beams, channel beams, voided slabs | Ends, bottoms and exterior face of fascia beams | 4 foot length at the ends of beams subject to deck joint leakage  |
| Spread box beams                                | Ends, sides and bottoms                         | 4 foot length at the ends of beams subject to deck joint leakage  |

Epoxy waterproofing seal coating is not required for diaphragm connection areas.

As per bearing manufacturer's recommendations, epoxy waterproofing shall be omitted from the bearing contact area. This requirement shall be reviewed.

- \* For continuous bridges epoxy waterproofing seal coat shall be applied only to the beam ends located under or near deck joints.
- \*\* If the structure is located in a severe salt intrusion zone or a salt splash zone, (Zone 3A or 3B, see chart entitled "Zonal Areas of New Jersey Affected by Salinity" in Subsection 24.18 of this Manual) and is located less than 15 feet above the mean high salt water mark, the entire beam, along with both sides, bottom and ends shall be treated with epoxy waterproofing seal coat.

## Section 26 - Reinforcement Steel Details

### 26.1 Reinforcement Presentation

#### 1. Soft Metric Reinforcing Bars

Due to the past requirement of providing contract plans in metric units, the reinforcement steel industry shifted to stamping of reinforcement in soft metric size designations. As advised by the Concrete Reinforcing Steel Institute (CRSI) this practice is to continue for the foreseeable future.

Accordingly, it is important for Designers to be aware of this practice with respect to the detailing of soft metric reinforcing bars on contract plans. The term "soft metric" is used in the context of bar sizes and bar size designations. "Soft metric conversion" means describing the nominal dimensions of inch-pound reinforcing bars in terms of metric units, but not physically changing the bar sizes. In 1997, producers of reinforcing bars (the steel mills) began to phase in the production of soft metric bars. Within a few years, the shift to exclusive production of soft metric reinforcing bars was essentially achieved. Virtually all reinforcing bars currently produced in the USA are designated in soft metric units. Thus, USA-produced reinforcing bars furnished to any construction project will be in a soft metric designation. Therefore, to be consistent with what is delivered to Department projects, plan development must detail soft metric bar sizes.

Designation of Bar Sizes. The sizes of soft metric reinforcing bars are physically the same as the corresponding sizes of inch-pound bars. Soft metric bar sizes, which are designated #10, #13, #16, and so on, correspond to inch-pound bar sizes #3, #4, #5, and so on. The metric bar designations are simply a re-labeling of the inch-pound bar designations. The following table shows the one-to-one correspondence of the soft metric bar sizes to the inch-pound bar sizes.

**Soft Metric Bar Sizes Vs. Inch-Pound Bar Sizes**

| Soft Metric Bar Size Designation | Inch-Pound Bar Size Designation |
|----------------------------------|---------------------------------|
| #10                              | #3                              |
| #13                              | #4                              |
| #16                              | #5                              |
| #19                              | #6                              |
| #22                              | #7                              |
| #25                              | #8                              |
| #29                              | #9                              |
| #32                              | #10                             |
| #36                              | #11                             |
| #43                              | #14                             |
| #57                              | #18                             |

**Minimum Yield Strengths or Grades.** Virtually all steel mills in the USA are currently producing reinforcing bars to meet the metric requirements for tensile

properties in the ASTM specifications. Minimum yield strengths in metric units are 300, 350, 420 and 520 Mpa (megapascals), which are equivalent to 40,000, 50,000, 60,000 and 75,000 psi, respectively. Metric Grade 420 is the counterpart of Standard Grade 60.

**Bar Marking.** Soft metric reinforcing bars are required to be identified with the Producer's mill designation, bar size, type of steel, and minimum yield strength or grade.

Based on the fact that industry produces reinforcement steel bars in a metric size designation, Designers must indicate the metric bar size in plan sheet detailing. The following guidance shall also be followed in plan sheet preparation.

- a.) On any plan sheet that presents the drawings for a portion of a bridge structure, such as a pier, all reinforcement bars pertinent to that pier shall be detailed and billed on that sheet (see Subsection 26.2 g. below).
- b.) The same designation shall not be used to detail reinforcement steel that is of a different size, length or shape and that is to be placed in a substructure element or in a superstructure.
- c.) When detailing lengths of reinforcement bars, consideration must be given to transportation and handling, and where extremely long lengths are contemplated, to availability and special orders.
- d.) All sizes of bars are readily available in lengths up to 60 feet. However, #10 and #13 bars more than 40 feet long tend to bend in handling; therefore, they should be avoided. Sizes #16 through #57 in lengths exceeding 60 feet can be rolled at mills by special order. Seventy (70) feet should be considered the practical limit in any circumstance.
- e.) When the location of bar splices is arbitrary, as in the case of the longitudinal reinforcement of deck slabs on stringers, the following maximum lengths are preferred:

|                      |        |
|----------------------|--------|
| #19 bars and up..... | 50'-0" |
| #16 bars.....        | 39'-0" |
| #13 bars .....       | 30'-0" |

2. Provide corrosion protected reinforcement for the following components:
  - Deck slab, top and bottom mat
  - Sidewalks, parapets, median barriers
  - Haunch area
  - Mild reinforcement in prestressed box and slab beams and in prestressed concrete beams
  - Abutment backwall
  - Grillage reinforcement in abutments and piers
  - Footings dowels in corrosive environments
  - Integral abutment relief slabs and sleeper slabs
  - Precast culverts, precast arch and 3-sided precast culverts – top mats if fill is less than two feet
  - Cast in place culverts – top and bottom mats if top slab is used as riding surface

- Bottom one third of noise barrier panels, noise barrier posts and footing if located within roadway splash zone
- Pedestals and barrier pedestals of sign support structures

The above list shall not be considered all inclusive. The Bridges and Structures Design Manual should be studied for thorough guidance. Engineering judgment should also be used to aid in identifying where corrosion protected reinforcement may be helpful in protecting other components of the structure.

3. The current types of corrosion protected reinforcement permitted include the following:
  - Epoxy coated
  - Galvanized
  - Stainless steel
  - Stainless steel clad

While it is understood that epoxy coated reinforcement is most commonly used, a Designer should evaluate site specific locations to assess if components of a bridge may warrant use of either of the other types stated above. The other types may be considered to be more worthy of achieving service life longevity.

## 26.2 Reinforcement Designation

1. To provide uniformity in all bridge plans, the following rebar designations shall be used:

|    |            |
|----|------------|
| A  | Abutments  |
| C  | Culverts   |
| D  | Dowels     |
| F  | Footings   |
| P  | Piers      |
| S  | Deck Slabs |
| SS | Sidewalks  |
| PP | Parapets   |

Use additional prefix letter or number when needed, i.e., NA for North Abutment, EA for East Abutment, 1 for Span 1, 2 for Pier 2, etc.

2. The following illustrates detailing notations:

25 - #16 - F1@ 18"  
 20 - #16 - W2 @ 18"  
 18 - #16 - W3 @ 18"  
 20 - #16 - 1S2 @ 6"  
 20 - #16 - 2S3 @ 6"

3. Explanation of abbreviations shall be noted on the plans.

### Legend

|      |                      |
|------|----------------------|
| (FF) | Indicates Front Face |
| (RF) | Indicates Rear Face  |
| (T)  | Indicates Top        |
| (B)  | Indicates Bottom     |

4. If it becomes necessary to provide varying length reinforcement bars to accommodate a flared condition on any part of a structure, do not detail the

bars in a table of small increment changes in length; detail the bars in groups of the same length to accommodate the flare by variance of lap. All bars in the same group shall carry the same bar designation.

5. Bars may be detailed to the closest 1 inch of length and the mass of reinforcement bars shown in the Bill of Material shall be to the nearest ten (10) pounds.
6. The dimension of all laps shall be shown on the plans.
7. The Bill of Material shall be in the following form:

| <b>Reinforcement Steel – Pier #1</b> |       |      |        |          |
|--------------------------------------|-------|------|--------|----------|
| No.                                  | Mark. | Size | Length | Remarks  |
| 24                                   | 1P1   | #25  | 15'-5" | Detailed |
| 12                                   | 1P2   | #25  | 30'-0" | Straight |

When epoxy coating is required on rebars, "Epoxy Coated" shall be noted in the **Remarks** column.

When galvanizing is required on rebars, "Galvanized" shall be noted in the **Remarks** column.

When stainless steel is required on rebars, "Stainless Steel" shall be noted in the **Remarks** column.

8. Bent bars shall be detailed with complete dimensions. Hooks and bends shall conform to CRSI practices.
9. Other reasonable systems of bar designations will be considered for approval on an individual basis.
10. The Designer shall designate which corrosion protective system is to be used. Mixing of corrosion protection types in a single structural unit should be avoided.

## Section 27 - Classes of Concrete

### 27.1 NJDOT Standard Specifications Concrete Class Designations

The NJDOT Standard Specifications for Road and Bridge Construction provide the following classes of concrete for the various items of work of concrete structures:

| <b>Structural Concrete Items</b>   | <b>Concrete Class</b> | <b>Design Compressive Strength (f'c)</b> |
|--|-----------------------|--|
| <b>Cast-in-Place Items</b>   |                       |  |
| Nonreinforced Footing  | B                     | 3000 psi                                 |
| Reinforced Footings  | B                     | 3000 psi                                 |
| Abutments, Walls   | B                     | 3000 psi                                 |
| Concrete Barrier Curb, Bridge  | B                     | 3000 psi                                 |
| Piles  | B                     | 3000 psi                                 |
| Drilled Shafts   | A (or SCC)            | 4000 psi                                 |
| Columns and Caps for Piers, Arch Spans, Rigid Frames, Culverts, Approach Slabs | A                     | 4000 psi                                 |
| Decks, Sidewalks, Concrete Patch, Parapets, Curbs, Pylons                      | HPC-1                 | 4000 psi                                 |
| Seal (Tremie) Concrete   | S                     | 2000 psi                                 |
| <b>Prestressed Items</b>   |                       |  |
| Beams  | P, P-1 & P-2          | *  |
| Columns  | P, P-1 & P-2          | *  |
| Piles  | P, HPC                | *  |
| *P=5000 psi, P-1=5500 psi, P-2=6000 psi, HPC=as specified                      |                       |  |
| <b>Precast Items</b>   |                       |  |
| Crib Wall Members  | A                     | 4000 psi                                 |
| Piles  | B                     | 3000 psi                                 |
| Culverts   | P                     | 5000 psi                                 |
| Proprietary Retaining Wall Members   | P                     | 5000 psi                                 |
| Noise Barriers   | P                     | 5000 psi                                 |
| Columns  | P                     | 5000 psi                                 |
| <b>Others</b>  |                       |  |
| Concrete Slope Protection  | B                     | 3000 psi                                 |

## **Section 28 - Bridge Lighting**

### **28.1 General Requirements**

1. The Department's Traffic Signal and Safety Engineering Unit will determine the need for lighting (or provisions for future lighting) on an individual project/structure basis.
2. If light standards are to be located on the bridge as part of the project (or in a future contract), provisions shall be made in the parapet for a concrete boss with the circle of anchor bolts embedded therein.
3. A 2 foot – 8 inch high parapet and a 2 foot – 10 inch barrier require a 11½" bolt circle.
4. Light standards shall not be located in the midspan range. They shall be located as near to a support as practical to reduce the effect of vibrations caused by live load.

## Section 29 - Culverts and Arches

### 29.1 General Criteria

1. The design of cast-in-place concrete culverts, precast concrete box culverts, precast concrete arch structures and precast concrete three-sided structures shall conform to Subsection 5.14.5 and Section 12 of the *AASHTO LRFD Bridge Design Specifications*.
2. Designers may advance the use of precast concrete member usage. That is, it is not necessary to establish alternate methods of culvert construction to meet project specific requirements. Use of precast concrete box culverts, precast concrete arch structures or three (3) sided precast concrete structures is generally permitted.
3. As specified in Subsection 3.10.1 of the *AASHTO LRFD Bridge Design Specifications*, consideration of seismic effects on buried structures in New Jersey is not required.

### 29.2 Waterway Openings

For establishing waterway openings, reference for guidance shall be made to the following documents:

- *AASHTO LRFD Bridge Design Specifications* Article 2.6
- *AASHTO Model Drainage Manual*
- U.S. Department of Transportation, Federal Highway Administration, Publication No. FHWA HI-96-032 November, 1995, Hydraulic Engineering Circular (HEC) documents
- *The NJDEP Stream Encroachment Technical Manual*

### 29.3 Hydraulic and Hydrologic Data

1. The following tabulation with complete information shall be shown on preliminary bridge plans and final bridge plans:

| Hydraulic And Hydrologic Data       |         |
|-------------------------------------|---------|
| Drainage Area (SQ.MI)               |         |
| Design Discharge (C.F.S.)           |         |
| Design Water Surface Elevation (FT) |         |
| Energy Line Elevation (FT)          |         |
| Frequency                           | 100 YR. |

2. All culverts shall be designed, through methods outlined in Section 42 of this Manual, to resist scour.

### 29.4 General

1. For cast-in-place reinforced concrete box culverts, the horizontal joint between the walls and top slab shall be designated **Optional Construction Joint** when the height between the upper and lower horizontal joints is 8 feet or less. If the Contractor elects to omit the joint, he shall delay placing the concrete in the top slab for at least 2 hours after the concrete in the walls has been placed.



In addition, the joint between the invert slab and the side walls shall be detailed as a construction joint, and the invert slab concrete shall achieve a minimum compressive strength of 3000 psi prior to the construction of the remainder of the culvert.

2. Wingwall footings at their junction with the invert slab shall be detailed without a construction or contraction joint so that the footing concrete is placed monolithically with the invert slab.
3. In order to minimize adverse hydraulic characteristics, large storm drains (2 feet diameter or larger) shall not be discharged through walls of culverts.
4. The illustration on Guide Plate 3.12-4 shows guidelines for establishing excavation payment limits for roadway and bridge items of work.
5. Guide Plates 3.12-1 and 3.12-2 provide guidelines for developing uniform details on contract drawings for single and twin cell box culverts, respectively. The designer shall design and detail the culvert on the plans assuming cast-in-place concrete construction.
6. The Special Provisions for select projects (such as where staging is required or where limited construction time is essential to restore normal vehicular or rail traffic) may require precast culvert construction.

In such cases, the Structural Design Engineer shall select opening sizes for the cast in place concrete culvert which are obtainable in standard precast concrete sections. The Designer shall contact various local precasters to obtain the latest information on standard precast culvert sizes that are commercially available.

7. Provisions for a low flow fish passage in the form of a fish trough or other means may be required for culverts in certain locations. Environmental regulatory criteria should be verified when planning the design for such conditions.
8. In order to increase the inlet performance and for improved flow through the culvert, the bottom of inner top slab and walls edges shall be beveled as follows at the entrance of the culvert:
  - a. For single cell box culverts, a 45 degree bevel of  $\frac{1}{2}$  inch per foot of culvert clear height shall be provided for the top slab and bottom edge of the culvert entrance. A 45 degree bevel of  $\frac{1}{2}$  inch per foot of culvert clear width shall be provided for both side walls and inside edges of the culvert waterway entrance.
  - b. For twin cell box culverts, in addition to the bevels specified above, the center wall shall have a 45 degree of  $2\frac{1}{2}$  inches on both sides. This is based on a minimum 8 inch wall thickness. For every 1 inch increase in the center wall thickness, there shall be a  $\frac{1}{2}$  inch increase of the bevel on both sides.

## **29.5 Design Criteria For Precast Reinforced Concrete Box Sections For Culverts**

1. Precast reinforced concrete box sections shall not be used where the top slab is to be used as a riding surface.
2. When the earth fill above the top of culvert is less than 2 feet, the design dead load shall include 25 pounds per square foot for future application of a 2 inch thick wearing surface.

3. The minimum concrete usage for precast concrete elements shall be Class "P" and have a minimum design compressive strength of  $f'_c = 5000$  psi.
4. The minimum concrete cover over the circumferential reinforcement shall be 1½ inches except on the exterior side of the top slab where it shall be 2 inches.
5. The wall thickness for precast culverts shall be a minimum of 8 inches. The top and bottom slab thickness shall be a minimum of 10 inches. Dependent on project site conditions these thicknesses may be reduced. Any reduction must account for an adherence to concrete cover requirements and provision of required reinforcement size and distribution. Calculations shall be provided and shall account for the reduction.
6. A flexible watertight rubber gasket shall be provided at the joint between the precast units. The gasket shall be continuous around the circumference of the joints. Details of the transverse joint between the culvert sections shall be provided on the plans.
7. A coarse aggregate layer shall be provided under the precast reinforced concrete box culvert sections. The depth of the coarse aggregate layer shall be a minimum of 2 feet. It shall extend 1 foot on each side of precast reinforced concrete box culvert section.
8. A waterstop shall be provided to prevent water from entering vertical joints between the end of precast culvert sections and any cast-in-place appurtenances such as wingwalls, cutoff walls, aprons and cast-in-place culvert end sections.
9. Two rows of threaded inserts or bar extensions (longitudinal tie bolts) shall be provided in the end culvert section to facilitate the attachment of the culvert end section to the wingwalls. A detail of this connection shall be provided on the plans.
10. As per item 9, provide the same detail, if applicable, for the headwall attachment.
11. If precast concrete units are used in parallel for multicell installations, the parallel units shall be placed a maximum of 6 inches apart. The 6 inch space between the units shall be filled in conformance with the Standard Specifications. The purpose of this procedure is to ensure a positive means of lateral support between the parallel precast units.
12. The use of precast concrete end sections, including headwalls and wingwalls, are permitted.  
  
However, precast end sections shall not be used when the skew angle requirements result in a situation where the short wall of a precast end section is less than 3 feet.  
  
If approved for use, adequate provisions shall be made for cast in place appurtenances such as wingwalls, aprons and cutoff walls.
13. When the earth fill over the precast culvert is less than 2 feet, the top mat of reinforcement, and ties, in the top slab shall be corrosion protected.

14. Lifting devices or holes will be permitted in each box section for the purpose of handling and erection. All lifting holes shall be filled with nonshrink grout, after the grout has cured, the area shall be coated with an epoxy waterproofing seal coat.
15. Placement of precast units:
  - The precast units shall be pulled against the prior installed section such that an adequate seal is obtained between the two connecting units and the rubber gasket.
  - Prior to backfilling, a 2 foot wide strip of filter fabric shall be placed over the top and side transverse joints.
  - To provide continuity and concrete shear transfer between the precast box sections, a longitudinal tie rod or prestressing strand shall be placed in position through a 1½ inch diameter hole.
  - Four (4) longitudinal ties, one in each corner of the precast section, shall be provided.
  - Longitudinal ties that are used to tie the precast units together shall be ¾ inch diameter high tensile strength steel bars conforming to AASHTO M 275 (ASTM A 722) Type I or ½ inch 7 wire Grade 270 ksi strands conforming to AASHTO M 203 (ASTM A 416) or equivalent. The Designer shall evaluate the practicality of using steel bars. Issues such as needed length and shipping may preclude the use of steel bars. Under such circumstances wire strands will be more practical.
  - No splices are permitted in the strands. Bars shall be galvanized in accordance with AASHTO M 111.
  - End anchorages (nuts, washers and anchor plates) shall be compatible with the tie rod system and shall be galvanized in accordance with AASHTO M 111.
  - The anchorages and end fittings for the ½ inch 7 wire strand and the corrosion protection method shall be detailed on the plans.
  - Each tie rod shall be stressed to a tension of 30 kips.
  - After tensioning, the exposed ends of the ties shall be removed so that no part of the ties, or of the end fittings, extend beyond a point 1 inch inside the anchorage pocket.
  - All hardware associated with the end anchorage systems shall be galvanized. After tensioning has been completed the exposed parts of the end fittings shall be coated with two coats of bituminous paint.
  - If hand holes are used for the installation of longitudinal ties, they shall be spaced appropriately.
16. Precast reinforced concrete culvert units shall be manufactured in steel forms and steam cured.
17. Precast reinforced concrete culvert units shall not be shipped until 72 hours after fabrication and the 28 day compressive strength requirement is met.
18. Precast reinforced concrete culvert units shall be given one coat of an epoxy waterproofing seal coat on the exterior of the roof slab. This coating shall be provided at the precasting plant. In addition, any top slab hand hole pockets or lifting holes, which are grouted in the field, shall receive one coat of epoxy waterproofing seal coat after the grout has properly cured.

19. Working drawings shall be submitted for the design of the culvert units.
20. Materials used for precast concrete box culverts shall conform to the current edition of the NJDOT Standard Specifications for Road and Bridge Construction.

Reinforcement steel shall conform to AASHTO M31, Grade 60. Welded deformed steel wire fabric, conforming to AASHTO M221 and having a diameter of at least 3/8 inches may be substituted for deformed bars.

Longitudinal tie bolts, where utilized, shall conform to the requirements of current ASTM designation A307 and shall be hot-dip galvanized after fabrication, including threading in accordance with the requirements of current ASTM A153.

### **29.6 Precast Concrete Arch Structures**

1. Precast concrete arch structures are a cost effective solution to short span bridges or tunnels. The system includes precast arch elements, and precast wingwalls that are founded on cast-in-place footings.
2. Working drawings shall be provided for the design of such structures. The drawings shall provide the following detailing:
  - a. Plan, Elevation and Section views of the arch units. Also, details for all appurtenances; such as, wingwalls and headwalls and details of the joint sealing method between the units shall be indicated.
  - b. Erection details that indicate handling points, section lengths, profiles and dimensions of each unit, reinforcement layout and lifting loads.
3. Hydraulic data, as indicated in Subsection 29.3, shall be provided by the Designer. This will facilitate the design of the precast concrete arch structure. The precast units shall be designed with a minimum concrete compressive strength of 5000 psi (Class P concrete).
4. When the earth cover over the arch units is less than 2 feet, corrosion protected reinforcement shall be provided in the outside/top of reinforcement.
5. The concrete cover over the reinforcement steel shall be 2 inches on the outside face of the arch unit and 1½ inches on the inside face.
6. The arch units shall be founded on cast-in-place concrete footings that conform to Class B concrete. The footing shall be a monolithic body either through a single concrete pour or tied together by construction joints.

### **29.7 Precast Reinforced Concrete Three-Sided Structures**

1. Precast unit thicknesses and concrete cover stipulations shall conform to the respective requirements that are provided in Subsection 29.5 for precast box culverts.
2. Other requirements stated in Subsection 29.5 for concrete class, watertight rubber gaskets, waterstops and corrosion protected reinforcement location shall be applied for the design of three-sided precast concrete structures.
3. Concrete foundation requirements shall be the same as those stated in Item 6 of Subsection 29.6.

## **Section 30 - Sign and VMS/DMS Support Structures (Overhead and Cantilever)**

### **30.1 General Design Criteria**

#### **30.1.1 Design Specifications**

The 2001 (4th) Edition of the *AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals*, with the latest interim.

The 2007 Edition of the *NJDOT General Design Criteria and Standard Drawings for Overhead And Cantilever Sign Support Structures* (Referred to as Standard Drawings) is available for use in a project which includes fixed-message sign support structures. It has been reviewed to verify adherence to loading criteria that are specified in the *AASHTO Standard Specifications* referenced above. See Subsection 30.6 for more information.

The 2009 Edition of the *NJDOT General Design Criteria and Standard Drawings for Cantilever and Butterfly Dynamic Message Sign Support Structures* (referred to as DMS Standard Drawings) is available for use in a project which includes cantilever and butterfly Dynamic Message Sign (DMS) support structures.

See Subsection 30.2 for additional criteria concerning support structures for variable/dynamic message signs (VMS/DMS) if the *DMS Standard Drawings* are not applicable.

See Section 31 of this Manual for criteria concerning Bridge Mounted Sign Support Structures.

The Design shall verify the availability of steel pipe sizes, especially the 26" diameter pipe, in planning a structural configuration.

#### **30.1.2 Functional Requirements**

Vertical Clearance for Sign Support Structures:

The minimum vertical underclearance shall conform to Table 3.3.2 of this Manual. As indicated on the *Standard Drawings*, the minimum vertical underclearance for overhead and cantilever sign support structures shall be 17 ft. 9 inches.

#### **30.1.3 Wind Load**

A Design Wind Speed of 80 mph was used to develop the *Standard Drawings*.

The use of the 80 mph wind speed is based on the criteria specified in Appendix C of the above *AASHTO Specifications* for Wind Pressure determination.

#### **30.1.4 Allowable Stress**

The allowable stresses utilized for aluminum alloy ancillary members are in accordance with the publication titled "*Aluminum Design Manual - Specifications and Guidelines for Aluminum Structures.*"

Do not use of aluminum arm truss and post members.

#### **30.1.5 Fatigue Resistance**

The 2007 *Standard Drawings* have been analyzed to verify that both the Overhead and Cantilever structures meet Fatigue Category II criteria as identified in Section 11 of the above referenced *AASHTO Specifications*.

### 30.2 Variable/Dynamic Message Sign (VMS/DMS) Support Structures – Design Guidance

1. Initially, the *Standard Drawings* shall be studied to determine if member sizes therein can be used for VMS/DMS support structure member selection.
2. The VMS/DMS signs shall be placed outside traffic lanes if possible to allow the use of front-access type cabinets. The use of walk-in type cabinets is required whenever a VMS/DMS is over traffic lanes. Generally walk-in type cabinets are 4 feet deep and 8.5 feet high. NJDOT ITS Unit should be contacted regarding the type, size and weight of VMS/DMS cabinets, and provision of maintenance walkway.
3. The following guidance shall be followed in designing and developing contract documents for the construction of VMS/DMS sign support structures:
  - A strength design and fatigue analysis shall be performed to determine adequate member sizes using three dimensional modeling. For Cantilever sign structures, all joints shall be assumed to be rigid. The greatest sign area shall initially be considered for use.
  - Potential use of fixed-message signs, on a project to project basis, will be permitted on overhead VMS/DMS sign support structures only. Accordingly, the General Notes for overhead VMS/DMS sign support structures shall indicate the sign area for which the VMS/DMS Structure has been designed, and the sign design area that can be accommodated by the remaining truss area.
  - To accommodate the potential future placement of fixed-message signs, the minimum height of the overhead truss, that is to be considered for the placement of the VMS/DMS cabinet, shall be 26'-3" to the centerline of the truss. This is considerate of a fixed-message sign design height of 15' and the 17'-9" minimum vertical underclearance to the lower limit, and the sign lighting system or maintenance walkway. If a sign lighting system or maintenance walkway is not erected, the minimum vertical underclearance shall be to the bottom of the fixed-message sign panel.
  - VMS/DMS cabinets shall be centered vertically between the upper and lower truss chord members.
  - The horizontal distance from the centerline of the truss chords to the center of gravity of the VMS/DMS cabinet shall be minimized.
  - Cantilever VMS/DMS sign support structures shall be designed to accommodate one VMS/DMS cabinet only. A note to this effect shall be provided in the General Notes portion of the contract plans.
4. If it is determined that support structures cannot be provided by use of the *Standard Drawings or DMS Standard Drawings*, the design of Overhead, Cantilever, and butterfly VMS/DMS structures shall conform to the following publications and to the criteria stated below:
  - The *AASHTO Standard Specifications* referenced above with the latest interim.
  - American Welding Society AWS D1.1 - Structural Welding Code - Steel (Current Edition)
  - VMS/DMS support structures shall be designed for strength, fatigue and deflection.

- Section 3 of the *AASHTO Standard Specifications* may be used to identify loading criteria, except for wind pressures which is to be determined in accordance with the Appendix C using a Design Wind Speed of 80 mph.
  - Wind Drag Coefficient ( $C_d$ ):  
 $C_d = 1.20$  for horizontal wind pressure on VMS/DMS, and  $1.70$  for vertical wind load on VMS/DMS, such as truck-induced gusts;  
Refer to the *AASHTO Standard Specifications* Table C-2 (or Table 3-6) for Wind Drag Coefficient for other members
  - Fatigue Category II. See Subpart 5 below for clarification of fatigue analysis parameters.
  - Deflection Criteria:  
For the overhead support structures, the maximum deflection shall be limited to 2 ½ inches per 100 feet of the span length.  
For the single-member-arm cantilever support structures, each applicable wind load range described in Subpart 5. should be applied separately and the largest vertical or horizontal deflection range should be limited to 8 inches. The 8 inch range is defined as the sum of the potential upward and downward or potential horizontal axis displacement of the cantilever structure.  
This criteria is included to minimize potential vibration damage to the VMS/DMS, ensure motorist visibility, and to reduce motorist concerns. Deflection shall also be in accordance with Section 10 of the *AASHTO Standard Specifications*.  
Permanent truss camber equal to 1/1000 of the truss span length, shall be provided in addition to the dead load camber for both overhead and cantilever support structures.
5. Natural wind gusts, truck induced gusts and galloping shall be applied in conducting a fatigue analysis. The following guidance may be followed for this analysis:
- Apply each load separately to the sign structure model, as determined by the chords and posts, and design the strut to chord connections based upon the forces in the strut and the chord at each wind load range.
  - Fatigue resistance categories for the gusset plate/chord connection and other welded details shall be based on details listed in Table 11-2 of the *AASHTO Standard Specifications*.
  - The Fatigue Importance Factors ( $I_F$ ) that shall be used for the fatigue analysis (Fatigue Category II) shall be as follows:
    - Galloping - 0.65
    - Natural Wind Gusts - 0.75
    - Truck Induced Gusts - 0.89
  - For cantilever and butterfly VMS/DMS support structures, all three phenomena shall be applied. For the overhead VMS/DMS support structure, the natural wind gusts and truck induced gusts phenomena need be applied.
  - Truck induced gusts shall be applied to any 12 ft length of the bottom face of the VMS/DMS cabinet, and to the projected area of the bottom chords, the lighting system/walkway and any miscellaneous attachments, to create the maximum stress range, excluding any portion of the structure not located directly above the traffic lane

- Gusset plates should be designed for actual bending stresses and checked against allowable stresses.
6. Upon completion of the initial fatigue analysis, if member sizes are determined to be inadequate, new sizes shall be selected and a new analysis shall be made. All detailing of finalized member size shall conform to the truss and tower configuration of the Standard Drawings. This will avoid the introduction of unique detailing to fabricators who provide support structures for Department projects.

### **30.3 Truss Chord Bolted Connections/Anchor Bolt Installations**

1. Erection procedures contained in the *NJDOT Standard Specifications for Road and Bridge Construction*, concerning installation of sign support structures, shall be adhered to in developing contract documents.
2. Truss chord bolted connections shall be installed in accordance with the criteria stated in Section 11.5.6 of the *AASHTO LRFD Bridge Construction Specifications*.
3. The *NJDOT Standard Drawings* include Tables that specify bolt tension values to which high strength bolts and anchor bolts are to be installed. These Tables should be referenced when reviewing Working Drawings.

### **30.4 Foundations**

1. At least one boring for each footing location is required (see Section 34).
2. Foundation conditions may require different foundation types or sizes other than those indicated on the *Standard Drawings* for Overhead, Cantilever Sign Support structures and VMS/DMS Sign Support Structures. In such a case, the Standard Contract Plans shall be modified accordingly. A foundation report shall be included in the Plan submission (see Section 34 of this Manual). The foundation report can simply state, when warranted, that a study of the borings confirms that foundation indicated on the Standard Plans are satisfactory for use in the design without any changes.
3. Subsurface utilities which cannot be relocated, or other special conditions, Foundation may require individual footing designs.
4. Footings should be designed within the NJDOT right of way if possible.
5. Top of concrete pedestals shall not project higher than 4 inches above finished ground line.
6. Foundation designs should be provided in furnishing of contract drawings for Overhead, Cantilever, and VMS/DMS Sign support structures.
7. Refer to Subsection 16.3 of this Manual for guidance concerning bottom of footing locations.
8. When alternate Foundation Designs, are considered, refer to Tables 30.1 and 30.2 for Overhead Sign Supports and for Cantilever Sign Supports, respectively for application of loads.
9. For the foundation design of Cantilever and Butterfly VMS/DMS support structures, other than spread footing as shown in the *Standard Drawings*, use Tables 30.3 and 30.4 for application of loads. These loads are per design



criteria, including weight and size of VMS/DMS cabinet, as shown on the VMS/DMS Standard Drawings.

10. According to the Section 13 of the *AASHTO Standard Specifications*, design of foundations shall be based on the 17<sup>th</sup> Edition of the *AASHTO Standard Specifications for Highway Bridges* for the design requirements not addressed in the above mentioned section.

### **30.5 Plan Submissions**

1. Final bridge plans will be required for sign support structures in accordance with Section 7 of this Manual. This submission shall include: Key Plan to Structures, Elevation of Structures, Foundation Report and Boring Logs, and Estimated Construction Cost.
2. If changes are made on any of the Standard Contract Plans to suit the conditions of a particular project, such as the type or size of the foundation, then copies of those plans that were changed, shall be included with the Final plan submission.
3. Working drawings to be prepared by the contractor and approved or certified by the Designer are required by the *NJDOT Standard Specifications for Road and Bridge Construction*.

### **30.6 Standard Drawings**

1. *Standard drawings* for sign support structures are available for use in a project. They may be obtained from the NJDOT Engineering Documents Unit or downloaded from the NJDOT website (<http://www.state.nj.us/transportation>).
2. Unless as permitted herein, no changes in design criteria or details shall be made on the *Standard Drawings* without prior authorization.
3. The Design Unit should verify, during the Preliminary Design, locations where the sign panels are to be of the 100% reflectorized area type.  
Otherwise, the use of a track lighting system is to be planned for. Suitable notes are included on the *Standard Drawings* to permit the use of track lighting system.
4. For the permanent record, the design calculations submitted at the Final Submission shall include a list of the Standard Design Instruction Drawings used in preparing the contract plans.
5. The design guidance in Subsection 30.2 for VMS/DMS support structures may be applied to an individual design for fixed-message sign support structures, except wind drag coefficient (Cd).

### **30.7 Structure Numbers**

Structure numbers (7 digit) for the individual sign structures will be assigned during the Final Plan review (similar to the structure numbers for bridges as per Section 35). Temporary identification numbers used during the design phase shall be changed accordingly in the tabulations and contract pay items.

### **30.8 General Criteria and Miscellaneous Requirements**

1. In the furnishing of sign panels for overhead and cantilever sign support structures, the size of the panels shall be such that the panel shall project a minimum of 6 inches above and below the respective top and bottom chord.

2. The proposed approximate quantities for Foundation Excavation, Concrete Footings and Reinforcement Steel in Structures shall reflect the summation of, respectively, all the overhead and cantilever sign structures that are within a contract. The location of sign panels shall be measured from the centerline of an end post.
3. Each sign support structure shall be listed individually in numerical order for each type that is in a contract. Refer to Subsection 30.7 for assigning of structure numbers.
4. Contract Pay Items for Lighting and Electrical work are usually included with the Roadway Items of work.

**Table 30.1 - Overhead Sign Support****Loads At Bottom of Baseplate**

| SS (%) | Span (ft) | Height (ft) | Pdl,max (kips) | Pdl,min (kips) | Pwind (kips) | Pice,max (kips) | Pice,min (kips) | Hwind (kips) | Ht,wind (kips) | Mt,wind (kips-ft) |
|--------|-----------|-------------|----------------|----------------|--------------|-----------------|-----------------|--------------|----------------|-------------------|
| 40%    | 45.00     | 25.00       | 4.33           | 2.39           | 30.85        | 2.65            | 0.40            | 4.03         | 0.60           | 29.1              |
| 60%    | 45.00     | 25.00       | 4.65           | 2.44           | 42.53        | 2.84            | 0.43            | 5.48         | 0.81           | 49.97             |
| 70%    | 45.00     | 25.00       | 4.81           | 2.47           | 48.75        | 2.94            | 0.44            | 6.25         | 0.98           | 47.30             |
| 80%    | 45.00     | 25.00       | 4.97           | 2.49           | 54.64        | 3.03            | 0.45            | 6.98         | 1.10           | 53.30             |
| 40%    | 45.00     | 30.00       | 4.65           | 2.72           | 39.14        | 2.72            | 0.47            | 5.21         | 0.60           | 36.34             |
| 60%    | 45.00     | 30.00       | 5.22           | 3.08           | 52.80        | 2.92            | 0.58            | 7.16         | 0.81           | 51.21             |
| 70%    | 45.00     | 30.00       | 5.38           | 3.11           | 60.35        | 3.01            | 0.59            | 8.13         | 0.98           | 59.13             |
| 80%    | 45.00     | 30.00       | 5.54           | 3.13           | 67.50        | 3.11            | 0.61            | 9.04         | 1.10           | 66.62             |
| 40%    | 45.00     | 40.00       | 5.29           | 2.72           | 47.14        | 2.81            | 0.62            | 6.22         | 0.60           | 43.60             |
| 60%    | 45.00     | 40.00       | 5.61           | 3.46           | 64.16        | 3.00            | 0.66            | 8.26         | 0.81           | 61.45             |
| 70%    | 45.00     | 40.00       | 6.07           | 3.84           | 71.53        | 3.16            | 0.78            | 9.26         | 0.98           | 70.95             |
| 80%    | 45.00     | 40.00       | 6.23           | 3.87           | 79.96        | 3.26            | 0.80            | 10.29        | 1.10           | 79.95             |
| 40%    | 55.00     | 25.00       | 4.88           | 2.57           | 36.50        | 3.10            | 0.40            | 4.74         | 0.72           | 34.83             |
| 60%    | 55.00     | 25.00       | 5.26           | 2.61           | 50.93        | 3.33            | 0.43            | 6.52         | 1.03           | 49.51             |
| 70%    | 55.00     | 25.00       | 5.45           | 2.64           | 58.01        | 3.45            | 0.45            | 7.40         | 1.18           | 56.73             |
| 80%    | 55.00     | 25.00       | 5.82           | 2.94           | 63.61        | 3.55            | 0.55            | 8.37         | 1.32           | 63.94             |
| 40%    | 55.00     | 30.00       | 5.20           | 2.88           | 46.21        | 3.17            | 0.47            | 6.09         | 0.72           | 43.54             |
| 60%    | 55.00     | 30.00       | 5.83           | 3.26           | 62.98        | 3.41            | 0.59            | 8.47         | 1.03           | 61.89             |
| 70%    | 55.00     | 30.00       | 6.02           | 3.29           | 71.58        | 3.52            | 0.61            | 9.56         | 1.18           | 70.91             |
| 80%    | 55.00     | 30.00       | 6.46           | 3.62           | 78.47        | 3.68            | 0.73            | 10.60        | 1.32           | 79.93             |
| 40%    | 55.00     | 40.00       | 5.83           | 3.58           | 55.38        | 3.26            | 0.64            | 7.21         | 0.72           | 52.24             |
| 60%    | 55.00     | 40.00       | 6.52           | 3.99           | 74.64        | 3.55            | 0.78            | 9.64         | 1.03           | 74.27             |
| 70%    | 55.00     | 40.00       | 6.71           | 4.03           | 84.77        | 3.66            | 0.80            | 10.87        | 1.18           | 85.09             |
| 80%    | 55.00     | 40.00       | 7.19           | 4.43           | 92.96        | 3.80            | 0.93            | 12.28        | 1.32           | 95.91             |
| 40%    | 65.00     | 25.00       | 5.41           | 2.70           | 42.1         | 3.55            | 0.40            | 5.43         | 0.84           | 40.54             |
| 60%    | 65.00     | 25.00       | 5.86           | 2.77           | 58.97        | 3.82            | 0.44            | 7.52         | 1.20           | 57.70             |
| 70%    | 65.00     | 25.00       | 6.36           | 3.19           | 65.37        | 3.95            | 0.58            | 8.65         | 1.37           | 66.30             |
| 80%    | 65.00     | 25.00       | 6.58           | 3.23           | 73.30        | 4.09            | 0.61            | 9.67         | 1.55           | 74.68             |
| 40%    | 65.00     | 30.00       | 5.97           | 3.34           | 52.28        | 3.62            | 0.55            | 7.1          | 0.84           | 50.67             |
| 60%    | 65.00     | 30.00       | 6.42           | 3.42           | 72.74        | 3.88            | 0.60            | 9.71         | 1.20           | 72.13             |
| 70%    | 65.00     | 30.00       | 6.98           | 3.88           | 80.65        | 4.08            | 0.77            | 10.95        | 1.37           | 82.87             |
| 80%    | 65.00     | 30.00       | 7.21           | 3.92           | 90.39        | 4.21            | 0.79            | 12.23        | 1.55           | 93.35             |
| 40%    | 65.00     | 40.00       | 6.36           | 3.73           | 63.54        | 3.70            | 0.64            | 8.19         | 0.84           | 68.79             |
| 60%    | 65.00     | 40.00       | 7.40           | 4.53           | 84.45        | 4.04            | 0.91            | 11.21        | 1.20           | 86.56             |
| 70%    | 65.00     | 40.00       | 7.72           | 4.70           | 95.51        | 4.19            | 0.98            | 12.71        | 1.37           | 99.44             |
| 80%    | 65.00     | 40.00       | 7.94           | 4.74           | 106.88       | 4.30            | 1.00            | 14.12        | 1.55           | 112.02            |
| 40%    | 75.00     | 25.00       | 6.11           | 3.04           | 48.18        | 4.04            | 0.47            | 6.23         | 0.96           | 47.09             |
| 60%    | 75.00     | 25.00       | 6.93           | 3.55           | 65.06        | 4.35            | 0.65            | 8.67         | 1.38           | 66.46             |
| 70%    | 75.00     | 25.00       | 7.17           | 3.59           | 74.00        | 4.50            | 0.67            | 9.83         | 1.57           | 75.97             |
| 80%    | 75.00     | 25.00       | 7.43           | 3.63           | 82.94        | 4.65            | 0.7             | 10.98        | 1.77           | 85.48             |
| 40%    | 75.00     | 30.00       | 6.67           | 3.70           | 59.65        | 4.11            | 0.63            | 8.10         | 0.96           | 58.86             |
| 60%    | 75.00     | 30.00       | 7.55           | 4.23           | 80.27        | 4.47            | 0.83            | 10.98        | 1.38           | 83.07             |
| 70%    | 75.00     | 30.00       | 7.80           | 4.28           | 91.24        | 4.62            | 0.86            | 12.43        | 1.57           | 94.96             |
| 80%    | 75.00     | 30.00       | 8.68           | 4.95           | 102.22       | 4.77            | 0.89            | 13.87        | 1.77           | 106.85            |

**Table 30.1 - Overhead Sign Support****Loads At Bottom of Baseplate**

| SS (%) | Span (ft) | Height (ft) | Pdl,max (kips) | Pdl,min (kips) | Pwind (kips) | Pice,max (kips) | Pice,min (kips) | Hwind (kips) | Ht,wind (kips) | Mt,wind (kips-ft) |
|--------|-----------|-------------|----------------|----------------|--------------|-----------------|-----------------|--------------|----------------|-------------------|
| 40%    | 75.00     | 40.00       | 7.36           | 4.43           | 70.72        | 2.24            | 0.83            | 9.23         | 0.98           | 70.62             |
| 60%    | 75.00     | 40.00       | 8.28           | 5.06           | 95.07        | 4.58            | 1.05            | 12.71        | 1.38           | 99.68             |
| 70%    | 75.00     | 40.00       | 8.53           | 5.10           | 107.82       | 4.73            | 1.07            | 14.34        | 1.57           | 113.96            |
| 80%    | 75.00     | 40.00       | 9.63           | 6.00           | 120.69       | 4.87            | 1.10            | 15.97        | 1.77           | 128.22            |
| 40%    | 85.00     | 25.00       | 6.96           | 3.53           | 54.41        | 4.57            | 0.58            | 7.06         | 1.12           | 53.92             |
| 60%    | 85.00     | 25.00       | 8.07           | 4.33           | 72.73        | 4.95            | 0.85            | 9.81         | 1.57           | 75.71             |
| 70%    | 85.00     | 25.00       | 8.35           | 4.38           | 82.39        | 5.12            | 0.89            | 11.07        | 1.78           | 86.15             |
| 80%    | 85.00     | 25.00       | 8.82           | 4.69           | 90.30        | 5.30            | 1.01            | 12.30        | 2.00           | 96.62             |
| 40%    | 85.00     | 30.00       | 7.56           | 4.23           | 67.36        | 4.65            | 0.77            | 9.15         | 1.12           | 67.40             |
| 60%    | 85.00     | 30.00       | 8.7            | 5.02           | 89.69        | 5.08            | 1.04            | 12.40        | 1.57           | 94.64             |
| 70%    | 85.00     | 30.00       | 9.21           | 5.42           | 99.30        | 5.24            | 1.19            | 14.11        | 1.78           | 107.69            |
| 80%    | 85.00     | 30.00       | 9.49           | 5.47           | 110.90       | 5.40            | 1.22            | 15.71        | 2.00           | 120.78            |
| 40%    | 85.00     | 40.00       | 8.25           | 5.98           | 79.80        | 4.78            | 0.97            | 10.41        | 1.12           | 80.87             |
| 60%    | 85.00     | 40.00       | 9.43           | 5.85           | 106.11       | 5.18            | 1.26            | 14.30        | 1.57           | 113.56            |
| 70%    | 85.00     | 40.00       | 10.57          | 6.77           | 119.98       | 5.34            | 1.29            | 16.10        | 1.78           | 129.24            |
| 80%    | 85.00     | 40.00       | 10.85          | 6.83           | 133.87       | 5.51            | 1.33            | 17.89        | 2.00           | 144.94            |
| 40%    | 95.00     | 25.00       | 8.20           | 4.56           | 59.07        | 5.11            | 0.86            | 8.01         | 1.26           | 60.96             |
| 60%    | 95.00     | 25.00       | 8.83           | 4.67           | 80.57        | 5.48            | 0.93            | 10.83        | 1.74           | 84.18             |
| 70%    | 95.00     | 25.00       | 9.74           | 5.46           | 88.65        | 5.74            | 1.18            | 12.26        | 1.99           | 96.25             |
| 80%    | 95.00     | 25.00       | 10.56          | 6.04           | 101.26       | 5.92            | 1.22            | 13.96        | 2.29           | 110.30            |
| 40%    | 95.00     | 30.00       | 8.59           | 4.94           | 74.49        | 5.19            | 0.94            | 10.22        | 1.26           | 76.20             |
| 60%    | 95.00     | 30.00       | 9.69           | 5.71           | 97.14        | 5.59            | 1.24            | 13.81        | 1.74           | 105.22            |
| 70%    | 95.00     | 30.00       | 10.41          | 6.25           | 108.91       | 5.83            | 1.39            | 15.65        | 1.99           | 120.30            |
| 80%    | 95.00     | 30.00       | 11.45          | 7.04           | 124.26       | 6.01            | 1.43            | 17.79        | 2.29           | 137.90            |
| 40%    | 95.00     | 40.00       | 9.57           | 6.08           | 86.53        | 5.30            | 1.27            | 11.78        | 1.26           | 91.44             |
| 60%    | 95.00     | 40.00       | 11.04          | 7.07           | 117.36       | 5.70            | 1.35            | 15.76        | 1.74           | 126.27            |
| 70%    | 95.00     | 40.00       | 11.77          | 7.60           | 130.48       | 5.94            | 1.50            | 17.83        | 1.99           | 144.38            |
| 80%    | 95.00     | 40.00       | 12.59          | 8.30           | 145.43       | 6.15            | 1.69            | 20.10        | 2.29           | 165.48            |
| 40%    | 105.00    | 25.00       | 8.71           | 4.71           | 64.43        | 5.53            | 0.86            | 8.72         | 1.38           | 66.73             |
| 60%    | 105.00    | 25.00       | 10.06          | 5.63           | 85.82        | 6.02            | 1.17            | 11.87        | 1.93           | 93.09             |
| 70%    | 105.00    | 25.00       | 10.92          | 6.22           | 99.40        | 6.22            | 1.21            | 13.71        | 2.24           | 108.23            |
| 80%    | 105.00    | 25.00       | 12.26          | 7.42           | 108.71       | 6.54            | 1.50            | 15.37        | 2.53           | 121.90            |
| 40%    | 105.00    | 30.00       | 9.34           | 5.40           | 79.50        | 5.64            | 1.05            | 11.03        | 1.38           | 83.42             |
| 60%    | 105.00    | 30.00       | 10.73          | 6.42           | 105.47       | 6.11            | 1.90            | 15.17        | 1.93           | 116.36            |
| 70%    | 105.00    | 30.00       | 11.80          | 7.22           | 121.99       | 6.30            | 1.43            | 17.47        | 2.24           | 135.30            |
| 80%    | 105.00    | 30.00       | 13.14          | 8.43           | 133.34       | 6.74            | 1.72            | 19.55        | 2.53           | 155.38            |
| 40%    | 105.00    | 40.00       | 10.07          | 6.24           | 94.21        | 5.74            | 1.28            | 12.77        | 1.38           | 101.11            |
| 60%    | 105.00    | 40.00       | 12.09          | 7.78           | 121.34       | 6.22            | 1.50            | 17.29        | 1.93           | 138.62            |
| 70%    | 105.00    | 40.00       | 12.94          | 8.49           | 142.78       | 6.44            | 1.69            | 19.74        | 2.24           | 162.36            |
| 80%    | 105.00    | 40.00       | 14.30          | 9.70           | 156.13       | 6.76            | 1.98            | 22.09        | 2.53           | 182.86            |
| 40%    | 115.00    | 25.00       | 10.14          | 5.90           | 68.82        | 6.11            | 1.18            | 9.57         | 1.54           | 74.12             |
| 60%    | 115.00    | 25.00       | 11.98          | 7.27           | 92.25        | 6.68            | 1.53            | 13.08        | 2.14           | 103.08            |
| 70%    | 115.00    | 25.00       | 12.86          | 7.87           | 106.33       | 6.90            | 1.57            | 15.04        | 2.45           | 119.23            |
| 80%    | 115.00    | 25.00       | 13.23          | 7.94           | 118.38       | 7.12            | 1.63            | 16.72        | 2.76           | 133.05            |

**Table 30.1 - Overhead Sign Support****Loads At Bottom of Baseplate**

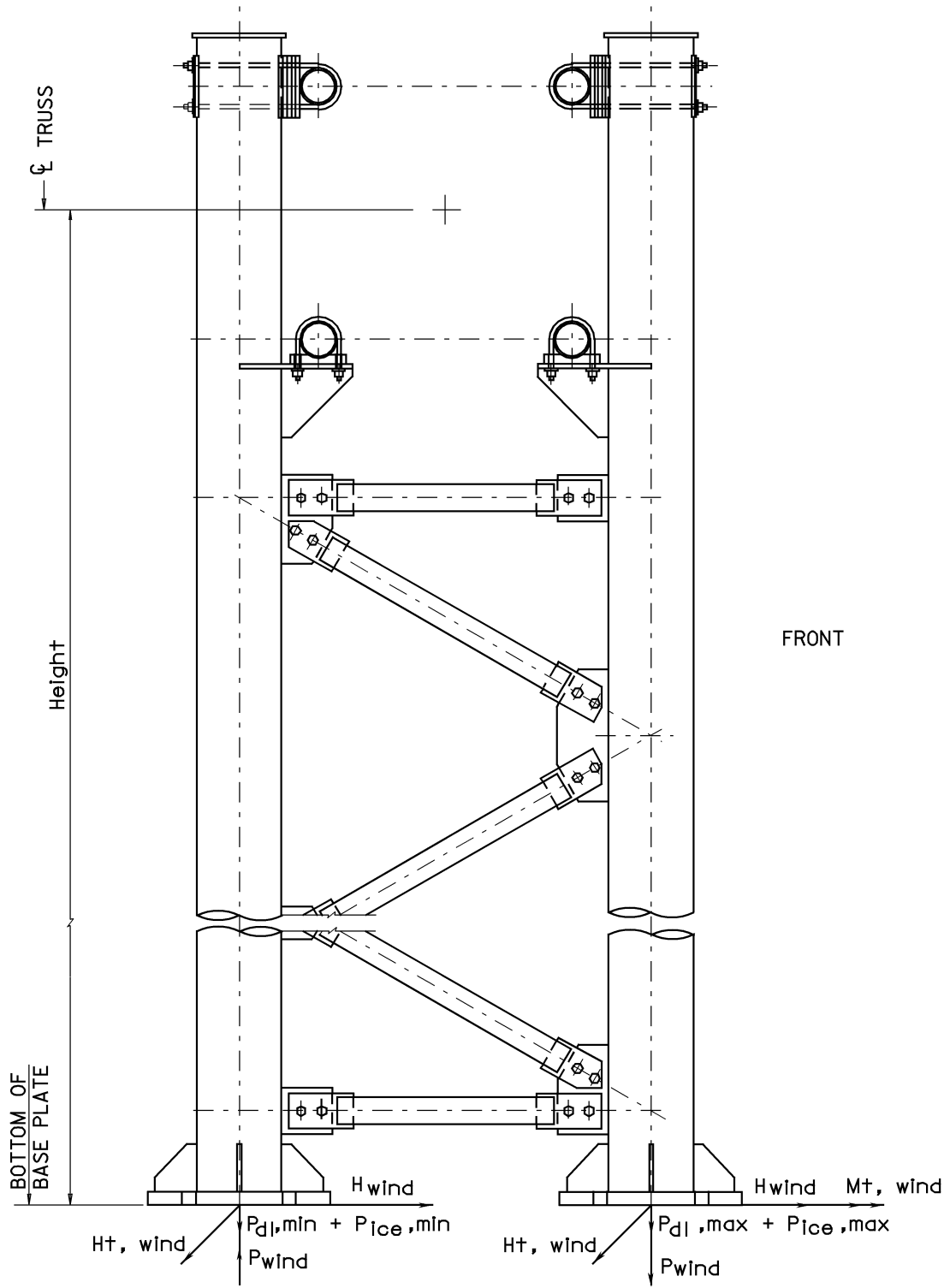
| SS (%) | Span (ft) | Height (ft) | Pdl,max (kips) | Pdl,min (kips) | Pwind (kips) | Pice,max (kips) | Pice,min (kips) | Hwind (kips) | Ht,wind (kips) | Mt,wind (kips-ft) |
|--------|-----------|-------------|----------------|----------------|--------------|-----------------|-----------------|--------------|----------------|-------------------|
| 40%    | 115.00    | 30.00       | 10.58          | 6.34           | 86.61        | 6.21            | 1.28            | 12.16        | 1.54           | 92.66             |
| 60%    | 115.00    | 30.00       | 12.65          | 8.07           | 113.34       | 6.77            | 1.75            | 16.69        | 2.14           | 128.86            |
| 70%    | 115.00    | 30.00       | 13.74          | 8.88           | 130.49       | 6.98            | 1.80            | 19.14        | 2.47           | 149.05            |
| 80%    | 115.00    | 30.00       | 14.10          | 8.96           | 145.17       | 7.20            | 1.85            | 21.25        | 2.76           | 166.30            |
| 40%    | 115.00    | 40.00       | 11.30          | 7.18           | 102.53       | 6.30            | 1.51            | 14.04        | 1.54           | 111.19            |
| 60%    | 115.00    | 40.00       | 13.56          | 9.09           | 130.75       | 6.90            | 2.02            | 18.86        | 2.14           | 155.24            |
| 70%    | 115.00    | 40.00       | 14.89          | 10.15          | 152.81       | 7.12            | 2.07            | 21.63        | 2.47           | 178.86            |
| 80%    | 115.00    | 40.00       | 15.25          | 10.23          | 169.96       | 7.34            | 2.12            | 24.00        | 2.76           | 199.56            |
| 40%    | 125.00    | 25.00       | 12.02          | 7.55           | 74.37        | 6.72            | 1.53            | 10.60        | 1.71           | 82.50             |
| 60%    | 125.00    | 25.00       | 13.33          | 8.23           | 101.95       | 7.20            | 1.63            | 14.43        | 2.37           | 114.21            |
| 70%    | 125.00    | 25.00       | 13.73          | 8.30           | 114.99       | 7.44            | 1.67            | 16.25        | 2.68           | 129.21            |
| 80%    | 125.00    | 25.00       | 14.37          | 8.79           | 125.04       | 7.65            | 1.85            | 18.15        | 2.99           | 140.06            |
| 40%    | 125.00    | 30.00       | 12.69          | 8.34           | 91.58        | 6.81            | 1.75            | 13.57        | 1.71           | 103.25            |
| 60%    | 125.00    | 30.00       | 14.21          | 9.24           | 125.16       | 7.28            | 1.85            | 18.38        | 2.37           | 142.77            |
| 70%    | 125.00    | 30.00       | 14.60          | 9.33           | 141.03       | 7.52            | 1.90            | 20.66        | 2.68           | 161.45            |
| 80%    | 125.00    | 30.00       | 15.41          | 9.97           | 152.56       | 7.76            | 2.10            | 22.83        | 2.99           | 180.16            |
| 40%    | 125.00    | 40.00       | 14.05          | 9.70           | 110.66       | 6.92            | 1.86            | 15.49        | 1.71           | 123.89            |
| 60%    | 125.00    | 40.00       | 15.36          | 10.52          | 146.58       | 7.41            | 2.12            | 20.77        | 2.37           | 171.30            |
| 70%    | 125.00    | 40.00       | 15.75          | 10.61          | 165.14       | 7.65            | 2.17            | 23.33        | 2.68           | 193.75            |
| 80%    | 125.00    | 40.00       | 16.52          | 11.22          | 179.70       | 7.88            | 2.36            | 26.03        | 2.99           | 216.20            |
| 40%    | 135.00    | 25.00       | 12.66          | 7.86           | 79.67        | 7.16            | 1.56            | 11.33        | 1.84           | 88.67             |
| 60%    | 135.00    | 25.00       | 14.97          | 10.30          | 107.91       | 7.83            | 1.99            | 15.69        | 2.58           | 124.56            |
| 70%    | 135.00    | 25.00       | 16.07          | 10.40          | 121.24       | 8.08            | 2.04            | 15.60        | 2.91           | 140.27            |
| 80%    | 135.00    | 25.00       | 16.73          | 10.89          | 130.48       | 8.30            | 2.23            | 19.59        | 3.23           | 156.00            |
| 40%    | 135.00    | 30.00       | 13.34          | 8.65           | 98.03        | 7.24            | 1.79            | 14.50        | 1.84           | 110.84            |
| 60%    | 135.00    | 30.00       | 16.53          | 11.33          | 130.48       | 7.91            | 2.22            | 19.96        | 2.58           | 155.70            |
| 70%    | 135.00    | 30.00       | 17.37          | 11.98          | 144.67       | 8.16            | 2.43            | 22.24        | 2.91           | 175.35            |
| 80%    | 135.00    | 30.00       | 17.78          | 12.08          | 160.51       | 8.41            | 2.49            | 24.13        | 3.23           | 194.99            |
| 40%    | 135.00    | 40.00       | 14.69          | 10.01          | 118.40       | 7.35            | 1.90            | 16.53        | 1.84           | 133.00            |
| 60%    | 135.00    | 40.00       | 17.68          | 12.61          | 155.24       | 8.04            | 2.49            | 22.54        | 2.58           | 186.85            |
| 70%    | 135.00    | 40.00       | 18.48          | 13.23          | 170.55       | 8.28            | 2.68            | 25.37        | 2.91           | 210.42            |
| 80%    | 135.00    | 40.00       | 18.90          | 13.33          | 189.10       | 8.53            | 2.75            | 28.06        | 3.23           | 233.99            |
| 40%    | 145.00    | 25.00       | 16.05          | 11.04          | 86.49        | 8.07            | 2.24            | 12.63        | 2.06           | 99.30             |
| 60%    | 145.00    | 25.00       | 17.47          | 11.76          | 116.30       | 8.62            | 2.36            | 16.89        | 2.79           | 134.46            |
| 70%    | 145.00    | 25.00       | 18.16          | 12.25          | 127.38       | 8.85            | 2.55            | 18.99        | 3.13           | 151.04            |
| 80%    | 145.00    | 25.00       | 18.61          | 12.35          | 141.10       | 9.12            | 2.61            | 21.00        | 3.48           | 167.63            |
| 40%    | 145.00    | 30.00       | 16.72          | 11.84          | 106.38       | 8.15            | 2.47            | 16.11        | 2.06           | 124.13            |
| 60%    | 145.00    | 30.00       | 18.35          | 12.77          | 142.70       | 8.69            | 2.60            | 21.69        | 2.79           | 168.07            |
| 70%    | 145.00    | 30.00       | 19.25          | 13.44          | 155.51       | 8.96            | 2.81            | 23.88        | 3.13           | 188.80            |
| 80%    | 145.00    | 30.00       | 19.66          | 13.55          | 172.24       | 9.23            | 2.86            | 26.40        | 3.48           | 209.54            |
| 40%    | 145.00    | 40.00       | 18.08          | 13.20          | 128.39       | 8.26            | 2.58            | 18.35        | 2.06           | 148.95            |
| 60%    | 145.00    | 40.00       | 19.50          | 14.06          | 167.21       | 8.82            | 2.87            | 24.24        | 2.79           | 201.68            |
| 70%    | 145.00    | 40.00       | 20.30          | 14.69          | 183.25       | 9.08            | 3.07            | 29.21        | 3.13           | 226.56            |
| 80%    | 145.00    | 40.00       | 20.77          | 14.81          | 202.83       | 9.34            | 3.14            | 30.05        | 3.48           | 251.45            |

**Table 30.1 - Overhead Sign Support****Loads At Bottom of Baseplate**

| SS (%) | Span (ft) | Height (ft) | Pdl,max (kips) | Pdl,min (kips) | Pwind (kips) | Pice,max (kips) | Pice,min (kips) | Hwind (kips) | Ht,wind (kips) | Mt,wind (kips-ft) |
|--------|-----------|-------------|----------------|----------------|--------------|-----------------|-----------------|--------------|----------------|-------------------|
| 40%    | 155.00    | 25.00       | 14.92          | 11.57          | 91.97        | 8.56            | 2.33            | 13.41        | 2.19           | 105.77            |
| 60%    | 155.00    | 25.00       | 20.03          | 14.23          | 119.52       | 9.27            | 2.93            | 18.27        | 3.01           | 145.18            |
| 70%    | 155.00    | 25.00       | 20.51          | 14.35          | 133.43       | 9.56            | 3.00            | 20.37        | 3.37           | 162.44            |
| 80%    | 155.00    | 25.00       | 20.98          | 14.47          | 147.34       | 9.84            | 3.07            | 22.46        | 3.73           | 179.70            |
| 40%    | 155.00    | 30.00       | 18.30          | 13.10          | 113.06       | 8.63            | 2.57            | 17.10        | 2.19           | 130.21            |
| 60%    | 155.00    | 30.00       | 21.09          | 15.43          | 146.00       | 9.38            | 3.19            | 22.99        | 3.01           | 181.48            |
| 70%    | 155.00    | 30.00       | 21.56          | 15.55          | 162.98       | 9.66            | 3.26            | 25.61        | 3.37           | 203.05            |
| 80%    | 155.00    | 30.00       | 22.34          | 16.13          | 176.06       | 9.93            | 3.47            | 28.34        | 3.73           | 224.62            |
| 40%    | 155.00    | 40.00       | 19.47          | 14.39          | 130.51       | 8.76            | 2.84            | 19.30        | 2.19           | 158.64            |
| 60%    | 155.00    | 40.00       | 20.12          | 16.60          | 172.18       | 9.48            | 3.43            | 26.21        | 2.19           | 217.77            |
| 70%    | 155.00    | 40.00       | 22.59          | 16.72          | 192.07       | 9.76            | 3.50            | 29.16        | 2.19           | 243.65            |
| 80%    | 155.00    | 40.00       | 23.44          | 17.37          | 207.56       | 10.03           | 3.72            | 30.26        | 2.19           | 269.54            |
| 40%    | 165.00    | 25.00       | 19.69          | 14.16          | 97.30        | 9.19            | 2.75            | 14.54        | 2.39           | 115.04            |
| 60%    | 165.00    | 25.00       | 20.95          | 14.79          | 126.65       | 9.76            | 3.02            | 19.35        | 3.19           | 154.03            |
| 70%    | 165.00    | 25.00       | 22.26          | 15.82          | 140.08       | 10.18           | 3.30            | 21.69        | 3.59           | 173.35            |
| 80%    | 165.00    | 25.00       | 23.07          | 16.42          | 154.52       | 10.46           | 3.54            | 23.82        | 3.97           | 191.44            |
| 40%    | 165.00    | 30.00       | 20.57          | 15.17          | 119.61       | 9.27            | 2.98            | 18.51        | 2.39           | 143.80            |
| 60%    | 165.00    | 30.00       | 22.00          | 15.99          | 154.71       | 9.87            | 3.29            | 24.33        | 3.19           | 192.54            |
| 70%    | 165.00    | 30.00       | 23.30          | 17.02          | 171.14       | 10.29           | 3.59            | 27.27        | 3.59           | 216.70            |
| 80%    | 165.00    | 30.00       | 24.11          | 17.61          | 184.63       | 10.56           | 3.80            | 30.13        | 3.97           | 239.30            |
| 40%    | 165.00    | 40.00       | 21.73          | 16.42          | 140.26       | 9.39            | 3.26            | 20.91        | 2.39           | 172.55            |
| 60%    | 165.00    | 40.00       | 23.02          | 17.16          | 183.38       | 9.96            | 3.53            | 27.72        | 3.19           | 230.04            |
| 70%    | 165.00    | 40.00       | 24.72          | 18.72          | 197.59       | 10.37           | 3.97            | 30.17        | 3.59           | 260.05            |
| 80%    | 165.00    | 40.00       | 25.21          | 18.85          | 217.66       | 10.66           | 4.06            | 3.47         | 3.97           | 287.16            |

## Notes:

1. Refer to the following sketch for the location of the load applications for the Overhead Sign Support Structure.
2. The Tables are for fixed-message sign support structures only.



**TOWER ELEVATION**

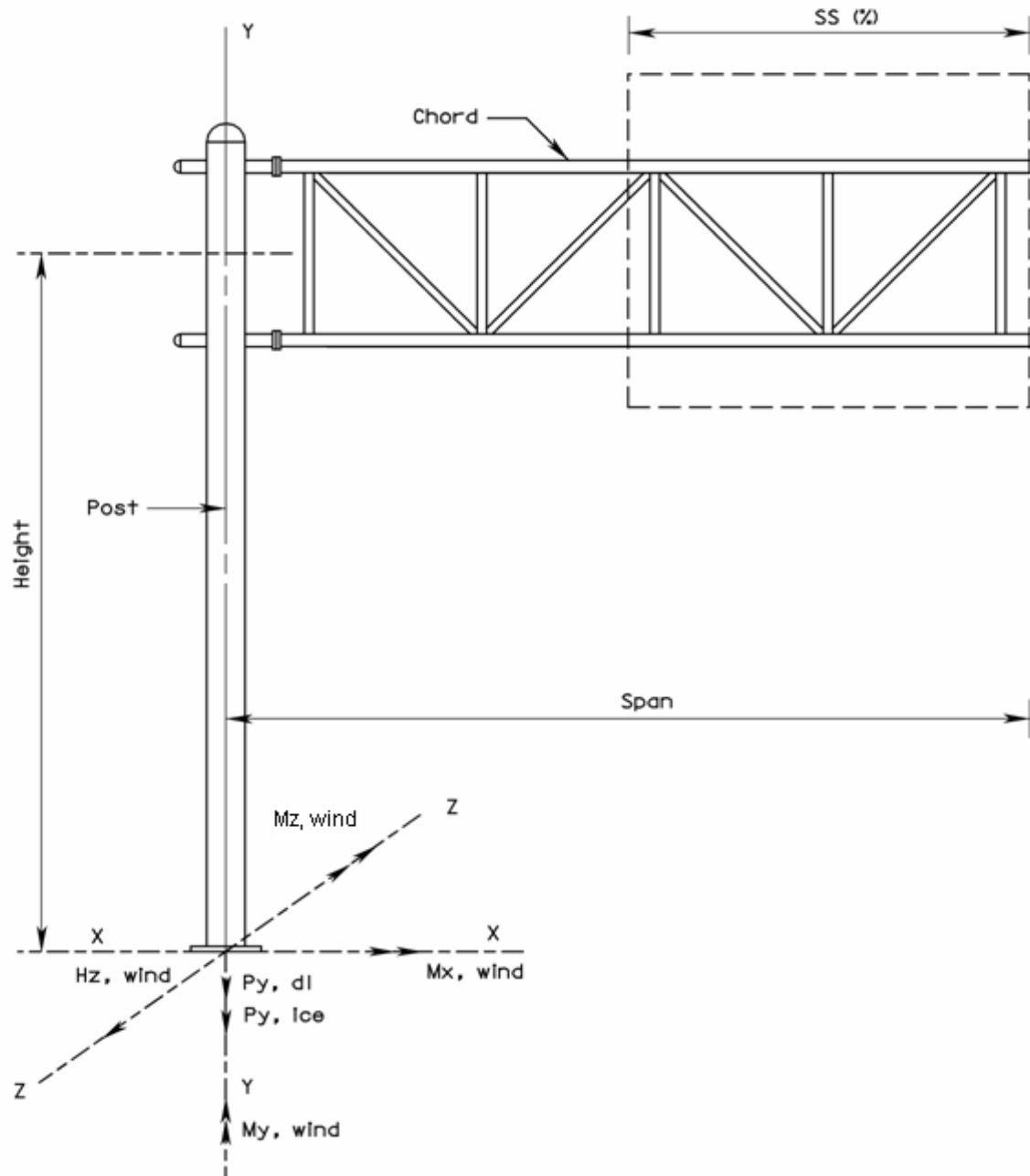
**Table 30.2 - Cantilever Sign Support****Loads At Bottom of Baseplate**

| SS (%) | Span (ft) | Height (ft) | H <sub>z</sub> , wind (kips) | P <sub>y,dl</sub> (kips) | P <sub>y,ice</sub> (kips) | M <sub>x,wind</sub> (kips-ft) | M <sub>y,wind</sub> (kips-ft) | M <sub>z,dl</sub> (kips-ft) |
|--------|-----------|-------------|------------------------------|--------------------------|---------------------------|-------------------------------|-------------------------------|-----------------------------|
| 40%    | 20.00     | 25.00       | 5.30                         | 4.86                     | 1.92                      | 133.73                        | 68.29                         | 30.23                       |
| 50%    | 20.00     | 25.00       | 6.25                         | 5.91                     | 2.05                      | 157.78                        | 77.81                         | 37.59                       |
| 60%    | 20.00     | 25.00       | 7.13                         | 6.06                     | 2.14                      | 180.89                        | 85.61                         | 38.90                       |
| 70%    | 20.00     | 25.00       | 8.08                         | 6.52                     | 2.27                      | 204.98                        | 91.67                         | 39.93                       |
| 80%    | 20.00     | 25.00       | 9.46                         | 6.67                     | 2.36                      | 241.37                        | 101.98                        | 40.65                       |
| 40%    | 30.00     | 25.00       | 8.41                         | 8.64                     | 3.08                      | 213.04                        | 158.02                        | 89.68                       |
| 50%    | 30.00     | 25.00       | 9.70                         | 9.97                     | 3.24                      | 246.90                        | 178.51                        | 109.65                      |
| 60%    | 30.00     | 25.00       | 11.56                        | 10.51                    | 3.42                      | 294.99                        | 206.55                        | 112.62                      |
| 70%    | 30.00     | 25.00       | 12.89                        | 10.73                    | 3.55                      | 329.71                        | 220.23                        | 114.90                      |
| 80%    | 30.00     | 25.00       | 14.28                        | 11.27                    | 3.73                      | 365.41                        | 229.99                        | 116.57                      |
| 40%    | 40.00     | 25.00       | 12.10                        | 13.68                    | 4.49                      | 308.26                        | 302.37                        | 209.78                      |
| 50%    | 40.00     | 25.00       | 13.86                        | 16.09                    | 4.71                      | 353.76                        | 339.12                        | 251.64                      |
| 60%    | 40.00     | 25.00       | 15.56                        | 17.38                    | 4.89                      | 398.38                        | 369.23                        | 256.87                      |
| 70%    | 40.00     | 25.00       | 17.26                        | 17.68                    | 5.06                      | 442.99                        | 392.66                        | 260.94                      |
| 80%    | 40.00     | 25.00       | 19.11                        | 17.97                    | 5.24                      | 491.39                        | 412.80                        | 263.85                      |
| 40%    | 20.00     | 30.00       | 5.49                         | 5.72                     | 2.04                      | 170.28                        | 68.27                         | 30.24                       |
| 50%    | 20.00     | 30.00       | 6.37                         | 6.45                     | 2.13                      | 199.17                        | 77.81                         | 37.59                       |
| 60%    | 20.00     | 30.00       | 7.33                         | 6.99                     | 2.28                      | 229.51                        | 85.60                         | 38.91                       |
| 70%    | 20.00     | 30.00       | 8.21                         | 7.14                     | 2.36                      | 258.42                        | 91.67                         | 39.93                       |
| 80%    | 20.00     | 30.00       | 9.68                         | 7.67                     | 2.51                      | 305.38                        | 101.98                        | 40.67                       |
| 40%    | 30.00     | 30.00       | 8.56                         | 9.30                     | 3.28                      | 268.73                        | 158.02                        | 89.68                       |
| 50%    | 30.00     | 30.00       | 9.93                         | 11.04                    | 3.40                      | 312.46                        | 178.48                        | 109.68                      |
| 60%    | 30.00     | 30.00       | 11.81                        | 11.65                    | 3.59                      | 372.83                        | 206.54                        | 112.65                      |
| 70%    | 30.00     | 30.00       | 13.13                        | 11.87                    | 3.72                      | 416.26                        | 220.22                        | 114.94                      |
| 80%    | 30.00     | 30.00       | 14.54                        | 12.49                    | 3.91                      | 461.15                        | 229.99                        | 116.61                      |
| 40%    | 40.00     | 30.00       | 12.36                        | 14.89                    | 4.67                      | 389.60                        | 302.31                        | 209.84                      |
| 50%    | 40.00     | 30.00       | 14.06                        | 18.20                    | 4.84                      | 445.37                        | 339.12                        | 251.64                      |
| 60%    | 40.00     | 30.00       | 15.76                        | 18.50                    | 5.02                      | 501.13                        | 369.23                        | 256.87                      |
| 70%    | 40.00     | 30.00       | 17.46                        | 19.99                    | 5.20                      | 556.90                        | 392.66                        | 260.94                      |
| 80%    | 40.00     | 30.00       | 19.30                        | 20.29                    | 5.38                      | 617.40                        | 412.80                        | 263.85                      |
| 40%    | 20.00     | 40.00       | 5.70                         | 6.72                     | 2.19                      | 208.68                        | 68.25                         | 30.25                       |
| 50%    | 20.00     | 40.00       | 6.58                         | 7.46                     | 2.28                      | 243.37                        | 77.80                         | 37.60                       |
| 60%    | 20.00     | 40.00       | 7.56                         | 8.06                     | 2.43                      | 280.08                        | 85.59                         | 38.92                       |
| 70%    | 20.00     | 40.00       | 8.44                         | 8.21                     | 2.52                      | 314.79                        | 91.66                         | 39.94                       |
| 80%    | 20.00     | 40.00       | 9.93                         | 8.82                     | 2.68                      | 371.46                        | 101.97                        | 40.68                       |
| 40%    | 30.00     | 40.00       | 8.81                         | 10.46                    | 3.35                      | 327.36                        | 157.99                        | 89.71                       |
| 50%    | 30.00     | 40.00       | 10.19                        | 12.25                    | 3.58                      | 380.15                        | 178.46                        | 109.70                      |
| 60%    | 30.00     | 40.00       | 11.99                        | 12.48                    | 3.71                      | 450.92                        | 206.54                        | 112.65                      |
| 70%    | 30.00     | 40.00       | 13.41                        | 13.16                    | 3.91                      | 505.04                        | 220.21                        | 114.97                      |
| 80%    | 30.00     | 40.00       | 14.73                        | 14.81                    | 4.04                      | 557.19                        | 229.99                        | 116.61                      |
| 40%    | 40.00     | 40.00       | 12.55                        | 17.22                    | 4.80                      | 471.33                        | 302.31                        | 209.84                      |
| 50%    | 40.00     | 40.00       | 14.25                        | 19.30                    | 4.98                      | 538.25                        | 339.12                        | 251.64                      |
| 60%    | 40.00     | 40.00       | 15.95                        | 21.03                    | 5.15                      | 605.17                        | 369.23                        | 256.87                      |
| 70%    | 40.00     | 40.00       | 17.65                        | 21.30                    | 5.33                      | 672.09                        | 392.66                        | 260.94                      |
| 80%    | 40.00     | 40.00       | 19.50                        | 22.98                    | 5.51                      | 744.94                        | 412.80                        | 263.85                      |

## Notes:

1. Refer to the following sketch for the location of the load applications for the Cantilever Sign Support Structures.
2. The Table is for fixed-message sign support structures only.





### Cantilever Sign

**Table 30.3 - Cantilever VMS/DMS Support****Loads At Bottom of Baseplate****Table 30.4 - Butterfly VMS/DMS Support****Loads At Bottom of Baseplate****Section 31 - Bridge Mounted Signs****31.1 General Criteria**

1. Bridge mounted sign support structures shall be designed and detailed on an individual structure basis.
2. When bridge mounted signs are to be installed on grade separation structures, close liaison between the Designer and Traffic Signal and Safety Engineering is essential. The overhead signs should be located as near to the most advantageous position for traffic operation as possible, but where structurally adequate support structure details can be provided.

While the type of bridge mounted sign structure is not preferred, the best locations from a structural standpoint are usually near an abutment, bent cap, or other support. This will reduce the effect of live load vibrations. When the sign does not extend above the top of parapet or railing, the installation of a sign on an overpass is generally not objectionable aesthetically.

3. Support structures for bridge mounted signs shall be designed with the use of hot-dipped galvanized steel tubes or hot dipped galvanized structural steel members.
4. The provision of maintenance walkways for bridge mounted signs is generally not required.
5. Design and details of support structures shall be such as to provide space for painting and inspection of stringers.
6. Normally, signs should be placed parallel with the structure for skews up to 10 degrees. At greater angles of skew, support structures shall be detailed to position the sign at approximately right angles to the roadway.

When the roadway is on a tangent, horizontal curve or there is a horizontal curve within the normal sight distance, the Traffic Signal and Safety Engineering Unit shall determine the appropriate skew angle for the traffic based on the traffic speed and horizontal curve angle.

7. Support structures shall be detailed to position the sign and maintenance walkway in a horizontal position regardless of the grade of the stringers.
8. Support structures shall be detailed to position the lower limit of the maintenance walkway and lighting 1'-3" minimum above the underside of the fascia stringer.
9. Proposed overhead bridge mounted signs shall be shown on preliminary bridge plans.

If information concerning signs is not available at the time of preliminary bridge plan submission, revised plans shall be submitted for approval at a later date.

The same procedure shall apply to bridge mounted signs proposed for existing bridges within the limits of any design contract. Design calculations indicating the influence of the additional loading stresses on the existing structural elements shall be included. Installation of additional diaphragms from the fascia to the first and second girders may be required.

10. Drilling for inserts into prestressed concrete beams will not be permitted.

## Section 32 - Utilities

### 32.1 General Criteria

1. The Design Unit shall determine utilities that will be affected by the construction of any bridge structure at the earliest possible stage. It shall be their responsibility to deal with these utilities and to provide location plans or any other required sketches for their information. When the utility has to be accommodated on the structure, the Design Unit shall secure approval from the representative of the utility and the Bureau of Structural Engineering for the location and method of support.
2. Due consideration shall be given to the weight of the pipes, ducts, etc. in the design of the beams and diaphragms. Utilities shall be assumed to be placed prior to placing the concrete deck slab, but pipes need not be considered full.
3. To insure that the function, aesthetics, painting and inspection of stringers of a structure are maintained, the following applies to the installation of utilities on structures:
  - a. Permanent installations, which are to be carried on and parallel to the longitudinal axis of the structure, shall be placed out of sight, between the fascia beams and above the bottom flanges, on the underside of the structure.
  - b. Conglomeration of utilities in the same bay shall be avoided in order to facilitate maintenance painting and future inspection of steel stringers in a practical manner.
  - c. In those instances where the proposed type of superstructure is not adaptable to carrying utilities in an out-of-sight location in the underside of the structure, an early determination must be made as to whether or not utilities are to be accommodated and, if so, the type of superstructure must be selected accordingly.

### 32.2 Support Systems

1. Utilities shall not be supported by a system which requires inserts in the concrete deck slab. They shall be supported directly on structural beams. Also, utilities shall not be supported by a system that requires drilling into prestressed concrete beams. Welding onto structural steel beams is not permitted.
2. It shall be the responsibility of the design unit to obtain approval of support details from the individual utility companies prior to the Final submission.

### 32.3 Plans

Preliminary and final General Plan and Elevation drawings shall show information about all existing and proposed utilities carried under the superstructure or in the vicinity of foundations. Complete information as to the name of owner, size, type, abandonment, proposed relocation, material to be furnished by utility company, etc. shall be noted.

### 32.4 Department Policy

Department Policy is promulgated in the New Jersey Administrative Code (N.J.A.C.) Title 16, Chapter 25, entitled *Utility Accommodation*.

The following guidance in regard to utility installations on bridges should be followed:

### **General Considerations**

1. In most cases, attachment of utility facilities to highway structures, such as bridges, is a practical arrangement and considered to be in the public interest. However, attaching utility lines to a highway structure can materially affect the structure, the safe operation of traffic, the efficiency of maintenance as well as the appearance and therefore must be provided for during the design stage.
2. Since highway structure designs and site conditions vary, the adoption of a standard method to accommodate utility facilities is not feasible; however, the method employed should conform to logical engineering considerations for preserving the highway, its safe operation, maintenance and appearance. Generally, acceptable utility installations are those which will occupy a position beneath the structure's floor, between the outer girders of beams or within a cell, and at an elevation above low superstructure steel or masonry.
3. The general controls for providing encasement, allied mechanical protection and shut-off valves to pipeline crossings of highways and for restriction against varied use shall be followed for pipeline attachments to bridge structures, except that sleeves are required only through the abutment backwalls. Where a pipeline attachment to a bridge is encased, the casing should be effectively opened or vented at each end to prevent possible buildup of pressure and to detect leakage of gases or fluid.
4. Since an encasement is not normally provided for a pipeline attachment to a bridge, additional protective measures shall be taken. Such measures shall employ higher factor of safety in the design, construction, and testing of the pipeline than would normally be required for cased construction.
5. Communication and electric power line attachments shall be suitably insulated, grounded, and carried in protective conduit or pipe from the point of exit from the ground to re-entry. The cable shall be carried to a manhole located beyond the backwall of the structure. Carrier pipe and casing pipe should be suitably insulated from electric power line attachments.
6. Guy wires in support of any utility will never be allowed to attach to a bridge structure.
7. Cell phone or other type antennas shall not be mounted from or on any bridge or sign support structure.

### **32.5 Pipelines On Railroad Bridges And Property**

Design and detailing of pipelines on railroad property, bridges over railroad tracks, or bridges carrying railroad tracks shall be coordinated with the proper railroad agency.

### **32.6 Pipeline Expansion Joints (Water Mains)**

1. Allowances must be made for changes in pipe length due to thermal expansion and alternate contraction. While Dresser type couplings will take care of the normal amount of expansion and contraction in each length of pipe, Dresser type expansion joints are required where no flexible joints are used in the

pipeline or when the amount of concentrated movement at one point is in excess of the amount that can be safely absorbed by the standard coupling.

2. A Dresser type expansion joint should be located in the pipeline adjacent to every point where expansion means are provided in the superstructure.
3. Use Dresser type couplings to accommodate the differential movement between the structure and the line itself, and to provide flexibility to accommodate vibrations of the structure. Each coupling can safely accommodate up to 3/8" longitudinal movement. This is equivalent to the amount of movement resulting from a 120° F temperature variation in a 40 foot length of steel pipe.
4. Proper alignment is important to insure free and concentric movement of the slip-type expansion joint. Alignment guides should be designed to allow free movement in only one direction along the axis of the pipe and to prevent any horizontal or vertical movement of the pipe. Suitable pipe alignment guides may be obtained from reliable pipe alignment guide manufacturers. Alignment guides should be fastened to some rigid part of the installation, such as the framework of the bridge. Alignment guides should be located as close to the expansion joint as possible, up to a maximum of 4 pipe diameters. The distance from the first pipe guide to the second should not exceed a maximum of 14 pipe diameters from the first guide. Where an anchor is located adjacent to an expansion joint, it too, should be located as close to the expansion joint as possible - to a maximum of 4 pipe diameters from the expansion joint. Additional pipe supports are usually required. It must be kept in mind that pipe supports should not be substituted for alignment guides.
5. The main pipe anchors must be designed to withstand the full thrust resulting from internal line pressure; also, the force required to collapse the slip pipe, and the frictional forces due to guides and supports.

## **Section 33 - Cofferdams and Sheet Piling**

### **33.1 General Criteria**

1. When identified by the Designer as a project requirement, the use of Cofferdams shall be scheduled in a project. Cofferdams shall be constructed to protect a foundation and the foundation's construction against damage from a rise in water elevation.
2. The availability of domestically produced hot rolled steel sheet piling is limited. Designation of a PZ section shall only be indicated after the Designer has ascertained its domestic availability.
3. The Designer must determine if the use of a concrete seal will be needed to facilitate a foundation's construction. If this is so determined, then a Permanent Cofferdam system or Permanent Sheet piling system that, utilizes a concrete seal, shall be designed and accordingly detailed on the final plans. The top of the concrete seal shall be detailed to be below the bottom of water elevation and below the proposed bottom elevation of the footing.
4. Sheet piling below the top of seal concrete shall be designated to be left-in-place. (See Guide Sheet Plate 3.13-1 for typical details).

### **33.2 Temporary Cofferdam Installations**

1. According to the provisions of the NJDOT Standard Specifications, the design of Cofferdam systems, that are planned to be temporary installations, shall be submitted as Working Drawings. The Standard Specifications may be referenced for requirements concerning Working Drawing submissions. The final plans shall indicate the required Cofferdam installation limits.
2. When, as part of a temporary condition, a steel sheet piling system is required for dewatering, the Designer shall clearly identify this requirement in the Contract documents.
3. When the need for utilization of steel sheet piling for a Temporary Cofferdam has been determined, the Designer shall provide the following criteria on the plans:
  - Strength or grade of material to be used
  - Minimum Section Modulus
  - Minimum Tip Elevation
  - Horizontal limits of the sheeting in relationship to the footing location(s)
  - Mean high water elevation

This information is to be used by the Contractor for his Working Drawing submission.

### **33.3 Permanent Cofferdam and Permanent Sheet piling Installations**

1. The design of any Cofferdam system that, based on warranting site conditions and engineering judgment, is believed to require a permanent installation, shall be provided in the final contract documents. All required material designations and construction parameters shall be indicated. The NJDOT Standard Specifications can be referred to for correlation of the construction parameters and Payment Provisions.

2. When it is determined that Steel Sheeting is required for dewatering or to address any structural stability construction issue, the complete design of the Steel Sheeting system shall be provided in the contract documents. All required material designations and construction parameters; such as, bottom tip elevation shall be indicated. The NJDOT Standard Specifications can be referred to for correlation of the construction parameters and Payment Provisions.
3. Unless otherwise warranted by a project's specific site conditions, the following payment limit provisions shall also be designated on the plans:
  - a. The lower payment limit of sheeting left in place shall be the bottom of the excavation.
  - b. The upper payment limit shall be the top elevation of the seal concrete.
4. The need for provision of a concrete seal shall be evaluated and, if warranted, detailed as part of the Permanent Cofferdam or Permanent Sheeting installation.

### **33.4 Temporary Sheeting**

1. The use of Temporary Sheeting shall be based on conditions where protection of property (embankment control), traffic (stage construction), utilities, construction safety code requirements, etc. is a construction consideration. When a project's construction is governed by such considerations, Temporary Sheeting shall be scheduled in the Contract documents.

The proposed horizontal limits of the Temporary Sheeting shall be detailed in the Plan view of the structure.

2. Ordinarily the design and type of temporary sheeting is the choice of the Contractor. However, it shall be the responsibility of the Designer to review borings and subsurface soil reports so that any adverse subsurface conditions can be identified. In such cases, the Project's Special Provisions shall provide guidance as to type of sheeting that can be used and any driving and pulling directions that must be followed.
3. Payment limits for Temporary Sheeting must be shown in schematic outline on the plans. The following payment limit guidelines may be utilized:
  - Lower Limit: Bottom of excavation
  - Upper Limit: A vertical plane of the top of sheeting.
  - Horizontal Limits: Determined by the Design Engineer based on extent of construction

### **33.5 Material Requirements**

1. Material for steel sheet piling shall conform to ASTM A 572, Grade 50.
2. Sheet piling that is to be used in a marine environment shall conform to ASTM A 572, Grade 50 and be coated with a 16 mil application of coal tar epoxy as per SSPC Paint Specification No. 16.



## Section 34 - Geotechnical Engineering

### 34.1 General Plan Preparation

- A. Location of borings and identification numbers shall be shown on both preliminary and final General Plan and Elevation sheets for each bridge and structure.
- B. Subsurface soil profiles and boring log information shall not be shown on the contract plans. Copies of boring logs and other test data are available to bidders as separate documents. Upon submission of final construction documents (PS&E), the Designer shall submit one set of compact disc (CD) consisting of PDF format of boring logs, and other subsurface investigation data (CTP, etc.) and lab test data and one hard copy of aforementioned logs and data to the Geotechnical Engineering Unit and Project Manager. An electronic submission of the boring logs and boring location plan sheets should be forwarded to the Geotechnical Engineering Unit per the submission guidelines on the NJDOT website at the following link:  
<http://www.state.nj.us/transportation/refdata/geologic/>.

### 34.2 Subsurface Exploration Program

The Designer is to prepare a subsurface exploration program for the project. Prior to developing this program, the Designer should initiate a search for all existing subsurface information within the project limits. Generally, design test boring requests should be initiated as soon as sufficient information is available concerning horizontal/vertical geometry and structure locations. To assist in the preparation of a program, the Designer should refer to Subsections 34.2., Item 6, Suggested Methods and Procedures for Test Borings and 34.2., Item 7, Guidelines for Spacing and Depths of Test Borings of this Manual for guidance.

#### 34.2.1 Gather Subsurface Information

- A. The Designer is responsible for providing the field layout of the proposed test borings. The stakeout shall consist of a hub driven flush, and a lath with the boring number and the elevation of existing ground shown on it. In heavily wooded and shrubby areas, additional markings should be provided to direct boring crews to the sites. For water boring locations, a suitable range pole system may be required. In tidal streams, a tide gauge should be provided.  
  
A tabulation of the as-staked data including station, offset, reference line, and existing ground elevation, should be provided to the Geotechnical Engineering Unit prior to the commencement of drilling operations. In addition, a tabulation of boring locations referenced to the New Jersey Plane Coordinate System, and GI compatible, should also be provided. The location data must be referenced to a baseline which is shown on the appropriate construction plans for the project.
- B. All completed borings are to be plotted and labeled on the construction plans, or on the plan sheet index, if available. In addition, if the borings are for structural design, they should also be plotted and labeled on the General Plan and Elevation sheet for each structure in the bridge plans.
- C. Preliminary laboratory testing programs, if deemed necessary, should be submitted to the Geotechnical Engineering Unit with the boring request. When cohesive soils are encountered during the boring operations, the Designer

should recommend any immediate revisions or additions to the program to obtain additional samples suitable for appropriate laboratory testing (i.e. undisturbed samples). Requests for field tests, such as in-situ vane shears, should be submitted with the original boring request, or as soon as possible thereafter.

- D. Required borings shall be located on the plan of the structure by station and offset from the base line. Five copies of the print shall be enclosed with the memorandum of transmittal. Request for borings shall be made as early as possible in the final design stage.

#### **34.2.2 Subsurface Exploration Program**

- A. When submitting a subsurface exploration request, the Designer should provide background information on the scope of the project, available information on soil contamination, and the following information.
  1. A tabulation of proposed borings with station, offset, purpose, proposed roadway cut/fill depth, and estimated quantity of soil/rock.
  2. Roadway profiles showing proposed and existing borings.
  3. Typical sections and cross sections, when applicable (such as for rock cut areas).
  4. Structure plot plans with proposed borings and bottom elevation of proposed footings, on ISO A4 sheets.
- B. The exploration request plans should consist of two sets of the following:
  1. A Key Sheet.
  2. 1:1000 or 1:2000 scale plans on standard ISO A1 sheets with borings plotted and labeled. If 1:1000 or 1:2000 scale plans are not available, alternate scaled may be substituted.

#### **34.2.3 Subsurface Exploration Program Review Process**

- A. The Geotechnical Engineering Unit will review the Designer's program, and, if necessary, conduct meetings with the Designer to finalize the exploration program.
- B. The review process will also address soil contamination and the need for Health and Safety oversight during drilling, as recommended by the Bureau of Environmental Services.
- C. After finalization of the boring program and determination of Health and Safety needs, the Designer will be advised to obtain the services of a drilling subcontractor.

#### **34.2.4 Subsurface Exploration By Contractor**

Upon notification of approval of the boring program, the Designer shall:

- A. Provide contract documents for review and comment.
- B. Provide additional copies of the finalized plans and contract documents, if requested.

- C. Submit resumes to the Geotechnical Engineering Unit for inspectors to be used during the performance of the boring contract.
- D. Receive bids, and provide two copies of each bid proposal, tabulation of bids, and award recommendations.
- E. Provide a copy of the executed contract, performance bond, and insurance certificates.
- F. Within five days of completion of each week during actual drilling activity, submit "Weekly Contract Drilling Reports" (forms provided by the Geotechnical Engineering Unit), and one copy of the inspectors' field logs for all borings completed that week. The logs will contain sample identifications, after Burmister, and detailed rock descriptions including rock type, color, condition, percent recovery, and Rock Quality Designation after D. Deere.
- G. Prepare and submit final typed logs on ISO A4 sheets, including the name of the Contractor and drilling personnel, within 20 days of completion of all borings. The format of a typical boring log is illustrated on Page 1.34-8.
- H. Prepare and submit final as-drilled boring location plans to the Geotechnical Unit for approval within 20 days of completion of all borings.
- I. Certify that the contractor has complied with all directions regarding clean-up and restoration of work areas and that all selected samples and cores have been inspected for delivery. Also, provide one week notice for delivery of samples and cores for storage by the Department.

#### **34.2.5 Field and Laboratory Test**

During the performance of borings or immediately following the completion of all borings, the Designer shall submit, to the Geotechnical Engineering Unit, a laboratory testing program for soil and rock samples. Upon review of the program, the Geotechnical Engineering Unit will authorize the Designer to perform the testing by using his own forces or a recognized Geotechnical Laboratory based upon a fee proposal.

#### **34.2.6 Suggested Methods and Procedures for Test Boring**

##### A. Boring Method

Borings shall be performed as per the most current edition of the *AASHTO Manual on Subsurface Investigations*.

##### B. Standard Penetration Test

1. The standard penetration test (SPT) shall be performed as per the most current edition of ASTM D 1586.
2. The SPT for each boring is to be taken at the surface and at intervals not exceeding 5 ft. Two or more consecutive tests are to be made starting at the approximate bottom elevation of structure footing. The SPT should also be made where changes in material or consistency are indicated.
3. Representative samples of the materials recovered shall be retained in sample jars, and the jars immediately labeled to indicate the project, boring number, sample number, and depth. If possible, jars shall be filled to the top

with the material as representative of the undisturbed state as possible. All wash samples should be so identified.

#### C. Undisturbed Sampling

Undisturbed samples shall be obtained as per the most current edition of ASTM D 1587.

#### D. Field Identification of Sample

1. Soil samples shall be identified by methods proposed by Burmister ("*Suggested Methods of Test for Identification of Soils*" by D.M. Burmister, 1958).
2. Rock cores shall be identified by lithologic name and by descriptive terms relating to color, structure, mineralization and weathering. Recovery shall be ratio of the length of the recovered core to the length of coring run, expressed as a percentage. Also to be recorded is the Rock Quality Designation (RQD), after Deere. (Deere, Don U., *Geologic Considerations*, Rock Mechanics Seminar, April and May, 1968).

#### E. Rock Coring

Rock coring shall be accomplished with diamond core bits and double tube M-series core barrels. Coring shall be performed in 5 foot runs except in boulder areas, where shorter runs may be necessary until top of rock is confirmed. Drilling pressure, speed and water flow should be adjusted and only straight drill rods should be used in order to maximize recovery.

#### F. Additional Field Testing

Additional field tests (such as vane shear, Cone Penetrometer Test (CPT), Flat Plate Dilatometer Test (DMT), hand penetrometer, & pressure meter) should be conducted where appropriate, as per manufacturers' recommendations and applicable testing standards.

#### G. Groundwater Observation

1. The water level, initial and 24 hours after completion of the boring, shall be recorded or the "caved-in" depth shall be recorded as wet or dry.
2. Groundwater monitoring wells shall be installed and subsequently abandoned and sealed as per the most current NJDEP regulations.
3. Water readings shall be recorded at each structure location. Where applicable, piezometers and/or groundwater monitoring wells at structure locations should be installed at the opposite ends of the structure, in the deepest test borings to be performed at that footing.

#### H. Presentation of Data

Borehole data shall be presented on a NJDOT approved log form (see Boring Log Form in Section 34.3). Field and final typed logs shall be completed by the Engineer and shall indicate level of proposed cut or fill and/or footing bottom at the boring location, as applicable.

**Note:** These suggested methods are not intended to be either all inclusive or exacting, but to serve only as a guide to methods of exploration.

### 34.2.7 Guidelines for Spacing and Depths of Test Boring

#### A. Spacing

##### 1. Embankment

- a. Minimum one boring every 100 to 500 feet along the alignment.
- b. In compressible, cohesive soils, UD borings every 200 to 500 feet, based on initial information.
- c. Proposed spacing should also account for the height of the proposed embankment and the anticipated subsurface condition.

##### 2. Cut

- a. Minimum one boring every 100 to 500 feet along the alignment.
- b. In rock areas, one to two NX size borings every 100 to 200 feet. Borings should be located so that problematic areas such as the ends of hills, saddles, and photo lineaments or suspected faults are investigated as well as the dominant structures.

##### 3. Structure

- a. For structures, minimum one boring every 50 feet along the proposed footing and at least two borings per footing, except for relatively small footings, where one boring may be sufficient.
- b. For walls and culverts, minimum one boring every 50 to 100 feet.
- c. For noise barriers, minimum one boring every 100 to 200 feet.
- d. For temporary or left-in-place structures, sufficient borings should be taken for design and constructability evaluations.
- e. For subsurface structures (pipes, electrical conduit, manholes, inlets and other similar structures), in areas with boulders, shallow bedrock or high ground water, borings should be taken at 100- to 500-foot intervals along the proposed subsurface structure.

#### B. Depth Criteria

##### 1. Embankment

- a. For an embankment height smaller or equal to 30 feet, the initial 10-20% of borings shall penetrate to depths equal to 2 times the height of the embankment (but not to exceed 50 feet) except to penetrate below compressible soils, in which case: penetrate approximately 15 feet (4 samples at 5-foot intervals) in coarse or fine grained soils with SPT value (N) greater than 30.
- b. For an embankment height greater than 30 feet, initial 10-20% of borings to penetrate to a depth of 1-1/2 times height of embankment except to penetrate below compressible soils, in which case: either penetrate approximately 15 feet (4 samples at 5-foot intervals) into coarse or fine grained soils with SPT value (N) greater than 30, or else 10 feet into rock or glacial till.

- c. Remaining embankment borings should be adjusted to reflect initial findings.

## 2. Cut

Borings in cut areas to extend a minimum of 8 feet below proposed profile grade. When compressible materials are encountered, depths of borings shall be extended as necessary.

## 3. Structure

- a. For structures on shallow foundations, at least one boring per footing to penetrate not less than 25 feet (6 samples at 5-foot intervals) into granular or non-compressible soils (such as till) with N values exceeding 30 per sample or at least 10 feet into rock. The depths of remaining borings to be determined based on initial results.
- b. For structures on deep foundations, a minimum of 20 feet below the anticipated pile or shaft tip elevation. Where pile or shaft groups will be used, at least two times the maximum pile group dimension below the anticipated tip elevation, unless the foundation will be end bearing on rock in which case a minimum of 10 feet of rock core shall be obtained at each exploration location to assure the boring has not been terminated on a boulder. For shafts supported on or extending into rock, a minimum of 10 feet of rock core, or a length of rock core equal to at least three times the shaft diameter for isolated shafts or two times the maximum shaft group dimension for a shaft group, whichever is greater, shall be obtained to assure the exploration has not terminated in a boulder and to determine the physical characteristics of rock within the zone of foundation influence for design.
- c. For retaining walls, extend the boring to a minimum depth of 2 times the wall height or a minimum of 10 feet into bedrock.
- d. For temporary sheeting, extend the boring to a minimum depth of 2 times the wall height.

**Note:** These criteria are meant to serve as guidelines, and programs should be adjusted as needed based upon the project type, local geological conditions and other applicable factors.

### 34.3 Boring Log Form

Form SO-2M

New Jersey Department of Transportation

Route: \_\_\_\_\_

Local Name: \_\_\_\_\_

NJDOT Boring No.: \_\_\_\_\_

SECTION: \_\_\_\_\_

FIELD BORING NO.: \_\_\_\_\_

STATION: \_\_\_\_\_

OFFSET: \_\_\_\_\_

REFERENCE LINE: \_\_\_\_\_

GROUND ELEVATION: \_\_\_\_\_

BORINGS BY: \_\_\_\_\_

DATE STARTED: \_\_\_\_\_

Ground Water Elevation

INSPECTOR: \_\_\_\_\_

DATE COMPLETED: \_\_\_\_\_

0 Hr.

Date: \_\_\_\_\_

24 Hr.

Date: \_\_\_\_\_

P.P. Installed

| DEPTH<br>(Ft) | NO. | DEPTH | Blows On Spoon |     |     |     | REC. | SOIL DESCRIPTION & STRATIGRAPHY |
|---------------|-----|-------|----------------|-----|-----|-----|------|---------------------------------|
|               |     |       | 0              | 150 | 300 | 450 |      |                                 |
| 5             |     |       |                |     |     |     |      |                                 |
| 10            |     |       |                |     |     |     |      |                                 |
| 15            |     |       |                |     |     |     |      |                                 |
| 20            |     |       |                |     |     |     |      |                                 |
| 25            |     |       |                |     |     |     |      |                                 |
| 30            |     |       |                |     |     |     |      |                                 |
| 34            |     |       |                |     |     |     |      |                                 |
| 40            |     |       |                |     |     |     |      |                                 |

|  |        |    |
|--|--------|----|
| Nominal I.D. of Drive Pipe               | 2 1/2" | 4" |
| Nominal I.D. of Split Barrel Sampler     | 1 1/2" |    |
| Weight of hammer on Drive Pipe           | 300 lb |    |
| Weight of hammer on Split Barrel Sampler | 140 lb |    |
| Drop of hammer on Drive Pipe             | 24"    |    |
| Drop of hammer on Split Barrel Sampler   | 30"    |    |

Core Size: \_\_\_\_\_

Soil descriptions represent a field identification after D.M. Burmister unless otherwise noted.

Driller: \_\_\_\_\_

The subsurface information shown hereon was obtained for State design and estimate purposes. It is made available to authorized users only that they may have access to the same information available to the State. It is presented in good faith, but is not intended as a substitute for investigations, interpretation or judgement of such authorized users.

NEW JERSEY DEPARTMENT OF TRANSPORTATION

Geotechnical Engineering Unit

Approximate Change in Strata: \_\_\_\_\_

Inferred Change in Strata: \_\_\_\_\_

## 34.4 Geotechnical Engineering Studies and Reports

### 34.4.1 General

- A. Upon completion of all subsurface exploration and laboratory testing, the Designer shall submit to the Geotechnical Engineering Unit two (2) copies of the following:
1. Geotechnical Roadway and Rock Engineering Reports
  2. Geotechnical Foundation Engineering Reports for each structure.
- B. Upon submission of the construction documents (PS&E), the Designer shall submit one set of compact disc (CD) consisting of PDF format of the following finalized reports and one set of hard copy of finalized reports to the Geotechnical Engineering Unit and NJDOT Project Manager.
1. A finalized Geotechnical Roadway and Rock Engineering Reports. This final report should include modifications and changes made during the phase reviews and should reflect the final roadway design shown on the final construction plans.
  2. Finalized Geotechnical Foundation Engineering Reports for each structure. This final report should include modifications and changes made to the foundation design during the phase reviews and should reflect the final foundation designs shown on the final construction plans.

**Note:** When computer programs are used in the preparation of these reports, the name, source and theoretical basis of each program should be provided in the appropriate report. Disks containing input/output files should also be provided.

### 34.4.2 Geotechnical Roadway Engineering Report

- A. This report shall include all studies performed with regard to Roadway Foundation design and shall consist of:
1. General project description including the geological condition, boring location sheets, soil and rock profiles with borings and groundwater elevations superimposed, and all other pertinent subsurface information.
  2. Description of all laboratory testing, evaluation of the test results, and the selection of soil and rock parameters used for the roadway foundation design.
- B. The geotechnical roadway analysis should include, but not be limited to, the following, if required:
1. Settlement Analysis: (i.e., amount and rate of settlement, instrumentation required i.e., Settlement Platforms, etc.)
  2. Slope Stability Analysis: (i.e., stability of slope of roadway fills and cuts instrumentation required i.e., Inclinometers, etc.)
  3. Slope Stabilization Analysis: (i.e., stabilization of slope with geosynthetic reinforcements)
  4. Ground Modification Analysis: (i.e., Preload or Surcharge with or without wick drains, dynamic deep compaction, stone columns, column supported embankment system, soil mixing, jet grouting, etc.)



## 5. Economic Analysis of Stabilization Techniques

**Note:** Computations for which analyses have been performed, references and cost estimates should be provided in this report.

- C. Explanation of instrumentation program in conjunction with the analyses above (i.e., monitoring wells, piezometers, settlement platforms, slope inclinometers, bench marks, etc.)
- D. Conclusions and recommendations

### 34.4.3 Rock Engineering Report

This report shall include studies and evaluations related to rock slopes or other applications and shall consist of:

- A. A compilation of all data which are significant to the stability of rock slopes from detailed line mapping of rock exposures, from core drilling observations and identifications, from field and laboratory tests, and from existing data; such as, publications, maps, aerial photos and other previous work.
- B. A geologic structural analysis determining structural domains and design sectors, developing a rock mass model using stereographic projection, investigating the possible failure modes, and synthesizing of strength parameters for stability analysis.
- C. Blasting and excavating considerations, remedial and stabilization measures, and cost estimates.
- D. Width of top of rock recommendations.
- E. Catchment area design recommendations.
- F. Geophysical surveys when appropriate.
- G. A summary table of information and recommendations.

**Note:** The Designer's attention is particularly directed to publications on rock engineering prepared by D. U. Deere, A. J. Hendron, and by D. R. Piteau and Associates, Ltd.

### 34.4.4 Geotechnical Foundation Engineering Report

#### A. Preliminary Geotechnical Engineering Report

The Designer gathers existing soil information using NJDOT GDMS (on-line soil boring data), Engineering Soil Survey Report by Rutgers University, available geologic publications, and as-built plans to conduct a geotechnical study and to prepare a Preliminary Geotechnical Engineering Report.

#### B. Final Geotechnical Engineering Report

This report shall contain specific foundation design criteria for each substructure unit and shall include:

1. Summary of all subsurface exploration data, including boring location sheets, subsurface soil profile, exploration logs, laboratory or in-situ test results, and groundwater information. The soil profile should include the elevation of the proposed and/or existing footings, existing water table and the standard penetration blow counts.
2. Interpretation and analysis of subsurface data. Laboratory testing shall be performed as necessary to determine the engineering properties, including

natural moisture content (if it is possible), unit weight, friction angle, cohesion, shear strength, compressibility, etc.,.

3. Settlement and stability analyses, where applicable, including the pertinent soil parameters, computations and cross sections.
4. Selection of type of foundation.

a. For structures supported on spread footings:

Method of foundation soil stabilization when required, limits of excavation, method of compaction, allowable soil bearing pressures, estimated differential and total residual settlement, and evaluation of overall global stability.

Refer to Subsection 16.3.1 of this Manual for additional information that is to be provided.

b. For structures supported on pile foundations:

1. Type of pile, nominal axial resistance and factored axial resistance, estimated down drag, group action, estimated tip elevation and/or minimum pile tip elevation of each pile, recommendations regarding the number and location of test piles, wave equation analysis, dynamic monitoring (Pile Driving Analyzer), CAPWAP, pile load test(s) (when required), and recommendations for special construction procedures (when necessary).
2. Refer to Subsection 16.3.2 of this Manual for additional information that is to be provided.
3. Cost comparisons of foundation alternatives, including different types of piles, when applicable.
4. Proposed method of dewatering, where necessary.
5. Estimated depth of scour, where applicable. Scour protection should be provided where required.
6. Seismic design and analysis for the foundations shall be in accordance with Section 38 of this Manual and AASHTO LRFD Bridge Design Specification.
7. Constructability and/or pile drivability for the proposed foundation. Other temporary and/or permanent sheeting or cofferdams should be discussed relative to their constructability.
8. All pertinent information regarding the existing structure, when the proposed foundation involves alterations to an existing structure or is close to an existing structure. Special methods of construction and their effect on the existing structure should also be included. Instrumentation may be required, i.e. Vibration Monitoring.
9. Illustrations
  - Roadway Plans for each structure to appropriate scale folded to the format of the report.
  - General soils profile for each structure.
  - Cross sections at specific locations where analyses have been performed.

- Tables and graphical illustrations.
- c. Structures supported on drilled shaft foundations:  
Refer to Section 16.3.3 Drilled Shaft Foundation.
- d. Structures supported on Micropile foundations:  
Refer to Section 16.3.4 Micropile Foundation.

### **34.5 Jetting and Preboring Of Piles**

To provide a general idea for the proper use of the following methods, the following guidelines for jetting and pre-boring are given. A review and recommendations by the Bureau of Structural Engineering's Geotechnical Engineering Unit may be warranted on a project to project basis.

#### **34.5.1 Jetting**

- A. Not to be used where a disturbance to existing foundations or utilities would result.
- B. Not to be used where disposal of jet water and soil would be a problem.
- C. In general, jetting would be used in very dense granular or silty soils where displacement piles are being driven in water.

#### **34.5.2 Pre-Boring**

- A. To be used when displacement piles are to be driven through a compacted fill over 10 feet high.
- B. To be used where driving piles full depth would disturb adjacent structures or utilities. Additionally, a survey, with photographs, should be performed before and after pre-boring and pile driving operations to verify occurrence of any damage to structures or utilities.
- C. Pre-drilling should not be used below bearing soils for friction piles.
- D. In loose granular soils or soft cohesive soils drilling mud may be necessary to keep the hole open.

## Section 35 - Structure Numbers and Names

### 35.1 NJDOT Asset Structure Numbering Standards

The Bureau of Structural Evaluation & Bridge Management is responsible for assigning new structure numbers for assets. Each new structure in the inventory will be assigned a single 7-digit number. The assigned structure numbers must be indicated on the contract plans. The 7-digit Structure Numbering System is based on ownership, location and structure type.

Requests for new Structure Numbers for all asset types, including highway carrying bridges, pedestrian bridges, railroad carrying bridges, overhead sign structures (span and cantilever), high mast light poles, tunnels and dams, shall be directed to the Bureau of Structural Evaluation & Bridge Management.

To request structure number, download the applicable form(s) from Bureau of Structural Evaluation & Bridge Management web site <http://www.nj.gov/transportation/eng/structeval/structnumber.shtm>, and look for Structure Numbering form(s) under the useful links. Complete applicable form(s) fully & accurately, and email to: [Pontis.Submission@dot.nj.gov](mailto:Pontis.Submission@dot.nj.gov). Please note, only electronic submissions (in PDF/A-1b format) will be accepted.

Once the Structure Number is assigned to any asset, it will not change.

#### 35.1.1 Highway Carrying State Maintained and New Jersey Transit (NJT) Owned Bridges

State Maintained bridge assets include structures owned by NJDOT (Routes 1 thru 676, and State Minor Bridges), D&R Canal, Orphan, and State Parks.

Bridges owned by New Jersey Transit (NJT) are also included for structure numbering.

#### 35.1.2 NJDOT Owned (Routes 1 thru 676) and Orphan Bridges

NJDOT owned (State Routes Only) bridges are divided into two categories:

- NBIS Bridges (Span length greater than 20 ft)
- Minor Bridges (Span length between 5 ft and 20 ft)

For structures on state routes, the number is structured as follows: the first four digits are the control section number and last three digits uniquely identify the individual structure. These assigned numbers are permanently fixed numbers for the structures. All new structures owned by NJDOT will consist of numbers only; no alphas are permitted at present.

The first four digits are the control section number.

1. The first two digits of the section number identify the county in which this section appears.

|            |    |            |    |          |    |
|------------|----|------------|----|----------|----|
| Atlantic   | 01 | Gloucester | 08 | Ocean    | 15 |
| Bergen     | 02 | Hudson     | 09 | Passaic  | 16 |
| Burlington | 03 | Hunterdon  | 10 | Salem    | 17 |
| Camden     | 04 | Mercer     | 11 | Somerset | 18 |
| Cape May   | 05 | Middlesex  | 12 | Sussex   | 19 |
| Cumberland | 06 | Monmouth   | 13 | Union    | 20 |
| Essex      | 07 | Morris     | 14 | Warren   | 21 |

2. The second two digits of the section number a unique highway segment within the County.

The last three digits uniquely identify the individual structure in a particular control section number. They will be assigned during the plan review, or earlier, when feasible. The following represents the ranges of numbers utilized:

Bridges:

State Maintained (including State Minor) 150 to 196  
and NJT Owned

All structure numbers are to be requested during the final design phase and shall be included on the structure plans. Once assigned, a structure number will typically not change through the life of the structure. The structure numbers must be shown in the upper right hand corner of all bridge and structure plan sheets (See Guide Sheet Plate 3.1-1). They shall also be shown in the Index of Structures tabulation of the Key Plan to Structures sheet.

### **35.1.3 State Structure Number for D&R Canal, NJDEP, and NJT Owned Bridges**

For new bridges, the first four digits of State Structure Number are based on the following table, by owner:

|                      |                      |
|----------------------|----------------------|
| <u>D&amp;R Canal</u> |                      |
| Main                 | 3000                 |
| Feeder               | 3001                 |
| DEP (State Parks)    | 3305 to 3489         |
| New Jersey Transit   | Same as State Routes |

The remaining 3 digits are uniquely identified based on the following table:

|                             |     |    |     |
|-----------------------------|-----|----|-----|
| D&R Canal (Main and Feeder) | 150 | to | 180 |
| DEP (State Parks)           | 001 | to | 002 |
|                             | 150 | to | 169 |
| New Jersey Transit          | 150 | to | 180 |

### **35.1.4 County and Municipality Owned Highway Carrying Assets**

County and Municipality owned bridge assets are divided into two broad categories, namely:

- NBIS Bridges (Span Length greater than 20 ft)
- Minor Bridges (Span length between 5 ft and 20 ft)

County bridge assets include structures owned by the 21 Counties within New Jersey. Each County has assigned their own unique structure numbering system for both NBIS and Minor Bridges. A State structure number is always established based on, but not necessarily the same as, the County's number.

### **35.1.5 Railroad Carrying and Pedestrian Bridges over State Owned Routes**

The Structure Numbers for Railroad carrying and Pedestrian Bridges on State Owned Routes are assigned as stated in Section 35.1.2.

### **35.1.6 Overhead Sign Structures over State Owned Routes**

The Structure Numbers for Overhead Sign Structures on State Owned Routes are assigned based on first four digits same as Control Section mentioned in Section 35.1.2.

The last three digits are based on the following table:

|   |     |    |     |
|---|-----|----|-----|
| Overhead Sign Structures                                      | 200 | to | 229 |
| If 220 to 229 is Full, then use                               | 230 | to | 239 |
| If the above two ranges are full, then, as a last resort, use | 240 | to | 289 |

If a Consultant or State Employee, while on field inspection, finds one or more Sign Structures not tagged with a green and white structure number, they shall compile a list with exact location & forward it to Bureau of Structural Evaluation & Bridge Management. The Bureau will determine whether to assign a new number or treat the sign structure as missing its structure number decal.

A group of Sign Structures located over the intersection will be assigned structure numbers in the direction of inventory route. When two or more routes intersect, structure numbers will be assigned by hierarchy of route.

### **35.1.7 High Mast Light Poles (HMLP) at Interchanges on State Owned Routes**

The Structure Numbers for High Mast Light at Interchanges on State Owned Routes are assigned based on first four digits as stated in Section 35.1.2.

The last three digits are based on the following table:

|                       |     |    |     |
|-----------------------|-----|----|-----|
| High Mast Light Poles | 800 | to | 820 |
|-----------------------|-----|----|-----|

A group of High Mast Light Poles (HMLP) located over the intersection will generally be assigned structure numbers in the direction of inventory route & in clockwise direction. When two or more routes intersect, structure numbers will be assigned by hierarchy of route.

If a Consultant or State Employee, on field inspection, finds one or more HMLPs not tagged with a green and white structure number, they shall compile a list with the exact locations & forward it to the Bureau of Structural Evaluation & Bridge Management. The Bureau will determine whether to assign a new number or treat the HMLP as missing its structure number decal.

### 35.1.8 Dams

The Structure Numbers for Dams, owned by the New Jersey Department of Environmental Protection (NJDEP) and maintained by NJDOT, are assigned based on first four digits as stated in Section 35.1.2.

The last three digits are based on the following table:

|      |     |    |     |
|------|-----|----|-----|
| Dams | 198 | to | 199 |
|      | 235 | to | 236 |

### 35.2 Structure Naming Standards

The Bureau of Structural Evaluation & Bridge Management is responsible for assigning/approving the Structure Names for the given assets.

The following examples illustrate the concept:

Rt. 280 over Newark Turnpike

Rt. 280 under Rt. 85 WB

Rt. 280 Ramp D over Sunset St.

Rt. 280 Culvert at Frank's Creek

Rt. 280 over Erie-Lackawanna RR

Pedestrian Bridge over Rt. 280 at Kenvil St.

### 35.3 Structure Naming for Overhead and Cantilever Sign and VMS / DMS Structures

The names of overhead and cantilever sign and VMS/DMS structures must be shown on contract plans. The structure names shall be based on type of structures, location (principal route and local street name), mile post, and other readily identifiable designations.

The following format illustrates the concept:

**"TYPE" Structure on "LOCATION" at "MP xx.xx"**

Where "TYPE" is:

Cantilever Sign, or Cantilever DMS;

Butterfly Sign, or Butterfly DMS;

Span Sign or Span DMS;

Multi-Span Sign;

Combination Sign

Examples of "LOCATION" are:

I-78 EB

I-78 EB Local

I-78 EB Local & Ramp

US 1 SB (9 SB & 46 WB)

Ramp to I-78 EB Express from Route 22 SB

Ramp C from I-78 EB to Lincoln Road

Route 514 (JFK Parkway) (if road name is prominent)

Route 514 EB (and Ramp to Route 7 WB)

Vincent Road (CR617)

“MP xx.xx”: Mile post is of the Route that the sign structure is physically on.

MP 13.42

MP 32.00



## Section 36 - Highway Lighting, Traffic Signal and ITS Monitoring Equipment Support Structures

### 36.1 Design

The 2009 Edition and Interim of the *AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals* shall be used for the design of the subject structure types.

The following stipulations to the usage of the AASHTO Specifications shall be followed for such designs:

1. In lieu of following the criteria of Section 3 of the cited AASHTO Specifications, Appendix C of the Specifications shall be referenced for determination of design wind pressures.
  - a. Accordingly, the minimum design wind speed to be used shall be 80 miles per hour. This will be based on a 50 year mean recurrence interval.
  - b. If, based on engineering judgment, a design wind velocity greater than 80 miles per hour is felt to be applicable for a particular project in areas where extreme exposure conditions exist, the Appendix C criteria should be followed for this determination.
2. Additional criteria for design considerations are as follows:
  - a. Luminaire dead load, projected area, and hardware weight shall refer to the Manufacturer's Specifications.
  - b. Weight and projected area of other equipments (traffic signals, CCTV camera, hardwares, etc.) shall refer to the Manufacturer's Specifications.
  - c. Table C-2 of the *AASHTO Specifications'* Appendix C shall be referred to for identification of applicable wind drag coefficients.
  - d. The wind pressure load shall be computed according to Subsection C.3 of the above cited Specifications' Appendix C.

Section 3 of the cited AASHTO Specifications shall then be used to identify Group Load Combinations. As discussed in Subsection 3.9 of the cited AASHTO Specifications, the same calculated wind pressure value shall be used for application of the load on the various support structure components.

- e. Maximum horizontal deflection at the top of the assembled standard (except CCTV pole) with fixtures attached due to a 40 miles per hour wind (V) shall not exceed 1.25% of the total shaft height.

When addressing a permitted horizontal deflection for CCTV pole designs, the design should be based on provision of a viewable installation. Accordingly, designing for a horizontal deflection of  $\pm 2$  inches from centerline of the pole at the top should be pursued.

- f. Due to advancement of electrical signal transmission technology, the NJDOT is expecting more use of antenna support structures. Since AASHTO Specifications do not specify design of such structures, the Designer is recommended be cautious in design consideration and analysis. The EIA/TIA document EIA/TIA 222 Rev.G may be referred to for further deflection requirements in order to accommodate movement and rotation of the

antenna equipment to be mounted on the support structures. Contact NJDOT Mobility and System Engineering Office (formerly ITS Office) for information related to use of antenna equipments.

### 3. Fatigue

- a. Section 11 of the *AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals* provides criteria for the fatigue design of cantilevered steel and aluminum support structures.
- b. A fatigue design of aluminum traffic signal support structures may be waived.
- c. Steel traffic signal support structures whose mast arm is greater than 50 feet shall be designed for fatigue to resist equivalent static wind effects that are specified in the AASHTO Specifications.

The fatigue design will be based on designing to resist Fatigue Category II wind load conditions.

Fatigue Importance Factors listed in Table 11-1 of the AASHTO Specifications shall be used for each fatigue design wind load.

- d. Designers are advised that when a traffic signal structure configuration with an arm length greater than 50 feet is required, an independent foundation for the structure shall have to be designed. In order to accommodate the foundation, the area where the foundation is to be constructed shall be assessed to verify the feasibility of constructing a shaft foundation that will facilitate a maximum 24 inch bolt circle.

### 36.2 Support Structure Standards

1. Details and material adherence criteria of lighting support, traffic signal and CCTV structure standards are provided in the *NJDOT Standard Electrical Details*.
2. The NJDOT Standard Specifications should be referred to for requirements regarding proper bolt assembly installation procedures.

### 36.3 ITS Support Structures

Criteria specified in Section 30 of this Manual should be referred to for design of VMS (DMS) ITS structural support systems.

### 36.4 Foundations

1. The *NJDOT Standard Electrical Details* should be referred to for foundation detailing. If existing soil appears to be unstable (soft, wet, compressible, muck, etc.), and may not support the foundation and handle construction equipments, NJDOT Geotechnical Engineering Unit should be contacted. If a unique design is required, the design shall be in accordance with applicable requirements in the *AASHTO Standard Specifications for Structural Supports* as well as in the 17th Edition of the *AASHTO Standard Specifications for Highway Bridges*.
2. At the time of work request, the following information for lighting support structures, on an individual contract basis, will be furnished by the Department's Traffic Signal and Safety Engineering Unit.
  - a. Interchange layout showing location of towers by station and offset.
  - b. Height of towers and number of luminaires.

- c. If other than 3 inches above existing (or finished) ground line, elevations of the top of concrete pedestals.
3. The Structural Design Engineer shall initially refer to previous construction contracts to review previous borings which may be useful in determining preliminary foundation design. Boring log identification numbers for previous construction contracts shall be shown on the contract plans.
  4. The proposed subsurface exploration (see Section 34) at each tower lighting location shall be submitted to the Geotechnical Engineering Unit for approval. One deep boring and one or more shallow borings may be required by the Geotechnical Engineer. Continuous sampling, to a reasonable depth, may be necessary and if so will be ordered by the Geotechnical Engineer.

Boring requests shall be directed to the Geotechnical Engineering Unit as soon as possible.

5. The foundations of tower lighting support structures that are located on undisturbed soils shall be designed for an allowable soil pressure that is estimated for a differential settlement that shall not exceed 1/2 inch.

Careful consideration shall be given to ground water conditions when estimating allowable pressure and settlement of the soil.

Rotation and displacement of a foundation must be restricted to alleviate the possibility of failure of the structure or its having an unsightly visual appearance. Deep foundations shall be used when soil conditions do not readily and reliably indicate the use of spread footings.

The foundation design criteria for tower lighting located on embankment fill shall be established with respect to soil bearing capacity and settlement. Consideration must be given to the stability of the embankment with respect to any possible vertical and/or horizontal movements.

The most important factor to be considered in the foundation design of a lighting support structure is the overturning factor. This will require an adequate provision for passive resistance and upward pull on spread footing and deep foundation design, respectively.

6. Adverse foundation conditions, property lines, subsurface utilities, temporary sheeting, traffic maintenance, and other special conditions which may require individual foundation designs shall be investigated by the Structural Design Engineer at each support structure location.

### **36.5 General Criteria**

Notes on the plans or guidance in the Special Provisions shall require that the contractor submit detail plans and calculations for the support structure shaft, mast arms, luminaires, anchor bolt assembly, and connection details. The contractor or his designer shall review these drawings to determine that design loads and forces are in accordance with the design assumptions of the foundations shown on contract plans.

## **Section 37 - Prefabricated Bridge Elements and Systems (PBES)**

### **37.1 General Criteria**

PBES offer significant advantages over onsite cast-in-place construction. Among these advantages are a substantial reduction in onsite time that is required to construct or rehabilitate a bridge, lowest costs resulting from offsite manufacturing, use of standardized components and improved safety due to reduced exposure time in the work zone. The controlled environment of offsite fabrication also ensures quality components for long-term service life performance.

Careful planning, design, and implementation are required to realize the significant advantages of PBES construction. Decision makers must consider if a project should be fast tracked, the applicability of a design, the abilities of contractors and suppliers in the local area, access to a project site and how construction requirements affect cost and schedule.

### **37.2 Decision Making Guidance**

Issues that must be addressed in deciding on the use of PBES include the following:

1. The lack of knowledge and experience in PBES design and detailing, including connections between components and durability of the connection details.
2. The ability of the PBES to accommodate curvilinear geometry.
3. Availability of prefabricators who are capable of producing components.
4. Limitations on component size and availability of equipment to erect the components.
5. Knowledge/experience of local bridge contractors and techniques that are needed to construct bridges of PBES components.

### **37.3 Considerations For Selection of a PBES**

1. Rapid Onsite Construction Warrants
  - a. Does the bridge have high average daily traffic (ADT) and/or high average daily truck traffic (ADTT), or is it over an existing high-traffic-volume highway? Safety concerns and costs may be reduced with the use of a PBES.
  - b. Is the project an emergency bridge replacement? Emergency bridge replacements particularly benefit from the use of prefabricated systems. The existing bridge cannot be used and must be replaced in the least time possible in order to minimize traffic disruption.
  - c. Is the bridge an evacuation route, or over a railroad or navigable waterway? Prefabricated bridges have a particular advantage over conventional bridges for these cases because they greatly expedite on-site installation.
  - d. Will the bridge construction impact traffic in terms of requiring lane closures or detours?
  - e. Will the bridge construction impact the critical path of the total project?
  - f. Can the bridge be closed during off-peak traffic periods such as nights and weekends?

- g. Is rapid recovery from natural/manmade hazards needed or is rapid completion of a bridge repair/replacement needed?
  - h. Is the bridge location subject to construction time restrictions due to adverse economic impact?
  - i. Does local weather limit the time of year when cast-in-place construction is practical?
2. Other Factors That May Warrant Use of PBES
- a. Safety Concerns. Do worker safety concerns; such as, working adjacent to electrical power lines or over water, limit conventional methods?
  - b. Environmental Issues. Is the site in an environmentally sensitive area requiring minimum disruption?
  - c. Material Availability. Availability of materials and local suppliers should be investigated.
  - d. Site Issues. Restrictions due to site conditions, contractor knowledge, or fabricator availability are issues that should be addressed.

### **37.4 FHWA Website**

For a more complete presentation of decision making guidance on the use of PBES, refer to the following FHWA website link:

[www.fhwa.dot.gov/bridge/prefab/framework.cfm](http://www.fhwa.dot.gov/bridge/prefab/framework.cfm)

## Section 38 - Seismic Design and Retrofit

### 38.1 History of Seismic Activity In New Jersey

In a Report published under the caption "Earthquake History of the United States" the United States has been divided into nine regions. New Jersey falls in the Eastern Region, an area that covers the Central Appalachian seismic region. Earthquakes that have occurred in New Jersey, of intensity equal to V or greater on the Modified Mercalli Intensity scale, are listed below.

| Location        | Date              | Intensity | Magnitude     |
|-----------------|-------------------|-----------|---------------|
|                 |                   | MM Scale  | Richter Scale |
| Newark          | September 1, 1895 | VI        | 5.0           |
| Asbury Park     | June 1, 1927      | VII       | 5.0           |
| Trenton         | January 24, 1933  | V         | 4.0           |
| Central NJ      | August 22, 1922   | V         | 4.0           |
| Salem County    | November 14, 1939 | V         | 4.0           |
| West Central NJ | March 23, 1957    | VI        | 5.0           |
| NJ – PA         | December 27, 1961 | V         | 4.0           |
| Southern NJ     | December 10, 1968 | V         | 4.0           |

### 38.2 General Criteria

The AASHTO "Guide Specifications for LRFD Seismic Bridge Design" (referred to as AASHTO Guide Specifications hereafter), which establishes a "displacement based" seismic design philosophy, shall be used for the seismic design of bridges in New Jersey.

All bridge structures in New Jersey shall initially be considered to be "standard", that is "non-critical" and "non-essential". Bridges shall be designed for the "life safety" performance objective considering a seismic hazard corresponding to a 7% probability of exceedance in 75 years (approximately 1,000 year return period).

However, consideration for increasing the Bridge Importance category is permitted. This consideration shall strictly be based on social/survival and security/defense factoring of the bridge structure's location. That is, if social/survival or security/defense importance factors of the bridge structure's location clearly indicate the location's critical nature, then increasing the Importance Category may be considered.

Approval for increasing the Importance Category/Performance Level shall be obtained from the Manager, Structural Engineering.

The foundation supporting a bridge structure shall be designed to not experience damage in an earthquake event.

Site-specific ground motion response analyses are required for Site Class F soils.

The following criteria are provided to address seismic designs:

### 38.3 Methods of Analysis

Based on the *AASHTO Guide Specifications*, the Seismic Design Category (SDC) shall be identified for seismic design of new bridges. The selection of seismic analysis and design procedures shall be based on the SDC.

#### 38.3.1 Seismic Analysis

The seismic analysis and design shall meet the minimum requirements for the identified SDC (A, B, C, D). The analysis may depend upon the following criteria:

- Dead weight of the structure
- Ground motion (acceleration coefficient)
- Type of soil
- Fundamental period of vibration
- Importance classification

#### 38.3.2 Single Span Bridges

Single span bridges do not require a detailed seismic modeling regardless of the Seismic Design Category (SDC). The design requirements may be limited to provision of minimum support lengths and connection forces.

- a. Adequate support lengths shall be provided in both the transverse and longitudinal directions.
- b. Consideration of connection forces between the bridge span and the abutment seats shall be designed both longitudinally and transversely to resist horizontal seismic force, following the *AASHTO Guide Specifications*.

The connection forces are based on the assumption that a single span bridge is very stiff and that a short fundamental period of response will occur. Other types of single span bridges, such as trusses, need additional precaution by the Designer.

#### 38.3.3 Load Factors for Seismic Design

In evaluating a bridge structure's history, a significant traffic count should warrant an increase to the live load factor for Extreme Event I load combination. The live load factor, 0.5, listed for an Extreme Event II load combination, may be used. A Designer should use his/her engineering judgment in assessing the traffic count in applying the increase.

#### 38.3.4 Higher Bridge Importance/Performance Category.

As stated above, the seismic Importance Category may be increased to that of "Critical" or "Operational" Performance Level. When this increase is approved on a project by project basis, the following methods may be used.

- A. For "Operational" performance objective in a higher design earthquake event considered based on Subsection 38.2, the design criteria are being developed. The Designer may contact the Manager, Structural Engineering, on project by project basis.
- B. Using a design earthquake event higher than 1,000 years return period in the *AASHTO Guide Specification*, the seismic design category (SDC) may be increased and seismic analysis procedure level is hence upgraded. *AASHTO Guide Specifications* shall be used for the seismic design at this SDC.

C. The following guidance may be followed for a seismic force analysis.

1. **The Mononobe-Okabe Method.** If warranted by the Bridge Importance designation, the Mononobe-Okabe Method, as defined in Section 11, Appendix A11 of the *AASHTO LRFD Bridge Design Specification*, may be used to analyze the effects of soil pressure on an earth retaining element. This method is an extension of Coulomb's method for analyzing soil pressure.

With the use of this method, the following shall apply:

- Backfill is assumed unsaturated so that liquefaction effects are negligible.
  - The backfill is assumed cohesion-less.
  - Seismically induced active and passive pressures will be considered.
2. **Load Combinations.** Extreme Event-I load combinations shall be applicable for a seismic analysis. Refer to the guidance provided in Section 3.4 of the *AASHTO LRFD Bridge Design Specifications*.
  3. **Abutments.** Refer to the AASHTO Guide Specifications for seismic analysis and design. The abutments shall be designed for seismic forces from the superstructure in addition to the static earth pressure. Consider both the active and passive pressures.

Also, refer to Subsection 15.3.11 of this Manual for additional guidance for integral abutment bridges.

4. **Liquefaction.** The potential for soil liquefaction and liquefaction related ground instability shall be investigated at relevant locations along project alignments. Effects of settlement of footings, loss in bearing capacity and increased lateral earth pressures shall be considered in the design of abutments, walls and footings.
5. **Seismic Slope Instability and Landslide.** The potential for seismic induced slope movements and landslide along the proposed alignment shall be investigated. Mitigation measures shall be incorporated in the design of abutments, walls and footings.
6. **FHWA Geotechnical Engineering Circular.** In addition to the *AASHTO LRFD Bridge Design Specifications*, the FHWA Geotechnical Engineering Circular No. 3 titled, *LRFD Seismic Analysis & Design of Transportation Geotechnical Features and Structural Foundations* may be referred to for guidance on seismic design.

#### 38.4 Seismic Retrofit of Existing Highway Bridges

1. The seismic retrofit design of existing highway structures shall follow the guidelines of the FHWA publication titled "*Seismic Retrofitting Manual for Highway Structures: Part 1 - Bridges*", dated January, 2006.

Based on the *Seismic Retrofitting Manual*, the Seismic Retrofit Category (SRC) shall be identified for seismic analysis of existing bridges, and hence retrofit requirements for this SRC can be established and analysis method can be selected.



2. As defined in Subsection 1.4.1 of the referenced *Seismic Retrofitting Manual*, the Performance Level (PL) for retrofitting bridges in New Jersey shall be initially assumed to be that of "Life Safety" (PL1).

As defined in Subsection 1.4.3 of the referenced Retrofit Manual, the Bridge Importance Classification of bridges in New Jersey shall be initially that of "Standard".

If a Designer believes that the classification for a bridge structure, should be taken as "Essential" or a higher level, correspondence to support this belief should be directed to the Manager, Structural Engineering for concurrence.

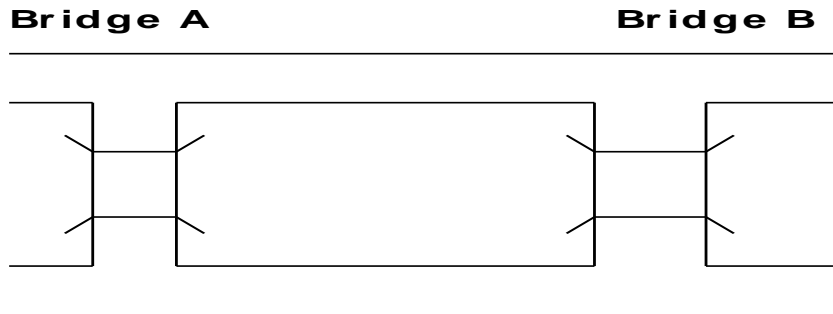
The Earthquake Ground Motion Level shall be assumed to be that of "Upper Level (UL)" as defined in Subsection 1.4.2 of the *Seismic Retrofitting Manual*. The UL earthquake ground motion has a relatively low probability of exceedance (7% in 75 years/1,000 year return period) within the life of a bridge.

3. A Seismic Retrofit Report shall be prepared to provide a determination as to a bridge structure's eligibility for a seismic retrofit.
- a. A flow chart to provide guidance in determining if a bridge structure qualifies as a seismic retrofit candidate can be found as attached. The results of the analysis, performed in accordance with the flow chart, shall be provided in the Seismic Retrofit Report.
  - b. In preparing the Seismic Retrofit Report, the following guidance shall be followed. Initially, seismic retrofitting of a bridge structure shall only be considered under the following conditions:
    - The planned work will involve widening of a deck by more than 30% of its deck area; or,
    - The planned work will involve an entire deck replacement; or,
    - The planned work will involve superstructure rehabilitation or replacement, major bearing seat area repairs, bearing repairs or bearing replacement.

When an entire deck replacement is planned, the retrofit considerations may be limited to bridge seat modifications and bearing replacement.

4. The Report should also include a study of a project to determine if retrofitting a bridge is a cost-effective measure. The following areas should be addressed:
- a. An investigation to determine the extent of retrofitting which may be required.
  - b. Prior to making a detailed evaluation of the seismic capacity of the bridge structure, the relationship of the bridge structure to other bridge structures on the route system, that may also be damaged during an earthquake, shall be considered.
    - 1) Consider two bridge structures that have similar functions, such as bridge structures A and B in parallel as detailed herein. It is possible that retrofitting bridge structure A would be more economical or that bridge structure A is more seismically adequate.

- 2) Accordingly, even though bridge structure A is not in the project scope and bridge structure B is, it would be more rational to retrofit bridge structure A than bridge structure B.



5. Several methods of seismic retrofit are outlined for bearings and expansion joints within the *FHWA Retrofit Manual* that is referenced above. Of these methods the following are recommended for consideration in order of preference based on the Seismic Retrofit Category (SRC). If applicable, a recommendation as to the proposed treatment of a bridge structure should be included in the Seismic Retrofit Report.

- a. Increase seat length, modify existing bearings and connections to resist seismic loads, or prevent toppling of existing bearings by installing longitudinal displacement stoppers.
- b. Longitudinal joint restraints and/ or shear keys as outlined in the *FHWA Retrofit Manual*.
- c. Bearing replacement with those type bearings described in Subsection 24.20 of this Manual. If conventional steel and elastomeric bearings are proposed to remain, typical modifications would include the following:

**i. Modifications to Steel Bearings**

- Increase size, number or embedment of anchor bolts.
- Increase the outer diameter of the pin head.
- Increase the width of the expansion rocker.
- Increase the top and bottom dimension of the pintle detail for increased movement.

**ii. Modifications to Elastomeric Bearings**

- Secure bearing against horizontal and vertical movement.
- Modify the plan area and/or thickness of the elastomeric bearing to reduce seismic forces to the substructure.

The methods outlined above are recommended procedures and are not intended to restrict the ingenuity and creativity of the Design Engineer. Each bridge is different; therefore, retrofit procedures will be approved on a project by project basis by the Manager, Bureau of Structural Engineering.

6. If it is found through a seismic analysis that the substructure is in need of seismic retrofit, it will probably be economically advantageous to study bearing replacement as part of a retrofit.

### **38.5 Bearings**

1. Refer to Section 24 of this Manual for guidance in providing bearing designs to meet seismic requirements.
2. The *AASHTO Guide Specifications for Seismic Isolation Design* shall be used for designing isolation bearings when they have been deemed necessary for accommodating seismic loads. These bearings have special performance characteristics, which will alter the dynamic response of a bridge.

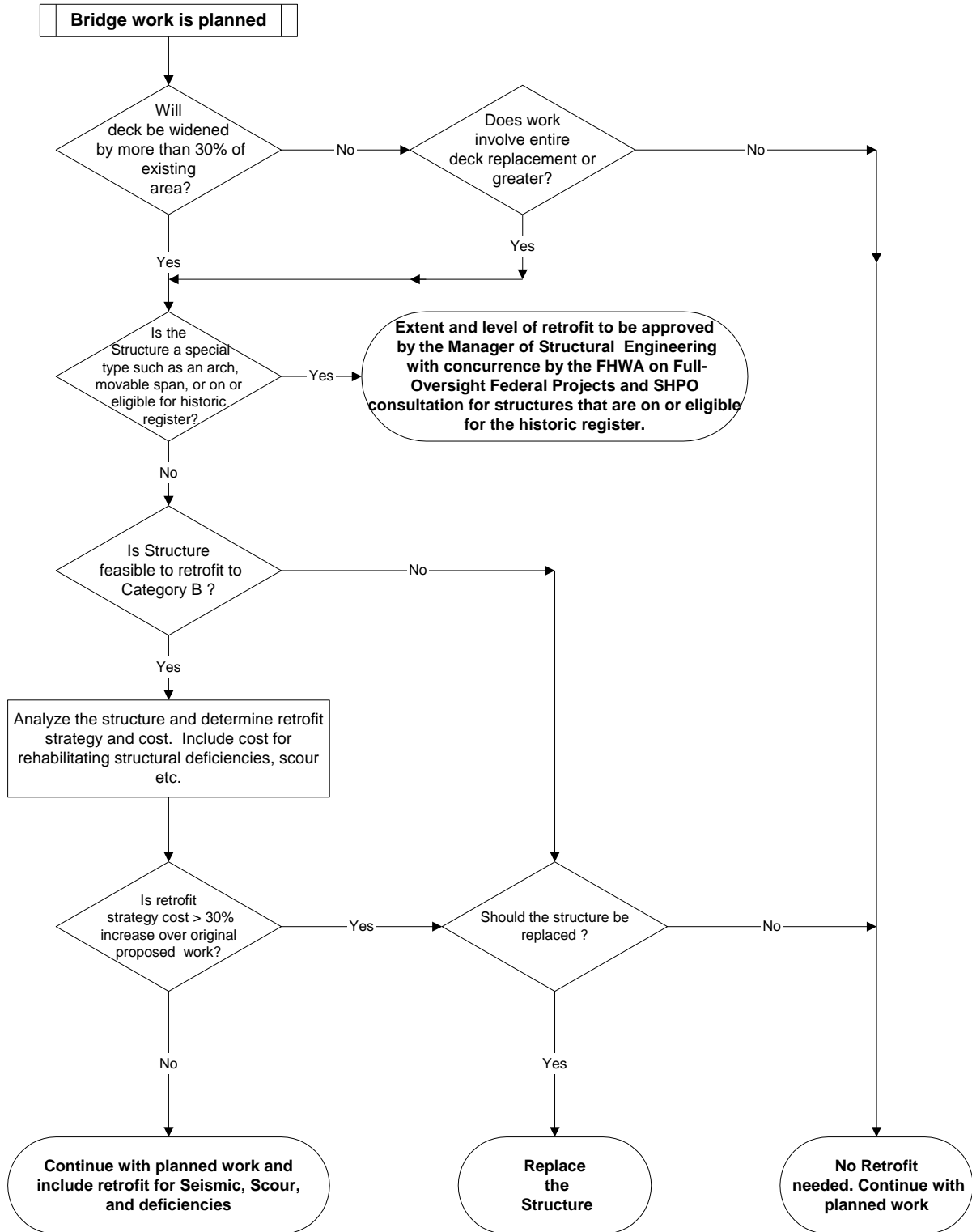
### **38.6 Computer Software**

For Single and multi-mode analysis standard computer programs such as SEISAB and STAAD-PRO may be used.

### **38.7 Flow Diagram For Retrofit**

The following flow diagram may be used to assess the benefits of providing seismic retrofit improvements to a bridge on a project by project basis.

## Additional Analysis Required for Existing Bridges Found in Planned Projects



## Section 39 - Scour At Bridges

### 39.1 General Criteria

1. In addition to the information presented within this Section, the specific guidance provided in Subsection 2.6 of the *AASHTO LRFD Bridge Design Specifications* should be referred to. As stated therein, the *AASHTO Model Drainage Manual* may be referred to for guidance and references on design procedures and references to hydrologic and hydraulic designs computer software.

Additionally the following Hydraulic Engineering Circulars (HEC) reports provide guidance that should be used in performing a scour analysis:

HEC 18 – *Evaluating Scour at Bridges*. Procedures for designing new, replacement and rehabilitation of bridges to resist scour are presented.

HEC 20 – *Stream Stability at Highway Structures*. Guidance for identifying stream instability and for the selection and design of appropriate countermeasures to mitigate damage to bridges is presented.

HEC 23 – *Bridge Scour and Stream Instability Countermeasures*. Bridge scour and stream instability countermeasures that have been implemented by various State Departments of Transportation are identified in this Report. Also, design guidelines for the countermeasures are provided.

2. Foundations of new bridges, bridges to be widened or bridges to be replaced, shall be designed to resist scour for a 100 year flood criteria, or a flood of a lesser interval, that may create the deepest scour at bridge foundations. A bridge may be in an inundated condition when the design flood for bridge scour occurs. This shall be referred to as the "Design Flood for Bridge Scour".

For existing bridges, the design flood criteria shall be the 100 year discharge, or a discharge of a lesser interval that is expected to produce the most severe adverse condition. However, the past history of floods at a particular location shall be evaluated to determine if a greater interval is justifiable to establish a flood discharge rate.

3. The foundation design shall be checked for a 500 year check flood, or if information for a 500 year flood is not available, 1.7 times the discharge rate of a 100 year flood. This shall be referred to as the "Check Flood for Bridge Scour".

### 39.2 Preliminary Scour Analysis

1. Data Collection and Review Process. To perform a Scour analysis of an existing bridge location or for planning construction of a new bridge, data collection should include the following:
  - a) Office Data Collection
    - 1) Data on the waterway's history with respect to flooding and, if available, a Preliminary Scour Evaluation Report
    - 2) Contract plans, As-built drawings, Aerial Surveys, Drainage area
    - 3) Photographic documentation
    - 4) FEMA Flood Insurance Studies from NJDEP

- 5) Bridge Evaluation Survey & Underwater Inspection Report, if any, from a local owner or the NJDOT
  - 6) Foundation Reports and Boring logs
  - 7) Existing Hydrologic and Hydraulic models, if available from NJDEP
- b) The NJDOT Structural Evaluation Unit should be contacted for obtaining information and documents on performance of scour analysis of existing bridge structure locations.

## 2. Identifying Scour Analysis Variables

Specific bridge scour variables or parameters shall be identified for a mathematical scour analysis. Such variables or parameters shall include the following:

### a) Hydrologic & Hydraulics Analysis

- 1) Hydrologic Analysis – Refer to Subsection 2.6.3 of the *AASHTO LRFD Bridge Design Specifications* for guidance. Determine the drainage area from USGS maps or other appropriate sources. List available flood records. Determine design flood discharge and discharges for other frequencies. Plot flood frequency and stage-discharge-frequency curves for the site.
- 2) Hydraulic Analysis – Subsection 2.6.4 of the *AASHTO LRFD Bridge Design Specifications* and Chapter 9 of the *AASHTO Highway Drainage Guidelines Manual* provides guidance in the hydraulic design of a stream crossing. The *AASHTO Highway Drainage Guidelines Manual* defines technical aspects of hydrologic and hydraulic design and presents a stream crossing design procedure that may be followed. The following guidance should also be used for a hydraulic analysis.
  - a) In the event of recent floods or shifting of a stream, an old hydraulic study should not be considered reliable. A new study should be carried out. The HEC-RAS, “*River Analysis System, User’s Manual*”, 1995, published by the U.S. Army Corps of Engineers, or WSPRO software may be used. Existing studies performed by FEMA, the U.S. Army Corps of Engineers, U.S. Soil Conservation Service and NJDEP may also be assessed.
  - b) The allowable velocity for a bridge location and the permissible backwater should be determined. This information may then be compared with computed velocities and backwater using HEC-RAS or WSPRO. The scour depth for a proposed bridge and, if economical, for an existing bridge should be estimated. Refer to item 3.) below for backwater criteria.
  - c) When a dam exists upstream of a bridge, the design flood for the dam and its spillway shall be considered when performing the scour analysis.
  - d) For criteria on bridge waterway sizing, refer to Subsection 2.6.4.3 of the *AASHTO LRFD Bridge Design Specifications*. Also, the NJDEP Technical Manual for Land Use Regulation Program Bureaus of Inland

and Coastal Regulations, Stream Encroachment Permits should be referenced to verify permitted requirements.

### 3) Backwater elevation criteria

- a) As per current NJDEP requirements, if projects are located in the Central Passaic Basin of the State, the permissible backwater rise and fill shall be, without exception, for either bridge replacement or new construction, zero.
- b) At other locations throughout the State, if an existing bridge structure, in a waterway, is to be replaced then the permitted water elevation rise shall be zero either upstream or downstream of the bridge structure.

Also, at other locations throughout the State, if new construction of a bridge structure is planned, then a 0.2 foot water elevation rise is permitted. For both new construction and bridge replacement scenarios, 20% net fill of the waterway location is permitted. For certain, as deemed necessary situations, an exception for additional fill may be granted.

### b) Stream Stability

The NJDEP publication "*Technical Manual for Land Use Regulation Program, Bureau of Inland and Coastal Regulations Stream Encroachment Permits*", HEC 18 and HEC 20 Reports may be used to determine stream stability variables.

### c) Geotechnical Considerations

The following data should be assessed in determining geotechnical impacts on the scour analysis:

- 1) Review subsurface information that is provided in the Geotechnical Report.
- 2) Evaluate historic scour related conditions and potential scour holes at the bridge site.
- 3) Soil classification – Based on laboratory tests for grain size samples, classify the soil.

## **39.3 Performing A Scour Analysis**

1. The following types of analyses should be conducted in the overall scour analysis of a bridge:

Level 1- Qualitative assessment of Stream stability, including lateral stability, vertical stability and determining the profiles and plan formations of streams and rivers. (Refer to HEC 20)

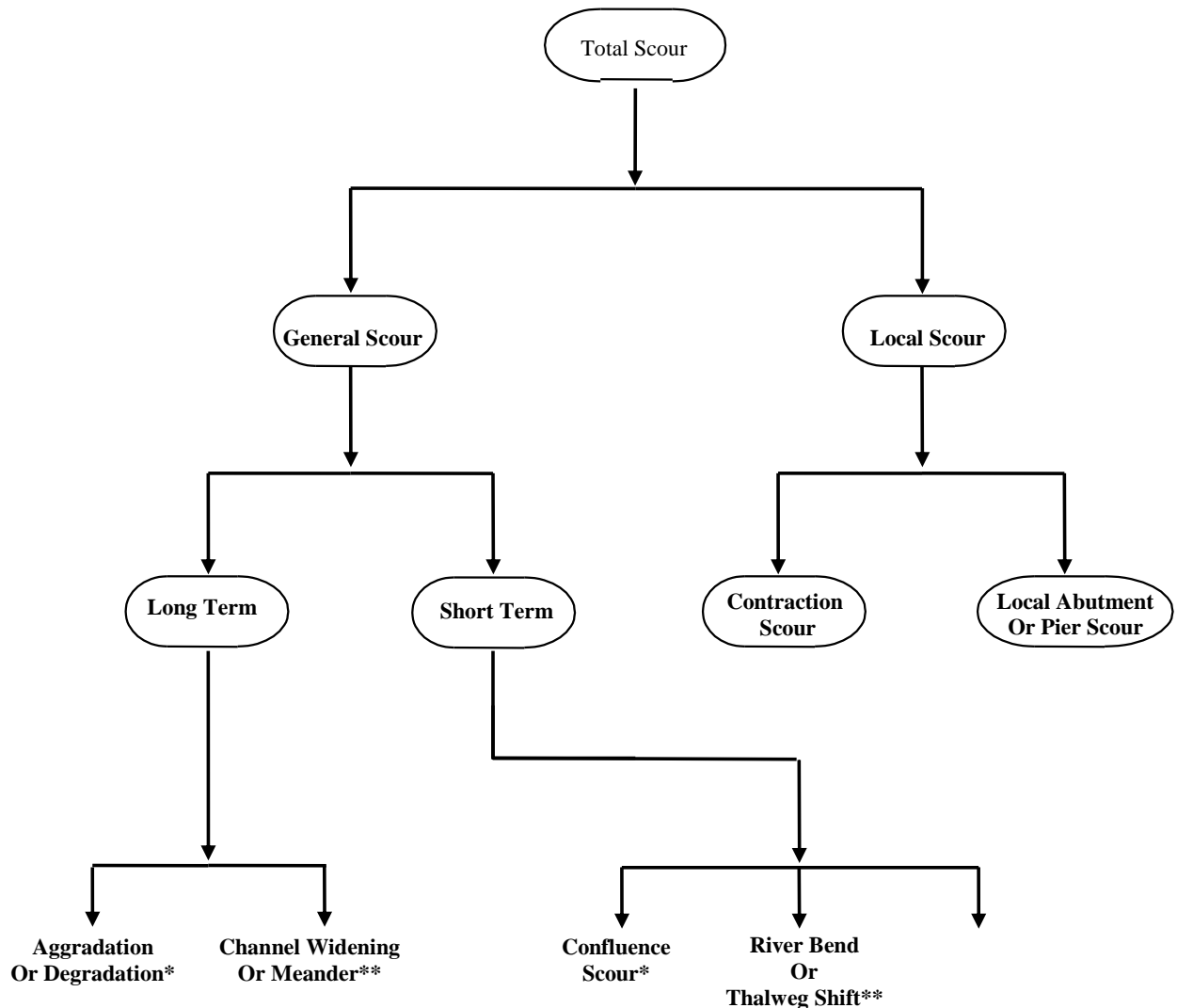
Level 2- More detailed quantitative analysis, including hydrologic, hydraulic and scour analysis to assess scour vulnerability. (Refer to HEC 18)

Level 3- Bridge scour design of stream instability countermeasures. (Refer to HEC 23)

2. If the determined estimated scour depth that must be addressed in the design process seems excessive, an evaluation of the site should be made. The evaluation should include a flood history assessment as well as any evidence of scour occurrence.

The evaluation can be used as a basis to recommend a reduction of the determined scour depth. A percentile reduction recommendation may be submitted to the Manager, Structural Engineering for approval.

3. The following flow diagram may be utilized to assess the impact of scour and scour components on a bridge structure site.





**Notes:**

1. Long term scour is based on the concept that long term streambed elevation changes can take place over the time scale of several years during the life of a bridge, due to aggradation or degradation. Also, natural or man-induced causes may affect the reach of a river in which the bridge is located.
2. Aggradation involves the deposition of material eroded from the channel or watershed upstream of the bridge.
3. Degradation involves the lowering or scouring of the longitudinal profile of a channel. The bends of meandering channels may move laterally in the vicinity of the bridge, causing the channel to widen and create lateral erosion and scour.
4. If bridge inspection records of cross sections of the stream at the bridge site are maintained over many years, long term scour can be calculated from streambed elevation changes. Projections of scour based on a long-term trend can be made.
5. Common Countermeasures used for aggradation are channel improvements by dredging or cleaning.
6. Countermeasures for degradation are channel lining with concrete pavement, increasing a bridge opening width or vegetation planting.

Upon determination of the effects of scour impact, a summary of scour depth may be prepared as presented in the following Table:

**Table 39-1 Scour Depth Summary at Abutment/Pier**

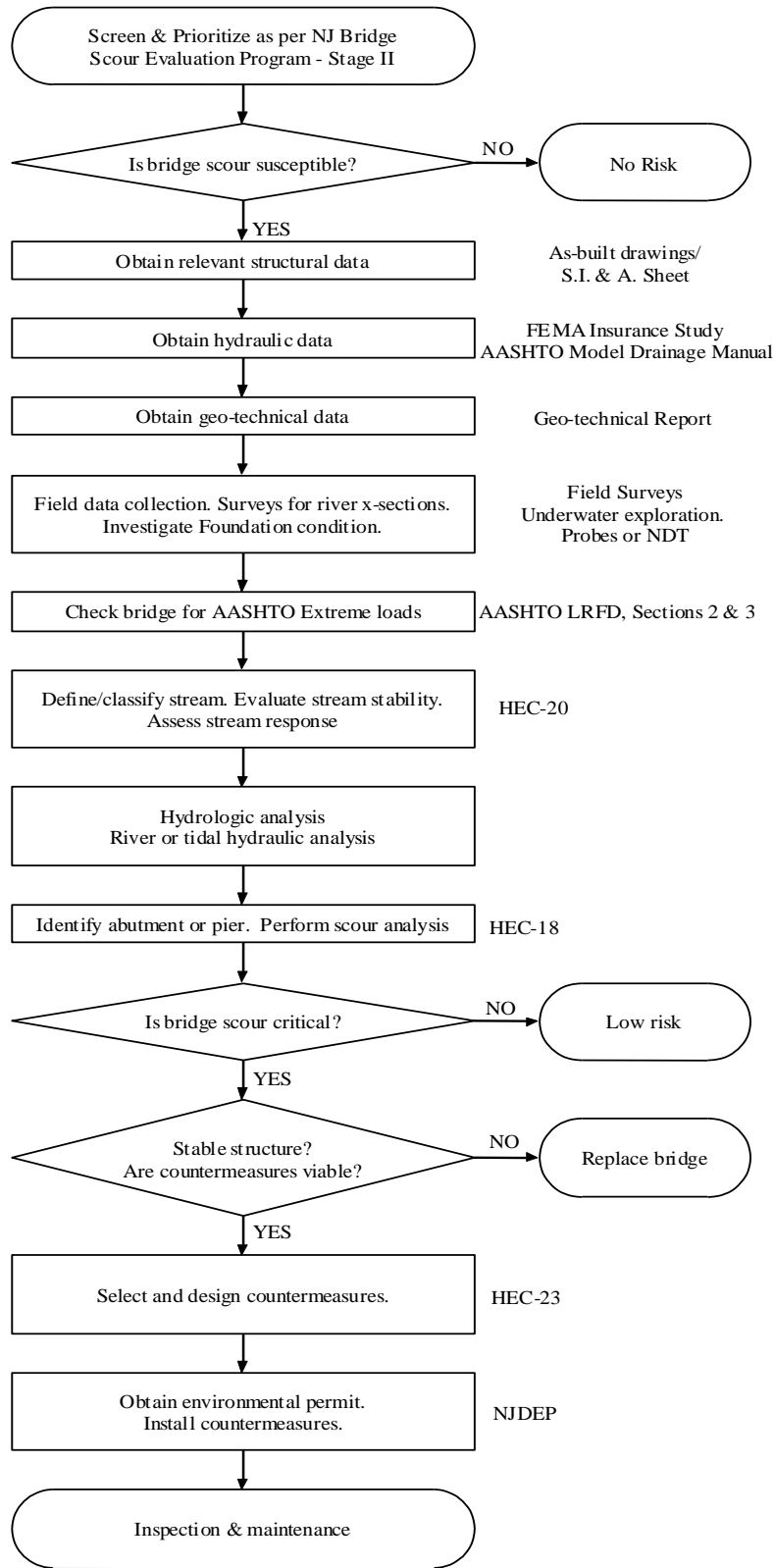
| Discharge Frequency | Computed Scour Depths in Feet |                  |                   |             |             | Proposed Elevations |                   |
|---------------------|-------------------------------|------------------|-------------------|-------------|-------------|---------------------|-------------------|
|                     | Long term Scour               | Short term Scour | Contraction Scour | Local Scour | Total Scour | Top of Footing      | Bottom of Footing |
| 50 Year             |                               |                  |                   |             |             |                     |                   |
| 100 Year            |                               |                  |                   |             |             |                     |                   |
| 500 Year*           |                               |                  |                   |             |             |                     |                   |

\* If 500 year Discharge is not available, use  $Q_{500} = 1.7 \times Q_{100}$

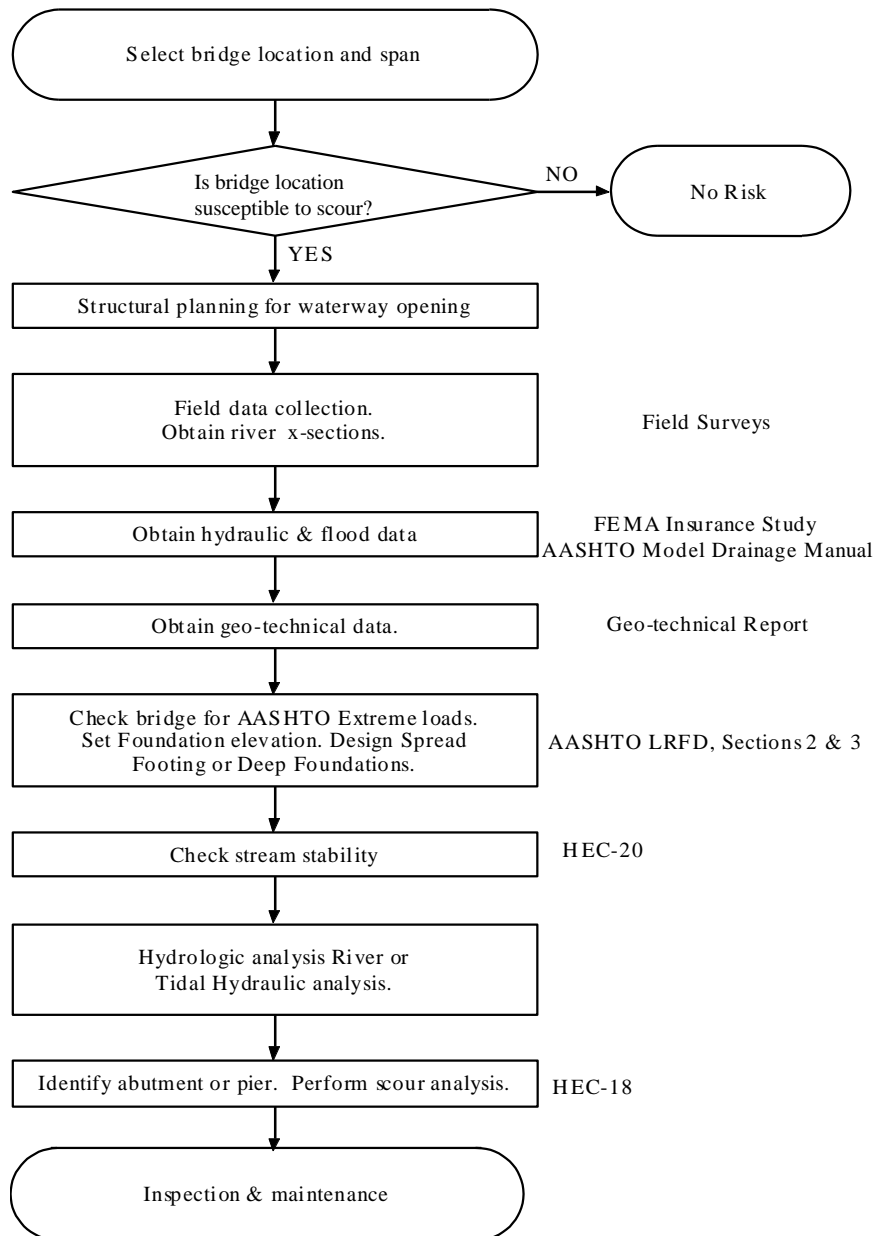
**39.4 Flow Diagrams For Detailed Scour Evaluation**

The following flow charts may be followed in developing a comprehensive scour analysis:

1. Existing Bridges and Bridges to be Widened



## 2. New Bridges and Bridges to be Replaced



### 39.5 Design Guidance

The following guidance may be followed in developing scour resistant bridge designs:

1. If it is determined from established inspection procedures, that all streambed material in the computed scour prism has been removed and is not available for bearing or for lateral support, an existing bridge should be considered for replacement.
2. The final submission shall include a Hydraulic and Scour Report. The Report should establish a design procedure for scour resistance. The following structural elemental information should be addressed in this Report:
  - a. Superstructure
    - 1.) The bridge superstructure and the general elevation of approach roadways shall be above the maximum flood level of 100 years or other designated critical flood.
    - 2.) For streams that carry a large amount of debris, the elevation of the lower chord of the bridge shall be at least 2 feet above the freeboard for a 100 year flood.
  - b. Abutment and Wingwalls
    - 1.) The design of abutments and wingwalls shall be considerate of the potential that the channel may shift and that scour may occur during the life of the structure.
    - 2.) Design loads shall be based on the *AASHTO LRFD Bridge Design Specifications*, Section 3, Extreme Events I (including water loads (WA) for scour depths based on mean discharges).
  - c. Piers
    - 1.) Location of piers in small streams should be avoided. Small streams are susceptible to flooding during localized rain storms. Erosion of a pier's foundation may occur.
    - 2.) The number of piers in any stream channel shall be limited so that ice forces and potential for local and contraction scour are minimized.
    - 3.) In order to reduce drift build up, piers shall be aligned with the flow direction.
    - 4.) Design loads shall be based on the *AASHTO LRFD Bridge Design Specifications*, Section 3, Extreme Events II (including water loads (WA) for scour depths based on mean discharges).
    - 5.) Piers subject to tidal conditions shall be protected on all sides by means identified in Section 19 of this Manual.
    - 6.) If there is a hazard of ice and debris buildup, multiple pile bents shall be avoided.
    - 7.) A solid wall or hammerhead pier is preferred to a column bent or pile bent pier. For scour estimation, evaluate a bent pier as a solid pier. Circular or elongated pier shapes shall be preferred to rectangular shapes.

d. Foundation Planning Based on Scour Analysis

1.) Scour Depth Considerations

- a.) Subsection 2.6.4.4 of the *AASHTO LRFD Bridge Design Specifications* may be referenced for guidance concerning bridge foundation design concepts.
- b.) Foundations shall be designed for the condition that all stream bed material, in the 100 year scour prism above the total scour line, has eroded and is not available for bearing or lateral support.

3. Spread Footings on Soil

- a) Use spread footings only where the stream bed is extremely stable.
- b) Place top of footing below the sum of the long-term degradation, contraction scour, and lateral migration.
- c) Place the bottom of the footing below the total scour.

4. Spread Footings on Erodible Rock

- a) Consult an Engineering geologist for rock erodibility.
- b) Estimate the potential scour depth and place the bottom of footing 6 inches below that depth.
- c) Place the final footing in contact with the sides of excavation and fill the excavation above the footing with riprap.
- d) Blasting shall not be permitted for rock excavation.

5. Spread Footings on Non-erodible Rock. For highly resistant rock such as granite and non-erodible limestone, place the bottom of the footing on a clean rock surface 0.5 feet below the bedrock and consider doweling for increased lateral restraint.

6. Deep Foundations

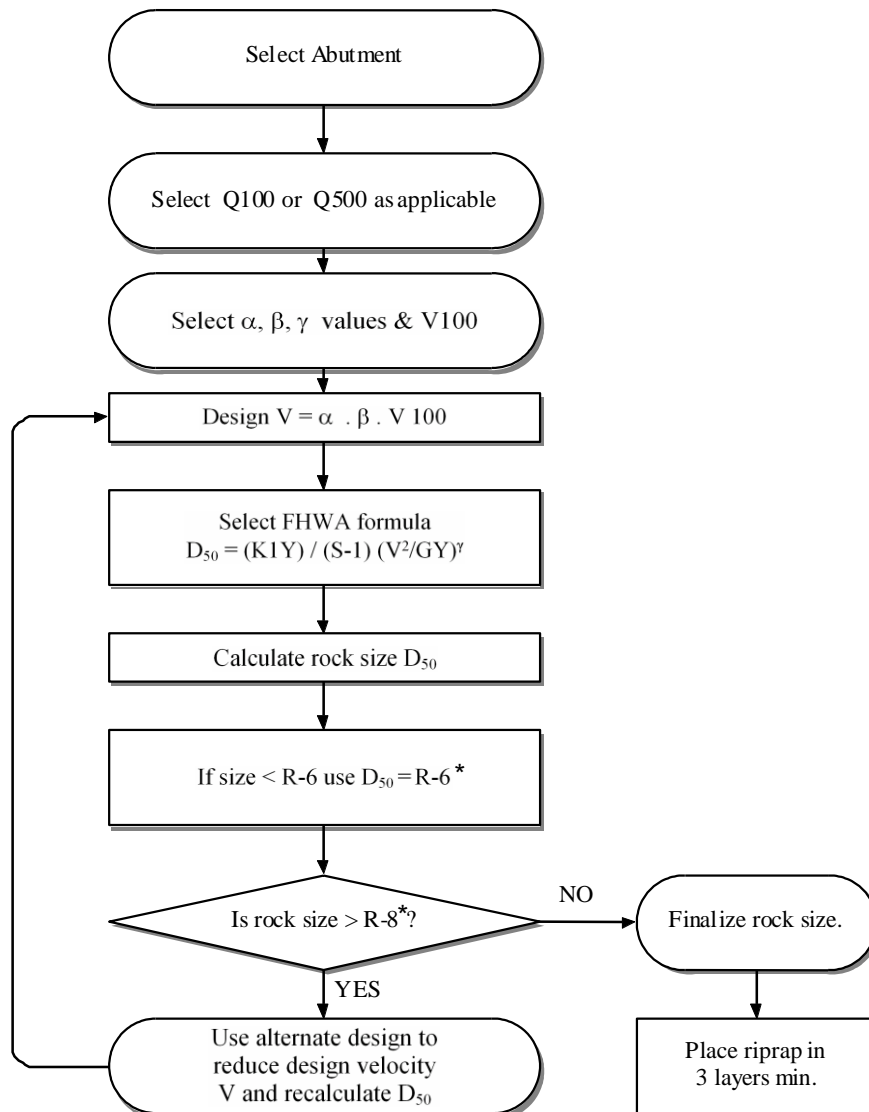
- a) When a stream bed is not stable, deep foundations should be considered.
- b) For driven piles or drilled shafts with footings or caps, refer to HEC 18 Chap. 3 Section 3.2.e.
- c) If, due to an increase in unsupported pile length that is measured up to the total scour depth line, pile stability shall be checked for column action requirements. Additional lateral loads due to stream pressure, currents, debris and ice loads should be considered in the pile design.
- d) For stub abutments, piles shall be carried at least 3 feet below the thalweg elevation.
- e) When piles cannot be driven, use drilled shafts.

### **39.6 Scour Countermeasure Development Procedures**

1. Selection and Design of Scour Countermeasures for Existing Bridges

- a) Scour countermeasure methods shall provide vertical and lateral channel stability and minimize or eliminate aggradation, degradation, lateral erosion and local scour.

- b) Such methods to structural features may include:
- driving sheet piling to protect existing footings or
  - driving sacrificial piles to deflect flow and induce deposition in a local scour hole at piers.
2. The Department has completed a Research project titled *Handbook of Scour Countermeasure Designs*. Detailed guidelines on developing permanent countermeasures are provided in the Final Report. The Final Report may be downloaded from the following NJDOT Research website:
- [www.state.nj.us/transportation/refdata/research](http://www.state.nj.us/transportation/refdata/research)
- Designers are encouraged to study the Final Report for possible use of the Report's recommendations.
3. Using Riprap as a Temporary Countermeasure
- a) Limitations of riprap: Although natural riprap is the most commonly used armoring, it requires monitoring since it is not held in position similar to other types of armoring; such as, articulated concrete blocks, grout filled bags, gabion or reno mattress.
- b) Riprap should only be considered as a temporary countermeasure when retrofitting an existing bridge. Alternate countermeasures as described in HEC-23 and in this Section; such as, heavier armoring, river training measures, channel improvements, modifying the structural features including monitoring, shall be adopted.
- c) The following flow diagram may be followed in designing a riprap system for abutment protection:



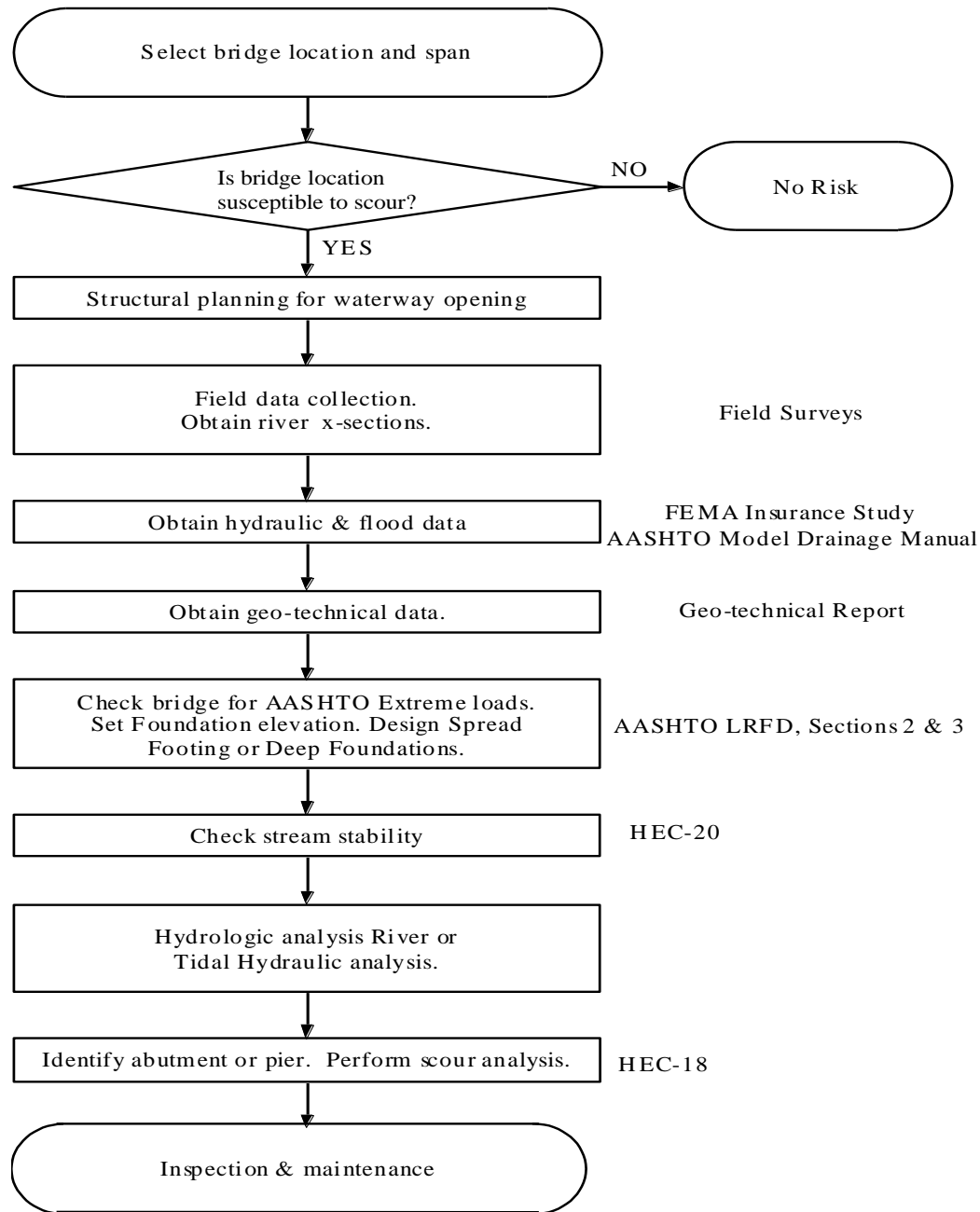
\* NCSA Classification

Riprap at Abutment on Spread Footing (on soil).

NOTES:

1. If rock exists at a depth lower than the design depth, place bottom of footing at 6" below rock surface.
2. Set design depth = 1/2 scour depth if only riprap countermeasure is used.

The following flow diagram may be followed in designing a riprap system for pier protection:





## d) Rip-Rap Layout Procedures

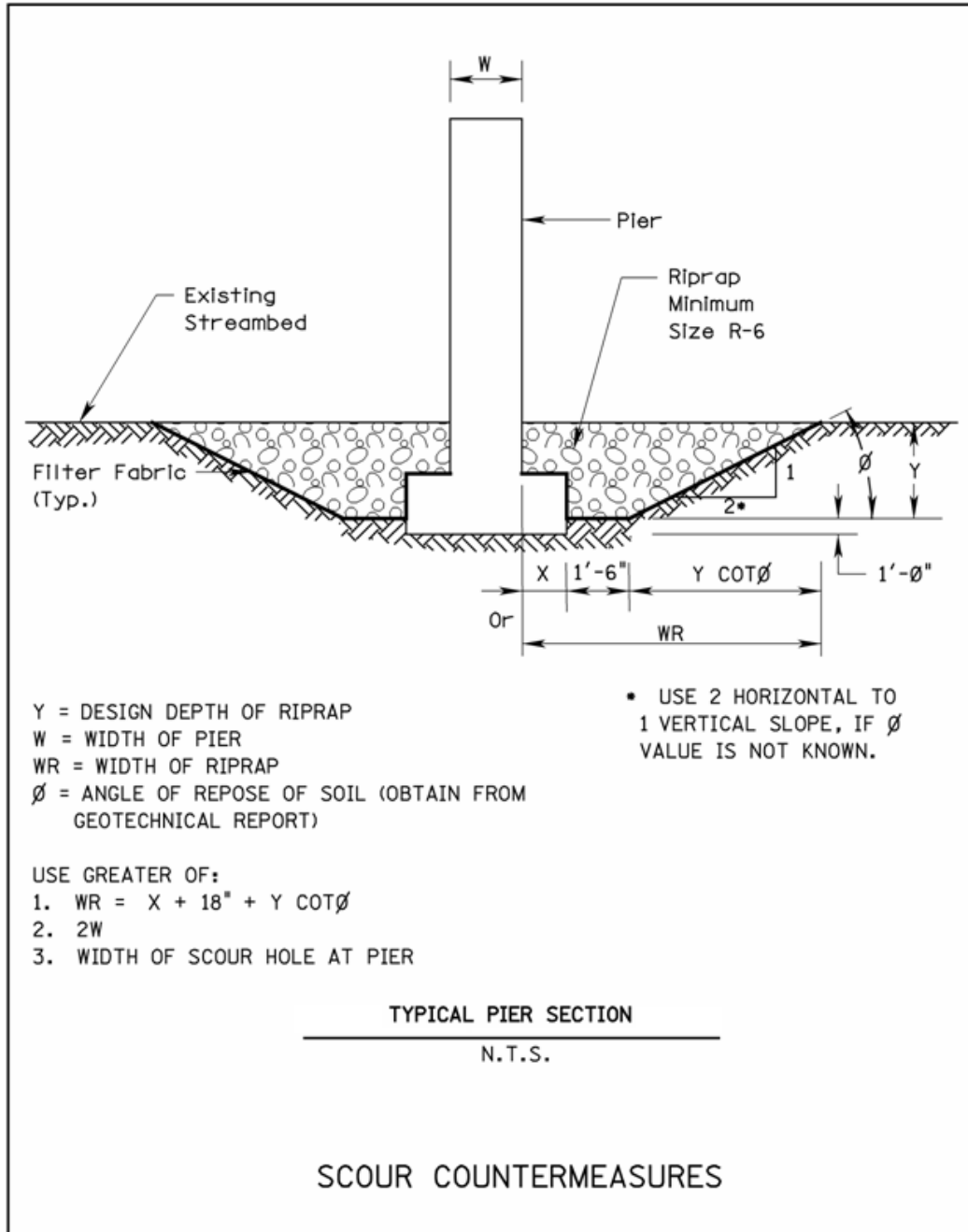
- 1) Riprap grading – Designate 50 percent of stones in a layer to be equal or greater than the specified size ( $D_{50}$ ). The specified size can be calculated by hydraulic considerations using FHWA formulae (see flow diagrams above). The remaining 50 percent of the stones can be of a smaller size than the ( $D_{50}$ ) to fill the smaller voids between the stones.
- 2) Maximum stone size in a layer  $< 1.5 D_{50}$ .
- 3) Minimum thickness of each layer = 1 foot.
- 4) Minimum number of layers = 3.
- 5) Width of a riprap layer on a footing, at the river side of an abutment or around the pier shall be the maximum of the following:
  - $2 \times$  (width of abutment or pier at base) or
  - $(1 \text{ foot} + d \cot \theta)$ , where  $d$  is the design scour depth at the abutment or the pier and  $\theta$  is the angle of natural repose for the soil, as obtained from the Geotechnical Report.
- 6) Place riprap around the footings with the slope starting at a distance of 1 foot from vertical face of the footing.
- 7) Before placing riprap, check that the excavation line that is located adjacent to the abutment and around the pier meets OSHA safety requirement for the type of soil.
- 8) The top of riprap shall be below the river bed to avoid encroachment of the river, or dislodging of the stones by floating debris, ice or currents.
- 9) If a riprap design is based on a scour analysis, use a reduced design depth  $d = y/2$ , Where  $y$  = computed scour depth.
- 10) If the design depth "d" is greater than the available depth between riverbed elevation and bottom of footing, and the rock is not available within depth "d", or if the computed  $D_{50}$  size  $> R-8$ , alternate countermeasures will be required.

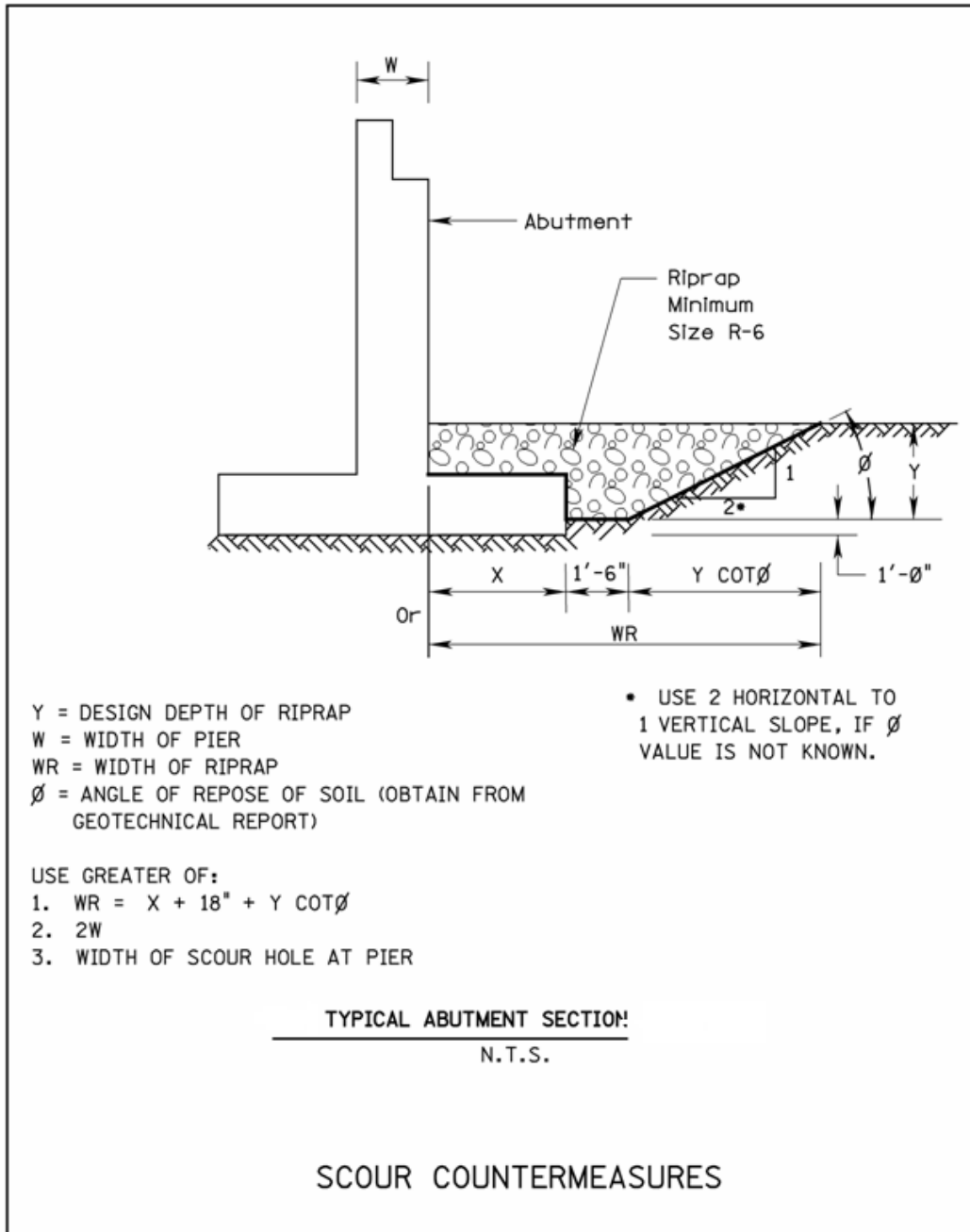
**39.7 Scour Protection At Culverts**

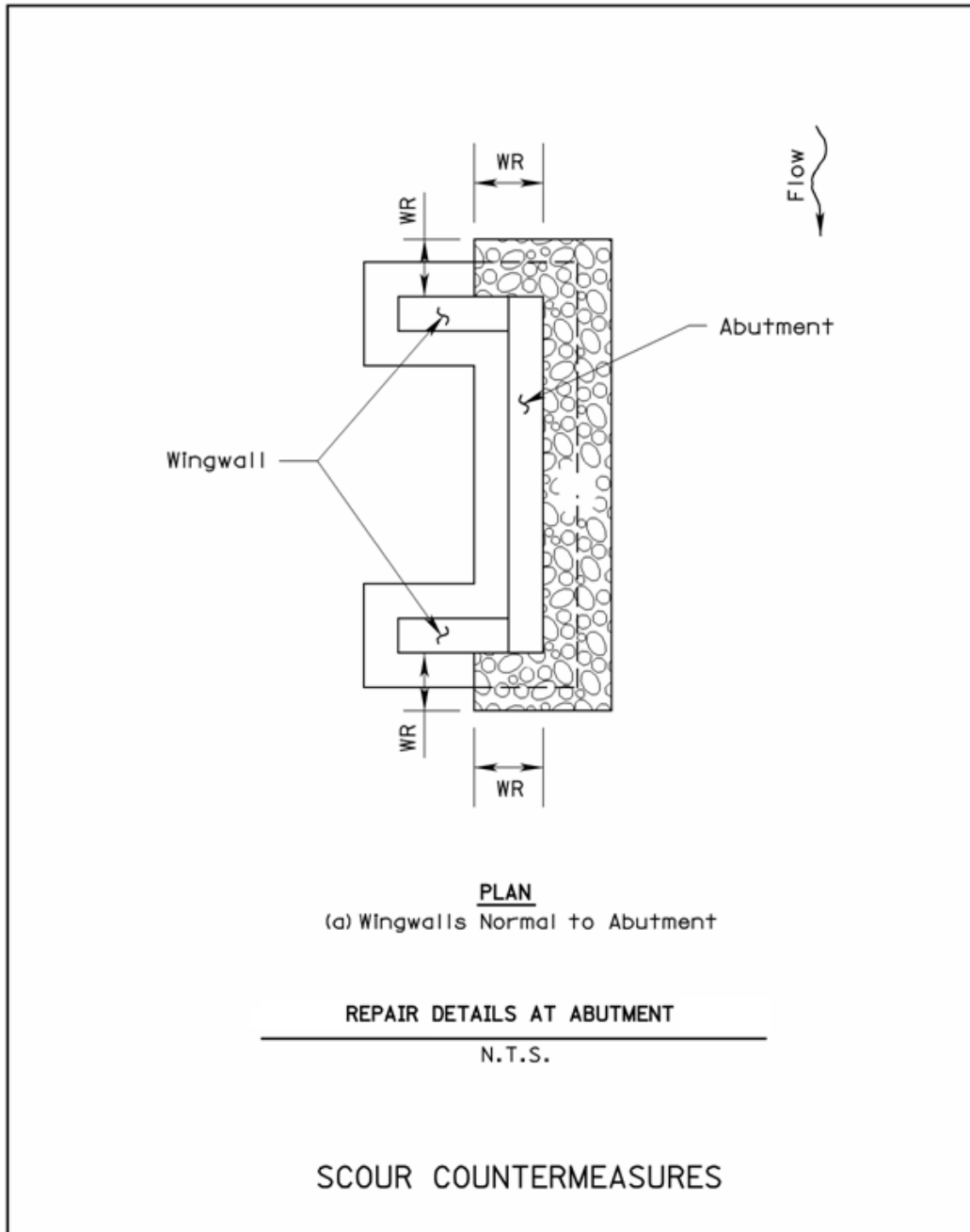
1. Hydraulic design: Chapter 4 of *AASHTO Highway Drainage Guidelines Manual* and HEC 23 provide design procedures for the hydraulic design of highway culverts. Included therein are design examples, tables and charts that provide a basis for determining the selection of a culvert opening.
2. Footings for any flared wingwalls, provided at the entry and the exit of culverts will be protected by riprap or alternate armoring countermeasures.
3. For high velocities exceeding 12 ft/sec, riprap at wingwalls will be replaced by a concrete apron, which is to extend between the opposite wingwalls and to the edge of the culvert.
4. Regular monitoring will be required if riprap has been installed at the entry and exit of culverts.

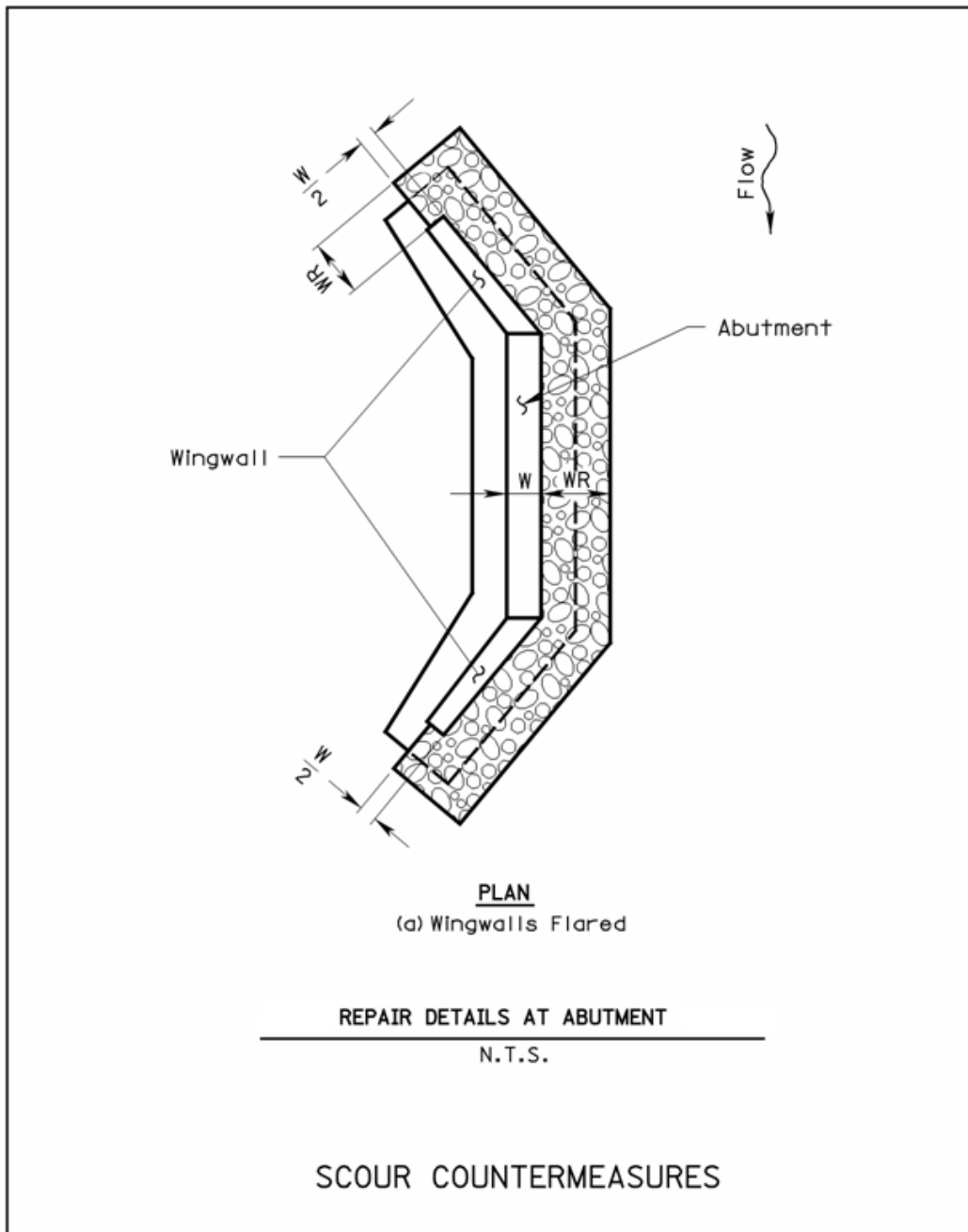
### 39.8 Scour Protection Detailing

The following illustrations provide details for riprap placement at abutments and piers.









## Section 40 - Noise Barriers

### 40.1 General Criteria

1. The Designer shall obtain preliminary information necessary for the design of noise barriers from the Department. This information will include the following:
  - Types of noise barriers to be used
  - Required height, length and offset for noise abatement
  - Architectural treatments

The Designer shall identify and verify all existing utility conduits in the vicinity of the proposed noise barrier wall alignment. If any existing utility interferes with the noise barrier, the Department shall be contacted for possible relocation of the existing utility conduits.

2. The *AASHTO Guide Specifications for the Structural Design of Sound Barriers* shall be followed as the overall Design Specifications for designs.

Design criteria, not specifically herein addressed, shall conform to applicable Sections of the current *AASHTO LRFD Bridge Design Specifications*, and as modified by Section 3 of the Manual.

3. Working drawings should be checked for conformance to appropriate design requirements.

The following Tables, as produced from the above referenced *AASHTO Guide Specifications*, shall be used for the design of Noise Barriers:

**Table 40-1 Minimum Wind Pressure on Sound Barriers Located In Coastal Regions**

| Distance From Average Level of Adjoining Ground Surface To Centroid Of Loaded Area In Each Height Zone, Feet | Cc   | Minimum Pressure (P), psf For The Indicated Wind Velocity (V), mph |    |     |     |
|--|------|--|----|-----|-----|
|  |      | 80   | 90 | 100 | 110 |
| 0 < H < 14   | 1.20 | 40   | 50 | 62  | 75  |
| 14 < H < 29  | .37  | 46   | 58 | 71  | 87  |
| Greater Than 29  | 1.49 | 50   | 63 | 77  | 94  |

This Table is to be used for both ground mounted and structure mounted noise barriers in flat unobstructed areas exposed to wind flowing over large bodies of water and extending inland from the shoreline a distance of 0.5 miles.

**Table 40-2 Minimum Wind Pressure On Sound Barriers Located On Bridge Structures, Retaining Walls, Or Traffic Barriers**

| Distance From Average Level of Adjoining Ground Surface To Centroid Of Loaded Area In Each Height Zone, Feet | Cc   | Minimum Pressure (P), psf For The Indicated Wind Velocity (V), mph |    |     |     |
|--|------|--|----|-----|-----|
|  |      | 80   | 90 | 100 | 110 |
| 0 < H < 14   | 0.80 | 27   | 34 | 42  | 50  |
| 4.3 < H < 29   | 1.00 | 33   | 42 | 52  | 63  |
| Greater Than 29  | 1.10 | 37   | 46 | 57  | 69  |

This Table is to be used in open terrain with scattered obstructions. This includes flat, open country and grasslands. This exposure shall be used for all sound barriers located on bridge structures, retaining walls or traffic barriers that are not covered by Table 40-1.

**Table 40-3 Minimum Wind Pressures On Sound Barriers Not Located On Structure**

| Distance From Average Level of Adjoining Ground Surface To Centroid Of Loaded Area In Each Height Zone, Feet | Cc   | Minimum Pressure (P), psf For The Indicated Wind Velocity (V), mph |    |     |     |
|--|------|--|----|-----|-----|
|  |      | 80   | 90 | 100 | 110 |
| 0 < H < 14   | 0.59 | 20   | 25 | 31  | 37  |
| 14 < H < 29  | 0.75 | 25   | 32 | 39  | 40  |
| Greater Than 29  | 0.85 | 28   | 36 | 40  | 53  |

This Table is to be used in urban and suburban areas with open terrain that does not meet the requirements of Table 40-4. Generally, this Table should be used for ground mounted noise barriers.

**Table 40-4 Minimum Wind Pressure On Sound Barriers Not Located On Structures.**

| Distance From Average Level of Adjoining Ground Surface To Centroid Of Loaded Area In Each Height Zone, Feet | Cc   | Minimum Pressure (P), psf For The Indicated Wind Velocity (V), mph |    |     |     |
|--|------|--|----|-----|-----|
|  |      | 80   | 90 | 100 | 110 |
| 0 < H < 14   | 0.37 | 12   | 16 | 19  | 23  |
| 14 < H < 29  | 0.50 | 17   | 21 | 26  | 31  |
| Greater Than 29  | 0.59 | 20   | 25 | 31  | 37  |

This table is to be used in urban and suburban areas with numerous closely spaced obstructions having the size of single-family dwellings or larger that prevail in the upwind direction from the noise wall for a distance of at least 1500 feet. Wind loads shall be applied perpendicular to the wall surface.

Adjacent ground surface can be defined as the ground elevation (or water elevation) immediately adjacent to the structure. In situations where noise barriers are mounted on bridges and retaining walls, the height to be utilized in determining the design wind pressure,  $P$ , shall be taken from the lowest average ground or water elevation adjacent to the noise barrier, to the centroid of the loaded area.

4. The following are load combinations to which the noise barriers may be subjected. Each part of the structure shall be proportioned for the load combinations. Foundations shall be proportioned according to Subsection 40.4.
  - Wind Loads
  - Earth Loads
  - Traffic Loads
  - Ice and Snow Loads
  - Bridge Loads
5. The *AASHTO LRFD Bridge Design Specifications* shall be used to determine Load Factors for these loading combinations. The following information for Seismic Loads as well as the *AASHTO LRFD Bridge Design Specifications* shall be referenced in considering the Seismic load combination.

### Seismic Loads

The seismic dead load, EQD, in the following formula shall be computed as follows:

$$EQD = A \times f \times D$$

|        |     |   |   |
|--------|-----|---|---|
| Where: | EQD | = | Seismic dead load   |
|        | D   | = | Dead load of noise barrier, excluding foundations           |
|        | A   | = | Acceleration coefficient (as per Section 45 of this Manual) |
|        | f   | = | Dead load coefficient                                       |

### f

|      |  |
|------|--|
| 0.75 | Dead load, except on bridges   |
| 2.50 | Dead load, on bridges  |
| 8.0  | Dead load for connections of walls, not cast in place, to bridges          |
| 5.0  | Dead loads for connections of walls, not cast in place, to retaining walls |

6. The dead load shall consist of the weight of all the component materials making up the noise barrier, excluding the foundation. The point of application of the Seismic Dead Load, EQD, of the individual components shall be at their respective centers of gravity.

When a noise barrier is supported by a bridge superstructure, the wind or seismic load shall be transferred to the superstructure and substructure of the bridge. Additional reinforcement may be required in traffic barriers and overhangs to resist the loads transferred by the noise barrier.



## 7. Functional Requirements

- a. Guide rail or concrete barrier curb shall be used when the noise barrier is located within the clear zone (see Section 8 of the *NJDOT Roadway Design Manual* for more information).
- b. Stopping sight distance criteria shall apply in determining the location of a noise barrier. Horizontal clearances which reduce the stopping sight distance shall be avoided. In those extreme cases where reduced stopping sight distances may be warranted, a design exception shall be provided to justify the need.
- c. Minimum Height - Noise barriers should have a minimum height consistent with that of a right of way fence (measured from the top of the barrier to the ground). Height requirements will be determined by noise studies performed by the Bureau of Environmental Services. When the tops of noise walls have to be stepped, the maximum height of step should not exceed 2 feet.

When noise barriers higher than 15 feet are required by sound studies, consideration of surrounding features should be evaluated such that an exceptionally high wall does not create an unsightly impact on the environmental aesthetic features of the territory. In such situations, noise barriers in combination with earth mounds should be considered.

- d. Barriers can obstruct light as well as noise. Special consideration shall be given to possible roadway icing and other induced environmental conditions caused by the placement of the wall.
- e. It is important to have drainage facilities along noise barriers to assure soil stability. Soil with phi ( $\phi$ ) of 25 degrees or less may develop flowing characteristics when saturated. Surface runoffs should be directed away from the noise barrier.
- f. Provisions may be necessary to allow fire fighters and chemical spill cleanup crews access to fire hydrants on the opposite side of the noise barrier. The designer should consult with local fire and emergency officials regarding their specific needs.
- g. For noise barriers that must bridge over conduits, provisions should be made to accommodate differential settlement in the noise walls substructures.
- h. The Preliminary Submission for Noise Barriers shall include a Report to address the possibility of icing, the storage of snow, utilities impact, drainage, mounting on culverts and the issues discussed in items d, e, f and g above.

## 8. Maintenance Considerations

- a. Noise barriers placed within the area between the shoulder and right of way line may complicate the ongoing maintenance and landscaping operations, especially if landscaping is placed on both sides of the noise barrier. Special considerations should be given to maintaining the adjoining land behind the noise barrier and adjacent to the right of way line. A minimum 4 to 6 feet wide shrub planting area between the proposed guide rail and the noise barrier might be considered.

- b. In some urban areas, noise barriers may be subjected to graffiti being placed on their surfaces. In these locations, the surface texture selected should be such that it is difficult to place the graffiti or such that the graffiti is easily removed. Noise barriers with rough textures and dark colors tend to discourage graffiti.
- c. Access to the back side of the noise barrier should be provided for inspection, litter control, soil erosion monitoring, grass mowing and maintenance. In subdivision areas, access may be via local streets, when available. If access is not available via local streets, access gates or openings are essential at intervals along the noise barrier. Offset barriers concealing the access opening must be overlapped a minimum of 4 times the offset distance in order to maintain the integrity of the noise attenuation of the main barrier. Location of the access openings should be coordinated with the appropriate agency or land owner. Gates in the noise barriers along federal aid routes require justification and FHWA approval.

## 9. Noise Barriers on Bridges

- a. Provisions for expansion shall be placed in the noise barrier at locations of bridge deck expansion joints and at parapet deflection joints.
- b. For noise barrier retrofit onto existing bridges, the Designer must verify that the dead and live load from the wall do not overstress any component of the bridge including the existing parapets, slab overhang, girders and superstructure members.

The dead load of noise barriers can affect the overload capacity and deflection of some bridges. Check the change in load capacity of the bridge and verify whether the change is acceptable.

- c. When Noise Barriers are to be installed on a bridge structure, the Designer shall closely examine all proposed connections. Connections of aluminum panels to the bridge structure and those of the noise barrier panels shall be reviewed to assure that disassemblies will not occur. Traffic induced vibration should be considered as part of the examination.

## 40.2 Types of Barriers

1. Timber or precast prestressed reinforced concrete post and panel systems are preferred; however, if unusual site conditions prohibit the use of a post and panel system, another noise barrier type may be considered (such as aluminum for bridges). Determination of the type of barrier and architectural treatments to be used at a site prior to the design of the barrier will be made by the Department. The Designer shall obtain the necessary information regarding barrier type and architectural treatments from the Department and shall refine and incorporate this information into the design.

Refer to Standard within this Manual for information concerning standardization of Noise Barrier criteria.

Example considerations of noise barrier architectural treatments:

- Flush posts and panels on the traffic face of the barrier to provide a smooth appearance to motorists.
- Coloring of the surfaces by tinting, staining or other methods.

- End treatments
  - Sloping transitions (rather than stepped transitions)
  - Planting pockets
  - Meandering barriers (posts and panels not arranged in a straight line, parallel to the centerline of the roadway).
  - Caps on top of the barriers to provide horizontal continuity.
2. In most cases, foundations for noise barriers shall be drilled shafts; however, in cases where shallow rock formations exist, spread footings will be unavoidable. Noise barriers on bridges shall be mounted on the parapets or attached directly behind the parapet.

In a retrofit or rehabilitation situation, where it is determined that the existing or rehabilitated structure cannot accommodate the noise barrier loading, a separate supporting structure for the noise barrier may be considered. Sound leakage between the parapet and noise barrier shall be prevented by the use of flashing or other mechanical means.

3. A number of proprietary sound barrier systems are available. The materials, load carrying mechanisms and capabilities vary with each system; however, these systems shall conform to the criteria outlined herein as well as current NJDOT Standard Specifications for Road and Bridge Construction and applicable project Special Provisions. Proprietary wall systems shall be approved prior to the design of the barrier.

On Federal-Aid projects, alternate systems must be specified in the Contract documents

### **40.3 Materials**

1. Concrete for cast in place foundations and precast/prestressed posts and panels shall conform to the NJDOT Standard Specifications. Class B concrete shall be used as a minimum for foundations. Class P concrete shall be used as a minimum for precast elements.
2. Reinforcing steel shall conform to the NJDOT Standard Specifications, Grade 60,  $f_s = 24,000$  psi.

Welded wire fabric fabricated from deformed wire may be substituted for reinforcing bars.

The provision of corrosion protected reinforcement shall be as determined on a project to project basis. The location of the noise barrier panels, in relationship to the offset distance from the roadway, shall be evaluated to determine if provision of corrosion protected reinforcement is warranted.

If the location of the noise barrier panels may subject the panels to splashing from the roadway surface, provision of corrosion protected reinforcement, should be recommended. In such cases, the bottom one third height of the panels should be scheduled for placement of corrosion protected reinforcement.

3. Glued laminated timber material is preferred for construction of timber noise barriers.

Glued laminated timber material shall meet the requirements of the *NJDOT Standard Specifications for Road and Bridge Construction*.

Solid sawn lumber elements and workmanship shall conform to the provisions of the *NJDOT Standard Specifications for Road and Bridge Construction*.

4. Allowable stresses for aluminum shall conform to the current edition of the *Aluminum Association Specifications for Aluminum Structures*. The allowable stresses pertaining to bridge structures shall be utilized.

#### **40.4 Foundation Design**

1. The method of design for drilled shaft foundations shall be approved, or as directed, by the NJDOT Geotechnical Engineering Unit.
2. Special Requirements for Sloped Soil Conditions

A level ground condition may be defined as one in which the ground surface is approximately level or, when sloping down and away from the drilled shaft foundation, is not steeper than 1:10 (V:H) for  $\phi = 35$  degrees or 1:14 (V:H) for  $\phi = 25$  degrees.

When these conditions prevail within a distance of two times the drilled shaft foundation embedment, the ground may be considered level, regardless of steeper slopes outside these limits.

Drilled shafts located in slopes shall be protected by a berm. The berm shall be level and provide a minimum cover of 1 foot over the drilled shaft. It shall extend a minimum of 1 foot beyond the face of the drilled shaft.

Sloped soil conditions shall be taken into account when computing the required embedment length for drilled shaft foundations.

3. A foundation report shall be submitted for noise barriers in accordance with Section 34 of this Manual.

## Section 41 - Bridge Security

The terrorist events of September 11, 2001 have led to an acute awareness that the nation's infrastructure is very much vulnerable to aggression. Among the infrastructure elements that are vulnerable to attack are bridge structures and tunnels. Designers of bridge structures and tunnels must be cognizant of methods that provide security to the design of bridge structures and tunnels.

Subsection 2.7 of the *AASHTO LRFD Bridge Design Specifications* has been added to establish guidance on assessing the importance of a bridge toward determining if a formal vulnerability assessment is warranted. The following criteria may be used to perform this assessment.

### 41.1 Vulnerability Assessment

1. Assess the location of the bridge structure or tunnel. Would the loss of the bridge create loss of access to major cities, recreation facilities or lead to major replacement cost? Would the loss create a long detour route? Would the loss cause severe economic impact to the Community, State or Region?
2. Assess the traffic usage of the bridge structure or tunnel. If the bridge were attacked, would there be a major loss of life? Is there a significant traffic count that, if attacked during peak rush hours, a large number of deaths and injuries would result?
3. Assess the prominence or historical significance of the bridge structure or tunnel. Is the bridge structure or tunnel of historical significance to the State or local community?
4. Assess the impact to the environmental if the bridge structure or tunnel location is targeted. Are there targets that are adjacent to or near the bridge or tunnel that could cause severe environmental threats if attacked?
5. Assess the presence of public service facilities. Would the loss of a bridge structure or tunnel result in the disruption of service by emergency vehicles (ambulances, fire equipment), the disruption of services by State or Federal agencies and by military personnel?

The above aspects may include others. Designers must use judgment and advice of NJDOT staff and the knowledge of others to assess the vulnerability of bridge structures or tunnels. This assessment should be documented and included in the project's Preliminary Design Submission. The Vulnerability Assessment should be a part of rehabilitation, reconstruction, replacement or new bridge projects.

### 41.2 Vulnerability Countermeasures

After assessing the vulnerability of a bridge structure or tunnel, certain countermeasures should be established within the project documents to provide security measures.

Following are suggested countermeasure methods that can be called for in the Plans or Special Provisions:

1. Restrict parking under a bridge structure. This can be done by the use of concrete barriers, bollards, and chain-link fences. Barriers should be placed to also restrict parking adjacent to a bridge structure.

2. Detail the installation of surveillance cameras that can be tied to NJDOT Headquarters or Operations control.
3. Restrict the placement of vegetation that would obstruct surveillance measures.
4. Restrict access to ventilation machinery in tunnels. Detail installation of emergency shut-off mechanisms.
5. Restrict access to key details that, if damaged, would result in the loss of the structure.
6. Detail the restriction of access to movable bridge machinery and operator's housing.
7. Detail the installation of lighting throughout a bridge structure to ensure surveillance. This should include lighting under a bridge that is located over a waterway.
8. Detail, in general, all bridge components so that no component is concealed from view.
9. Prohibit the use of non-redundant members.
10. Protect all main load carrying members from direct impact from automobile, marine or rail traffic.
11. Locate utilities in such a way as to minimize their potential use against the structure. Appropriate shut offs shall be provided adjacent to the structure.
12. Consider protection measures from fire hazard.

Subsection 3.14.16 of the *AASHTO LRFD Bridge Design Specifications* provides guidance on assessing the intentional use of a water vessel to damage a bridge structure. Also, Subsection 3.15 provides general guidance to assess blast force effects to a bridge structure. These Specifications should be studied in providing an overall bridge security assessment. When evaluation of blast impact and protection from blast are warranted for a new bridge construction and a bridge retrofit, the AASHTO "Bridge Security Guidelines" may be referenced.

It should be realized that the above countermeasures may not be all inclusive. Designers are encouraged to research and recommend other methods. The security of a bridge structure or tunnel is a paramount concern to the Department. Security measures will protect New Jersey's motorists and provide the security that must be part of being a citizen of the United States.

### **41.3 Critical Bridges**

NJDOT has screened all bridges in New Jersey for vulnerability assessment, and has developed recommendations for hazard mitigations for the most critical bridges that may require a high security level. Designer should contact the Director of Bridge Engineering and Infrastructure Management during the early stages of design to get any necessary guidance in this regards.

## Section 42 - Permit Procedures

Use the Checklist in Attachment 42.2 to ensure all applicable elements have been addressed.

### 42.1 NJDEP Water Quality Certificate

1. The Certificate should be obtained from the New Jersey Department of Environmental Protection at approximately the time of the Preliminary Submission.
2. Water Quality Certification is required for those projects that need a US Army Corps of Engineers Section 404 or 10 Permit and projects requiring US Coast Guard Permits.

### 42.2 NJDEP Stream Encroachment Permit

All documents concerning hydraulic and hydrologic data shall be prepared for application to the New Jersey Department of Environmental Protection.

### 42.3 Tidelands Grant, Lease or License

1. The application is to be made to the Bureau of Tidelands, New Jersey Department of Environmental Protection.
2. Documents similar to those required for US Coast Guard Permit shall be prepared.

### 42.4 NJDEP Coastal Area Facilities Review Act Permit (CAFRA)

Environmental Resources, with engineering input, will make the application for the entire project permit to the New Jersey Department of Environmental Protection.

### 42.5 US Coast Guard Section 9 Permit

1. A United States Coast Guard (USCG) Permit is required for all bridge construction or reconstruction projects across navigable waters of the United States except as noted in Part (d) below. As stated in Title 23 Code of Federal Regulations (CFR), Part 650, Subpart H., the USCG has the responsibility to determine whether a USCG Permit is required for the improvement or construction of a bridge over navigable waters, except for federally aided bridges, in which case the FHWA exercises that responsibility. The USCG also has the responsibility to approve the bridge location alignment and appropriate navigational clearances in all bridge permit applications.

The Manager, Bureau of Structural Engineering will make application for USCG permit. The design unit shall initiate coordination with the USCG at an early stage of project development and provide opportunity for the USCG to be involved throughout the environmental review process in accordance with 23 CFR Part 771. Required documents are to be prepared by the Designer (see Attachment 42.1). For more information see the Bridge Permit Application Guide at the US Coast Guard website at [www.uscg.mil](http://www.uscg.mil). The Bureau of Environmental Services shall be kept advised of this application process for tracking and scheduling purposes.

Per 23 CFR 650, Subpart H, the following items must be considered for bridges requiring a USCG Permit

- a) The Designer shall accomplish sufficient preliminary design and consultation during scope development to investigate bridge alternatives. The feasibility of any proposed movable bridges, the horizontal and vertical clearances that may be required. Other location considerations which, included with any proposal for a movable bridge, provide a comparative analysis of engineering, social economic and environmental benefit and impacts are to be considered.
- b) The Designer shall consider hydraulic, safety, environmental and navigational needs along with highway costs when designing proposed navigable waterway crossing
- c) For bridges where the risk of ship collision is significant, the Designer shall consider, in addition to the USCG requirements, the need for pier protection and warning systems. Refer to Section 19 of this Manual for further clarification.
- d) Special navigational clearances shall normally not be provided for accommodation of floating construction equipment of any type that is not required for navigation channel maintenance. If the navigational clearances are influenced by the needs of such equipment, the USCG should be consulted to determine the appropriate clearances to be provided.
- e) For projects which require FHWA approval of plans, specifications and estimates, preliminary bridge plans shall be approved at the appropriate level by the FHWA for structural concepts, hydraulics and navigational clearances prior to submission of the permit application.
- f) If the project contains alternative designs for the same configuration (fixed or movable), the permit application shall be prepared in sufficient detail so that all alternatives can be evaluated by the USCG. If appropriate, the USCG will issue a permit for all alternatives.

For more information concerning the USCG Permit process, refer to the *Bridge Permit Application Guide* available through the USCG, and 23 CFR 650, Subpart H available through the FHWA.

2. Under the law, a Coast Guard permit is not required if the proposed construction, reconstruction, rehabilitation or replacement is over waterways which conform to either of the following criteria.
  - a) The waterway is not to be used or is not susceptible for use in its natural condition or by reasonable improvement as a means to transport interstate or foreign commerce and is not a tidal waterway.
  - b) The waterway is tidal; however, it is used only by recreational boating, fishing and other small vessels less than 20 feet in length.

The appropriate District Offices of the US Army Corps of Engineers should be contacted if the susceptibility of channel improvement for navigation is unknown. The USCG District Office at the address below should be contacted if the types of vessels using the waterway is unknown.

3. For federal aid bridge projects which cross waterways with navigational traffic and where it is believed that a Coast Guard permit may not be require, supporting information shall be provided early in the scope development to the



FHWA to enable them to make a determination that a permit is not required and that proposed navigational clearances are reasonable.

For waterways where the USCG has not declared jurisdiction, the Coast Guard will be notified by sending a Notice of Planned Action on an individual project basis. The documents shall be prepared by the Designer and sent to the respective address below:

For Projects North of Toms River, address to:

Commander  
 First Coast Guard District  
 Battery Park Building  
 New York, New York 1000-5073  
 Telephone Number: 212-668-7021

For Projects South of Toms River, address to:

Commander  
 Fifth Coast Guard  
 431 Crawford Street  
 Portsmouth, VA 23704-5004  
 Telephone Number: 757-398-6222

Construction in waterways exempt from a Coast Guard permit may be subject to other Coast Guard authorizations such as approval of navigation lights and signals and timely notice to local mariners of waterway changes. Therefore, the Coast Guard should be notified whenever the proposed action may substantially affect local navigation.

#### **42.6 NJDEP Waterfront Development Permit**

The Bureau of Environmental Services, with engineering input, will make the application for the entire project permit to the NJDEP.

#### **42.7 NJDEP Freshwater Wetlands Permit**

The Bureau of Environmental Services, with engineering input, will submit the entire application to the NJDEP.

#### **42.8 US Army Corps Section 404 And 10 Permit**

The Bureau of Environmental Services will submit these applications, with engineering input, to the District Engineer, Philadelphia District or New York District.

#### **42.9 Pinelands Commission Permit**

The Bureau of Environmental Services submits the entire application, with engineering input, to the New Jersey Pinelands Commission.

(References: Coast Guard Authorization Act of 1982; Section 123(b) of the Federal Aid Highway Act of 1987; 23 CFR 650 (H) dated April 1, 1991.)

## 42.10 Navigable Waterways In New Jersey

The following listing of navigable waterways is not a complete list but may be used as a reference.

This listing was taken from the Coast Guard Publication *Bridges Over Navigable Waters of the United States, Part 1, Atlantic Coast*. If doubt exists as to whether a section of waterway in question has been deemed navigable, the US Coast Guard should be contacted.

Intercoastal Waterways:

|                                 |                        |
|---------------------------------|------------------------|
| Barnegat Bay                    | Great Channel          |
| Beach Thorofare (Atlantic City) | Ingram Thorofare       |
| Beach Thorofare (Margate)       | Inside Thorofare       |
| Beach Thorofare (Ocean City)    | Ludlam Thorofare       |
| Broad Thorofare                 | Manahawkin Bay         |
| Cape May Canal                  | Manasquan River        |
| Crook Horn Thorofare            | Middle Thorofare       |
| Grassy Sound Channel            | Point Pleasant Canal   |
| Absecon Creek                   | Fortescue Creek        |
| Absecon Inlet                   | Grassy Sound Channel   |
| Alloway Creek                   | Graven Thorofare       |
| Arthur Kill                     | Great Channel          |
| Assiscunk Creek                 | Great Egg Harbor Bay   |
| Avalon Canal                    | Great Egg Harbor Inlet |
| Babcock Creek                   | Great Egg River        |
| Barnegat Bay                    | Great Thorofare        |
| Bass Harbor                     | Hackensack River       |
| Bass River                      | Hope Creek             |
| Beach Creek                     | Hudson River           |
| Beach Thorofare                 | Jobs Creek             |
| Beaver Creek                    | Jonathans Thorofare    |
| Beaver Dam Creek                | Kill Van Kull          |
| Bellmans Creek                  | Lawrence Brook         |
| Berry Creek                     | Leonards Thorofare     |
| Berry Creek Canal               | Little Silver Creek    |
| Bidwell (Biddle) Creek          | Little Salem River     |
| Big Creek                       | Little Sheephead Creek |
| Big Sheepshead Creek            | Little Timber Creek    |
| Big Thorofare                   | Lovelands Thorofare    |
| Black Creek                     | Luppatatcong Creek     |
| Branchport Creek (Pleasure Bay) | Manahawkin Bay         |
| Bull Creek                      | Manahawkin Creek       |
| Cape Island Creek               | Manantico Creek        |
| Cedar Creek                     | Manasquan Creek        |
| Cedar Swamp Creek               | Matawan Creek          |
| Cheesequake Creek               | Maurice River          |
| Clam Thorofare                  | Middle Thorofare       |
| Cohansey River                  | Milburn Creek          |
| Colby's-Bobby's Run             | Mill Creek             |
| Compton Creek (Shoal Harbor)    | Mill Tail Creek        |

|                                     |                                 |
|-------------------------------------|---------------------------------|
| Cooks Creek                         | Mullica River                   |
| Cooper River                        | Muskee Creek                    |
| Corson Inlet                        | Nacate Creek                    |
| Crafts Creek                        | Navesink River (Swimming River) |
| Crammers Creek                      | Newark Bay                      |
| Crosswick Creek                     | Newton Creek                    |
| Debbies Creek                       | Newton Creek North Branch       |
| Delaware River                      | Newton Creek South Branch       |
| Dennis Creek                        | Noes Creek                      |
| Dividing Creek                      | Nut Swamp                       |
| Dock Thorofare                      | Oceanport Creek                 |
| Double Creek                        | Oldmans Creek                   |
| Duck Thorofare                      | Old Turtle Creek                |
| East Creek                          | Overpeck Creek                  |
| Elizabeth River                     | Oyster Creek                    |
| Flat Creek                          | Passaic River                   |
| Forked River                        | Parkers Creek                   |
| Patcong Creek                       | Sluice Creek                    |
| Pemberton Creek                     | South River                     |
| Pennsauken Creek                    | Stockton Lake Brook             |
| Pennsauken Creek South Branch       | Stow Creek                      |
| Piles Creek                         | Stump Creek                     |
| Post Creek                          | Swimming River (Navesink River) |
| Pleasure Bay (Branchport Creek)     | Tennents Brook                  |
| Raccoon Creek                       | Toms River North Branch         |
| Rahway River                        | Toms River South Branch         |
| Rancocas River (Creek)              | Toms River Jakes Branch         |
| Rancocas River (Creek) South Branch | Town Neck Creek                 |
| Raritan River                       | Townsend Inlet                  |
| Richardsons Channel                 | Troutmans Creek                 |
| Risley River                        | Tuckahoe River                  |
| Salem Canal                         | Tuckerton Creek                 |
| Salem River                         | Wading River                    |
| Scotch Bonnet Thorofare             | Watsons Creek                   |
| Second River                        | West Creek                      |
| Shark River                         | Westecunk Creek                 |
| Shark River (North Channel)         | Whirlpool Creek                 |
| Shark River (South Channel)         | Willet Thorofare                |
| Sheepshead Creek                    | Woodbridge Creek                |
| New Jersey Ship Channel             | Woodbury Creek                  |
| Shrewsbury River                    |                                 |

**Attachment 42.1 - Sample Letter of Application for USCG Permit**

Commander

Address (north or south of Toms River)

Dear Sir/Madam:

Application is hereby made by (name of consultant or engineering firm) (name of applicant) at (address) for approval by the Commandant, U.S. Coast Guard, of the location and plans of a (type of bridge structure) to be constructed (or modified) across the (name of waterway) at (city), (state) \_\_\_\_\_ kilometers (miles) above the mouth of the waterway as shown on the attached plans.

Federal funds will/will not be utilized and have been/are being applied for. Federal agencies which must grant approvals, easements, or other actions for this project include

The bridge will have a/no significant impact on the human environment. The impacts on the human environment are as follows: (briefly describe key issues)

An environmental analysis describing these effects has been prepared in the format of Section 102(2)(C) of the National Environmental Policy Act of 1969 and is enclosed.

There are/are no wildlife and waterfowl refuges, recreational areas, public parks or historic sites in the vicinity or in the way of the (type of structure) or its approaches. (as appropriate)

Legal authority for the (type of structure) is found in the General Bridge Act of 1942. The laws of the State of \_\_\_\_\_ do not require us to obtain a state permit for this work (or enclose state permits).

Enclosed herewith is a letter of authorization from (structure owner) and an extract of (the motion from Corporate meetings, etc.) authorizing me to make this application.

This (type of structure) will replace the existing (type of structure) at (city, state), and will be removed when the new (type of structure) is completed. (If applicable)

Sincerely

Encls.

1. Original and three copies of map of the vicinity and plans of (type of structure)
2. Environmental Analysis (or two copies of FHWA Final EIS or FONSI) as appropriate
3. Authorization for applicant to make application
4. Evidence of ownership of old (type of structure)
5. Water quality certification under 33 U.S.C. 1251 (or copy of letter requesting same)
6. CZM consistency statement
7. State agency concurrence in CZM consistency certification

## Attachment 42.2 - Checklist

### Enclosures To Application Form (as applicable)

- letter authorizing agent to act in applicant's behalf
- letter authorizing modification or removal of another's bridge
- State license to construct the proposed bridge
- extract from a corporation's charter
- proof of ownership of the land the proposed bridge will be located on
- extracts of motions from meetings authorizing construction of the proposed bridge
- water quality certificate
- CZM consistency statement
- state concurrence with consistency certificate
- environmental document
- other federal, state and local permit
- identification of property owners adjacent to proposed bridge site

### Drawing

#### Location Map

- show the location of the proposed bridge in red
- show the location of existing bridge
- show wildlife and waterfowl refuges, historical and archaeological sites, public parks and recreation area
- show graphic scale
- show north arrow
- show direction of streamflow by use of an arrow
- show towns in project vicinity

#### Plan View

- show properties adjacent to the proposed bridge and identify respective owner
- show length and width of bridge (proposed and, as appropriate, existing)
- show fendering system and indicate type of construction material
- show banks of the waterway
- show navigation channel limit
- show and identify structures immediately adjacent to the proposed bridge and their pier alignment in relation to the proposed bridge
- show graphic scale
- show north arrow
- show horizontal clearance normal to the channel axis
- show channel axis

#### Elevation View (looking upstream)

- show the navigational opening in red
- show the horizontal clearance normal to the channel
- show the vertical clearance above the appropriate datum
- show the elevation of the waterway bottom
- show the amount of fill
- show the graphic scale

#### Title Block

- indicate applicant
- indicate waterway name and mile point
- indicate the location of project (city, county, state)
- indicate date of plan
- indicate sheet number.

## Section 43 - Highway Bridge Evaluation Program

### 43.1 General

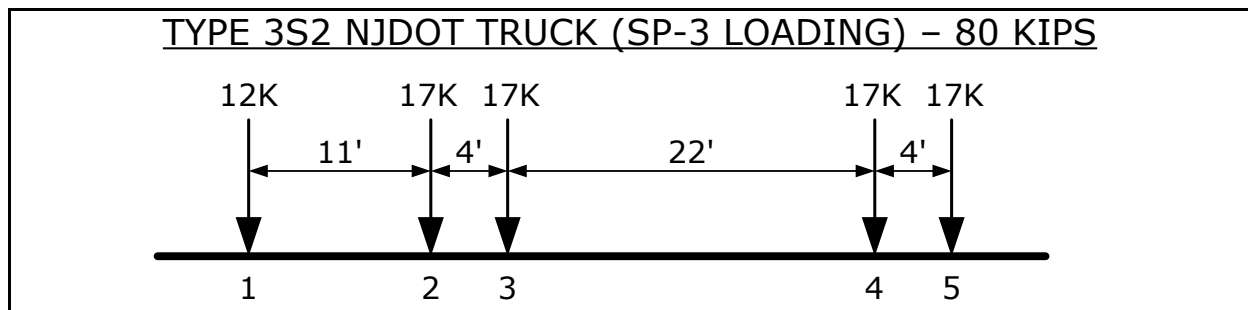
For a comprehensive treatment of this Section's criteria, reference is directed to the *Bridge Inspector's Reference Manual (BIRM)* published by the U.S. Department of Transportation, Federal Highway Administration and the Manual for Bridge Evaluation (MBE) published by the American Association of State Highway and Transportation Officials (AASHTO).

### 43.2 Evaluation Criteria

The current *AASHTO Manual for Bridge Evaluation* shall govern inspection and rating of existing bridges with the following amendments and modifications unless specified:

#### 1. Rating Live Load:

Live load models for bridge load ratings shall be in conformance with the MBE except that the standard 3S2 vehicle configuration shall be modified to the Type 3S2 NJDOT Truck Configuration below:



#### 2. Distribution of Loads (AASHTO LRFD specs page 4-32 subsection 4.6.2.2.2):

In rating the fascia or curb stringers, the distribution of truck loads to these members shall be based on a simple beam action (lever rule) instead of the above referenced AASHTO Manual formula. For the above members taking no truck loads (for instance, due to the presence of wide sidewalks), give only the dead load and sidewalk live load stresses (no vehicle ratings).

#### 3. Typical Legal Loads Used for Posting:

Substitute the loadings for the NJDOT Type 3S2 truck shown on Page 43-1 herein for the values shown for the Type 3S2 truck.

#### 4. MBE (Page 6-85) Table 6B.5.2.1-1: Inventory Rating Allowable Stresses:

Substitute the values shown below for the allowable stresses shown in the subject table.

| <b>Steel-Unknown</b> | <b>Allowable Inventory Rating Stress</b> |
|----------------------|--|
| Prior to 1905        | 14,500 psi instead of 14,000 psi         |
| 1905 to 1936         | 16,500 psi instead of 16,000 psi         |

#### 5. MBE (Page 6-100) 6B.5.2.4 Concrete:

Under Section 6B.5.2.4.1 Bending, the allowable stresses for compression due to bending should be  $0.40 f'_c$  for inventory and  $0.55 f'_c$  for operating ratings provided that the field investigation indicates that the concrete is sound and that contract plans and controls specified and furnished compressive strengths of 2,400 psi or more.

6. MBE (Page 6-102) 6B.5.2.5 Prestressed Concrete:

The allowable stress in the precompressed tensile zone of prestressed concrete members is specified in the *AASHTO Standard Specifications for Highway Bridges* (Article 9.15.2.2). For calculating inventory rating by the working stress or load factor (serviceability) methods, an allowable tension stress of  $3 \sqrt{f'_c}$  shall be utilized for members with bonded reinforcement.

7. MBE (Page 6-123) Appendix C6B Live Load Moments on Longitudinal Stringers or Girders:

Substitute the values shown for the Type 3S2 truck with the values for the NJDOT Type 3S2 truck shown in the table on Page 43-1 herein.

It should be noted that the values shown for the Type 3S2 truck in Appendices C6B, D6B, and E6B require revisions to conform to the NJDOT Type 3S2 truck.

8. General Comments

The allowable stresses listed in MBE Tables 6B.5.2.1-2 and 6B.5.2.1-1 (for Operating and Inventory Ratings respectively) are not absolutes. They are intended to provide general guidance. These allowable stresses may be modified if other values can be justified by test results, more detailed information of the materials, more refined structural analysis, consideration of traffic types and volumes, frequency of interim inspection and other related factors.

These given allowable stresses do not necessarily include all the allowable stresses required for a bridge rating. Values not given in these instructions should be obtained from appropriate sources (e.g. original design plans and specifications; current and past editions of the *Standard Specifications for Highway Bridges*, AASHTO and AASHTO; historical records; ASTM Specifications; etc.).

An initial (1<sup>st</sup> cycle) inspection and rating analysis of a new or replacement highway carrying bridge shall be performed within 90 days of the bridge being opened to traffic. The inspection shall be performed according to the provisions of this Section.

**Revisions to Appendix C6B**

Live Load Moments per Wheel Line on Longitudinal Stringers or Girders

**NJDOT Type 3S2 Truck**

| <b>Span C/C</b> | <b>Without Impact</b> | <b>With Impact</b> | <b>Span C/C</b> | <b>Without Impact</b> | <b>With Impact</b> |
|-----------------|-----------------------|--------------------|-----------------|-----------------------|--------------------|
| <b>Feet</b>     | <b>ft. kips</b>       | <b>ft. kips</b>    | <b>Feet</b>     | <b>ft. kips</b>       | <b>ft. kips</b>    |
| 5               | 10.6                  | 13.8               | 32              | 134.3                 | 174.7              |
| 6               | 12.8                  | 16.6               | 34              | 145.9                 | 189.7              |
| 7               | 15.2                  | 19.7               | 36              | 157.3                 | 204.5              |
| 8               | 19.1                  | 24.9               | 38              | 168.8                 | 219.5              |
| 9               | 23.1                  | 30.1               | 40              | 180.4                 | 234.5              |
| 10              | 27.2                  | 35.4               | 42              | 191.6                 | 249.3              |
| 11              | 31.3                  | 40.7               | 44              | 203.3                 | 263.5              |
| 12              | 35.4                  | 46.0               | 46              | 214.8                 | 277.6              |
| 13              | 39.6                  | 51.4               | 48              | 226.2                 | 291.6              |
| 14              | 43.7                  | 56.8               | 50              | 244.1                 | 313.8              |
| 15              | 47.9                  | 62.3               | 52              | 263.8                 | 338.2              |
| 16              | 52.1                  | 67.7               | 54              | 283.3                 | 362.5              |
| 17              | 56.3                  | 73.1               | 56              | 303.0                 | 386.7              |
| 18              | 60.4                  | 78.6               | 58              | 322.8                 | 411.0              |
| 19              | 64.6                  | 84.0               | 60              | 342.2                 | 434.9              |
| 20              | 68.9                  | 89.5               | 70              | 441.2                 | 554.3              |
| 21              | 73.1                  | 95.0               | 80              | 540.3                 | 672.1              |
| 22              | 77.3                  | 100.5              | 90              | 639.6                 | 788.3              |
| 23              | 82.8                  | 107.6              | 100             | 739.1                 | 903.3              |
| 24              | 88.5                  | 115.0              | 120             | 938.2                 | 1129.7             |
| 25              | 94.2                  | 122.5              | 140             | 1137.6                | 1352.3             |
| 26              | 100.0                 | 129.9              | 160             | 1337.2                | 1571.8             |
| 27              | 105.7                 | 137.4              | 180             | 1536.7                | 1788.6             |
| 28              | 111.4                 | 144.9              | 200             | 1736.5                | 2003.6             |
| 29              | 117.2                 | 152.4              | 250             | 2236.0                | 2534.2             |
| 30              | 122.9                 | 159.8              | 300             | 2736.2                | 3057.9             |



### 43.3 Evaluation Survey Report Format - A -

The report of the results of a first cycle bridge survey and rating of an existing bridge, performed by or for the Department, shall adhere to the following format:

- A. **Report Cover Sheet:** The report's cover sheet shall include the bridge owner's logo, name and address; the bridge number, name,, municipality, county, bridge survey cycle number and date. The cover sheet shall be white for all report cycles.

The report shall be bound using a standard 3-hole punch type binding.

- B. **Letter of Transmittal** (Consultant Projects Only): The letter of transmittal shall be addressed as follows (see attached sample):

Manager, Structural Evaluation and Bridge Management  
New Jersey Department of Transportation  
1035 Parkway Avenue, PO Box 615  
Trenton, New Jersey 08625-0600  
ATTN: Project Manager (Name)

Re: Bridge Survey and Rating of ("Bridge Number, Name, BR-NBIS/BR-Z-NBIS ( ) and Route Number").

In addition, the letter should include the date of the agreement with the New Jersey Department of Transportation and any disclaimer and/or restrictions on the information contained in the report and its use and the due date for the submission of the particular report (preliminary or final). Also, include a Quality Assurance Statement for the structure.

- C. **Table of Contents:** One page indicating items 1 thru 12 in order shown as follows and providing the page number in the report on which each item starts. All pages in the report shall be numbered (i.e. Cycle No. - Page No.) centered at the bottom.

|   | <b>Page No.</b> |
|---|-----------------|
| 1. Maps   | x-x             |
| 2. Structural Data                                    | x-x             |
| 3. Component Rating Summary                           | x-x             |
| 4. Conclusions and Recommendations                    | x-x             |
| 5. Historical Information                             | x-x             |
| 6. Bridge Description                                 | x-x             |
| 7. Structural Inventory & Appraisal and Pontis Sheets | x-x             |
| 8. Load Rating Summary Sheet (LRSS)                   | x-x             |
| 9. Drawings, Soundings and Photographs                | x-x             |
| 10. Field Notes                                       | x-x             |
| 11. Associated Documents                              | x-x             |
| 12. Vandalism Report                                  | x-x             |

1. **Maps:** Two maps, are required: one "General Location Map" and the other, a more detailed and specific "Local Map". Each map shall be on a separate 8½ by 11 inch sheet.

- a. **General Location Map:** For State owned bridges a map of the entire state of New Jersey, scale approximately 1: 1 000 000 "pin pointing" the location of the structure being reported on (by bridge number, name and

route number). This map should show county boundaries and names, principal cities, main roads (Interstate, U.S., State and Toll Roads) and the roads or the road and waterway involved in the structure being reported.

For reports on County or Municipality owned bridges, the general location map shall be of those territories and of a suitable scale.

- b. **Local Map:** A current U.S.G.S. map of the immediate vicinity of the "reported" structure; scaling 1: 20 000 with the structure centered on the page. Include roads, railroads, waterways, county and township names and a north arrow. Features intersecting the bridge should be clearly labeled.
2. **Structural Data:** A summary shall be included as per the attached format.
  3. **Component Rating Summary:** The items in this format are self-explanatory, however, further explanation for some items is provided as follows:
    - a. **Component/Material:** The components shall be listed in Format "A". Type of material used for majority of construction shall be given below the component in the same vertical column. Delete the components which are not applicable.
    - b. **Condition Rating:** The condition rating of various components shall be the overall rating of the component as per the current Recording and Coding Guides for the Structural Inventory and Appraisal of Bridges by FHWA & NJDOT and should be consistent with the ratings given on field notes and the SI&A sheet.
    - c. **General Remarks:** Summarize the significant defects and give a brief account of what was found during the bridge survey, as it relates to the structural integrity of the bridge. Defects for which repairs are recommended must be mentioned. Photos of these defects should be referenced in this section.

The Deck section should include the condition of the top and underside of the deck, sidewalks, deck joints, bridge railing, etc. For reinforced concrete decks give the percentage of spalled area (open or concrete/asphalt patched) and estimated contaminated area (underdeck).

The Superstructure section should include the condition of main load carrying members and diaphragms (include percent loss of section if any) and the bearings.

The Substructure section should include the condition of the abutments, pier(s), retaining walls, etc., and information on scour or undermining.

The Safety Features section should include the adequacy of bridge railing and approach guide rails.

The Deck Geometry section should comment on the adequacy of the traffic lanes and shoulder widths on the bridge. Also, comment on the continuity of the approach roadway (lanes and shoulders) across the bridge.

Field measured minimum clearances and where they occur should be provided (minimum vertical clearance above and below, and lateral underclearance left and right as per SI&A coding requirements). For bridges over waterways, horizontal and vertical clearances of the major waterway opening should also be given as per field measurements.

4. **Conclusions and Recommendations:** Conclusions resulting from the bridge evaluation survey regarding the adequacy (structural, alignment, clearances, etc.) of the bridge should be given here. Also, include possible explanation of the causes of any inadequacies found.

Include a statement of the overall condition of the structure, and provide comments on any major components rated at 6 or below.

For bridges with fracture critical members (FCM's), provide a list and description of all FCM's and a brief summary from in-depth FCM inspection findings, if possible.

For bridges over waterways, include a statement relative to the scour potential of the bridge based on the Bridge Scour Evaluation. The statement should specify if the bridge is scour critical or not based on the Bridge Scour Evaluation. If the bridge has not yet been evaluated, the Priority Category as determined in the Bridge Scour Evaluation should be specified. If the Prioritization Category is 2 or less, the statement should include which low ratings (2 or less) led to this rating. Where the bridge has not yet been evaluated for scour potential, include a statement that the bridge is or is not potentially scour critical based on engineering judgment along with the reasons for this determination.

Make specific recommendations for safety improvements, major repair work (i.e. structure rehabilitation and/or replacement, raising superstructure, bridge widening, etc. to correct Structurally Deficient/ Functionally Obsolete conditions) and other repair work to correct significant defects, deterioration and inadequacies found during this bridge survey. The recommendations should be specific about the location of defects and the methods of repair. The recommendations for other repair work should be listed in the order of priority. Each recommendation should be referenced to the photos. For major repair/ rehabilitation work, provide cost estimates, however, for other repair work, provide quantities only.

Identify any priority repair work and reference any priority repair memorandums which were issued.

In addition, list all areas of deterioration or structural members which should be inspected at frequencies of less than two years and indicate the inspection cycle in months for each area or member. Be very specific about locations to be inspected. Also identify any specific elements that should be monitored during each routine survey (such as cracks for propagation, etc.).

5. **Historical Information:** If available, this information should include when and under what agency the structure was built; when and by whom any subsequent alterations were made, their nature and extent, etc. Historical significance of the structure, if applicable, should be indicated.

6. **Bridge Description:** Furnish a brief description of the structure. Include the type of design and construction, materials in the deck, superstructure and substructure components, and important dimensions. Also, comment on the substructure foundation design if based on FHWA Hydraulic Engineering Circular (HEC-18). A more detailed description should be given if plans are not available.
7. **Structural Inventory & Appraisal and Pontis Sheets:** This section should contain an 8½ by 11 inch computer printouts of the "Structure Inventory and Appraisal and Pontis Sheets". These sheets must be coded in accordance with the current FHWA Recording and Coding Guide for the Inventory and Appraisal of the Nations Bridges and Recording and Coding Guide for the Structure Inventory and Appraisal of New Jersey bridges.

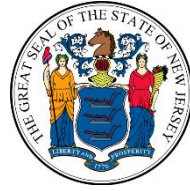
Examples of SI&A/PONTIS data forms are included in the Format A sample report.

8. **Load Rating Summary Sheet (LRSS):** In this section, include computations of ratings for various major bridge components. The ratings shall be computed in accordance with the current AASHTO "*Manual for Condition Evaluation of Bridges*" (as modified in this Manual) and the NJDOT Highway Bridge Load Rating Manual) and all current AASHTO interims. Ratings shall be reported using LRFR and either ASR or LFR methodologies. Include a summary of the computations listing all ratings with references and the allowable stresses used (see attached samples). Also, include the name of any rating computer program used and indicate any noteworthy assumptions made (such as section loss location(s), top or bottom flange in tension or compression controls, etc.). Include a Member Identification Sketch, 8½ by 11 inches, showing the designation and location of the superstructure members rated in the summary. All superstructure members shall be rated unless instructed otherwise by Manager of Structural Evaluation and Bridge Management, New Jersey Department of Transportation.
9. **Drawings, Soundings & Photographs:** Bridge drawings and color photographs (minimum 3.2 MP digital images) of unique defects should be included in this section of the report. Drawings shall include a plan view containing lateral and vertical clearances, span lengths, etc. for all bridges over a roadway and/or railroad. Drawings shall also include elevation views of sounding sketches done in accordance with the current edition of the "Underwater Inspection and Evaluation of New Jersey Bridges Guidelines Manual" for bridges over waterways.

Photographs of both full elevations, both roadway views, upstream and downstream views (if applicable), underside of each superstructure type, all significant defects (including those warranting Priority action or monitoring, or any elements rated at 6 or below), any posting signs, any repairs made and any special equipment used (Snooper, cherry picker, maintenance and protection of traffic, special ladders, etc.) should be included in the report. The photographs should be placed in the report in the following order: Elevations, Roadways, Stream Views, Underside, Defects requiring Priority

action, Bridge elements rated 6 or below (in order of Field Notes), Posting Signs, Repairs, and Special Equipment.

10. **Field Notes:** Detailed typed field notes using the Department's current Field Note Format for the type of structure being surveyed Include an 8 ½ by 11 inch cross section drawing showing the deck with lane, shoulder and sidewalk widths; out to out curb to curb widths, curb reveals; and median barrier, etc. Field notes shall include measurements taken during the bridge survey and PONTIS Core element condition evaluation data. A sample of the current Field Note forms and CADD sketches can be obtained from the Structural Evaluation and Bridge Management Unit.
11. **Associate Documents:** Attach the diver's inspection report (if applicable) done in accordance with the current edition of the "Underwater Inspection and Evaluation of New Jersey Bridges Guidelines Manual".  
  
Attach any memorandum prepared for any Priority/Emergency condition observed at the time of the inspection. Include the memo sheets as well as any photograph sheets. The Structural Evaluation Priority Notification report generated by the online Work Orders system must also be attached in the report before each Priority Repair memorandum.  
  
Attach the detailed load rating report (if applicable) done in accordance with the current edition of the "NJDOT Highway Bridge Load Rating Manual".  
  
Additionally, include any special reports such as fatigue analysis, ultrasonic testing, chemical analysis, coupon testing, hydraulic analysis, geotechnical streambed analysis, etc. Provide photographs showing the equipment used.
12. **Vandalism Report:** Include the completed form to report vandalism of the subject structure.

**Sample – Format A for State Bridges****Format "A"**

State of New Jersey  
 NEW JERSEY DEPARTMENT OF TRANSPORTATION  
 1035 PARKWAY AVENUE  
 P.O. Box 600  
 TRENTON, NEW JERSEY 08625-0600

**BRIDGE EVALUATION SURVEY REPORT**

**STRUCTURE NO. #####-###**  
**NJ ## OVER XX ROAD AND XX RIVER OR RAILROAD**  
**XX BOROUGH AND/OR TOWNSHIP**  
**XX COUNTY**

1<sup>ST</sup> CYCLE

MONTH DD, YYYY

**NOTES:**

1. Red and yellow guidance text **NOT** to be included in actual report document (user must delete).
2. Blue placeholder text to be properly edited and converted to black text (upon completion of the report, select all text using the Ctrl "A" command and change color to black).
3. Entire report shall be within table. \*Activate Gridlines\*
4. This textbox to be removed.

Prepared By

**XYZ Consultant**  
 (Consultant's Logo)

**123 Main Street**  
**Trenton, NJ 08625**

**Format "A"**

**N.J.D.O.T. - STRUCTURAL EVALUATION AND BRIDGE MANAGEMENT  
BRIDGE EVALUATION SURVEY REPORT  
CYCLE NO. 1**

**STRUCTURAL DATA:**

|                 |   |   |  |
|-----------------|---|---|--|
| Bridge No.:     | #### - ###  | Year Built:                                   | Widened/Rehab:                               |
| Route No.:      | ##  | Length:                                       | Width:                                       |
| (Item AA)       |   |   |  |
| Mile Point:     |   | Date of this Evaluation:                      | MM/DD/YYYY                                   |
| Municipality:   |   | By:   |  |
|                 |   | Date of FCM/Pin & Hanger Inspection:          | MM/DD/YYYY                                   |
| County:         |   | By:   | (Only when special inspection is applicable) |
|                 |   | Special Equipment Used:                       |  |
| Name:           | NJ ## over XX Road<br>and XX River or<br>Railroad | Date of Underwater/Fathometric<br>Inspection: | MM/DD/YYYY                                   |
|                 |   | By:   | (Only when applicable)                       |
| Structure Type: |   | Date of Special Testing:                      | MM/DD/YYYY                                   |
|                 |   | Date of Elec./Mech. Inspection (Level: II):   |  |
|                 |   | Scour Critical:                               | Yes / No                                     |

If "Yes" give reasons in Conclusions section along with scour statement.

**OVERALL PHYSICAL CONDITION:**

(Indicate which Item(s) controls: 59, 60, and/or 62)

**OVERALL CONDITION (ITEM 67):**

(Indicate which Item(s) controls: 59, 60, 62, and/or 66)

Inspection Team Leader: XYZ \_\_\_\_\_  
 Certifying Engineer: ABC P.E. \_\_\_\_\_  
 N.J. P.E. Number: ### \_\_\_\_\_

Initials: \_\_\_\_\_

I certify that this report is an accurate description of the subject structure, to the extent determinable by visual inspection and testing performed.

Signature: \_\_\_\_\_  
 Date: \_\_\_\_\_



| <u>COMPONENT/MATERIAL</u>  | <u>CONDITION RATING</u>                | <u>REMARKS</u>                                 |
|--|--|--|
| <b>DECK</b><br>(XXXXX)   | Excellent / Very Good /<br>Good / etc. | State the deficiency, or "No apparent defects" |
| <b>APPROACHES</b><br>(XXXXX)   | Excellent / Very Good /<br>Good / etc. | State the deficiency, or "No apparent defects" |
| <b>SUPERSTRUCTURE</b><br>(XXXXX)   | Excellent / Very Good /<br>Good / etc. | State the deficiency, or "No apparent defects" |
| <b>SUBSTRUCTURE</b><br>(XXXXX)   | Excellent / Very Good /<br>Good / etc. | State the deficiency, or "No apparent defects" |
| <b>WATERWAY/CHANNEL</b>  | Excellent / Very Good /<br>Good / etc. | State the deficiency, or "No apparent defects" |
| <b>SAFETY FEATURES</b>   | ####                                   | State the deficiency, or "No apparent defects" |
| <b>DECK GEOMETRY</b>   | 9 / 8 / 7 / etc.                       | XXXXXX   |
| <b>UTILITIES</b>   | Excellent / Very Good /<br>Good / etc. | State the deficiency, or "No apparent defects" |
| The minimum vertical underclearance is <u>##.## ft.</u> under <u>XXXXXXXXXX</u>    |  |  |
| The lateral underclearances are: Left: <u>##.## ft.</u> Right: <u>##.## ft.</u>    |  |  |
| For waterways include horizontal and vertical clearances of the main channel span. |  |  |



**Format "A"****CONCLUSIONS AND RECOMMENDATIONS:**

Provide the overall condition of the structure and indicate which item controls (Item 59, 60, 62, or Inventory Rating).

Provide comments on any major components (Items 58, 59, 60, 61, 62 and/or BA) rated at 6 or below. Comments should provide general summary of the defects causing the condition rating of 6 or less.

Provide a list and description of any fracture critical members. Provide a brief summary of in-depth FCM inspection findings if applicable.

Provide statement on scour potential. For scour critical bridges, include proposed countermeasures with costs under major work section below. Include the findings of "Underwater Inspection Report". If underwater inspection was done during current or previous (last) cycle, include a copy of the report.

Indicate reasons why the structure is structurally deficient and/or functionally obsolete, if applicable. Provide a major work statement and major work details (including escalated costs). For scour critical structures, include improvement costs from NJDOT Memorandum dated May 2, 2008 titled "Bridge Scour Countermeasures Conceptual Design and Cost Estimates for Inspection Reports".

Indicate any required priority repair work, and reference priority repair letter at end of report.

Provide recommendations for interim inspections, monitoring of any elements, etc.

Provide any recommendations for future inspectors, particularly regarding access concerns.

Use all applicable sections. If a section is not applicable to a particular structure, delete the entire row from the template.

**Sample SI & A Sheet (pg 1 of 4 provided as Sample)**

**StructNum:** 1212150

**NJDOT SI and A Sheet**

**Name:** NJ 18 / SOUTH RIVER, CONRAIL, MAIN ST.(CR 615) **S.R.:** 87.7 **SD/FO-** 0 -Not Deficient

| IDENTIFICATION           |                           |                         |                   |
|--------------------------|---------------------------|-------------------------|-------------------|
| 1 State:                 | 34 New Jersey             | 8 Struct Num:           | 1212150           |
| 7 Facility Carried:      | NJ 18                     | 9 Location:             | 0.4 MIN OF CR 516 |
| 5A Rta.(On/Under):       | Route On Structure        | 5B Rta. Signing Prefix: | 3 -State Hwy      |
| 5C Level of Service:     | 1 -Mainline               | 5D Rta. Number:         | 00018             |
| 5E Directional Suffix:   | 0 - Not Applicable        | % Responsibility :      | NA                |
| 2 SHD District:          | 02- Central               | 3 County Code:          | Middlesex         |
| 4 Place Code:            | East Brunswick (Township) | 11 Mile Post:           | 34.820 mi         |
| 6 Feature Intersected :  | S.RIVER,CONRAIL, MAIN ST  |                         |                   |
| 16 Latitude:             | 40d 24' 46.56"            | 17 Longitude:           | 074d 21' 59.04"   |
| 98 Border Bridge Code:   | -2 Not Applicable (P)     |                         |                   |
| 99 Border Bridge Number: | NA                        |                         |                   |

| INSPECTION         |           |                          |            |
|--------------------|-----------|--------------------------|------------|
| 91 Frequency:      | 24 months | 90 Inspection Date:      | 10/23/2012 |
| 92A FC Frequency:  | NA        | 93A FC Inspection Date:  | NA         |
| 92B UW Frequency:  | NA        | 93B UW Inspection Date:  | NA         |
| 92C SI Frequency:  | NA        | 93C SI Date:             | NA         |
| Element Frequency: | 24 months | Element Inspection Date: | 10/23/2012 |

| CLASSIFICATION              |                          |                          |                        |
|-----------------------------|--------------------------|--------------------------|------------------------|
| 100 STRAHNET Highway:       | 3 - STRAHNET CONNEC      | 101 Parallel Structure:  | N -No    bridge exists |
| 102 Direction of Traffic:   | 2 -2-way traffic         | 103 Temporary Structure: | _ Blank                |
| 104 Highway System:         | 1 -On the NHS            | 112 NBIS Length:         | Y - Long Enough        |
| 20 Toll Facility:           | 3 -On free road          | 26 Functional Class:     | 14 -Urban Other Princ  |
| 37 Historical Significance: | 5 -Not eligible for NRHP |                          |                        |
| 22 Owner:                   | 01 NJDOT                 |                          |                        |
| 21 Custodian:               | 01 NJDOT                 |                          |                        |

| STRUCTURE TYPE AND MATERIALS     |                          |
|----------------------------------|--------------------------|
| 46 Number of Approach Spans :    | 0                        |
| 45 Number of Spans Main Unit:    | 4                        |
| 43A/B Main Span Material/Design: |                          |
| 4 -Steel Continuous              | 02 -Stringer/Girder      |
| 107 Deck Type:                   | 1- Conc., Cast-in-Place  |
| 108A Wearing Surface:            | 1 -Monolithic Concrete   |
| 108B Membrane:                   | 0 -None                  |
| 108C Deck Protection:            | 1- Epoxy Coated Reinfor. |

| CONDITION   |                   |                                |
|-------------|-------------------|--------------------------------|
| 58 Deck:    | 7 -Good           | 59 Super:                      |
| 62 Culvert: | N -Not applicable | 61 Channel/Channel Protection: |
| 60 Sub:     | 7 -Good           | 6 -Bank Slumping               |

| LOAD RATING AND POSTING      |                         |                             |                        |
|------------------------------|-------------------------|-----------------------------|------------------------|
| 65 Inv entory Rating Method: | 1- LF Load Factor       | 63 Operating Rating Method: | 1 -LF Load Factor      |
| 66 Inv entory Rating:        | HS41.0                  | 64 Operating Rating:        | HS89.0                 |
| 31 Design Load:              | 9 -HS 25 or greater     | 70 Posting:                 | 5 At/Above Legal Loads |
| 41 Posting status:           | A -Open, no restriction |                             |                        |

| AGE AND SERVICE            |                       |                         |        |
|----------------------------|-----------------------|-------------------------|--------|
| 27 Year Built:             | 1999                  | 106 Year Reconstructed: | -4     |
| 42A Type of Service On:    | 5 -Highway-pedestrian |                         |        |
| 42B Type of Service Under: | 8 -Hwy-waterway-RR    |                         |        |
| 28A Lanes on:              | 8                     | 28B Lanes Under:        | 4      |
| 29 ADT:                    | 55,604                | 109 Truck ADT:          | 4 %    |
|                            |                       | 30 Year of ADT:         | 2010   |
|                            |                       | 19 Detour Length:       | 2.0 mi |

| APPRAISAL                                   |                         |                         |                         |
|---|-------------------------|-------------------------|-------------------------|
| 36A Bridge Rail:                            | 0 -Substandard          | 36C Approach Rail:      | 0 -Substandard          |
| 36B Transition:                             | 0 -Substandard          | 36D Approach Rail Ends: | 1 -Meets Standards      |
| 67 Str. Evaluation:                         | 7                       | 68 Deck Geometry:       | 6 Equal Min Criteria    |
| 69 Underclearance, Vertical and Horizontal: | 6 -Equal Minimum        |                         |                         |
| 71 Waterway Adequacy:                       | 9 -Above Desirable      | 72 Approach Alignment:  | 8 -Equal Desirable Crit |
| 113 Scour Critical:                         | 8 -Stable Above Footing |                         |                         |

| GEOMETRIC DATA                                  |                       |                            |                         |
|---|-----------------------|----------------------------|-------------------------|
| 48 Length Max Span:                             | 139.0 ft              | 49 Structure Length:       | 484.0 ft                |
| 50A Curb/Sdwk Width L:                          | 5.9 ft                | 50B Curb/Sidewalk Width R: | 5.9 ft                  |
| Width Curb to Curb 51:                          | 109.6 ft              | 52 Width Out to Out:       | 126.0 ft                |
| 32 Approach Roadway Width:                      | 110 ft                | 33 Median:                 | 3 Closed Med w/Barriers |
| Deck Area:                                      | 60,988.3 sq. ft       |                            |                         |
| 34 Skew:  | 14.00 °               | 35 Structure Flared:       | 0 -No flare             |
| 53 Minimum Vertical Clearance Over Bridge:      | 9999                  |                            |                         |
| 54A Minimum Vertical Underclearance Reference:  | H -Hwy beneath struct |                            |                         |
| 54B Minimum Vertical Underclearance:            | 23.42 ft              |                            |                         |
| 55A Minimum Lateral Underclearance Reference R: | H -Hwy beneath struct |                            |                         |
| 55B Minimum Lateral Underclearance R:           | 20.00 ft              |                            |                         |
| 56 Minimum Lateral Underclearance L:            | 0.00 ft               |                            |                         |

| PROPOSED IMPROVEMENTS     |       |                          |
|---------------------------|-------|--------------------------|
| 94 Bridge Cost:           | (\$1) | 75 Type of Work:         |
| 95 Roadway Cost:          | (\$1) | 76 Length of Improvment: |
| 96 Total Cost:            | (\$1) | 114 Future ADT:          |
| 97 Year of Cost Estimate: | 0     | 115 Year of Future ADT:  |
|                           |       | -1                       |
|                           |       | -3 ft                    |
|                           |       | 67,847                   |
|                           |       | 2030                     |

| NAVIGATION DATA                     |                  |                          |        |
|-------------------------------------|------------------|--------------------------|--------|
| 38 Navigation Control:              | 0                | 0 -Permit Not Required   |        |
| 39 Vertical Clearance:              | 0.0 ft           | 40 Horizontal Clearance: | 0.0 ft |
| 111 Pier Protection:                | _ Not Applicable |                          |        |
| 116 Lift Bridge Vertical Clearance: |                  |                          |        |

**ELEMENT CONDITION STATE DATA**

| Str Unit | Elm/Erw | Description          | Units | Total Qty | % in 1 | Qty. St. 1 | % in 2 | Qty. St. 2 | % in 3 | Qty. St. 3 | % in 4 | Qty. St. 4 | % in 5 | Qty. St. 5 |
|----------|---------|----------------------|-------|-----------|--------|------------|--------|------------|--------|------------|--------|------------|--------|------------|
| 0        | 26/3    | Conc Deck/Coatd Bars | (SF)  | 60,984    | 100 %  | 60,984     | 0 %    | 0          | 0 %    | 0          | 0 %    | 0          | 0 %    | 0          |
| 0        | 107/3   | Paint Stl Opn Girder | (LF)  | 6,776     | 99 %   | 6,675      | 1 %    | 50         | 1 %    | 50         | 0 %    | 1          | 0 %    | 0          |
| 0        | 205/3   | R/Conc Column        | (EA)  | 24        | 100 %  | 24         | 0 %    | 0          | 0 %    | 0          | 0 %    | 0          | 0 %    | 0          |
| 0        | 210/3   | R/Conc Pier Wall     | (LF)  | 119       | 100 %  | 119        | 0 %    | 0          | 0 %    | 0          | 0 %    | 0          | 0 %    | 0          |
| 0        | 215/3   | R/Conc Abutment      | (LF)  | 266       | 87 %   | 231        | 13 %   | 35         | 0 %    | 0          | 0 %    | 0          | 0 %    | 0          |
| 0        | 234/3   | R/Conc Cap           | (LF)  | 378       | 100 %  | 378        | 0 %    | 0          | 0 %    | 0          | 0 %    | 0          | 0 %    | 0          |

**LOAD RATING SUMMARY SHEET (LRSS) (Revise as required)**

(Form NJ-BI-101 Created 1/25/2011)

**Project Information:**

Group: MMMM Agreement No.: N/A Contract ID: N/A Agree/Mod No.: N/A

**Rating Information:**

Method: LRFR: Yes / No LFR: Yes / No ASR: Yes / No Other (Specify): \_\_\_\_\_

Rating Date: \_\_\_\_\_ Computer Software Used: \_\_\_\_\_ Version: \_\_\_\_\_

Load Testing: Yes / No Cycle when Rating Performed: 1 Design Load: \_\_\_\_\_

**Structure Information: (Indicate N/A where appropriate)**

Plans Available? Yes / No Contract Designation: \_\_\_\_\_

Overlay? Yes / No Considered in Rating? Yes / No Type/Thickness: \_\_\_\_\_

Section Losses? Yes / No Considered in Rating? Yes / No Item 59 Cond.: \_\_\_\_\_

**For LRFR Use Only: (Indicate critical value if it varies amongst different members)**

Dynamic Load Allowance: \_\_\_\_\_ Condition Factor: \_\_\_\_\_ System Factor: \_\_\_\_\_

ADTT (one direction): \_\_\_\_\_ Resistance Factor: \_\_\_\_\_ FCM: Yes / No

**Load Rating Engineer (LRE):**

Name: \_\_\_\_\_ Firm: \_\_\_\_\_ Initial: \_\_\_\_\_

**Load Rating Reviewer (LRR) certification as per the NBIS Title 23 CFR Section 650.309(c):**

Name: \_\_\_\_\_ N.J. P.E. No.: \_\_\_\_\_

Firm: \_\_\_\_\_

I certify that this rating is an accurate representation of the subject structure, considering all deterioration and/or changes to loading conditions, to the extent determinable by research and visual inspection and testing performed. I am charged with the overall responsibility for bridge capacity evaluation for the above mentioned structure.

Sign and Seal if  
Rating Performed  
in this Cycle

**Sign, seal, and date, if rated this cycle.**

\_\_\_\_\_  
Sign Date

**LOAD RATING SUMMARY SHEET (LRSS) (cont.)**

**Rating Comments:**

List any assumptions. List any comments on posting requirements. Indicate the specific reason(s) for rating the bridge. Indicate the load path of the structure. Indicate all superstructure members that have not been considered in this rating. If non-standard rating software is used, indicate methodology used for rating calculations. List any considerations that may simplify future ratings. Indicate any alterations made to the NJDOT Default LARS Customization files. Add lines as necessary.

The Load Factor/Working Stress and LRFR ratings, computed in accordance with the FHWA directive dated November 1993, AASHTO Manual for Bridge Evaluation, 2011, as modified by the NJDOT Highway Bridge Load Rating Manual and Section 43 of the NJDOT Design Manual, Bridges and Structures, are as follows:

| <u>Material</u><br>add/delete as necessary | <u>Compressive Strength</u> f'c | <u>Tensile Strength</u> | <u>Allowable Stresses (PSI)</u> |                  |                  |
|--|---------------------------------|-------------------------|---------------------------------|------------------|------------------|
|  |                                 |                         | <u>Yield</u>                    | <u>Inventory</u> | <u>Operating</u> |
| Concrete                                   |                                 | ---                     | ---                             |                  |                  |
| Concrete (Beam)                            |                                 | ---                     | ---                             |                  |                  |
| Structural Steel                           | ---                             | ---                     |                                 |                  |                  |
| Reinforcing Steel                          | ---                             | ---                     |                                 |                  |                  |
| Prestressing Steel                         | ---                             |                         |                                 |                  |                  |

| <u>Member</u>  | <u>Truck Type (Tons)</u> |       | <u>Rating (Tons) / Rating Factor</u> |            |                 |            |                 |                         |                 |                         |
|--|--------------------------|-------|--------------------------------------|------------|-----------------|------------|-----------------|-------------------------|-----------------|-------------------------|
|  |                          |       | <u>ASR -or- LFR</u>                  |            |                 |            | <u>LRFR</u>     |                         |                 |                         |
|  |                          |       | <u>As-Built</u>                      |            | <u>As-Insp.</u> |            | <u>As-Built</u> |                         | <u>As-Insp.</u> |                         |
|  |                          |       | <u>Inv.</u>                          | <u>Op.</u> | <u>Inv.</u>     | <u>Op.</u> | <u>Inv.</u>     | <u>Op.</u> <sup>1</sup> | <u>Inv.</u>     | <u>Op.</u> <sup>1</sup> |
| Interior Stringer <sup>2</sup><br>02-IG003<br>Cond. Rating = # | H15                      | (15T) |                                      |            |                 |            |                 |                         |                 |                         |
|  | HS-20                    | (36T) |                                      |            |                 |            |                 |                         |                 |                         |
|  | 3                        | (25T) |                                      |            |                 |            | ---             |                         | ---             |                         |
|  | 3S2                      | (40T) |                                      |            |                 |            | ---             |                         | ---             |                         |
|  | 3-3                      | (40T) |                                      |            |                 |            | ---             |                         | ---             |                         |
|  | HL-93                    | (NL)  | ---                                  | ---        | ---             | ---        |                 |                         |                 |                         |
| Interior Stringer<br>03-IG002<br>Cond. Rating = #              | H15                      | (15T) |                                      |            |                 |            |                 |                         |                 |                         |
|  | HS-20                    | (36T) |                                      |            |                 |            |                 |                         |                 |                         |
|  | 3                        | (25T) |                                      |            |                 |            | ---             |                         | ---             |                         |
|  | 3S2                      | (40T) |                                      |            |                 |            | ---             |                         | ---             |                         |
|  | 3-3                      | (40T) |                                      |            |                 |            | ---             |                         | ---             |                         |
|  | HL-93                    | (NL)  | ---                                  | ---        | ---             | ---        |                 |                         |                 |                         |

<sup>1</sup> Operating level rating of design load or legal load rating

<sup>2</sup> Controlling Member

NL – Notional Load

#### 43.4 Re-Evaluation Survey Report Format - B -

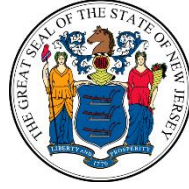
The report of the results of a re-evaluation bridge survey and rating of an existing bridge where major rehabilitation has been performed and/or significant changes to the structure ratings are required, performed by or for the Department, shall adhere to the following format:

- A. **Report Cover Sheet:** The report's cover sheet shall utilize the same form as indicated in Format A except that it shall be labeled as a *Re-Evaluation Survey Report* and a statement shall be included indicating that the report shall be filed immediately after the preceding cycle report (see attached sample in Format B).  
The report shall be bound using a standard 3-hole punch type binding.
- B. **Letter of Transmittal** (Consultant Projects Only): The letter of transmittal shall be addressed as shown in Format A (see sample in Format A).
- C. **Table of Contents:** One page indicating items 1 thru 11 in order shown as follows and providing the page number in the report on which each item starts. All pages in the report shall be numbered (i.e. Cycle No. - Page No.) at the bottom and centered.

|   | <b>Page No.</b> |
|---|-----------------|
| 1. Maps   | X-X             |
| 2. Structural Data                                    | X-X             |
| 3. Component Rating Summary                           | X-X             |
| 4. Conclusions and Recommendations                    | X-X             |
| 5. Bridge Description                                 | X-X             |
| 6. Structural Inventory & Appraisal and Pontis Sheets | X-X             |
| 7. Load Rating Summary Sheet (LRSS)                   | X-X             |
| 8. Drawings, Soundings and Photographs                | X-X             |
| 9. Field Notes  | X-X             |
| 10. Associated Documents                              | X-X             |
| 11. Vandalism Report                                  | X-X             |

1. **Maps:** Two maps are required as specified in Format A.
2. **Structural Data:** A summary and work done shall be included as indicated in Format A with any addition of any observations of "work done" noted.
3. **Component Rating Summary:** The component summary shall be included as indicated in Format A.
4. **Conclusions & Recommendations:** Conclusions shall be provided as indicated in Format A. Also, comment on any major changes in the condition of all components since the previous bridge survey report cycle. If no changes have occurred, include a statement to that effect.
5. **Bridge Description:** Furnish a brief description of the structure and the major rehabilitation work performed since the previous evaluation. Include the type of design and construction, materials in the deck, superstructure and substructure components, and important dimensions. Also, comment on the substructure foundation design if based on FHWA Hydraulic Engineering Circular (HEC-18). A more detailed description should be given if plans are not available.

6. **Structural Inventory & Appraisal and Pontis Sheets:** This section should contain the above listed data forms as indicated in Format A.
7. **Load Rating Summary Sheet (LRSS):** In this section, include computations of ratings for various major bridge components as indicated in Format A.
8. **Drawings, Soundings & Photographs:** This section shall contain bridge drawings, sounding sketches, and photographs as indicated in Format A.
9. **Field Notes:** Provide field notes and sketches as specified in Format A in this section.
10. **Associated Documents:** Include the diver's inspection report (if applicable) as specified in Format A.  
  
Attach any memorandum prepared for any Priority/Emergency condition observed at the time of the inspection as specified in Format A.  
  
Attach the detailed load rating report (if applicable) as specified in Format A.  
  
Additionally, include any special reports as specified in Format A.
11. **Vandalism Report:** Include the completed form to report vandalism of the subject structure as specified in Format A.

**Sample – Format B for State Bridges**

State of New Jersey  
 NEW JERSEY DEPARTMENT OF TRANSPORTATION  
 1035 PARKWAY AVENUE  
 P.O. Box 600  
 TRENTON, NEW JERSEY 08625-0600

**BRIDGE RE-EVALUATION SURVEY REPORT**

STRUCTURE NO. ####-###  
 NJ ## OVER XX ROAD AND XX RIVER OR RAILROAD  
 XX BOROUGH AND/OR TOWNSHIP  
 XX COUNTY

##<sup>TH</sup> CYCLE

MONTH DD, YYYY

**NOTE:** This Bridge Re-Evaluation Survey  
 Report shall be filed immediately  
 after the ##<sup>TH</sup> Cycle Inspection Report.

**NOTES:**

1. Red and yellow guidance text **NOT** to be included in actual report document (user must delete).
2. Blue placeholder text to be properly edited and converted to black text (upon completion of the report, select all text using the Ctrl "A" command and change color to black).
3. Entire report shall be within table. \*Activate Gridlines\*
4. This textbox to be removed.

Prepared By

**XYZ Consultant**  
 (Consultant's Logo)

**123 Main Street**  
**Trenton, NJ 08625**

**Format "B"**

**N.J.D.O.T. - STRUCTURAL EVALUATION AND BRIDGE MANAGEMENT  
RE-EVALUATION BRIDGE SURVEY REPORT**

**CYCLE NO. ##**

**STRUCTURAL DATA:**

Bridge No.: #### - ### Year Built: Widened/Rehab:  
 Route No.: ## Length: Width:  
 (Item AA)  
 Mile Point: Date of this Evaluation: MM/DD/YYYY  
 Municipality: By:  
 Date of Previous Evaluation: MM/DD/YYYY  
 County: By:  
 Date of FCM/Pin & Hanger Inspection: MM/DD/YYYY  
 Name: NJ ## over By: (Only when special inspection is applicable)  
 XX Road and Special Equipment Used:  
 XX River or Railroad  
 Structure Type: Date of Underwater Inspection: MM/DD/YYYY  
 By: (Only when applicable)  
 Date of Special Testing: MM/DD/YYYY  
 Date of Elec/Mech Inspection (Level: II): MM/DD/YYYY  
 Scour Critical: Yes/No  
 If Yes, give reasons in Conc. with scour statement

**WORK DONE:** (Reference a Photo)

**OVERALL PHYSICAL CONDITION:** (Indicate which Item(s) controls: 59, 60, and/or 62)

**OVERALL CONDITION (ITEM 67):** (Indicate which Item(s) controls: 59, 60, 62, and/or 66)

Inspection Team Leader: XYZ \_\_\_\_\_

Initials: \_\_\_\_\_

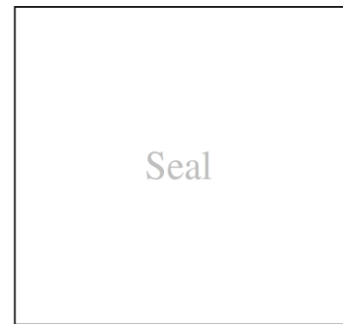
Certifying Engineer: ABC P.E. \_\_\_\_\_

N.J. P.E. Number: ### \_\_\_\_\_

I certify that this report is an accurate description of the subject structure, to the extent determinable by visual inspection and testing performed.

Signature: \_\_\_\_\_

Date: \_\_\_\_\_





**Format "B"****CONCLUSIONS AND RECOMMENDATIONS:**

Provide the overall condition of the structure and indicate which item controls (Item 59, 60, 62, or Inventory Rating).

Provide comments on any major components (Items 58, 59, 60, 61, 62 and/or BA) rated at 6 or below. Comments should provide general summary of the defects causing the condition rating of 6 or less.

Indicate any changes since the previous cycle. Provide justification for any upgrades or downgrades of Items 58, 59, 60, 61 or 62.

Provide a list and description of any fracture critical members. Provide a brief summary of in-depth FCM inspection findings if applicable.

Comment on conditions that require revisions to the load rating calculations.

Provide statement on scour potential. For scour critical bridges, include proposed countermeasures with costs under major work section below. Include the findings of "Underwater Inspection Report". If underwater inspection was done during current or previous (last) cycle, include a copy of the report.

Indicate reasons why the structure is structurally deficient and/or functionally obsolete, if applicable. Provide a major work statement and major work details (including escalated costs). For scour critical structures, include improvement costs from NJDOT Memorandum dated May 2, 2008 titled "Bridge Scour Countermeasures Conceptual Design and Cost Estimates for Inspection Reports".

Indicate any required priority repair work, and reference priority repair letter at end of report.

Provide recommendations for interim inspections, monitoring of any elements, etc.

Use all applicable sections. If a section is not applicable to a particular structure, delete the entire row from the template.

### 43.5 Re-Evaluation Survey Report Format - C –

The report of the results of a re-evaluation bridge survey and rating of an existing bridge that has **not** undergone major rehabilitation work or had significant changes to the structure ratings, performed by or for the Department, shall adhere to the following format:

- A. **Report Cover Sheet:** The report's cover sheet shall utilize the same form as indicated in Format B (see attached sample in Format B).

The report shall be bound using a standard 3-hole punch type binding.

- B. **Letter of Transmittal** (Consultant Projects Only): The letter of transmittal shall be addressed as shown in Format A (see sample in Format A).

- C. **Table of Contents:** One page indicating items 1 through 8 in order shown as follows and providing the page number in the report on which each item starts. All pages in the report shall be numbered (i.e. Cycle No.-Page No.) at the bottom and centered.

|   | <b>Page No.</b> |
|---|-----------------|
| 1. Structural Data                                    | x-x             |
| 2. Conclusions and Recommendations                    | x-x             |
| 3. Structural Inventory & Appraisal and Pontis Sheets | x-x             |
| 4. Load Rating Summary Sheet (LRSS)                   | x-x             |
| 5. Drawings, Soundings and Photographs                | x-x             |
| 6. Field Notes  | x-x             |
| 7. Associated Documents                               | x-x             |
| 8. Vandalism Report(s)                                | x-x             |

- Structural Data:** A summary of the work done since the previous bridge survey shall be included as per the attached format. The remaining items in this format are self-explanatory.
- Conclusions & Recommendations:** Conclusions shall be provided as indicated in Format B.
- Structural Inventory & Appraisal and Pontis Sheets:** This section should contain the above listed data forms as indicated in Format A.
- Load Rating Summary Sheet (LRSS):** In this section, include computations of ratings for various major bridge components as indicated in Format A.
- Drawings, Soundings & Photographs:** This section shall contain bridge drawings, sounding sketches, and photographs as indicated in Format A.
- Field Notes:** Provide field notes and sketches as specified in Format A in this section.
- Associated Documents:** Include the diver's inspection report (if applicable) as specified in Format A. Attach any memorandum prepared for any Priority/Emergency condition observed at the time of the inspection as specified in Format A.

Attach the detailed load rating report (if applicable) as specified in Format A.

Additionally, include any special reports as specified in Format A.

8. **Vandalism Report:** Include the completed form to report vandalism of the subject structure as specified in Format A.

**Format "C"**

**N.J.D.O.T. - STRUCTURAL EVALUATION AND BRIDGE MANAGEMENT  
RE-EVALUATION BRIDGE SURVEY REPORT**

**CYCLE NO. ##**

**STRUCTURAL DATA:**

Bridge No.: ##### - ### Year Built: Widened/Rehab:  
 Route No.: ## Length: Width:  
 (Item AA)  
 Mile Point: Date of this Evaluation: MM/DD/YYYY  
 Name: NJ ## over By:  
 XX Road and Date of Previous Evaluation: MM/DD/YYYY  
 XX River or  
 Railroad By:  
 Date of FCM/Pin & Hanger Inspection: MM/DD/YYYY  
 By: (Only when special inspection is applicable)  
 Special Equipment Used:  
 Structure Type: Date of Underwater Inspection: MM/DD/YYYY  
 By: (Only when applicable)  
 Date of Special Testing: MM/DD/YYYY  
 Date of Elec/Mech Inspection (Level: II): MM/DD/YYYY  
 Scour Critical: Yes/No  
 If Yes, give reasons in Conc. with scour statement

**WORK DONE:** (Reference a Photo)

**OVERALL PHYSICAL CONDITION:** (Indicate which Item(s) controls: 59, 60, and/or 62)

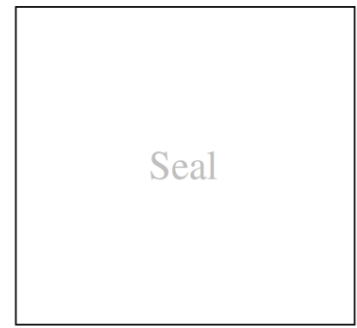
**OVERALL CONDITION (ITEM 67):** (Indicate which Item(s) controls: 59, 60, 62, and/or 66)

Inspection Team Leader: XYZ \_\_\_\_\_  
 Certifying Engineer: ABC P.E. \_\_\_\_\_  
 N.J. P.E. Number: ### \_\_\_\_\_

Initials: \_\_\_\_\_

I certify that this report is an accurate description of the subject structure, to the extent determinable by visual inspection and testing performed.

Signature: \_\_\_\_\_  
 Date: \_\_\_\_\_



### 43.6 Interim Survey Report Format - D -

The report of the results of an interim bridge survey and rating of an existing bridge, performed by or for the Department, shall adhere to the following format:

- A. **Report Cover Sheet:** The report's cover sheet shall utilize the same form as indicated in Format B, except that it should be noted as an "interim" evaluation rather than an incremental bridge evaluation cycle number (see attached sample in Format D).

The report shall be bound using a standard 3-hole punch type binding.

- B. **Letter of Transmittal** (Consultant Projects Only): The letter of transmittal shall be addressed as shown in Format A (see sample in Format A):
- C. **Table of Contents:** One page indicating items 1 thru 9 in order shown on the following page and providing the page number in the report on which each item starts. All pages in the report shall be numbered at the bottom and centered.

|   | <b>Page No.</b> |
|---|-----------------|
| 1. Structural Data                                    | x.I-x           |
| 2. Reason for Interim Survey                          | x.I-x           |
| 3. Current Condition                                  | x.I-x           |
| 4. Conclusions and Recommendations                    | x.I-x           |
| 5. Structural Inventory & Appraisal and Pontis Sheets | x.I-x           |
| 6. Load Rating Summary Sheet (LRSS)                   | x.I-x           |
| 7. Drawings, Soundings and Photographs                | x.I-x           |
| 8. Associated Documents                               | x.I-x           |
| 9. Vandalism Report(s)                                | x.I-x           |

1. **Structural Data:** A summary of findings and work done shall be included as per the attached format. The items in this format are self-explanatory.
2. **Reasons for Interim Survey:** Indicate specifically the areas or members of the bridge requiring an interim inspection. These areas could be locations of deterioration such as loss of concrete under a bearing or a tilted wingwall. They also could be structure members with low operating ratings (list all members with low operating ratings) or fracture critical members.
3. **Current Condition:** Indicate the current condition of the items identified in the previous section. Also, state if any changes have occurred since the last survey (in-depth or interim).
4. **Conclusions & Recommendations:** Conclusions resulting from the interim bridge evaluation survey regarding the items inspected should be given here. Also, include possible explanation of the causes of any inadequacies found. If the bridge is posted, state so, giving the posted limits (load or speed) and referencing photos clearly showing the posted weight or speed limits.

Make specific new recommendations for safety improvements, major repair work (i.e. structure rehabilitation and/or replacement, raising superstructure, bridge widening, etc. to correct Structurally Deficient/Functionally Obsolete conditions) and other repair work to correct significant defects, deterioration and inadequacies found during this interim bridge survey. The intent is to list any new repairs which are needed, not to repeat the recommendations from

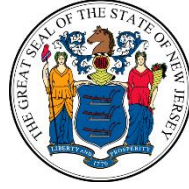
the latest bridge evaluation survey report. If no new repairs are necessary, this should be stated.

The recommendations should be specific about the location of defects and the methods of repair. The recommendations for other repair work should be listed in the order of priority. Each recommendation should be referenced to the photos. For major repair work, provide cost estimates. For other repair work, provide quantities only.

5. **Structural Inventory & Appraisal and Pontis Sheets:** This section should contain the above listed data forms as indicated in Format A.
6. **Summary of Ratings:** In this section, include computations of ratings for various major bridge components as indicated in Format A.
7. **Drawings, Soundings & Photographs:** This section shall contain bridge drawings, sounding sketches, photo location plan sketch and photographs as indicated in Format A with the following exceptions:  

Photographs of one elevation one roadway, and one underside, plus any posting signs, work done since previous inspection, Priority items, and any changes in the interim items inspected are required.
8. **Associated Documents:** Attach any memorandum prepared for any Priority/Emergency condition observed at the time of the inspection as specified in Format A.  

Additionally, include any special reports prepared as part of the Interim evaluation.
9. **Vandalism Report:** Include the completed form to report vandalism of the subject structure as specified in Format A.

**Sample – Format D for State Bridges**

State of New Jersey  
 NEW JERSEY DEPARTMENT OF TRANSPORTATION  
 1035 PARKWAY AVENUE  
 P.O. Box 600  
 TRENTON, NEW JERSEY 08625-0600

**INTERIM BRIDGE EVALUATION SURVEY REPORT**

STRUCTURE NO. #####-###  
 NJ ## OVER XX ROAD AND XX RIVER OR RAILROAD  
 XX BOROUGH AND/OR TOWNSHIP  
 XX COUNTY

MONTH DD, YYYY

**NOTE:** This Interim Bridge Evaluation Report  
 shall be filed immediately after the  
 ##<sup>TH</sup> Cycle Inspection Report.

**NOTES:**

1. Red and yellow guidance text **NOT** to be included in actual report document (user must delete).
2. Blue placeholder text to be properly edited and converted to black text (upon completion of the report, select all text using the Ctrl "A" command and change color to black).
3. Entire report shall be within table. \*Activate Gridlines\*
4. This textbox to be removed.

Prepared By

**XYZ Consultant**  
 (Consultant's Logo)

**123 Main Street**  
**Trenton, NJ 08625**

**Format "D"****N.J.D.O.T. - STRUCTURAL EVALUATION AND BRIDGE MANAGEMENT  
INTERIM BRIDGE EVALUATION SURVEY REPORT**FREQUENCY: ## MONTHS**STRUCTURAL DATA:**

Bridge No.: ####-### Year Built: \_\_\_\_\_ Widened/Rehab: \_\_\_\_\_  
Route No.: ## Length: \_\_\_\_\_ Width: \_\_\_\_\_  
**(Item AA)**  
Mile Point: \_\_\_\_\_ Date of this Evaluation: MM/DD/YYYY  
Name: \_\_\_\_\_ By: \_\_\_\_\_  
Date of Previous Evaluation: MM/DD/YYYY  
Type of Previous Evaluation: **(Indicate routine or interim)**  
By: \_\_\_\_\_  
Date of FCM/Pin hanger Inspection: MM/DD/YYYY  
By: **(Only When Special Inspection is applicable)**  
Special Equipment Used: \_\_\_\_\_  
Structure Type: \_\_\_\_\_ Date of Underwater Inspection: MM/DD/YYYY  
By: **(Only when applicable)**  
Date of Special Testing: MM/DD/YYYY  
Date of Elec./Mech. Inspection (Level: II): \_\_\_\_\_  
Scour Critical: Yes / No

**If "Yes" give reasons in Conclusions section along with scour statement.****WORK DONE:** **(Since most recent inspection – Regular or Interim). Refer to Photo.****OVERALL PHYSICAL CONDITION:** **(Indicate which Item(s) controls: 59, 60, and/or 62)****OVERALL CONDITION (ITEM 67):** **(Indicate which Item(s) controls: 59, 60, 62 and/or 66)**Inspection Team Leader: XYZ Initials: \_\_\_\_\_Certifying Engineer: ABC P.E.N.J. P.E. Number: ###

I certify that this report is an accurate description of the subject structure, to the extent determinable by visual inspection and testing performed.

Signature: \_\_\_\_\_

Date: \_\_\_\_\_





**Format "D"****REASONS FOR INTERIM INSPECTION:**

Indicate specifically the areas or members of the bridge requiring an interim inspection. These areas could be locations of deterioration such as loss of concrete under a bearing or a tilted wingwall. They also could be structure members with low operating ratings (list all members with low operating ratings) or fracture critical members.

**CURRENT CONDITION OR CHANGES IN ITEMS INSPECTED:**

Indicate the current condition of the items identified in the previous section. Also, state if any changes have occurred since the last survey (in-depth or interim).

**CONCLUSIONS & RECOMMENDATIONS:**

Conclusions resulting from the interim bridge evaluation survey regarding the items inspected should be given here. Also, include possible explanation of the causes of any inadequacies found. If the bridge is posted, state so, giving the posted limits (load or speed) and should be referenced to photos clearly showing the posted weight or speed limits. Indicate conditions that require revisions to the load rating calculations.

Make specific new recommendations for safety improvements, major repair work (i.e. structure rehabilitation and/or replacement, raising superstructure, bridge widening, etc. to correct Structurally Deficient or Functionally Obsolete conditions) and other repair work to correct significant defects, deterioration and inadequacies found during this interim bridge survey (Priority Repairs). The intent is to list any new recommendations which are needed, not to repeat the recommendations from the latest bridge evaluation survey report. If no new repairs are necessary, this should be stated. Recommendations should only pertain to component(s) requiring the interim inspection.

Any defects that require a repair requiring the issuing of a Priority Repair Memorandum should be addressed. If a memo written during the previous cycle/interim evaluation has not yet been repaired, Priority Repair Letter must be reissued.

The recommendations should be specific about the location of defects and the methods of repair. The recommendations for other repair work should be listed in the order of priority. Each recommendation should be referenced to the photos. For major repair work, provide cost estimates. For other repair work, provide quantities only.

## **43.7 Guidelines for CADD Bridge Evaluation Survey Field Inspection Drawings**

### **A. General**

Recording of the field bridge survey data on computer generated drawings/sketches is intended to supplement the existing handwritten field notes and sketches.

The purpose of utilizing CADD drawings in bridge inspection is two fold:

1. To provide a visual representation of the bridge conditions in addition to verbal descriptions in the bridge survey report (field notes).
2. To facilitate Electronic Storage and updating of bridge conditions and clearances observed during subsequent bridge survey cycles.

Using the existing bridge plans, base plans for various bridge components will be developed for the purpose of taking notes during the field inspection as well as for final report presentation. All base plans will be prepared on 11 by 17 inch sheets, or for small bridges, on 8½ by 11 inch sheets and made appropriately proportioned taking advantage of CADD flexibilities. For example, varying scales can be used lengthwise and widthwise, etc. North arrows should be oriented vertically or to the left when the CADD drawing is placed in the report.

The Department's CADD system is based on Bentley Microstation. However, it is preferable to the Structural Evaluation and Bridge Management Unit that sketches for bridge survey reports be prepared using Microsoft Visio. All CADD drawing files must be submitted to the Department with the final report on a CD. Two (2) copies of the CD are required.

### **B. Required Drawings**

The following drawings are required for bridge evaluation reports:

1. Member Identification Sketch (MIS)

A plan sketch will be necessary to clearly show each primary superstructure member and its corresponding unique identifier. The sketch will typically consist of a simple framing plan and shall be included in the Evaluation Survey Report for all cycles. The MIS sketch is not required to be drawn to scale or detailed, but it must be clear. If space permits, the unique member identifier shall be included adjacent to the member on the sketch. If the sketch becomes too crowded, which is likely for girder-floorbeam bridges), a table may instead be developed that clearly relates each unique member identifier to the proper member on the sketch.

2. Clearances

A clearance plan sketch showing the roadway and the features intersected shall be included for all bridges over roadways and/or railroads and must identify all clearance measurements such as minimum and maximum vertical and lateral underclearances, lane widths, curb-to-curb deck width, span length, sidewalk or median widths, etc. The clearance sketch shall also indicate any posting signs for clearance restrictions. All measurements must be field verified and recorded during each routing survey.

### 3. Soundings

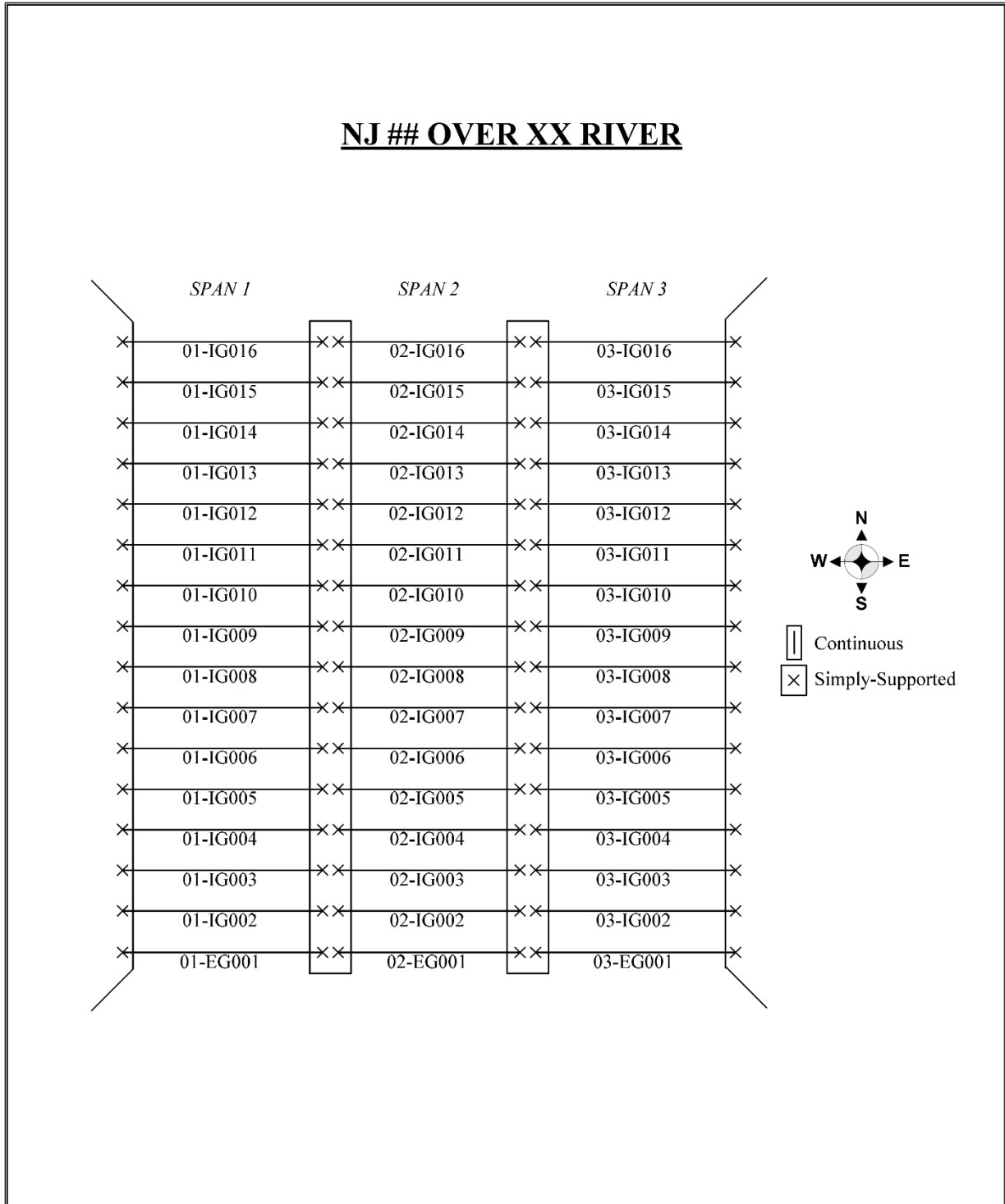
Sounding elevation sketches shall be provided for structures traversing waterways. The sounding plot should also include the plot from the initial sounding survey and a statement as to whether or not the channel profile has changed since the previous survey. When the length of the structure makes the scale of the drawing too small for plotting soundings, separate drawings should be provided. NOTE: Soundings must be done in accordance with the current edition of the "Underwater Inspection and Evaluation of New Jersey Bridges Guidelines Manual" and subsequent modifications.

### 4. Deck Cross Section

A deck cross section sketch shall be provided for all bridges. The sketch shall identify lane, shoulder and sidewalk widths and also out to out and curb to curb widths. The sketch shall also depict various appurtenances including parapets, fences, medians, etc. All cross section sketches must indicate the curb reveal.

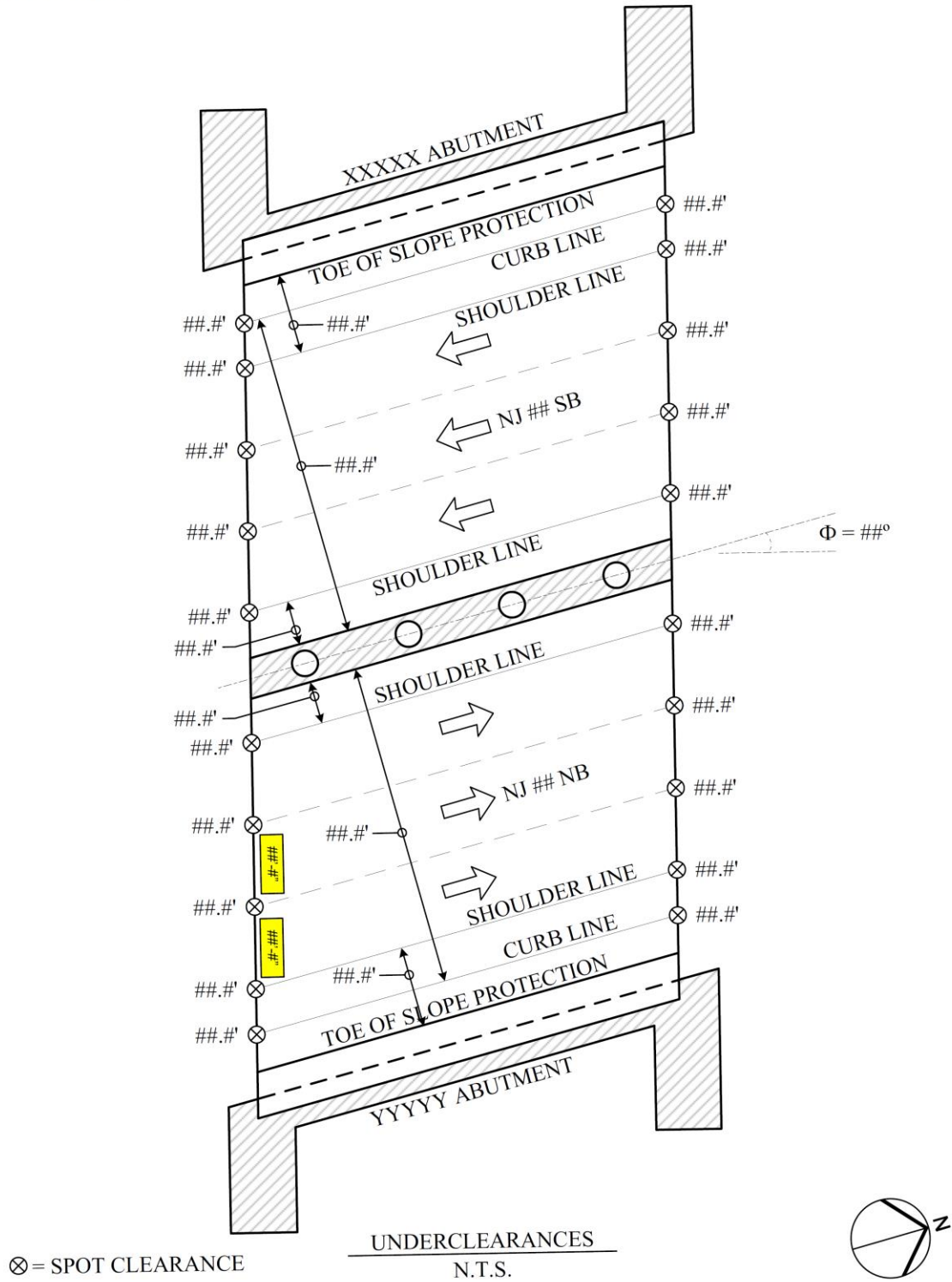
Structure No.: ####-### Route: ## Cycle No.: ##  
 Name: NJ ## over XX River Insp. Date: MM/DD/YYYY

**LARS MEMBER IDENTIFICATION SKETCH (MIS)**



Structure No.: ####-### Route: ## Cycle No.: ##  
 Name: NJ ## over NJ ## Insp. Date: MM/DD/YYYY

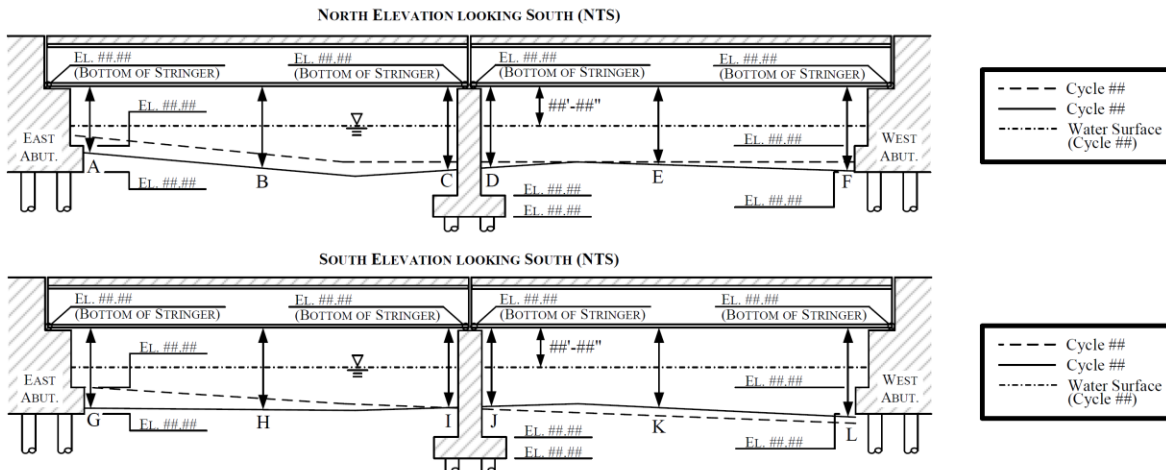
**CLEARANCES:**



Structure No.: ####-### Route: ## Cycle No.: ##  
 Name: NJ ## over XX River Insp. Date: MM/DD/YYYY

**SOUNDINGS:**

| SOUNDING DATA |                      |             |                      |             |
|---------------|----------------------|-------------|----------------------|-------------|
| LOCATION      | JUNE 1982 (CYCLE ##) |             | JULY 2009 (CYCLE ##) |             |
|               | CLEAR DIMENSION      | WATER DEPTH | CLEAR DIMENSION      | WATER DEPTH |
| NORTH         | A                    | ##'-##"     | ##'-##"              | ##'-##"     |
|               | B                    | ##'-##"     | ##'-##"              | ##'-##"     |
|               | C                    | ##'-##"     | ##'-##"              | ##'-##"     |
|               | D                    | ##'-##"     | ##'-##"              | ##'-##"     |
|               | E                    | ##'-##"     | ##'-##"              | ##'-##"     |
|               | F                    | ##'-##"     | ##'-##"              | ##'-##"     |
| SOUTH         | G                    | ##'-##"     | ##'-##"              | ##'-##"     |
|               | H                    | ##'-##"     | ##'-##"              | ##'-##"     |
|               | I                    | ##'-##"     | ##'-##"              | ##'-##"     |
|               | J                    | ##'-##"     | ##'-##"              | ##'-##"     |
|               | K                    | ##'-##"     | ##'-##"              | ##'-##"     |
|               | L                    | ##'-##"     | ##'-##"              | ##'-##"     |

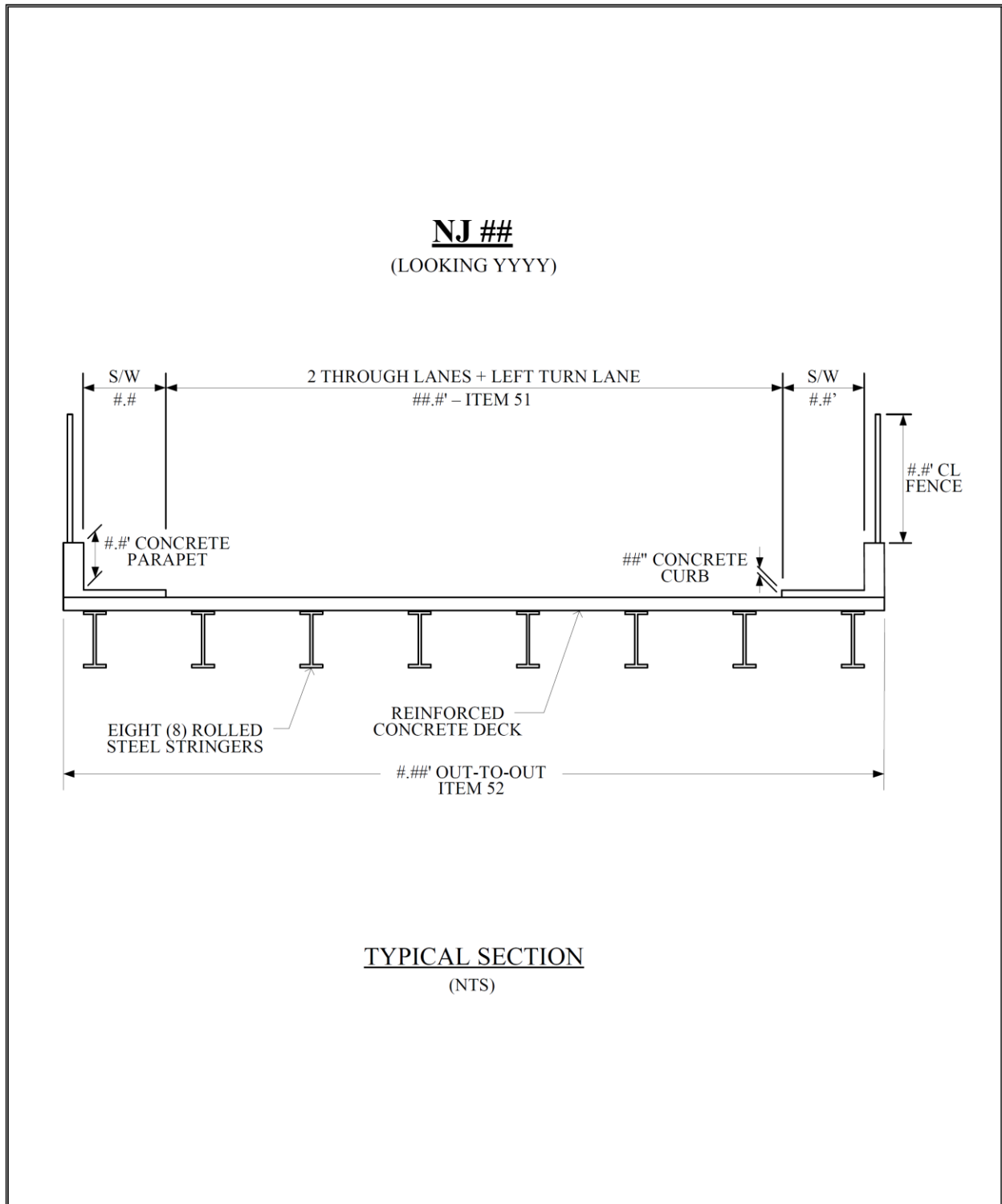


**NOTES:**

- THE CLEAR DIMENSIONS GIVEN ARE REFERENCED FROM THE BOTTOM OF THE GIRDERS TO THE STREAMBED.
- THE WATER DEPTH DIMENSIONS ARE MEASURED FROM THE WATER SURFACE (AT THE TIME OF THE INSPECTION) TO THE STREAMBED.

Structure No.: ####-### Route: ## Cycle No.: ##  
 Name: NJ ## over XX River Insp. Date: MM/DD/YYYY

**DECK CROSS SECTION**



## C. Other Drawings

The following drawings are optional for bridge evaluation reports when the inspector determines that the sketch will be useful in conveying the bridge condition. It is recommended that the same approximate scale be used for the base plan of the following drawing categories 1,2 and 3:

### 1. Deck

Approaches, approach guide rails and at least two (2) end spans (deck) should be shown on one sheet. For multi-span bridges (viaducts), use additional sheets for the top of the deck as necessary.

Underdeck CADD sheets should also show the framing (thin or dashed line) when applicable to facilitate the location of defects relative to the stringers, floor beams, diaphragms, etc.

### 2. Superstructure

Layered framing, if applicable, should be used to clearly show the deterioration of a member in each layer (stringer, floor beams, etc.). The number of sheets required will depend on the length of the structure, number of spans and the complexity of the superstructure. Bearings should be shown on the bridge seat plan.

For movable bridges, CADD drawings for trusses and/or towers should be part of the superstructure.

### 3. Substructure

These drawings should show the breastwall, bridge seat with (or without) bearing pedestals, wingwalls (projected), backwall, slope protection or all four faces of a pier to a suitable approximate scale. Any other substructure features (retaining walls, etc.) should be included as a vertical (or horizontal) projection adjacent to wingwalls.

For abutments, 1 (one) sheet per bridge should be used.

For piers, the number of sheets required will depend on the configuration and the number of piers. Normally three (3) piers can be shown on each sheet.

Abutment and pier plans will be prepared individually by taking advantage of similarities, if any.

For bridges with complex framing, bridges over five spans, or structures with severe deterioration, a summary sheet should include the description of the major findings of each component (deck, superstructure, substructure, channel, etc.) to supplement the CADD information. Also, the maximum length of bridge covered per sheet should be in the range of 45 meters or one to three spans as determined by the Engineer with the approval of the Project Manager.

Examples of typical CADD drawings which are deemed to be acceptable to the Department are attached following the Standard Defect Codes. These drawings are provided to show a representation of what the Department expects in CADD drawings.



## D. Standard Defect Codes

The following guidance is provided to indicate common defects with codes on sketches. Codes used on a sheet should have their description given at the bottom left hand part of the sheet.

Defect codes shall be a three digit code. The first digit shall correspond to the material category based on the following:

C - Concrete      T - Timber      S - Steel      M - Misc.

The second digit describes the type of defect, e.g. scaling, rusting, erosion, etc.

The third digit shall indicate the severity of the defect.

Codes will begin with the letter "A" indicating less severe or minor defects with alphabetically increasing severity, e.g.:

- |            |                     |
|------------|---------------------|
| a. Cracks: | A = Fine            |
|            | B = Medium          |
|            | C = Wide            |
| b. Spalls  | A = Incipient Spall |
|            | B = Small Spall     |
|            | C = Large Spall     |
| c. Scaling | A = Light           |
|            | B = Moderate        |
|            | C = Severe          |

The following is a list of codes developed for each category which by no means should be considered as a complete listing. It only serves as a guide and covers the most common defects and should be supplemented by full descriptions of other defects not easily categorized.

Also, where the bridge inspector believes further elaboration of a defect designated by the code is necessary, an additional sketch of the noted location (i.e. cross section of a beam, measurement of the defect, % loss of bearing area, etc.) should be provided to illustrate the defect observed. Inspectors are encouraged to use additional notes as needed to describe other defects or to further elaborate and locate defects described with codes.

It is very important to quantify the defects such as indicating the length of medium and wide cracks or areas of spalled and scaled concrete to facilitate comparison in future surveys and preparation of estimates. Make sure to include concrete patched spalled areas in the deck separately.

**43.7.1 Concrete (C) Defect Summary**

| Defect Code | Type Defect                 | Severity     |                |                       |
|-------------|-----------------------------|--------------|----------------|-----------------------|
|             |                             | A            | B              | C                     |
| 1           | Cracking                    | Fine         | Medium         | Wide                  |
| 2           | Cracking with Efflorescence | Fine         | Medium         | Wide                  |
| 3           | Efflorescence/ Exudation    | Light        | Moderate       | Heavy                 |
| 4           | Scaling                     | Light        | Moderate       | Severe                |
| 5           | Spalling                    | Small        | Large          | Large (+)             |
| 6           | Spalling with Exposed Steel | Small        | Large          | Large (+)             |
| 7           | Encasement Deterioration    | Minor spalls | Det. w/ cracks | Det. w/ Exposed Steel |

**43.7.2 Steel (S) Defect Summary**

| Defect Code | Type Defect                       | Severity       |                |                                |                            |
|-------------|-----------------------------------|----------------|----------------|--------------------------------|----------------------------|
|             |                                   | A              | B              | C                              | D                          |
| 1           | Paint Failure                     | Random Peeling | Up to 3%       | Up to 10%                      | >10%                       |
| 2           | Rusting                           | Spot           | Light          | Moderate                       | Severe                     |
| 3           | Corrosion with Up to Section Loss | Up to 10%      | Up to 20%      | Up to 30%                      | >30% (Specify %)           |
| 4           | Collision Damage                  | Minor Scrapes  | Local Buckling | Major Deform. No need for NDT. | Major Deform. NDT required |

Please provide location and description of Fatigue Details. Use letters as per AASHTO Details.

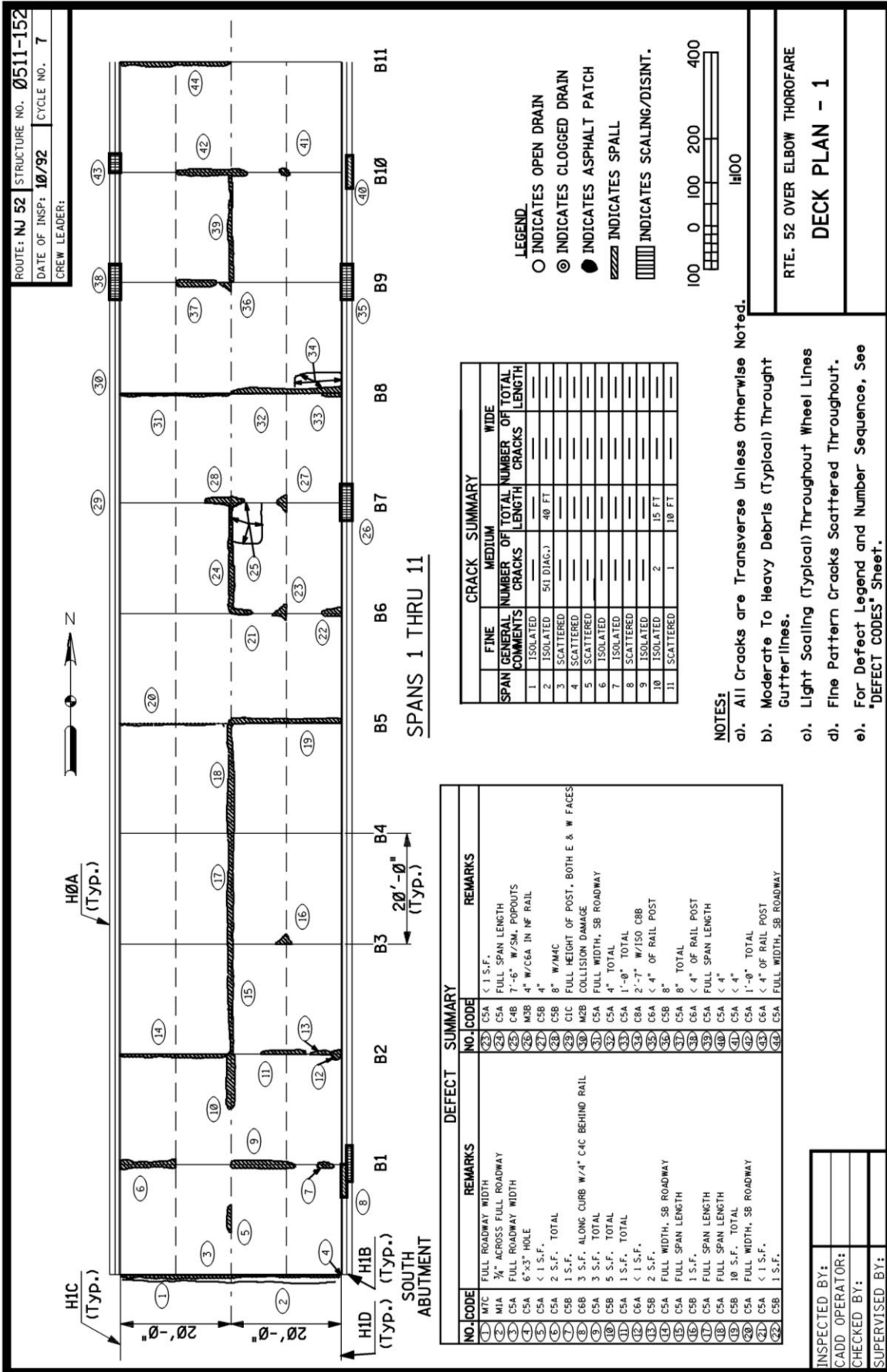
**43.7.3 Timber (T) Defect Summary**

| Defect Code | Type Defect   | Severity |          |                     |
|-------------|---------------|----------|----------|---------------------|
|             |               | A        | B        | C                   |
| 1           | Decay/Rotting | Minor    | Moderate | Severe              |
| 2           | Checks        | Fine     | Medium   | Wide                |
| 3           | Splits        | Minor    | Moderate | Severe              |
| 4           | Section Loss  | Up to10% | Up to20% | Over 20%(Specify %) |
| 5           | Deflection    | Minor    | Moderate | Severe              |

**43.7.4 Miscellaneous (M) Defect Summary**

| Defect Code | Type Defect                    | Severity    |             |                           |
|-------------|--------------------------------|-------------|-------------|---------------------------|
|             |                                | A           | B           | C                         |
| 1           | Approach Settlement            | Up to½ inch | Up to1 inch | > 2 inches (Specify Amt.) |
| 2           | Appr. Railing Broken/Damaged   | Minor       | Moderate    | Severe                    |
| 3*          | Excessively Expanded Bearing   | Minor       | Moderate    | Severe                    |
| 4*          | Excessively Contracted Bearing | Minor       | Moderate    | Severe                    |
| 5           | Joint Deterioration            | Minor       | Moderate    | Severe                    |

\*Specify degree of tilt on rocker bearings and temperature of steel



**CRACK SUMMARY**

| SPAN | FINE GENERAL COMMENTS |           | CRACK SUMMARY    |        | WIDE |
|------|-----------------------|-----------|------------------|--------|------|
|      | NUMBER OF COMMENTS    | LENGTH    | NUMBER OF CRACKS | LENGTH |      |
| 1    | ISOLATED              | 501 DIAG. | 40 FT            | ---    | ---  |
| 2    | ISOLATED              | ---       | ---              | ---    | ---  |
| 3    | SCATTERED             | ---       | ---              | ---    | ---  |
| 4    | SCATTERED             | ---       | ---              | ---    | ---  |
| 5    | SCATTERED             | ---       | ---              | ---    | ---  |
| 6    | ISOLATED              | ---       | ---              | ---    | ---  |
| 7    | ISOLATED              | ---       | ---              | ---    | ---  |
| 8    | SCATTERED             | ---       | ---              | ---    | ---  |
| 9    | ISOLATED              | ---       | ---              | ---    | ---  |
| 10   | ISOLATED              | ---       | ---              | ---    | ---  |
| 11   | SCATTERED             | ---       | ---              | ---    | ---  |

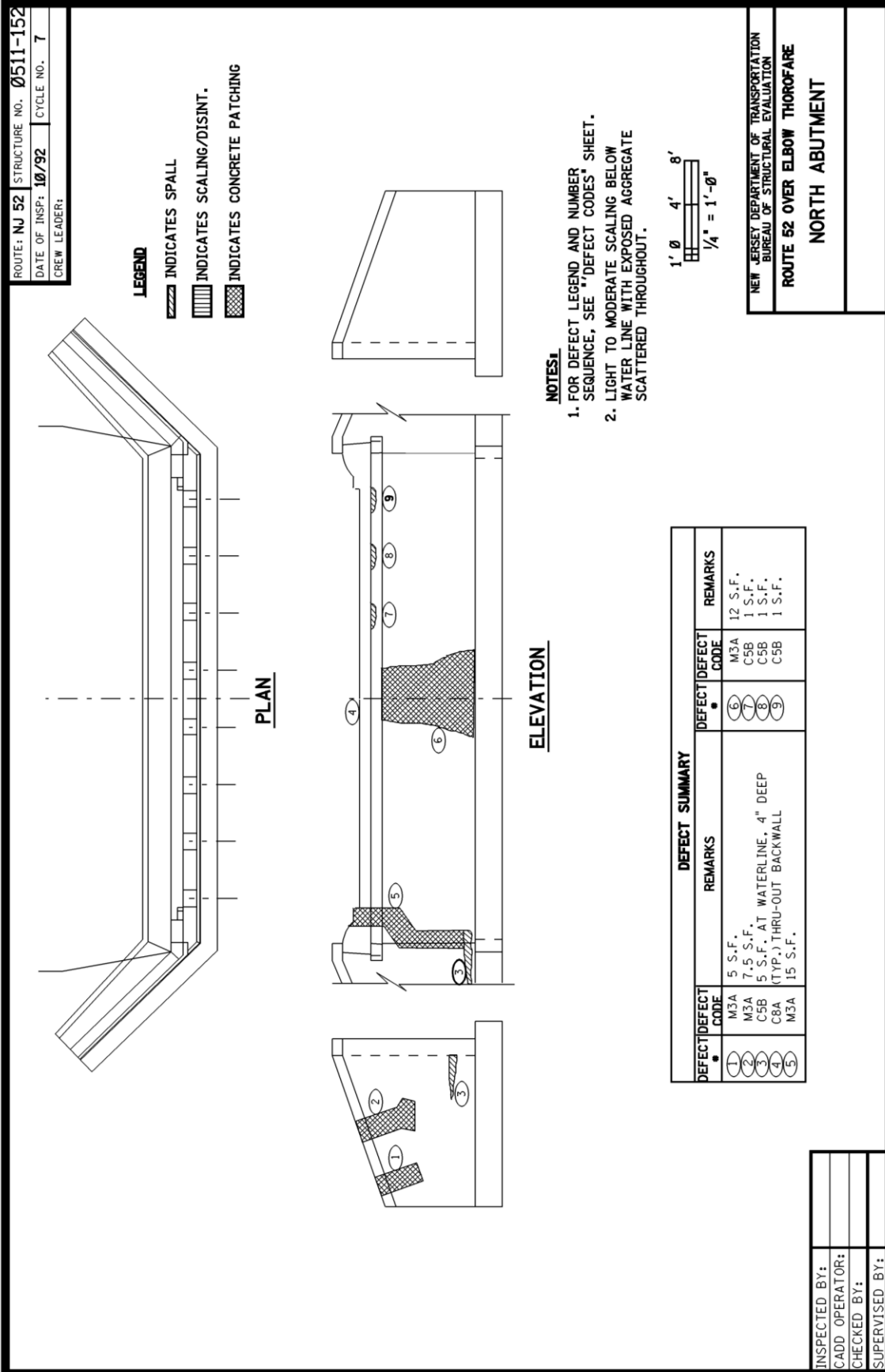
- NOTES:**
- All Cracks are Transverse Unless Otherwise Noted.
  - Moderate To Heavy Debris (Typical) Throughout Gutterlines.
  - Light Scaling (Typical) Throughout Wheel Lines
  - Fine Pattern Cracks Scattered Throughout.
  - For Defect Legend and Number Sequence, See "DEFECT CODES" Sheet.

**DEFECT SUMMARY**

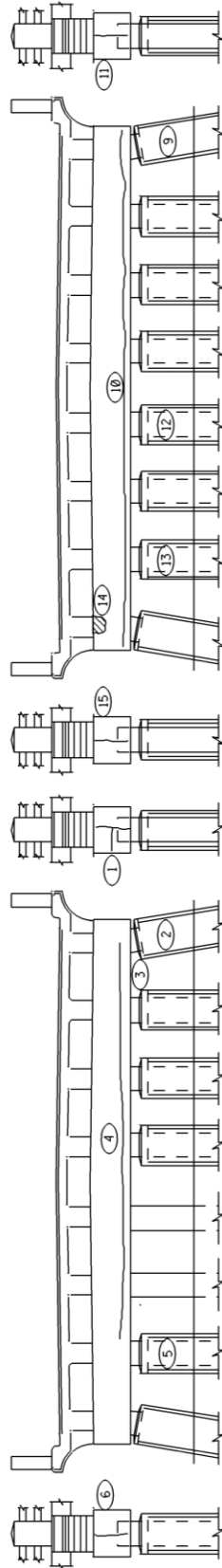
| NO. CODE | REMARKS                                    | NO. CODE | REMARKS                               |
|----------|--|----------|---------------------------------------|
| 23       | M7C FULL ROADWAY WIDTH                     | C3A      | < 1 S.F.                              |
| 24       | M1A 3/4" ACROSS FULL ROADWAY               | C4B      | FULL SPAN LENGTH                      |
| 25       | C5A FULL ROADWAY WIDTH                     | M3B      | 7'-6" W/SM. POPOUTS                   |
| 26       | C5A 6"x3" HOLE                             | C5B      | 4" W/C6A IN NF RAIL                   |
| 27       | C5A < 1 S.F.                               | C5B      | 4" W/M4C                              |
| 28       | C5A 2 S.F. TOTAL                           | C5B      | 8" W/M4C                              |
| 29       | C5B 1 S.F.                                 | C1C      | FULL HEIGHT OF POST, BOTH E & W FACES |
| 30       | C5B 3 S.F. ALONG CURB W/4" C4C BEHIND RAIL | M2B      | COLLISION DAMAGE                      |
| 31       | C5A 1 S.F. TOTAL                           | C5A      | FULL WIDTH, SB ROADWAY                |
| 32       | C5A 5 S.F. TOTAL                           | C4       | 4" TOTAL                              |
| 33       | C5A 1 S.F. TOTAL                           | C5A      | 1'-0" TOTAL                           |
| 34       | C6A < 1 S.F.                               | C8A      | 2'-7" W/150 C8B                       |
| 35       | C5B 2 S.F.                                 | C6A      | < 4" OF RAIL POST                     |
| 36       | C5A FULL WIDTH, SB ROADWAY                 | C5B      | 8" TOTAL                              |
| 37       | C5A FULL SPAN LENGTH                       | C5A      | 8" TOTAL                              |
| 38       | C5B 1 S.F.                                 | C6A      | < 4" OF RAIL POST                     |
| 39       | C5A FULL SPAN LENGTH                       | C5A      | FULL SPAN LENGTH                      |
| 40       | C5A FULL SPAN LENGTH                       | C5A      | < 4"                                  |
| 41       | C5B 10 S.F. TOTAL                          | C5A      | < 4"                                  |
| 42       | C5A FULL WIDTH, SB ROADWAY                 | C5A      | 1'-0" TOTAL                           |
| 43       | C5A < 1 S.F.                               | C6A      | < 4" OF RAIL POST                     |
| 44       | C5B 1 S.F.                                 | C5A      | FULL WIDTH, SB ROADWAY                |

|                |  |
|----------------|--|
| INSPECTED BY:  |  |
| CADD OPERATOR: |  |
| CHECKED BY:    |  |
| SUPERVISED BY: |  |





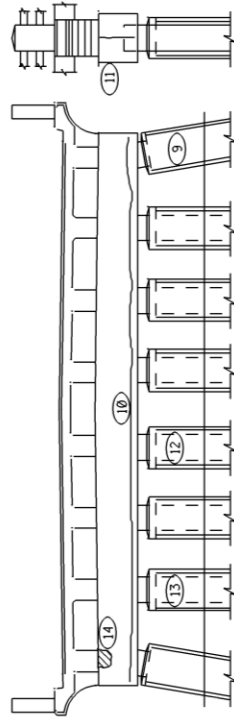
ROUTE: NJ 52 STRUCTURE NO. 0511-152  
 DATE OF INSP: 10/92 CYCLE NO. 7  
 CREW LEADER:



**SOUTH ELEVATION**

**NORTH ELEVATION**

**BENT 1**



**SOUTH ELEVATION**

**NORTH ELEVATION**

**BENT 2**

**LEGEND**  
 [Hatched Box] INDICATES SPALL



| DEFECT SUMMARY |     | DEFECT CODE           | REMARKS | DEFECT CODE | REMARKS                   |
|----------------|-----|-----------------------|---------|-------------|---------------------------|
| 1              | CIB | HORIZ AND VERT        | 10      | CIA         | HORIZ, FULL LENGTH OF CAP |
| 2              | C7B | 1'-0"x2'-0" AREA      | 11      | CIA         | FULL HEIGHT VERT          |
| 3              | C6B | 8"                    | 12      | C7C         | 80% OF ENCASEMENT         |
| 4              | CIA | 30' HORIZ             | 13      | C7C         | 90% OF ENCASEMENT         |
| 5              | C7C | 2'-0" MAX FULL CIRCUM | 14      | C5B         | 1 S.F., 1" DEEP           |
| 6              | CIA | 3'-0" VERT            | 15      | CIA         | FULL HEIGHT VERT          |
| 7              | CIB | 5'-0" HORIZ           | 16      | CIB         | 1'-0"x1'-0"x5'-0" LONG    |
| 8              | CIB | 5'-0" HORIZ           | 17      | CIB         | 4'-0" HORIZ               |
| 9              | C7C | 90% OF ENCASEMENT     | 18      | C7B         | 30% OF ENCASEMENT         |

- NOTES:**
- FOR DEFECT LEGEND AND NUMBER SEQUENCE, SEE "DEFECT CODES" SHEET.
  - FINE MAP CRACKING WITH LIGHT EFFLUORESCENCE SCATTERED THROUGHOUT PILE CAPS.

INSPECTED BY: \_\_\_\_\_  
 CADD OPERATOR: \_\_\_\_\_  
 CHECKED BY: \_\_\_\_\_  
 SUPERVISED BY: \_\_\_\_\_

NEW JERSEY DEPARTMENT OF TRANSPORTATION  
 BUREAU OF STRUCTURAL EVALUATION  
**ROUTE 52 OVER ELBOW THOROFARE**  
**BENTS 1 AND 2**

## Section 44 - Railroad Carrying Bridge Evaluation Program

### 44.1 Evaluation Survey Report Format - AR - (For Railroad Carrying Bridges)

The report of the results of a first cycle bridge survey and rating of an existing railroad bridge, performed by or for the Department, shall adhere to the following format:

- A. **REPORT COVER SHEET:** The report's cover sheet shall include the bridge owner's logo, name and address; the bridge number, name, railroad milepost, USRA line code, municipality, and county; the bridge survey cycle number and date; and the inspection firm's name, logo and address (see attached sample). The report covers shall be printed on white paper.

The report shall be bound using a standard 3-hole punch type binding.

- B. **LETTER OF TRANSMITTAL (CONSULTANT PROJECTS ONLY):** The letter of transmittal shall be addressed as follows (see attached sample):

Manager, Structural Evaluation and Bridge Management  
 New Jersey Department of Transportation  
 1035 Parkway Avenue  
 PO Box 615  
 Trenton, New Jersey 08625-0600  
 ATTN: Project Manager (Name)

Re: Bridge Survey and Rating of Bridge Number, Name, Railroad Milepost and Route Number

In addition, the letter should include the date of the agreement with the New Jersey Department of Transportation and any disclaimer and/or restrictions on the information contained in the report and its use and the due date for the submission of the particular report (preliminary or final). Also, include a Quality Assurance Statement for the structure.

- C. **Table of Contents:** One page indicating items 1 through 12 in order shown as follows and providing the page number in the report on which each item starts. All pages in the report shall be numbered (i.e. Cycle No.- Page No.) at the bottom and centered.

|   | <b>Page No.</b> |
|---|-----------------|
| 1. Maps   | X-X             |
| 2. Structural Data                                    | X-X             |
| 3. Component Rating Summary                           | X-X             |
| 4. Conclusions and Recommendations                    | X-X             |
| 5. Historical Information                             | X-X             |
| 6. Bridge Description                                 | X-X             |
| 7. Structural Inventory & Appraisal and Pontis Sheets | X-X             |
| 8. Load Rating Summary Sheet (LRSS)                   | X-X             |
| 9. Drawings, Soundings and Photographs                | X-X             |
| 10. Field Notes                                       | X-X             |
| 11. Associated Documents                              | X-X             |
| 12. Vandalism Report(s)                               | X-X             |



1. **Maps:** Two maps, are required: one "General Location Map" and the other, a more detailed and specific "Local Map". Each map shall be on a separate 8½ by 11 inches sheet and include the structure, name, railroad line, route number, railroad milepost and feature intersected (located in lower right corner).
  - a. **General Location Map:** For **State** owned bridges a map of the entire state of New Jersey, scale approximately 1: 1 000 000, pin pointing the location of the structure being reported on (by bridge number, name, railroad milepost and route number). This map should show railroad lines, with their USRA Line Code number and principal cities and/or towns along each line.
  - b. **Local Map:** A current map of the immediate vicinity of the reported structure; scaling 1: 20 000 with the structure centered on the page. Include roads, railroads, waterways, county and township names and a north arrow. Features intersecting the bridge should be clearly labeled.
2. **Structural Data:** A summary shall be included as per the attached format.
3. **Component Rating Summary:** The items in this format are self-explanatory, however, further explanation for some items is provided as follows:
  - a. **Component/Material:** The components shall be listed in Format "AR". Type of material used for majority of construction shall be given below the component in the same vertical column. Delete the components which are not applicable.
  - b. **Condition Rating:** The condition rating of various components shall be the overall rating of the component as per the current *FHWA Recording and Coding Guide for the Structural Inventory and Appraisal of Bridges* along with NJDOT Railroad Coding Instructions and should be consistent with the ratings given on field notes and SI&A sheet.
  - c. **General Remarks:** Summarize the significant defects and give a brief account of what was found during the bridge survey, as it relates to the structural integrity of the bridge. Defects for which repairs are recommended must be mentioned. Photos of these defects should be referenced in this section.

The Deck section should include the condition of the top and underside of the deck (concrete slab, ties and ballast plate), walkways, bridge railing, etc. For reinforced concrete decks give the percentage of spalled area (open or patched) and estimated contaminated area (underdeck).

The Superstructure section should include the condition of main load carrying members and diaphragms (include percent loss of section if any) and the bearings.

The Substructure section should include the condition of the abutments, pier(s), retaining walls, crash walls etc., and information on scour or undermining.

The terminology used throughout the evaluation bridge survey report for various elements shall be in accordance with the following:

Concrete: Describing concrete conditions shall be as defined and illustrated in the ACI Journal, November 1968, Report of ACI Committee 201 "*Guide for Making a Condition Survey of Concrete in Service*".

Steel: Describing steel conditions shall be as defined and illustrated in "*Bridge Inspector's Training Manual 90*" as published by the U.S. Department of Transportation, Federal Highway Administration.

Timber: Describing timber conditions shall be as defined in accordance with AREMA Chapter 7, Part 1.

The Safety Features section should include the adequacy of the guard rails, guard members, alignment of approach rail, field measured minimum clearances and where they occur (minimum vertical clearance above and below the bridge, and lateral underclearance left and right as per SI&A coding requirements and AREA track clearances). For bridges over waterways, horizontal and vertical clearances of the waterway channel should also be given as per field measurements.

4. **Conclusions & Recommendations:** Conclusions resulting from the bridge evaluation survey regarding the adequacy (structural, clearances, etc.) of the bridge and any unusual or special conditions indicating higher expenditures required to uphold rail service on a given line should be given here. Also, include possible explanations of the causes of any inadequacies found.

Include a statement of the overall condition of the structure, and provide comments on any major components rated at 6 or below.

For bridges with fracture critical members (FCM'S), provide a list and description of all FCM's and a brief summary from in-depth FCM inspection findings, if applicable.

For bridges over waterways, include a statement relative to the scour potential of the bridge based on the Bridge Scour Evaluation. The statement should specify if the bridge is scour critical or not based on the Bridge Scour Evaluation. If the bridge has not yet been evaluated, the Priority Category as determined in the Bridge Scour Evaluation should be specified. If the Prioritization Category is 2 or less, the statement should include which low ratings (2 or less) led to this rating. Where the bridge has not yet been evaluated for scour potential, include a statement that the bridge is or is not potentially scour critical based on engineering judgment along with the reasons for this determination.

Make specific recommendations for safety improvements, major repair work (i.e. structure rehabilitation and/or replacement), and other repair work to correct significant defects, deteriorations and inadequacies found during this bridge survey. The recommendations should be specific about the location of defects and the methods of repair. The recommendations for other repair work should be listed in the order of priority. Each recommendation should be referenced to the photos. For major repair/ rehabilitation work, provide cost estimates, however, for other repair work, provide quantities only.

All recommendations along with repair and/or replacement shall be based on upgrading all members to a level where inventory ratings are sufficient to sustain the maximum anticipated loading condition (Equivalent Cooper E).

Identify any priority repair work and reference any priority repair memorandums which were issued.

In addition, list all areas of deterioration or structural members which should be inspected at frequencies of less than two years and indicate the inspection cycle in months for each area or member. Be very specific about locations to be inspected. Also identify any specific elements that should be monitored during each routine survey (such as cracks for propagation, etc.).

5. **Historical Information:** If available, this information should include when and under what agency the structure was built; when and by whom any subsequent additions or improvements to the structure, trackline, waterway channels, clearances, track changes, etc. were made. A detailed description with reference to photographs and drawings if possible should be furnished for any of the above changes. Also include, if different from current designations, the railroad and branch in use when the bridge was built.
6. **Bridge Description:** Furnish a brief description of the structure. Include the type of construction, materials in the deck, superstructure and substructure components, and important dimensions. A more detailed description should be given if plans are not available.
7. **Structural Inventory & Appraisal and Pontis Sheets:** This section should contain 8½ by 11 inches computer printouts of the "Structure Inventory and Appraisal and Pontis Sheets". These sheets must be coded in accordance with the current *FHWA Recording and Coding Guide for the Inventory and Appraisal of the Nations Bridges* and *Recording and Coding Guide for the Structure Inventory and Appraisal of New Jersey Bridges* and supplemented by the Railroad Coding Instructions.
8. **Load Rating Summary Sheet (LRSS):** In this section, include computations made in arriving at the various load ratings. Include a summary as the first page of the computations listing all ratings with page number references and the allowable stresses used (see attached samples).
9. **Drawings, Soundings & Photographs:** Bridge drawings and color photographs (minimum 3.2 MP digital images) of unique defects should be included in this section of the report. Also, sounding sketches completed in accordance with the current edition of the "*Underwater Inspection and Evaluation of New Jersey Bridges Guidelines Manual*" should be included.  
  
Photographs of both full elevations and both track views, upstream and downstream views (if applicable) underside of each superstructure type, all significant defects (including those warranting Priority action or monitoring, or any elements rated at 6 or below), any posting signs, any repairs made and any special equipment used (Snooper, cherry picker, maintenance and protection of traffic, special ladders, etc.) should be included in the report. The photographs should be placed in the report in the following order: Elevations, Track Views, Stream Views, Underside, Defects requiring Priority action, Bridge elements rated 6 or below (in order of Field Notes), Posting Signs, Repairs and Special Equipment.
10. **Field Notes:** Detailed typed field notes using the Department's current Field Note Format for the type of structure being surveyed Field notes should

include measurements taken during the bridge survey. A sample of the current Field Note forms and sketches can be obtained from the Structural Evaluation and Bridge Management Unit.

11. **Associated Documents:** Attach the diver's inspection report (if applicable) done in accordance with the current edition of the "*Underwater Inspection and Evaluation of New Jersey Bridges Guidelines Manual*".

Attach any memorandum prepared for any Priority/Emergency condition observed at the time of the inspection. Include the memo sheets as well as any photograph sheets. The Structural Evaluation Priority Notification report generated by the online Work Orders system must also be attached in the report before each Priority Repair memorandum.

Attach the detailed load rating report (if applicable) done in accordance with the current edition of the "*NJDOT Highway Bridge Load Rating Manual*".

Additionally, include any special reports such as fatigue analysis, ultrasonic testing, chemical analysis, coupon testing, hydraulic analysis, geotechnical streambed analysis, etc. Provide photographs showing the equipment used.

12. **Vandalism Report:** Include the completed form to report vandalism of the subject structure.

## Sample – Format AR for Railroad Carrying Bridges



(Owner's Logo)

State of New Jersey  
NEW JERSEY DEPARTMENT OF TRANSPORTATION  
1035 PARKWAY AVENUE  
P.O. Box 600  
TRENTON, NEW JERSEY 08625-0600  
(Owner's Name and address)

### BRIDGE EVALUATION SURVEY REPORT

STRUCTURE NO. ####-###  
XX LINE OVER XX ROAD AND XX RIVER  
RR MP ##.##  
USRA LINE CODE ####  
XX BOROUGH AND/OR TOWNSHIP  
XX COUNTY

1<sup>ST</sup> CYCLE

MONTH DD, YYYY

#### NOTES:

1. Red and yellow guidance text **NOT** to be included in actual report document (user must delete).
2. Blue placeholder text to be properly edited and converted to black text (upon completion of the report, select all text using the Ctrl "A" command and change color to black).
3. Entire report shall be within table. \*Activate Gridlines\*
4. This textbox to be removed.

Prepared By

XYZ Consultant  
(Consultant's Logo)

123 Main Street  
Trenton, NJ 08625

**Sample Letter of Transmittal (Preliminary/Final Report)**

Manager  
Structural Evaluation and Bridge Management  
New Jersey Department of Transportation  
Engineering and Operations Building  
1035 Parkway Avenue  
PO Box 615- 5th Floor  
Trenton, New Jersey 08625-0600

Attn: Mr. \_\_\_\_\_, Project Manager

Evaluation Bridge  
Survey & Rating of  
Structure No.  
Route No.  
Structure Name

Gentlemen:

In accordance with our Agreement No. BI with the New Jersey Department of Transportation, dated \_\_\_\_\_, we are pleased to submit this **Preliminary Report/Final Report** for the above referenced bridge. A scanned and indexed report will be submitted on CD by a separate transmittal.

The report covers the results of a field inspection of the structure and recommendations for repair or replacement of major defects found. The inspection was made according to generally recognized standards and procedures, but it is not implied that all defects were or could have been disclosed by this inspection.

The inspection findings and recommendations in this report were reviewed to ensure a proper level of quality and uniformity. The report adheres to State practices for inspections and current NJDOT standards.

Consultant XYZ

**Format "AR"**

**N.J.D.O.T. - STRUCTURAL EVALUATION AND BRIDGE MANAGEMENT  
EVALUATION SURVEY REPORT FOR RAILROAD CARRYING BRIDGE**

**CYCLE NO. 1**

**STRUCTURAL DATA:**

|                 |                                   |   |                |
|-----------------|-----------------------------------|---|----------------|
| Bridge No.:     | #### - ###                        | Year Built:                                 | Widened/Rehab: |
| Route No.:      |                                   | Length:                                     | Width:         |
| RR Mile Point:  | Mile Point:                       | Date of this Evaluation:                    | MM/DD/YYYY     |
| Municipality:   |                                   | By:   |                |
|                 |                                   | Date of FCM/Pin hanger Inspection:          | MM/DD/YYYY     |
| County:         |                                   | By:   |                |
|                 |                                   | Special Equipment Used:                     |                |
| Name:           | XX Line over XX Road and XX River | Date of Underwater Inspection:              | MM/DD/YYYY     |
|                 |                                   | By:   |                |
| Structure Type: |                                   | Date of Special Testing:                    | MM/DD/YYYY     |
|                 |                                   | Date of Elec./Mech. Inspection (Level: II): |                |
|                 |                                   | Scour Critical:                             | Yes / No       |

**OVERALL PHYSICAL CONDITION:**

**OVERALL CONDITION (ITEM 67):**

**Inspection Team Leader:** XYZ \_\_\_\_\_  
**Certifying Engineer:** ABC P.E. \_\_\_\_\_  
**N.J. P.E. Number:** ### \_\_\_\_\_

**Initials:** \_\_\_\_\_

I certify that this report is an accurate description of the subject structure, to the extent determinable by visual inspection and testing performed.

Signature: \_\_\_\_\_

Date: \_\_\_\_\_



**Format "AR"**

Structure No.: ####-### Route: ## Cycle No.: 1  
 Name: XX Line over XX Road and XX River Insp. Date: MM/DD/YYYY

| <u>COMPONENT/MATERIAL</u>        | <u>CONDITION RATING</u>                | <u>REMARKS</u> |
|----------------------------------|--|----------------|
| <b>DECK</b><br>(XXXXX)           | Excellent / Very Good /<br>Good / etc. |                |
| <b>APPROACHES</b><br>(XXXXX)     | Excellent / Very Good /<br>Good / etc. |                |
| <b>SUPERSTRUCTURE</b><br>(XXXXX) | Excellent / Very Good /<br>Good / etc. |                |
| <b>SUBSTRUCTURE</b><br>(XXXXX)   | Excellent / Very Good /<br>Good / etc. |                |
| <b>WATERWAY/CHANNEL</b>          | Excellent / Very Good /<br>Good / etc. |                |
| <b>SAFETY FEATURES</b>           | ####                                   |                |
| <b>DECK GEOMETRY</b>             | 9 / 8 / 7 / etc.                       |                |
| <b>UTILITIES</b>                 | Excellent / Very Good /<br>Good / etc. |                |

The minimum vertical underclearance is ##.## ft. under XXXXXXXXXX

The lateral underclearances are: Left: ##.## ft. Right: ##.## ft.

For waterways include horizontal and vertical clearances of the main channel span.



**Format "AR"**

Structure No.: ####-### Route: ## Cycle No.: 1  
 Name: I ## over XX Road and XX River or Railroad Insp. Date: MM/DD/YYYY

**CONCLUSIONS AND RECOMMENDATIONS:**

Provide the overall condition of the structure and indicate which item controls (Item 59, 60, 62, or Inventory Rating).

Provide comments on any major components (Items 58, 59, 60, 61, 62 and/or BA) rated at 6 or below. Comments should provide general summary of the defects causing the condition rating of 6 or less.

Provide a list and description of any fracture critical members. Provide a brief summary of in-depth FCM inspection findings if applicable.

Provide statement on scour potential. For scour critical bridges, include proposed countermeasures with costs under major work section below. Include the findings of "Underwater Inspection Report". If underwater inspection was done during current or previous (last) cycle, include a copy of the report.

Indicate reasons why the structure is structurally deficient and/or functionally obsolete, if applicable. Provide a major work statement and major work details (including escalated costs). For scour critical structures, include improvement costs from NJDOT Memorandum dated May 2, 2008 titled "Bridge Scour Countermeasures Conceptual Design and Cost Estimates for Inspection Reports".

Indicate any required priority repair work, and reference priority repair letter at end of report.

Provide recommendations for interim inspections, monitoring of any elements, etc.

Use all applicable sections. If a section is not applicable to a particular structure, delete the entire row from the template.

**FOR STEEL AND CONCRETE MEMBERS**

**COOPER E RATING ANALYSIS**  
**INVENTORY RATINGS**

**Structure Number** \_\_\_\_\_

**Controlling Cooper E Rating** \_\_\_\_\_

| Member | Capacity of Bridge<br>Cooper E Load |       |              |       | Equivalent Cooper E Loading of Equipment<br>(For Proper Span Length) |       |          |       |          |       |          |       |          |       | Remarks |   |
|--------|-------------------------------------|-------|--------------|-------|--|-------|----------|-------|----------|-------|----------|-------|----------|-------|---------|---|
|        | As Built                            |       | As inspected |       | Load # 1   |       | Load # 2 |       | Load # 3 |       | Load # 4 |       | Load # 5 |       |         |   |
|        | E                                   | E     | E            | E     | E  | E     | E        | E     | E        | E     | E        | E     | E        | E     |         | E |
|        | Moment                              | Shear | Moment       | Shear | Moment   | Shear | Moment   | Shear | Moment   | Shear | Moment   | Shear | Moment   | Shear |         |   |
|        |                                     |       |              |       |  |       |          |       |          |       |          |       |          |       |         |   |
|        |                                     |       |              |       |  |       |          |       |          |       |          |       |          |       |         |   |
|        |                                     |       |              |       |  |       |          |       |          |       |          |       |          |       |         |   |
|        |                                     |       |              |       |  |       |          |       |          |       |          |       |          |       |         |   |
|        |                                     |       |              |       |  |       |          |       |          |       |          |       |          |       |         |   |
|        |                                     |       |              |       |  |       |          |       |          |       |          |       |          |       |         |   |
|        |                                     |       |              |       |  |       |          |       |          |       |          |       |          |       |         |   |
|        |                                     |       |              |       |  |       |          |       |          |       |          |       |          |       |         |   |
|        |                                     |       |              |       |  |       |          |       |          |       |          |       |          |       |         |   |
|        |                                     |       |              |       |  |       |          |       |          |       |          |       |          |       |         |   |
|        |                                     |       |              |       |  |       |          |       |          |       |          |       |          |       |         |   |
|        |                                     |       |              |       |  |       |          |       |          |       |          |       |          |       |         |   |
|        |                                     |       |              |       |  |       |          |       |          |       |          |       |          |       |         |   |
|        |                                     |       |              |       |  |       |          |       |          |       |          |       |          |       |         |   |

**Note: E = Cooper Load**

**FOR STEEL AND CONCRETE MEMBERS**

**COOPER E RATING ANALYSIS  
OPERATING RATINGS**

Structure Number \_\_\_\_\_

Controlling Cooper E Rating \_\_\_\_\_

| Member | Capacity of Bridge |        |              |        | Equivalent Cooper E Loading of Equipment |        |          |        |          |        |          |        |          |        | Remarks |  |
|--------|--------------------|--------|--------------|--------|--|--------|----------|--------|----------|--------|----------|--------|----------|--------|---------|--|
|        | Cooper E Load      |        |              |        | (For Proper Span Length)                 |        |          |        |          |        |          |        |          |        |         |  |
|        | As Built           |        | As inspected |        | Load # 1                                 |        | Load # 2 |        | Load # 3 |        | Load # 4 |        | Load # 5 |        |         |  |
|        | E                  | E      | E            | E      | E  | E      | E        | E      | E        | E      | E        | E      | E        | E      |         |  |
| Moment | Shear              | Moment | Shear        | Moment | Shear                                    | Moment | Shear    | Moment | Shear    | Moment | Shear    | Moment | Shear    | Moment | Shear   |  |
|        |                    |        |              |        |  |        |          |        |          |        |          |        |          |        |         |  |
|        |                    |        |              |        |  |        |          |        |          |        |          |        |          |        |         |  |
|        |                    |        |              |        |  |        |          |        |          |        |          |        |          |        |         |  |
|        |                    |        |              |        |  |        |          |        |          |        |          |        |          |        |         |  |
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|        |                    |        |              |        |  |        |          |        |          |        |          |        |          |        |         |  |

**Note: E = Cooper Load**

**FOR TIMBER MEMBERS**

**COOPER E RATING ANALYSIS**  
**INVENTORY RATINGS**  
**ASSIGNED LOCOMOTIVES**

**Structure Number** \_\_\_\_\_

**Controlling Cooper E Rating** \_\_\_\_\_

| Member | Capacity of Bridge |        |              |        | Equivalent Cooper E Loading of Equipment |        |          |        |          |        |          |        |          |   | Remarks |
|--------|--------------------|--------|--------------|--------|--|--------|----------|--------|----------|--------|----------|--------|----------|---|---------|
|        | Cooper E Load      |        |              |        | (For Proper Span Length)                 |        |          |        |          |        |          |        |          |   |         |
|        | As Built           |        | As inspected |        | Load # 1                                 |        | Load # 2 |        | Load # 3 |        | Load # 4 |        | Load # 5 |   |         |
|        | E                  | E      | E            | E      | E  | E      | E        | E      | E        | E      | E        | E      | E        | E |         |
| Moment | Shear              | Moment | Shear        | Moment | Shear                                    | Moment | Shear    | Moment | Shear    | Moment | Shear    | Moment | Shear    |   |         |
|        |                    |        |              |        |  |        |          |        |          |        |          |        |          |   |         |
|        |                    |        |              |        |  |        |          |        |          |        |          |        |          |   |         |
|        |                    |        |              |        |  |        |          |        |          |        |          |        |          |   |         |
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|        |                    |        |              |        |  |        |          |        |          |        |          |        |          |   |         |

**Note: E = Cooper Load**

**FOR TIMBER MEMBERS**

**COOPER E RATING ANALYSIS  
OPERATING RATINGS  
NOT ASSIGNED LOCOMOTIVES**

**Structure Number** \_\_\_\_\_

**Controlling Cooper E Rating** \_\_\_\_\_

| Member | Capacity of Bridge |        |              |        | Equivalent Cooper E Loading of Equipment |        |          |        |          |        |          |        |          |        | Remarks |  |
|--------|--------------------|--------|--------------|--------|--|--------|----------|--------|----------|--------|----------|--------|----------|--------|---------|--|
|        | Cooper E Load      |        |              |        | (For Proper Span Length)                 |        |          |        |          |        |          |        |          |        |         |  |
|        | As Built           |        | As inspected |        | Load # 1                                 |        | Load # 2 |        | Load # 3 |        | Load # 4 |        | Load # 5 |        |         |  |
|        | E                  | E      | E            | E      | E  | E      | E        | E      | E        | E      | E        | E      | E        | E      |         |  |
| Moment | Shear              | Moment | Shear        | Moment | Shear                                    | Moment | Shear    | Moment | Shear    | Moment | Shear    | Moment | Shear    | Moment | Shear   |  |
|        |                    |        |              |        |  |        |          |        |          |        |          |        |          |        |         |  |
|        |                    |        |              |        |  |        |          |        |          |        |          |        |          |        |         |  |
|        |                    |        |              |        |  |        |          |        |          |        |          |        |          |        |         |  |
|        |                    |        |              |        |  |        |          |        |          |        |          |        |          |        |         |  |
|        |                    |        |              |        |  |        |          |        |          |        |          |        |          |        |         |  |
|        |                    |        |              |        |  |        |          |        |          |        |          |        |          |        |         |  |
|        |                    |        |              |        |  |        |          |        |          |        |          |        |          |        |         |  |
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|        |                    |        |              |        |  |        |          |        |          |        |          |        |          |        |         |  |
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|        |                    |        |              |        |  |        |          |        |          |        |          |        |          |        |         |  |
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|        |                    |        |              |        |  |        |          |        |          |        |          |        |          |        |         |  |
|        |                    |        |              |        |  |        |          |        |          |        |          |        |          |        |         |  |
|        |                    |        |              |        |  |        |          |        |          |        |          |        |          |        |         |  |
|        |                    |        |              |        |  |        |          |        |          |        |          |        |          |        |         |  |

**Note: E = Cooper Load**

#### 44.2 Re-Evaluation Survey Report Format - BR - (For Railroad Carrying Bridges)

The report of the results of a re-evaluation Bridge survey and rating of an existing railroad bridge that has undergone major rehabilitation or had significant changes to the structure ratings, performed by or for the Department, shall adhere to the following format:

- A. **Report Cover Sheet:** The report's cover sheet shall utilize the same form as indicated in Format AR except that it shall be labeled as a *Re-Evaluation Survey Report* and a statement shall be included indicating that the report shall be filed immediately after the preceding cycle report (see attached sample in Format BR).
- B. **Letter of Transmittal** (Consultant Projects Only): The letter of transmittal shall be addressed as shown in Format AR (see sample in Format AR):
- C. **Table of Contents:** One page indicating items 1 through 11 in order shown as follows and providing the page number in the report on which each item starts. All pages in the report shall be numbered (i.e. Cycle No.- Page No.) at the bottom and centered.

|   | <b>Page No.</b> |
|---|-----------------|
| 1. Maps   | X-X             |
| 2. Structural Data                                    | X-X             |
| 3. Component Rating Summary                           | X-X             |
| 4. Conclusions and Recommendations                    | X-X             |
| 5. Bridge Description                                 | X-X             |
| 6. Structural Inventory & Appraisal and Pontis Sheets | X-X             |
| 7. Load Rating Summary Sheet (LRSS)                   | X-X             |
| 8. Drawings, Soundings and Photographs                | X-X             |
| 9. Field Notes  | X-X             |
| 10. Associated Documents                              | X-X             |
| 11. Vandalism Report(s)                               | X-X             |

1. **Maps:** Two maps are required as specified in Format AR.
2. **Structural Data:** A summary shall be included as indicated in Format A with the addition of any observations of "work done" noted.
3. **Component Rating Summary:** The component summary shall be included as indicated in Format AR.
4. **Conclusions & Recommendations:** Conclusions shall be provided as indicated in Format AR. Also, comment on any major changes in the condition of all components since the previous bridge survey report. If no changes have occurred, include a statement to that effect.
5. **Bridge Description:** Furnish a brief description of the structure and the major rehabilitation work performed since the previous evaluation. Include the type of construction, materials in the deck, superstructure and substructure components, and important dimensions. A more detailed description should be given if plans are not available.

6. **Structural Inventory & Appraisal and Pontis Sheets:** This section should contain the above listed data form as indicated in Format AR.
7. **Load Rating Summary Sheet (LRSS):** In this section, include computations of ratings for various major bridge components as indicated in Format AR (see samples in Format AR).
8. **Drawings, Soundings & Photographs:** This section shall contain bridge drawings, sketches, and photographs as indicated in Format AR.
9. **Field Notes:** Provide field notes and sketches as specified in Format AR in this section.
10. **Associated Documents:** Include the diver's inspection report (if applicable) as specified in Format AR.  
  
Attach any memorandum prepared for any Priority/Emergency condition observed at the time of the inspection as specified in Format AR.  
  
Attach the detailed load rating report (if applicable) as specified in Format AR.  
  
Additionally, include any special reports as specified in Format AR.
11. **Vandalism Report:** Include the completed form to report vandalism of the subject structure as specified in Format AR.

## Sample – Format BR for Railroad Carrying Bridges



(Owner's Logo)

State of New Jersey  
 NEW JERSEY DEPARTMENT OF TRANSPORTATION  
 1035 PARKWAY AVENUE  
 P.O. Box 600  
 TRENTON, NEW JERSEY 08625-0600  
 (Owner's Name and address)

### BRIDGE RE-EVALUATION SURVEY REPORT

STRUCTURE NO. ####-###  
 XX LINE OVER XX ROAD AND XX RIVER  
 RR MP ##.##  
 USRA LINE CODE ####  
 XX BOROUGH AND/OR TOWNSHIP  
 XX COUNTY

##<sup>TH</sup> CYCLE

MONTH DD, YYYY

NOTE: This Bridge Re-evaluation Report  
 shall be filed immediately after the  
 ##<sup>TH</sup> Cycle Inspection Report.

#### NOTES:

1. Red and yellow guidance text **NOT** to be included in actual report document (user must delete).
2. Blue placeholder text to be properly edited and converted to black text (upon completion of the report, select all text using the Ctrl "A" command and change color to black).
3. Entire report shall be within table. \*Activate Gridlines\*
4. This textbox to be removed.

Prepared By

XYZ Consultant  
 (Consultant's Logo)

123 Main Street  
 Trenton, NJ 08625



**Format "BR"****N.J.D.O.T. - STRUCTURAL EVALUATION AND BRIDGE MANAGEMENT  
RE-EVALUATION SURVEY REPORT FOR RAILROAD CARRYING BRIDGE**

CYCLE NO. ##

**STRUCTURAL DATA:**

Bridge No.: ##### - ### Year Built: Widened/Rehab:  
Route No.: Length: Width:  
RR Mile Point: Mile Point: Date of this Evaluation: MM/DD/YYYY  
Municipality: By:  
Date of Previous Evaluation: MM/DD/YYYY  
County: By:  
Date of FCM/Pin hanger Inspection: MM/DD/YYYY  
Name: XX Line over XX Road and XX River By:  
Special Equipment Used:  
Structure Type: Date of Underwater Inspection: MM/DD/YYYY  
By:  
Date of Special Testing: MM/DD/YYYY  
Date of Elec/Mech Insp. (Level: II): MM/DD/YYYY  
Scour Critical: Yes/No

**WORK DONE:****OVERALL PHYSICAL CONDITION:****OVERALL CONDITION (ITEM 67):**

Inspection Team Leader: XYZ

Initials: \_\_\_\_\_

Certifying Engineer: ABC P.E.

N.J. P.E. Number: ###

I certify that this report is an accurate description of the subject structure, to the extent determinable by visual inspection and testing performed.

Signature: \_\_\_\_\_

Date: \_\_\_\_\_

Seal

### 44.3 Re-Evaluation Survey Report Format - CR - (For Railroad Carrying Bridges)

The report of the results of a re-evaluation bridge survey and rating of an existing railroad bridge that has not undergone major rehabilitation or had a significant change in the structure rating, performed by or for the Department, shall adhere to the following format:

- A. **Report Cover Sheet:** The report's cover sheet shall include utilize the same form as indicated in Format BR (see attached sample in Format BR).
- B. **Letter of Transmittal** (Consultant Projects Only): The letter of transmittal shall be addressed as shown in Format AR (see sample in Format AR).
- C. **Table of Contents:** One page indicating items 1 through 8 in order shown as follows and providing the page number in the report on which each item starts. All pages in the report shall be numbered (i.e. Cycle No.- Page No.) at the bottom and centered.

|   | <b>Page No.</b> |
|---|-----------------|
| 1. Structural Data                                    | X-X             |
| 2. Conclusions and Recommendations                    | X-X             |
| 3. Structural Inventory & Appraisal and Pontis Sheets | X-X             |
| 4. Load Rating Summary Sheet (LRSS)                   | X-X             |
| 5. Drawings, Soundings and Photographs                | X-X             |
| 6. Field Notes  | X-X             |
| 7. Associated Documents                               | X-X             |
| 8. Vandalism Report(s)                                | X-X             |

1. **Structural Data:** A summary of findings and work done since the previous bridge survey shall be included as indicated in Format AR.
2. **Conclusions & Recommendations:**  
Conclusions shall be provided as indicated in Format BR.
3. **Structural Inventory & Appraisal and Pontis Sheets:** This section should contain the above listed data form as indicated in Format AR.
4. **Load Rating Summary Sheet (LRSS):** In this section, include computations of ratings for various major bridge components as indicated in Format AR (see samples in Format AR).
5. **Drawings, Soundings & Photographs:** This section shall contain bridge drawings, sketches, and photographs as indicated in Format A R.
6. **Field Notes:** Provide field notes and sketches as specified in Format AR in this section.
7. **Associated Documents:** Include the diver's inspection report (if applicable) as specified in Format AR.

Attach any memorandum prepared for any Priority/Emergency condition observed at the time of the inspection as specified in Format AR.

Attach the detailed load rating report (if applicable) as specified in Format AR.

Additionally, include any special reports as specified in Format AR.

8. **Vandalism Report:** Include the completed form to report vandalism of the subject structure as specified in Format AR.

#### 44.4 Interim Survey Report Format - DR - (For Railroad Carrying Bridges)

The report of the results of an interim bridge survey and rating of an existing railroad bridge, performed by or for the Department, shall adhere to the following format:

- A. **Report Cover Sheet:** The report's cover sheet shall utilize the same form as indicated in Format BR, except that it should be noted as an "interim" evaluation rather than an incremental bridge evaluation cycle number (see attached sample in Format DR).
- B. **Letter of Transmittal** (Consultant Projects Only): The letter of transmittal shall be addressed as shown in Format AR (see sample in Format AR):
- C. **Table of Contents:** One page indicating items 1 through 9 in order shown as follows and providing the page number in the report on which each item starts. All pages in the report shall be numbered at the bottom and centered.

|   | Page No. |
|---|----------|
| 1. Structural Data                                    | x.I-x    |
| 2. Reason for Interim Survey                          | x.I-x    |
| 3. Current Condition                                  | x.I-x    |
| 4. Conclusions and Recommendations                    | x.I-x    |
| 5. Structural Inventory & Appraisal and Pontis Sheets | x.I-x    |
| 6. Load Rating Summary Sheet (LRSS)                   | x.I-x    |
| 7. Drawings, Soundings and Photographs                | x.I-x    |
| 8. Associated Documents                               | x.I-x    |
| 9. Vandalism Report(s)                                | x.I-x    |

1. **Structural Data:** A summary of findings and work done shall be included as per the attached format. The items in this format are self-explanatory.
2. **Reasons for Interim Survey:** Indicate specifically the areas or members of the bridge requiring an interim inspection. These areas could be locations of deterioration such as loss of concrete under a bearing or a tilted wingwall. They also could be structure members with low operating ratings (List all members with low operating ratings) or fracture critical members.
3. **Current Condition:** Indicate the current condition of the items identified in the previous section. Also, state if any changes have occurred since the last survey (in-depth or interim).
4. **Conclusions & Recommendations:** Conclusions resulting from the interim bridge evaluation survey regarding the items inspected should be given here. Also, include possible explanation of the causes of any inadequacies found.

Make specific new recommendations for safety improvements, major repair work (i.e. structure rehabilitation and/or replacement), and other repair work to correct significant defects, deteriorations and inadequacies found during this interim bridge survey. The intent is to list any new repairs which are needed, not to repeat the recommendations from the latest bridge evaluation survey report. If no new repairs are necessary, this should be stated.

The recommendations should be specific about the location of defects and the methods of repair. The recommendations for other repair work should be listed in the order of priority. Each recommendation should be referenced to the photos. For major repair work, provide cost estimates. For other repair work, provide quantities only.

5. **Structural Inventory & Appraisal and Pontis Sheets:** This section should contain the above listed data form as indicated in Format AR.
6. **Load Rating Summary Sheet (LRSS):** In this section, include computations of ratings for various major bridge components as indicated in Format AR.
7. **Drawings, Soundings & Photographs:** This section shall contain bridge drawings, sounding sketches, photo location plan sketch and photographs as indicated in Format AR. If approved by the project manager, only one copy of the interim survey report may be required to have original photographs with the remaining copies black-and-white photocopies.
8. **Associated Documents:** Attach any memorandum prepared for any Priority/Emergency condition observed at the time of the Interim inspection as specified in Format A.  
  
Additionally, include any special reports prepared as part of the Interim evaluation.
9. **Vandalism Report:** Include the completed form to report vandalism of the subject structure as specified in Format AR.

## Sample – Format DR for Railroad Carrying Bridges



(Owner's Logo)

State of New Jersey  
 NEW JERSEY DEPARTMENT OF TRANSPORTATION  
 1035 PARKWAY AVENUE  
 P.O. Box 600  
 TRENTON, NEW JERSEY 08625-0600  
 (Owner's Name and address)

### INTERIM EVALUATION SURVEY REPORT

STRUCTURE NO. ####-###  
 XX LINE OVER XX ROAD AND XX RIVER  
 RR MP ##.##  
 USRA LINE CODE ####  
 XX BOROUGH AND/OR TOWNSHIP  
 XX COUNTY

MONTH DD, YYYY

NOTE: This Interim Evaluation Report  
 shall be filed immediately after the  
 ##<sup>TH</sup> Cycle Inspection Report.

#### NOTES:

1. Red and yellow guidance text **NOT** to be included in actual report document (user must delete).
2. Blue placeholder text to be properly edited and converted to black text (upon completion of the report, select all text using the Ctrl "A" command and change color to black).
3. Entire report shall be within table. \*Activate Gridlines\*
4. This textbox to be removed.

Prepared By

XYZ Consultant  
 (Consultant's Logo)

123 Main Street  
 Trenton, NJ 08625

**Format "DR"****N.J.D.O.T. - STRUCTURAL EVALUATION AND BRIDGE MANAGEMENT  
INTERIM EVALUATION SURVEY REPORT**FREQUENCY: ## MONTHS**STRUCTURAL DATA:**

Bridge No.: ####-### Year Built: \_\_\_\_\_ Widened/Rehab: \_\_\_\_\_  
Route No.: \_\_\_\_\_ Length: \_\_\_\_\_ Width: \_\_\_\_\_  
RR Mile Point: \_\_\_\_\_ Mile Point: \_\_\_\_\_ Date of this Evaluation: MM/DD/YYYY  
Name: XX Line over XX Road and  
XX River By: \_\_\_\_\_  
Date of Previous Evaluation: MM/DD/YYYY  
Type of Previous Evaluation: \_\_\_\_\_  
By: \_\_\_\_\_  
Date of FCM/Pin hanger Inspection: MM/DD/YYYY  
By: \_\_\_\_\_  
Special Equipment Used: \_\_\_\_\_  
Structure Type: \_\_\_\_\_ Date of Underwater Inspection: MM/DD/YYYY  
By: \_\_\_\_\_  
Date of Special Testing: MM/DD/YYYY  
Date of Elec./Mech. Inspection (Level: II): \_\_\_\_\_  
Scour Critical: Yes / No

**WORK DONE:****OVERALL PHYSICAL CONDITION:****OVERALL CONDITION (ITEM 67):**

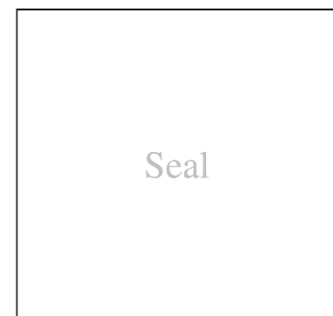
Inspection Team Leader: XYZ  
Certifying Engineer: ABC P.E.  
N.J. P.E. Number: ###

Initials: \_\_\_\_\_

I certify that this report is an accurate description of the interim inspection components of the subject structure, to the extent determinable by visual inspection and testing performed.

Signature: \_\_\_\_\_

Date: \_\_\_\_\_



## 44.5 Rating of Existing Railroad Structures

The following instructions shall be incorporated with the current *A.R.E.M.A. Manual* for the above subject.

### A. Steel and Concrete Structures

1. In rating railroad structures use 0.55fy for inventory (design stress) in all types of steel and wrought iron. Use 0.8fy for operating (rating stress) for A36, A7, open hearth steel, and wrought iron according to A.R.E.M.A. 7.3.4.3, Chapter 15; for other steel refer to A.R.E.M.A. 7.3.4.3, Chapter 15, for permissible operating (rating) stresses only.
2. Bridge ratings (inventory and operating) will be in terms of Cooper E loadings.
3. In rating existing concrete structures use the allowable service load stresses for inventory (design stresses) according to A.R.E.M.A. Chapter 8, Section 2.26, Page 8-2-29. Use the permissible unit stresses for operating (rating stresses according to A.R.E.M.A. Chapter 8, Page 8-19-4).
4. Structure members shall be rated for as-built and as-inspected condition using one of the Cooper E series in accordance with A.R.E.M.A.
5. For each controlling member equivalent Cooper E loads shall be computed for each live load shown in the attachment.
6. When any of the NJ Transit loads (1 through 5) are applied at normal operating speed, and Conrail's anticipated freight load, load 6 applied at 40 mph, is greater in terms of Cooper E loading than a specific member's Cooper E Inventory rating, the speed restrictions must be introduced (see A.R.E.M.A. Chapter 15, 7.3.3.3., for steel; and Chapter 8, Part 19, for concrete).
  - a. When the equivalent Cooper E for specific loading is greater than the Cooper E inventory rating of the structure with impact computed at 10mph, then 93% of the Cooper E operating rating of the structure will control (with impact computed at 10 mph) and no other trains except for the specific loading shall be allowed on the structure at the same time with a maximum speed of 10 mph.
  - b. If the equivalent Cooper E for a specific loading at 10 mph exceeds 93% of the operating rating of the structure, then the loading shall be restricted from the structure until the structure can be rehabilitated to a satisfactory capacity rating.
 

All recommendations for rehabilitating the structure shall be based on upgrading all member's inventory ratings to a level sufficient to sustain the maximum anticipated loading condition (Equivalent Cooper E).
8. When the equivalent Cooper E load for a specific loading is greater than the controlling members equivalent Cooper E load rated for "Regularly Assigned Locomotives", the loading shall be restricted to 10 mph.
9. When speed restrictions are required, a speed chart shall be made for the controlling member's Cooper E inventory rating. The speed chart shall range as follows:

Steel: from the equivalent Cooper E load at 60 mph for load 1 through 5, and 40 mph for load 5, to the equivalent Cooper E load at 10 mph.

Concrete: from the equivalent Cooper E load at 40 mph for all loads, to an equivalent Cooper E load 10 mph.

## B. Timber Structures

1. Rating of wood structures shall be done in accordance with A.R.E.M.A. Chapter 7, Page 7-2-23.
2. Structure members shall be rated using one of the Cooper E Series.
3. In accordance with Chapter 7, Page 7-2-24, when the support under a rail consists of three or more stringers assembled as a chord or acting in unison and extending over two spans with staggered joints, a partially continuous beam action may be assumed to exist and the computations may be made for stringers based on the average stress as determined from single beam analysis and that for a fully continuous condition.
4. When analyzing notched beams the average live load and reaction as found from above shall be used and the allowable end reaction shall be computed using the formula in Chapter 7, Section E, Art. 4, Page 7-2-16.
5. The permissible unit stresses for rating shall be in accordance with Chapter 7, Art. 13, Page 7-2-25.
6. Structure members shall be rated for "Locomotives Not Regularly Assigned" and for "Regularly Assigned Locomotives", and shall be in terms of equivalent Cooper E loads.

For each controlling member, equivalent Cooper E loads shall be made for each live load shown in the attachment.

8. When the equivalent Cooper E load for a specific loading is greater than the controlling members equivalent Cooper E load rated for "Regularly Assigned Locomotives", the loading shall be restricted to 10 mph.
9. When the equivalent Cooper E load for a specific loading is greater than the controlling members equivalent Cooper E load rated for "Not Regularly Assigned Locomotives", the "K" coefficient shall not be increased to 15% as stated in A.R.E.A. Chapter 7, Art. 13, page 7-2-25 and the loading shall be restricted from the structure until the structure can be rehabilitated to a satisfactory capacity rating.



The following Tables are provided in English and Metric units.

**Table 44.5-1 Moment and Shear, Load 1**

4 ES6 Diesels Coupled To AAR Cars

| SPAN |  | BENDING   | END SHEAR | FLOOR BEAM REACTION |
|------|--|-----------|-----------|---------------------|
| feet |  | ft-kips   | kips      | kips                |
| 8    |  | 104.00    | 55.52     | 55.52               |
| 10   |  | 130.00    | 62.40     | 69.80               |
| 12   |  | 156.00    | 69.33     | 79.31               |
| 13   |  | 170.93    | 72.00     | 82.97               |
| 14   |  | 191.20    | 74.29     | 87.62               |
| 15   |  | 211.59    | 76.27     | 93.06               |
| 16   |  | 234.00    | 78.00     | 97.82               |
| 18   |  | 286.75    | 82.25     | 105.75              |
| 20   |  | 350.08    | 88.83     | 112.10              |
| 25   |  | 513.52    | 104.90    | 132.31              |
| 30   |  | 720.51    | 115.62    | 155.53              |
| 35   |  | 909.45    | 124.60    | 175.11              |
| 40   |  | 1,120.95  | 132.60    | 197.55              |
| 45   |  | 1,353.16  | 144.22    | 221.25              |
| 50   |  | 1,653.91  | 157.70    | 245.40              |
| 60   |  | 2,333.01  | 180.23    | 290.30              |
| 70   |  | 3,064.51  | 205.24    | 338.32              |
| 80   |  | 3,951.05  | 229.16    | 384.67              |
| 90   |  | 4,978.17  | 252.46    | 432.62              |
| 100  |  | 6,134.89  | 277.27    | 479.84              |
| 120  |  | 8,709.13  | 325.27    | 561.23              |
| 140  |  | 11,841.20 | 372.92    | 637.47              |
| 160  |  | 15,386.66 | 420.60    | 712.16              |
| 180  |  | 19,467.94 | 468.08    | 785.28              |
| 200  |  | 23,991.78 | 512.94    | 854.94              |
| 225  |  | 29,753.54 | 563.29    | 939.53              |
| 250  |  | 36,388.54 | 616.07    | 1,023.29            |
| 275  |  | 43,174.78 | 669.76    | 1,098.19            |
| 300  |  | 50,698.08 | 720.24    | 1,160.61            |
| 350  |  | 67,114.30 | 821.96    | 1,258.69            |
| 400  |  | 85,493.60 | 922.42    | 1,332.26            |

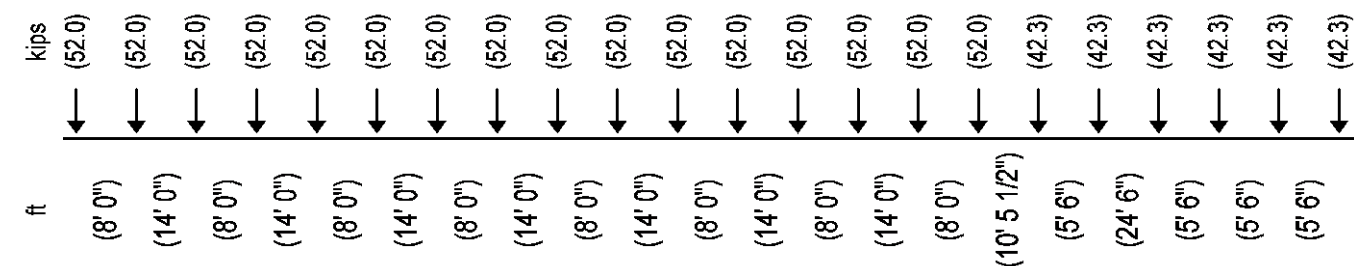
  

|      |            |            |            |              |                       |          |         |              |         |          |         |              |         |          |         |              |         |          |         |         |         |
|------|------------|------------|------------|--------------|-----------------------|----------|---------|--------------|---------|----------|---------|--------------|---------|----------|---------|--------------|---------|----------|---------|---------|---------|
| kips | (52.0)     | (52.0)     | (52.0)     | (52.0)       | (52.0)                | (52.0)   | (52.0)  | (52.0)       | (52.0)  | (52.0)   | (52.0)  | (52.0)       | (52.0)  | (52.0)   | (52.0)  | (42.3)       | (42.3)  | (42.3)   | (42.3)  | (42.3)  | (42.3)  |
|      | ↓          | ↓          | ↓          | ↓            | ↓                     | ↓        | ↓       | ↓            | ↓       | ↓        | ↓       | ↓            | ↓       | ↓        | ↓       | ↓            | ↓       | ↓        | ↓       | ↓       | ↓       |
| ft.  | (8' 0")    | (14' 0")   | (8' 0")    | (13' 7 1/2") | (8' 0")               | (14' 0") | (8' 0") | (13' 7 1/2") | (8' 0") | (14' 0") | (8' 0") | (13' 7 1/2") | (8' 0") | (14' 0") | (8' 0") | (10' 9 3/4") | (5' 6") | (25' 4") | (5' 6") | (8' 0") | (5' 6") |
|      | 43' 7 1/2" | 43' 7 1/2" | 43' 7 1/2" | 43' 7 1/2"   | 44' 4"                |          |         |              |         |          |         |              |         |          |         |              |         |          |         |         |         |
|      | 1 - ES6    | 1 - ES6    | 1 - ES6    | 1 - ES6      | AAR Cars (169.2 Kips) |          |         |              |         |          |         |              |         |          |         |              |         |          |         |         |         |

**Table 44.5-2 Moment and Shear, Load 2**

4 ES10 Diesels Coupled To 220 Kips Cars

| SPAN<br>ft. | BENDING<br>ft-kips | END SHEAR<br>kips | FLOOR | BEAM REACTION<br>kips |
|-------------|--------------------|-------------------|-------|-----------------------|
| 8           | 124.20             | 72.19             |       | 82.50                 |
| 10          | 155.25             | 79.75             |       | 99.00                 |
| 12          | 196.18             | 84.79             |       | 110.00                |
| 13          | 222.25             | 90.96             |       | 118.46                |
| 14          | 248.60             | 96.25             |       | 125.71                |
| 15          | 289.06             | 100.83            |       | 132.00                |
| 16          | 330.29             | 104.84            |       | 137.50                |
| 18          | 412.75             | 113.06            |       | 146.67                |
| 20          | 495.23             | 123.75            |       | 154.00                |
| 25          | 738.24             | 143.00            |       | 167.20                |
| 30          | 1,009.36           | 155.83            |       | 189.55                |
| 35          | 1,265.00           | 165.00            |       | 213.67                |
| 40          | 1,540.00           | 171.88            |       | 237.32                |
| 45          | 1,815.00           | 182.10            |       | 263.69                |
| 50          | 2,090.00           | 198.54            |       | 291.79                |
| 60          | 2,843.25           | 225.18            |       | 344.88                |
| 70          | 3,739.25           | 254.19            |       | 400.08                |
| 80          | 4,746.41           | 282.74            |       | 454.96                |
| 90          | 5,933.08           | 310.20            |       | 509.56                |
| 100         | 7,294.83           | 339.63            |       | 565.85                |
| 120         | 10,346.50          | 395.75            |       | 672.06                |
| 140         | 14,002.66          | 451.80            |       | 775.05                |
| 160         | 18,198.22          | 507.49            |       | 876.32                |
| 180         | 22,930.08          | 563.22            |       | 977.56                |
| 200         | 28,292.49          | 617.26            |       | 1,077.43              |
| 225         | 35,386.55          | 676.74            |       | 1,203.67              |
| 250         | 43,632.59          | 741.42            |       | 1,314.67              |
| 275         | 52,323.96          | 805.20            |       | 1,405.48              |
| 300         | 61,971.46          | 869.66            |       | 1,481.15              |
| 350         | 83,347.80          | 1,003.79          |       | 1,600.07              |
| 400         | 107,743.43         | 1,137.01          |       | 1,689.27              |



| 44' 5" | 44' 5" | 44' 5" | 44' 5" | 2' 0" |  
 1 - ES10 1 - ES10 1 - ES10 1 - ES10 220 kips Car

**Table 44.5-3 Moment and Shear, Load 3**

4-BF 15 Diesels Coupled To 220 Kips Cars

| SPAN<br>ft. | BENDING<br>ft-kips |  | END SHEAR<br>kips |  | FLOOR BEAM REACTION<br>kips |  |
|-------------|--------------------|--|-------------------|--|-----------------------------|--|
| 8           | 136.00             |  | 72.19             |  | 82.50                       |  |
| 10          | 170.00             |  | 79.75             |  | 99.00                       |  |
| 12          | 204.00             |  | 84.79             |  | 110.00                      |  |
| 13          | 222.25             |  | 90.96             |  | 118.46                      |  |
| 14          | 248.60             |  | 96.25             |  | 125.71                      |  |
| 15          | 289.06             |  | 100.83            |  | 132.00                      |  |
| 16          | 330.29             |  | 104.84            |  | 137.50                      |  |
| 18          | 412.75             |  | 113.06            |  | 146.67                      |  |
| 20          | 495.23             |  | 123.75            |  | 154.00                      |  |
| 25          | 738.24             |  | 143.00            |  | 167.20                      |  |
| 30          | 1,009.36           |  | 155.83            |  | 176.00                      |  |
| 35          | 1,265.00           |  | 165.00            |  | 190.14                      |  |
| 40          | 1,540.00           |  | 171.88            |  | 212.49                      |  |
| 45          | 1,815.00           |  | 180.89            |  | 238.33                      |  |
| 50          | 2,090.00           |  | 193.05            |  | 268.40                      |  |
| 60          | 2,640.00           |  | 221.83            |  | 330.00                      |  |
| 70          | 3,327.50           |  | 253.00            |  | 377.14                      |  |
| 80          | 4,249.82           |  | 276.38            |  | 420.75                      |  |
| 90          | 5,362.50           |  | 298.53            |  | 473.31                      |  |
| 100         | 6,710.00           |  | 325.88            |  | 532.40                      |  |
| 120         | 9,900.00           |  | 380.87            |  | 629.98                      |  |
| 140         | 13,200.00          |  | 430.37            |  | 731.23                      |  |
| 160         | 16,830.00          |  | 485.37            |  | 831.63                      |  |
| 180         | 21,298.75          |  | 534.87            |  | 929.59                      |  |
| 200         | 26,620.00          |  | 589.88            |  | 1,024.63                    |  |
| 225         | 33,495.00          |  | 652.54            |  | 1,149.16                    |  |
| 250         | 40,947.50          |  | 717.26            |  | 1,265.00                    |  |
| 275         | 49,354.27          |  | 780.85            |  | 1,365.09                    |  |
| 300         | 53,600.16          |  | 844.89            |  | 1,448.50                    |  |
| 350         | 79,233.59          |  | 971.01            |  | 1,579.57                    |  |
| 400         | 102,462.96         |  | 1,096.34          |  | 1,677.87                    |  |

|      |          |          |          |          |          |          |          |          |          |          |          |          |          |          |          |          |         |          |         |         |         |
|------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|---------|----------|---------|---------|---------|
| kips | (52.0)   | (52.0)   | (52.0)   | (52.0)   | (52.0)   | (52.0)   | (52.0)   | (52.0)   | (52.0)   | (52.0)   | (52.0)   | (52.0)   | (52.0)   | (52.0)   | (52.0)   | (42.3)   | (42.3)  | (42.3)   | (42.3)  | (42.3)  | (42.3)  |
|      | ↓        | ↓        | ↓        | ↓        | ↓        | ↓        | ↓        | ↓        | ↓        | ↓        | ↓        | ↓        | ↓        | ↓        | ↓        | ↓        | ↓       | ↓        | ↓       | ↓       | ↓       |
| ft.  | (9' 10") | (18' 4") | (9' 10") | (14' 7") | (9' 10") | (18' 4") | (9' 10") | (14' 7") | (9' 10") | (18' 4") | (9' 10") | (14' 7") | (9' 10") | (18' 4") | (9' 10") | (12' 4") | (5' 6") | (24' 6") | (5' 6") | (5' 6") | (5' 6") |

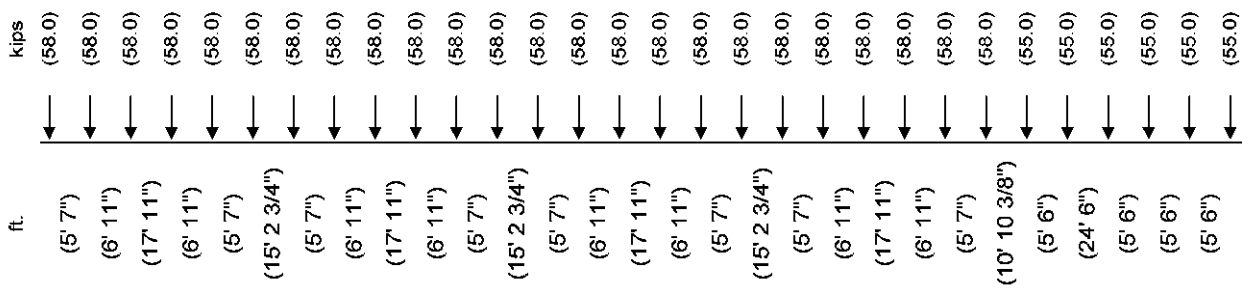
| 54' 4 1/2" | 52' 7" | 52' 7" | 54' 4 1/2" | 2' 0" \_ |

1 - BF 15 1 - BF 15 1 - BF 15 1 - BF 15 220 kips Cars

**Table 44.5-4 Moment and Shear, Load 4**

4—AS18AM Diesels Coupled To 220 Kips Cars

| SPAN | BENDING    | END SHEAR | FLOOR BEAM REACTION |
|------|------------|-----------|---------------------|
| ft   | ft-kips    | kips      | kips                |
| 8    | 116.00     | 75.55     | 83.38               |
| 10   | 150.75     | 83.64     | 101.50              |
| 12   | 204.99     | 89.03     | 113.58              |
| 13   | 232.54     | 93.34     | 118.46              |
| 14   | 260.30     | 99.10     | 125.71              |
| 15   | 290.58     | 104.90    | 132.00              |
| 16   | 334.04     | 108.46    | 137.50              |
| 18   | 420.98     | 115.74    | 146.67              |
| 20   | 507.93     | 123.75    | 156.71              |
| 25   | 738.24     | 143.00    | 182.17              |
| 30   | 1,009.36   | 155.83    | 199.45              |
| 35   | 1,265.00   | 169.76    | 225.18              |
| 40   | 1,567.13   | 184.04    | 251.93              |
| 45   | 1,922.13   | 195.15    | 281.04              |
| 50   | 2,277.13   | 208.00    | 310.24              |
| 60   | 2,991.69   | 233.60    | 368.14              |
| 70   | 3,940.65   | 265.66    | 428.08              |
| 80   | 5,038.55   | 293.94    | 488.79              |
| 90   | 6,323.45   | 326.70    | 544.72              |
| 100  | 7,756.12   | 357.23    | 603.66              |
| 120  | 11,044.18  | 415.49    | 722.97              |
| 140  | 14,982.75  | 475.05    | 834.91              |
| 160  | 19,551.73  | 536.29    | 942.32              |
| 180  | 24,512.55  | 595.69    | 1,051.66            |
| 200  | 30,183.20  | 655.24    | 1,154.55            |
| 225  | 38,162.61  | 730.11    | 1,279.14            |
| 250  | 47,095.20  | 804.54    | 1,396.95            |
| 275  | 56,497.58  | 867.97    | 1,496.50            |
| 300  | 66,731.53  | 939.41    | 1,579.46            |
| 350  | 89,794.20  | 1,076.70  | 1,709.82            |
| 400  | 115,455.43 | 1,214.54  | 1,807.59            |

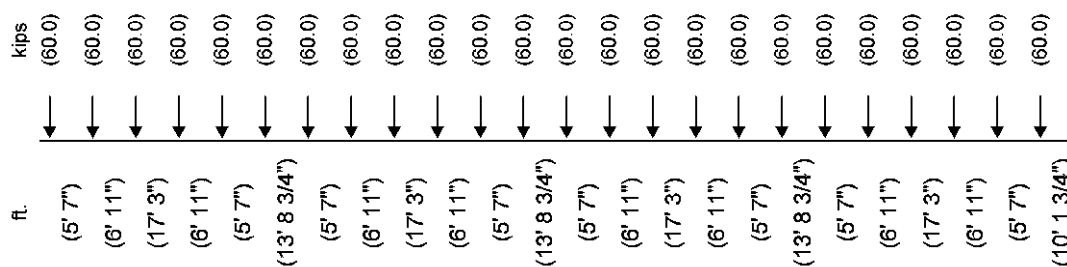


| 58'1 3/4" | 58'1 3/4" | 58'1 3/4" | 58'1 3/4" | 2' 0" |  
 1 - AS18AM 1 - AS18AM 1 - AS18AM 1 - AS18AM 220 kips Cars

**Table 44.5-5 Moment and Shear, Load 5**

4—AS16A Diesels Coupled To 220 Kips Cars

| SPAN | BENDING<br>ft-kips | END SHEAR<br>kips | FLOOR BEAM REACTION<br>kips |
|------|--------------------|-------------------|-----------------------------|
| 8    | 120.00             | 78.15             | 86.25                       |
| 10   | 155.95             | 86.52             | 105.00                      |
| 12   | 212.06             | 92.10             | 117.50                      |
| 13   | 240.56             | 96.55             | 122.31                      |
| 14   | 269.28             | 102.51            | 126.43                      |
| 15   | 300.60             | 107.68            | 132.00                      |
| 16   | 345.56             | 112.20            | 137.50                      |
| 18   | 435.50             | 119.73            | 151.14                      |
| 20   | 525.45             | 125.76            | 165.03                      |
| 25   | 750.36             | 143.00            | 190.02                      |
| 30   | 1,009.36           | 158.17            | 209.05                      |
| 35   | 1,287.80           | 177.01            | 236.40                      |
| 40   | 1,650.80           | 191.13            | 269.34                      |
| 45   | 2,012.80           | 205.08            | 299.41                      |
| 50   | 2,375.30           | 220.57            | 331.43                      |
| 60   | 3,135.70           | 247.83            | 393.71                      |
| 70   | 4,137.00           | 279.81            | 457.44                      |
| 80   | 5,386.80           | 313.31            | 523.92                      |
| 90   | 6,736.80           | 348.22            | 583.44                      |
| 100  | 8,285.65           | 379.04            | 647.92                      |
| 120  | 11,811.45          | 440.45            | 776.41                      |
| 140  | 16,010.40          | 506.32            | 890.05                      |
| 160  | 20,956.80          | 571.42            | 1,000.12                    |
| 180  | 26,254.80          | 633.66            | 1,109.53                    |
| 200  | 32,395.80          | 699.85            | 1,211.89                    |
| 225  | 40,895.24          | 776.36            | 1,335.15                    |
| 250  | 50,459.45          | 853.53            | 1,450.15                    |
| 275  | 60,249.39          | 923.22            | 1,549.22                    |
| 300  | 71,051.85          | 996.13            | 1,631.79                    |
| 350  | 94,882.88          | 1,140.10          | 1,761.53                    |
| 400  | 121,189.25         | 1,281.81          | 1,858.84                    |

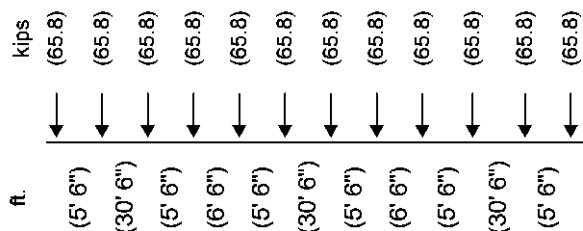


55' 11 3/4" | 55' 11 3/4" | 55' 11 3/4" | 55' 11 3/4" 12.80(2'0") | 1 - AS16A 1 - AS16A 1 - AS16A 1 - AS16A 220 kips Cars

**Table 44.5-6 Moment and Shear, Load 6**

263 Kip Car Min. Coupled Length 48'-0"

| SPAN<br>ft. | BENDING<br>ft-kips | END SHEAR<br>kips | FLOOR BEAM REACTION<br>kips |
|-------------|--------------------|-------------------|-----------------------------|
| 8           | 131.50             | 86.30             | 98.63                       |
| 10          | 172.80             | 95.34             | 118.35                      |
| 12          | 234.41             | 101.36            | 131.51                      |
| 13          | 265.69             | 108.74            | 141.62                      |
| 14          | 297.20             | 115.06            | 150.29                      |
| 15          | 345.55             | 120.54            | 157.80                      |
| 16          | 394.84             | 125.34            | 164.37                      |
| 18          | 493.43             | 135.15            | 175.33                      |
| 20          | 592.02             | 147.94            | 184.10                      |
| 25          | 882.53             | 170.95            | 199.83                      |
| 30          | 1,206.65           | 186.29            | 210.40                      |
| 35          | 1,512.25           | 197.25            | 217.91                      |
| 40          | 1,841.00           | 205.47            | 230.12                      |
| 45          | 2,169.75           | 211.86            | 249.85                      |
| 50          | 2,498.50           | 219.61            | 276.15                      |
| 60          | 3,156.00           | 244.92            | 341.99                      |
| 70          | 3,813.50           | 279.91            | 405.77                      |
| 80          | 4,602.50           | 319.67            | 453.67                      |
| 90          | 5,621.62           | 334.59            | 495.68                      |
| 100         | 6,903.75           | 356.37            | 549.67                      |
| 120         | 10,257.00          | 415.87            | 673.65                      |
| 140         | 14,202.00          | 469.17            | 768.34                      |
| 160         | 18,147.00          | 521.69            | 884.34                      |
| 180         | 22,305.69          | 580.06            | 990.63                      |
| 200         | 27,483.50          | 630.71            | 1,098.02                    |
| 225         | 35,307.75          | 702.79            | 1,237.85                    |
| 250         | 43,526.50          | 767.83            | 1,372.33                    |
| 275         | 51,926.06          | 839.21            | 1,510.10                    |
| 300         | 61,755.68          | 904.83            | 1,646.38                    |
| 350         | 84,554.49          | 1,042.14          | 1,920.65                    |
| 400         | 109,802.49         | 1,179.31          | 2,194.73                    |



| 48' 0" | 48' 0" | 48' 0" |

# **Appendix 1 – Overview, Maintenance and Innovation**

## Appendix 1 - Overview, Maintenance and Innovation

The State of New Jersey encompasses 7,417 square miles of land area. While ranking the 46<sup>th</sup> among the States in total area, it is the most densely populated State. It is also the most highly urbanized.

New Jersey's inventory contains over 6,400 records of highway carrying bridge structures. One of the structures of note is the Pulaski Skyway Bridge. The Pulaski Skyway opened to traffic in 1932. It was constructed to provide a high level crossing of the Hackensack Meadowlands between Jersey City and Newark. This improvement to the highway system was designed to feed traffic into the Holland and Lincoln Tunnels. The three and a half mile long structure consists of numerous short span Pratt deck trusses and two 1,250 ft. long steel cantilever through trusses that span the Passaic River and Hackensack River.



Another structure of note is the Scotch Road over I-95 Bridge, a modern high performance steel (HPS) integral abutment bridge. This bridge was the first HPS construction as well as the first integral jointless abutment bridge for the New Jersey DOT. The bridge, which opened to traffic in 2003, reflects a trend of reducing lifelong maintenance work and cost. The structure is 298 ft long, consisting of two equal continuous spans of HPS plate girders with expansion joints eliminated.





The challenge for bridge engineers in New Jersey is to maintain the integrity of the State's aging bridge structures and design innovative new structures to meet current and future traffic needs. The use of enhanced materials, such as High performance Steel (HPS) and High Performance Concrete (HPC), to better assure the expectancy of a bridge structure design life is highly encouraged. Subsequent to the new construction of bridge and other traffic structures, their condition must be evaluated on a periodic basis.

The 6<sup>th</sup> Edition of the Design Manual addresses the complete use of the AASHTO LRFD Bridge Design Specifications for designing bridge structures. The Manual adheres to the FHWA requirement that design of all new bridges under Federal Aid funded projects are to be designed to the AASHTO LRFD Bridge Design Specifications. This Manual provides guidance and direction to accomplish these tasks. Following the direction and guidance stated in this Manual for highway bridges and structures will provide consistency with the New Jersey DOT Standard Specifications for Road and Bridge Construction, the AASHTO LRFD Bridge Design Specifications, other relevant AASHTO design specifications, and FHWA guidelines.

The 6<sup>th</sup> Edition of the Design Manual supersedes the 5<sup>th</sup> Edition of New Jersey DOT Bridges and Structures Design Manual (2009).

## **Appendix 2 – Standard Drawings**

## **Appendix 3 – Guide Plates**

| <b>FEDERAL AID AND STRUCTURE IDENTIFICATION BLOCK</b>  |                     | <b>ISSUED: 2016</b> | <b>PLATE 3.1-1</b> |       |                     |       |              |      |  |   |   |                      |  |  |  |
|--|---------------------|---------------------|--------------------|-------|---------------------|-------|--------------|------|--|---|---|----------------------|--|--|--|
| <p>ROAD AND STRUCTURAL SHEETS COMBINED</p> <table border="1" style="margin-left: auto; margin-right: auto; border-collapse: collapse;"> <thead> <tr> <th style="width: 10%;">STATE</th> <th style="width: 40%;">FEDERAL PROJECT NO.</th> <th style="width: 10%;">SHEET</th> <th style="width: 40%;">TOTAL SHEETS</th> </tr> </thead> <tbody> <tr> <td style="text-align: center;">N.J.</td> <td></td> <td style="text-align: center;">○</td> <td style="text-align: center;">○</td> </tr> <tr> <td colspan="4" style="text-align: center; padding: 5px;"><b>STRUCTURE NO.</b></td> </tr> </tbody> </table> |                     |                     |                    | STATE | FEDERAL PROJECT NO. | SHEET | TOTAL SHEETS | N.J. |  | ○ | ○ | <b>STRUCTURE NO.</b> |  |  |  |
| STATE  | FEDERAL PROJECT NO. | SHEET               | TOTAL SHEETS       |       |                     |       |              |      |  |   |   |                      |  |  |  |
| N.J.   |                     | ○                   | ○                  |       |                     |       |              |      |  |   |   |                      |  |  |  |
| <b>STRUCTURE NO.</b>   |                     |                     |                    |       |                     |       |              |      |  |   |   |                      |  |  |  |
| <p><b>NOTES:</b></p> <ol style="list-style-type: none"> <li>1. PLACE BLOCK IN UPPER RIGHT-HAND CORNER OF 22"X36" PLAN SHEET.</li> <li>2. SEE SECTION 35 OF THIS MANUAL FOR INFORMATION CONCERNING STRUCTURE NUMBERS.</li> </ol>  |                     |                     |                    |       |                     |       |              |      |  |   |   |                      |  |  |  |

|                            |              |                |
|----------------------------|--------------|----------------|
| CREDIT BLOCK (CONSULTANTS) | ISSUED: 2016 | PLATE<br>3.1-2 |
|----------------------------|--------------|----------------|

AS ASSIGNED BY THE DEPARTMENT

|                   |       |         |       |
|-------------------|-------|---------|-------|
| CONTROL SECTION   | ----- | JOB NO. | ----- |
| DES BY            | ----- | CHK. BY | ----- |
| DWN. BY           | ----- | CHK. BY | ----- |
| EST. BY           | ----- | CHK. BY | ----- |
| SPECS. BY         | ----- | CHK. BY | ----- |
| IN CHARGE OF----- |       |         |       |

SIGNATURE OF PROJECT ENGINEER

NAMES SHALL BE ENTERED ONLY BY THE PERSON ASSIGNED THE PARTICULAR FUNCTION. USE LAST NAMES, ALL LOCATIONS.

**NOTES:**

1. PLACE BLOCK IN LOWER LEFT-HAND CORNER OF 22"x36" PLAN SHEET
2. VARIATIONS OF THE ABOVE BLOCK SUBJECT TO APPROVAL.

|  |              |                |                 |  |         |  |     |  |      |  |      |  |  |  |   |  |  |  |  |  |  |  |
|--|--------------|----------------|-----------------|--|---------|--|-----|--|------|--|------|--|--|--|---|--|--|--|--|--|--|--|
| CREDIT BLOCK (IN HOUSE)  | ISSUED: 2016 | PLATE<br>3.1-3 |                 |  |         |  |     |  |      |  |      |  |  |  |   |  |  |  |  |  |  |  |
| <p>AS ASSIGNED BY THE DEPARTMENT</p> <table border="1" style="margin: auto; border-collapse: collapse;"> <tr> <td style="width: 25%; padding: 5px;">CONTROL SECTION</td> <td style="width: 25%; border-bottom: 1px dashed black;"></td> <td style="width: 25%; padding: 5px;">JOB NO.</td> <td style="width: 25%; border-bottom: 1px dashed black;"></td> </tr> <tr> <td style="padding: 5px;">DES</td> <td style="border-bottom: 1px dashed black;"></td> <td style="padding: 5px;">CHK.</td> <td style="border-bottom: 1px dashed black;"></td> </tr> <tr> <td style="padding: 5px;">DWN.</td> <td style="border-bottom: 1px dashed black;"></td> <td style="padding: 5px;"></td> <td style="border-bottom: 1px dashed black;"></td> </tr> <tr> <td colspan="4" style="padding: 5px;">IN CHARGE -----<br/>Project Engineer-Structural Transportation</td> </tr> <tr> <td colspan="4" style="padding: 5px;">SUBMITTED -----<br/>Manager-Structural Design</td> </tr> </table> <p style="margin-left: 400px;">NAMES SHALL BE ENTERED ONLY BY THE PERSON ASSIGNED THE PARTICULAR FUNCTION. USE LAST NAMES, ALL LOCATIONS.</p> |              |                | CONTROL SECTION |  | JOB NO. |  | DES |  | CHK. |  | DWN. |  |  |  | IN CHARGE -----<br>Project Engineer-Structural Transportation |  |  |  | SUBMITTED -----<br>Manager-Structural Design |  |  |  |
| CONTROL SECTION  |              | JOB NO.        |                 |  |         |  |     |  |      |  |      |  |  |  |   |  |  |  |  |  |  |  |
| DES  |              | CHK.           |                 |  |         |  |     |  |      |  |      |  |  |  |   |  |  |  |  |  |  |  |
| DWN.   |              |                |                 |  |         |  |     |  |      |  |      |  |  |  |   |  |  |  |  |  |  |  |
| IN CHARGE -----<br>Project Engineer-Structural Transportation  |              |                |                 |  |         |  |     |  |      |  |      |  |  |  |   |  |  |  |  |  |  |  |
| SUBMITTED -----<br>Manager-Structural Design   |              |                |                 |  |         |  |     |  |      |  |      |  |  |  |   |  |  |  |  |  |  |  |
| <p><b>NOTE:</b></p> <p>PLACE BLOCK IN LOWER LEFT-HAND CORNER OF 22"x38" PLAN SHEET.</p>  |              |                |                 |  |         |  |     |  |      |  |      |  |  |  |   |  |  |  |  |  |  |  |

|                                      |                            |                                      |
|--------------------------------------|----------------------------|--------------------------------------|
| <p><b>TITLE BLOCK (IN HOUSE)</b></p> | <p><b>ISSUED: 2016</b></p> | <p><b>PLATE</b><br/><b>3.1-4</b></p> |
|--------------------------------------|----------------------------|--------------------------------------|

( DRAWING IS NOT TO SCALE )

8"

NEW JERSEY DEPARTMENT OF TRANSPORTATION  
BUREAU OF STRUCTURAL ENGINEERING

3 1/2"

1/2"

**TYPICAL DECK SECTION**

ROUTE

CONTRACT NO: \_\_\_\_\_

BRIDGE SHEET NO.   B   OF   B

TITLE, TYPE OF SHEET

| REVISION | BY | C'K'D | DATE |
|----------|----|-------|------|
|          |    |       |      |
|          |    |       |      |
|          |    |       |      |
|          |    |       |      |

3"

ROAD AND STRUCTURAL SHEETS COMBINED

\*B\* SHEET NUMBERING SYSTEM FOR ALL BRIDGE AND STRUCTURAL SHEETS. NUMBER CONSECUTIVELY FOR TOTAL NUMBER OF SHEETS. BRIDGES TO APPEAR IN ORDER OF STATIONS.

|  |                            |                               |
|--|----------------------------|-------------------------------|
| <p><b>TITLE BLOCK (CONSULTANT)</b></p> | <p><b>ISSUED: 2016</b></p> | <p><b>PLATE<br/>3.1-5</b></p> |
|--|----------------------------|-------------------------------|

(DRAWING IS NOT TO SCALE)

7'

NEW JERSEY DEPARTMENT OF TRANSPORTATION  
BUREAU OF STRUCTURAL ENGINEERING

TYPICAL DECK SECTION

ROUTE \_\_\_\_\_  
CONTRACT NO: \_\_\_\_\_

|   |   |   |   |
|---|---|---|---|
| RESERVED FOR SUBCONSULTANT'S SIGNATURE                      | RESERVED FOR FUTURE REVISION BLOCK  | (NAME OF CONSULTANT)<br>[***]                 | (ENGINEER'S SIGNATURE)<br>[DATE]                |
| (ITEM DESIGNED BY SUBCONSULTANT)<br>(NAME OF SUBCONSULTANT) | (SUBCONSULTANT'S SIGNATURE)<br>(SUBCONSULTANT'S NAME PRINTED)   | (ENGINEER'S NAME PRINTED)                     | (NEW JERSEY PROFESSIONAL ENGINEER LICENSE NO. ) |
| (TYPE OF LICENSE AND NO.) ***                               | TITLE, TYPE OF SHEET  | BRIDGE SHEET NO. <u>  B  </u> OF <u>  B  </u> | ROAD AND STRUCTURAL SHEETS COMBINED             |
| REVISION BY CKTD DATE                                       | <p style="font-size: 0.8em;">*B* SHEET NUMBERING SYSTEM FOR ALL BRIDGE AND STRUCTURAL SHEETS NUMBER CONSECUTIVELY FOR TOTAL NUMBER OF SHEETS. BRIDGES TO APPEAR IN ORDER OF STATIONS.</p> |   |   |

[\*\*\*] (CERTIFICATION OF AUTHORIZATION NO. OR PROFESSIONAL ASSOCIATION)



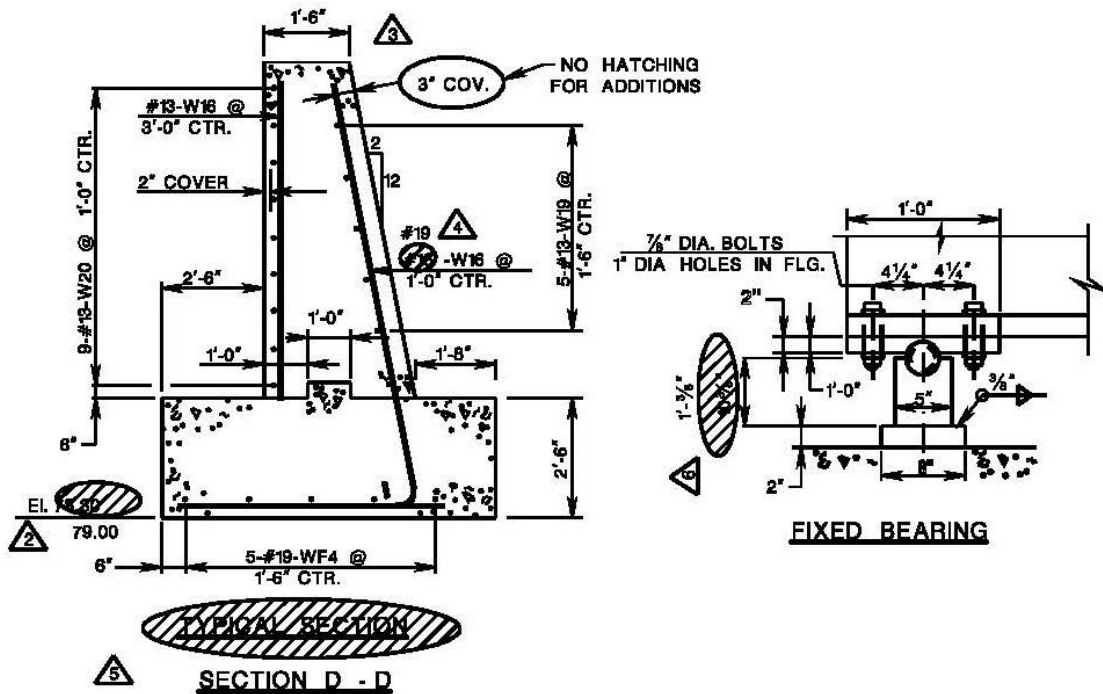
PLAN REVISIONS

ISSUED: 2016

PLATE  
3.2-1

LIST OF REINFORCEMENT STEEL

| No. | MARK | SIZE           | LENGTH | REMARKS   |
|-----|------|----------------|--------|---|
| 26  | P1   | #13            | 12'-8" | <del>DETAILED</del> STR. <span style="float: right;">△</span> |
| 16  | P2   | <del>#19</del> | 5'-3"  | DETAILED  |
| 62  | P3   | #19            | 17'-4" | STRAIGHT  |



**NOTE TO DESIGNER:**

SEE SECTION 1.39.1 FOR FURTHER INFORMATION.

**PROCEDURE FOR MAKING REVISIONS TO DRAWINGS AND NOTES**

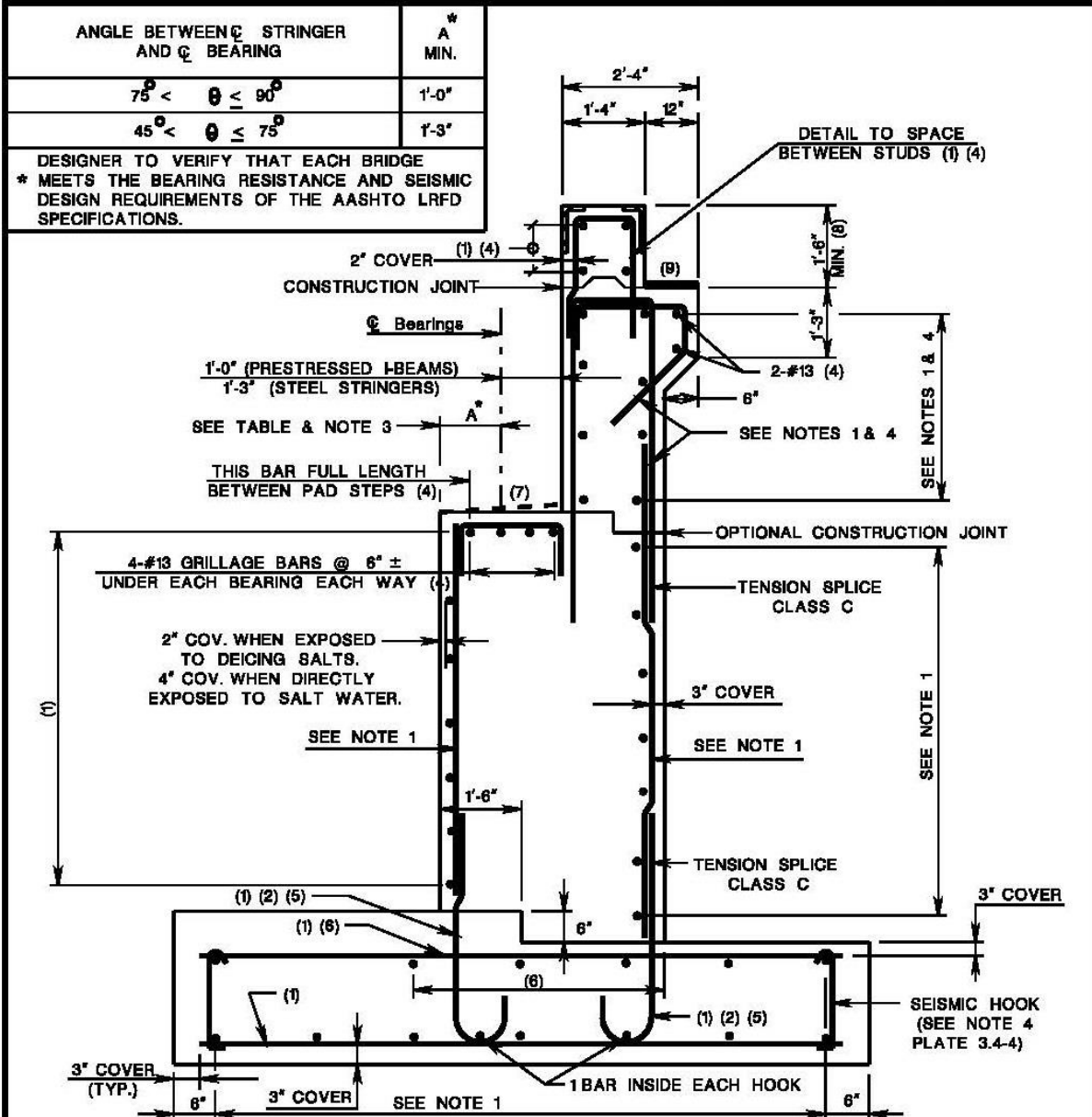
1. ENCLOSE INCORRECT ITEM IN A HEAVY OUTLINE.
2. LIGHTLY CROSS-HATCH ENCLOSED ITEM.
3. IDENTIFY REVISIONS WITH CONSECUTIVELY NUMBERED TRIANGLES.
4. LIST REVISIONS IN TABLE.

| REVISION | BY     | C'K'D  | DATE    |
|----------|--------|--------|---------|
| △6       | J.D.R. | O.F.M. | 2-21-81 |
| △5       | W.H.S. | D.A.T. | 2-14-81 |
| △4       | J.M.F. | L.R.M. | 2-10-81 |
| △3       | R.A.I. | J.R.   | 2-8-81  |
| △2       | J.P.G. | M.D.C. | 2-6-81  |
| △1       | J.B.D. | T.K.C. | 2-2-81  |

**ABUTMENT SECTION FOR STRUCTURES  
WITH APPROACH SLABS**

ISSUED: 2016

PLATE  
3.3-1

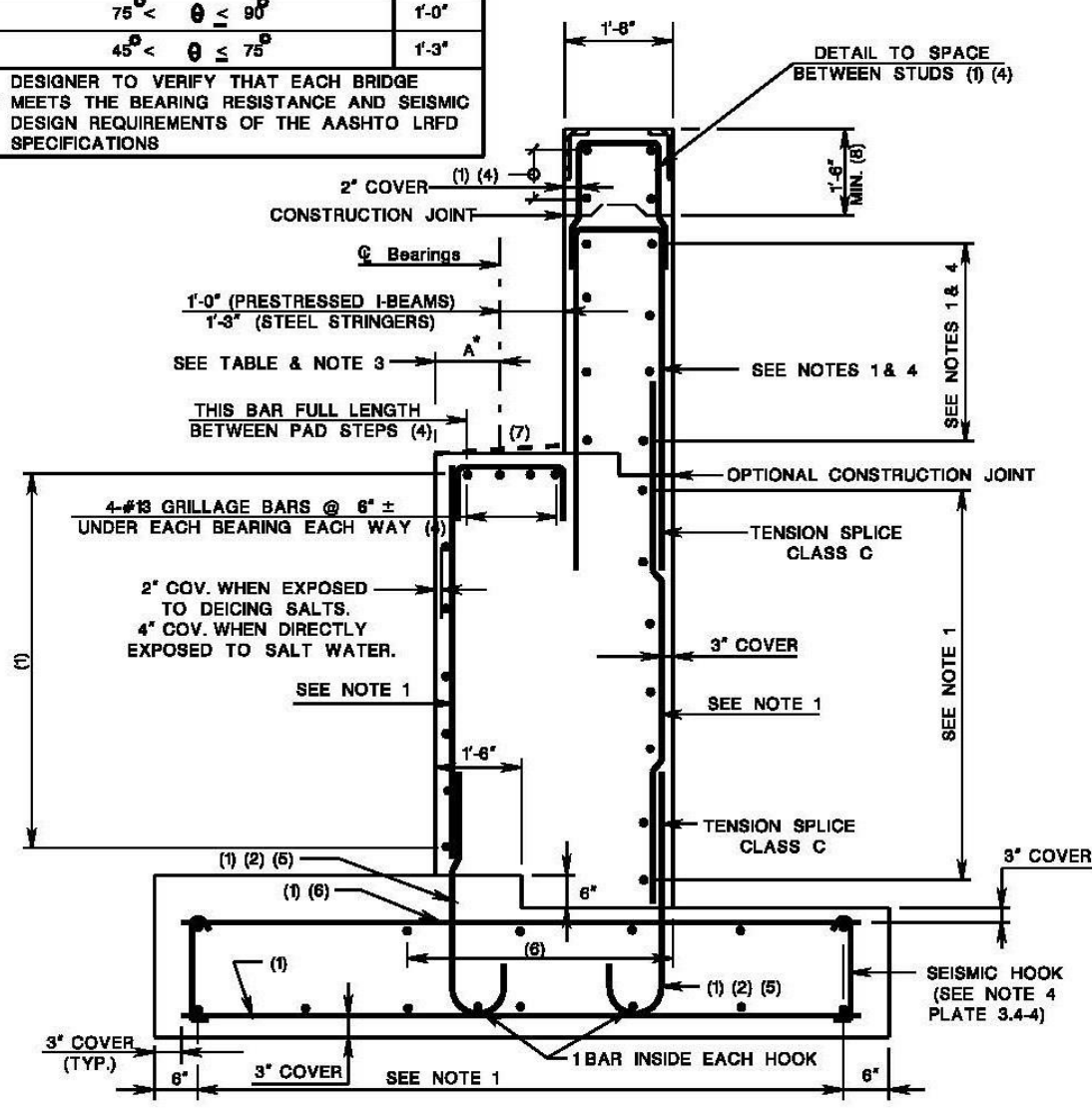


1. REINFORCEMENT NOT DESIGNATED SHALL BE AS REQUIRED BY DESIGN.
2. SEE PLATE 3.4-4 FOR ALTERNATE DOWEL DETAIL.
3. EDGE OF BRIDGE SEAT SHALL PROJECT AT LEAST 3" BEYOND THE EDGE OF THE BEARING MASONRY PLATE.
4. CORROSION PROTECTED BARS.
5. CORROSION PROTECTED DOWELS IN CORROSIVE ENVIRONMENTS.
6. TRANSVERSE STEEL IN TOP OF FOOTING SHALL BE DEVELOPED IN TENSION.
7. ABUTMENT SEATS SHALL BE SLOPED 5% FOR DRAINAGE BETWEEN THE LEVEL BEARING SEAT AREAS. REFER TO GUIDE PLATE 3.3-4 FOR MORE INFORMATION.
8. HEADER TO BE CONSTRUCTED AFTER THE DECK SLAB IS IN PLACE.
9. A 1/4" THICK PIECE OF PREFORMED BITUMINOUS JOINT FILLER SHALL BE LAID IN AND COVERED WITH ASPHALT ROOFING CEMENT ON THE SURFACE WHERE THE APPROACH SLAB SHALL REST.

**ABUTMENT SECTION FOR STRUCTURES WITHOUT APPROACH SLABS**  
**ISSUED: 2016**  
**PLATE 3.3-2**

|  |          |
|--|----------|
| ANGLE BETWEEN $\phi$ STRINGER AND $\phi$ BEARING | * A MIN. |
| $75^\circ < \theta \leq 90^\circ$                | 1'-0"    |
| $45^\circ < \theta \leq 75^\circ$                | 1'-3"    |

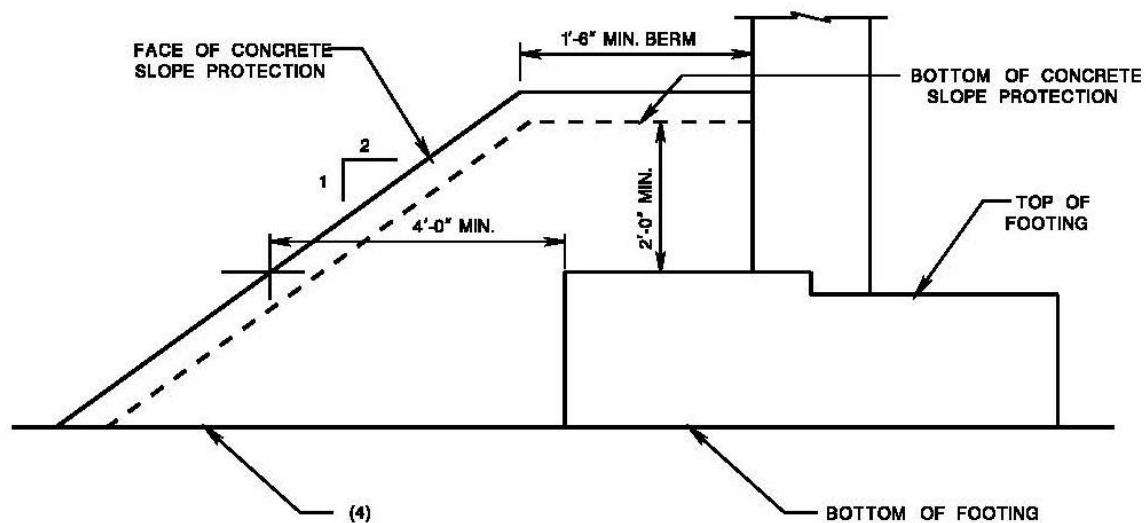
DESIGNER TO VERIFY THAT EACH BRIDGE \* MEETS THE BEARING RESISTANCE AND SEISMIC DESIGN REQUIREMENTS OF THE AASHTO LRFD SPECIFICATIONS



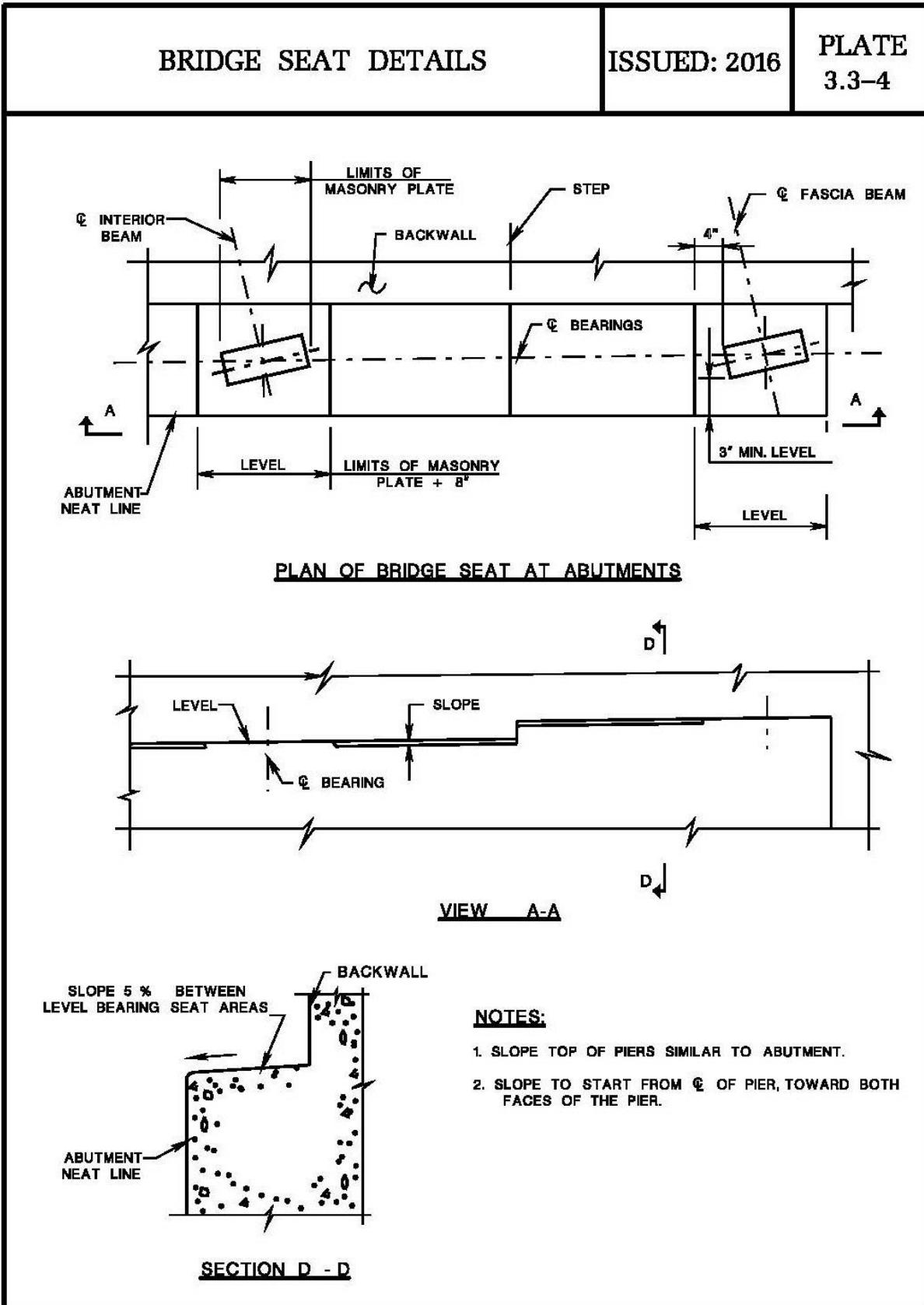
1. REINFORCEMENT NOT DESIGNATED SHALL BE AS REQUIRED BY DESIGN.
2. SEE PLATE 3.4-4 FOR ALTERNATE DOWEL DETAIL.
3. EDGE OF BRIDGE SEAT SHALL PROJECT AT LEAST 3" BEYOND THE EDGE OF THE BEARING MASONRY PLATE.
4. CORROSION PROTECTED BARS.
5. CORROSION PROTECTED DOWELS IN CORROSIVE ENVIRONMENTS.
6. TRANSVERSE STEEL IN TOP OF FOOTING SHALL BE DEVELOPED IN TENSION.
7. ABUTMENT SEATS SHALL BE SLOPED 5% FOR DRAINAGE BETWEEN THE LEVEL BEARING SEAT AREAS. REFER TO GUIDE PLATE 3.3-4 FOR MORE INFORMATION.
8. HEADER TO BE CONSTRUCTED AFTER THE DECK SLAB IS IN PLACE.

## FOOTINGS ON EMBANKMENTS

ISSUED: 2016

PLATE  
3.3-3**NOTES:**

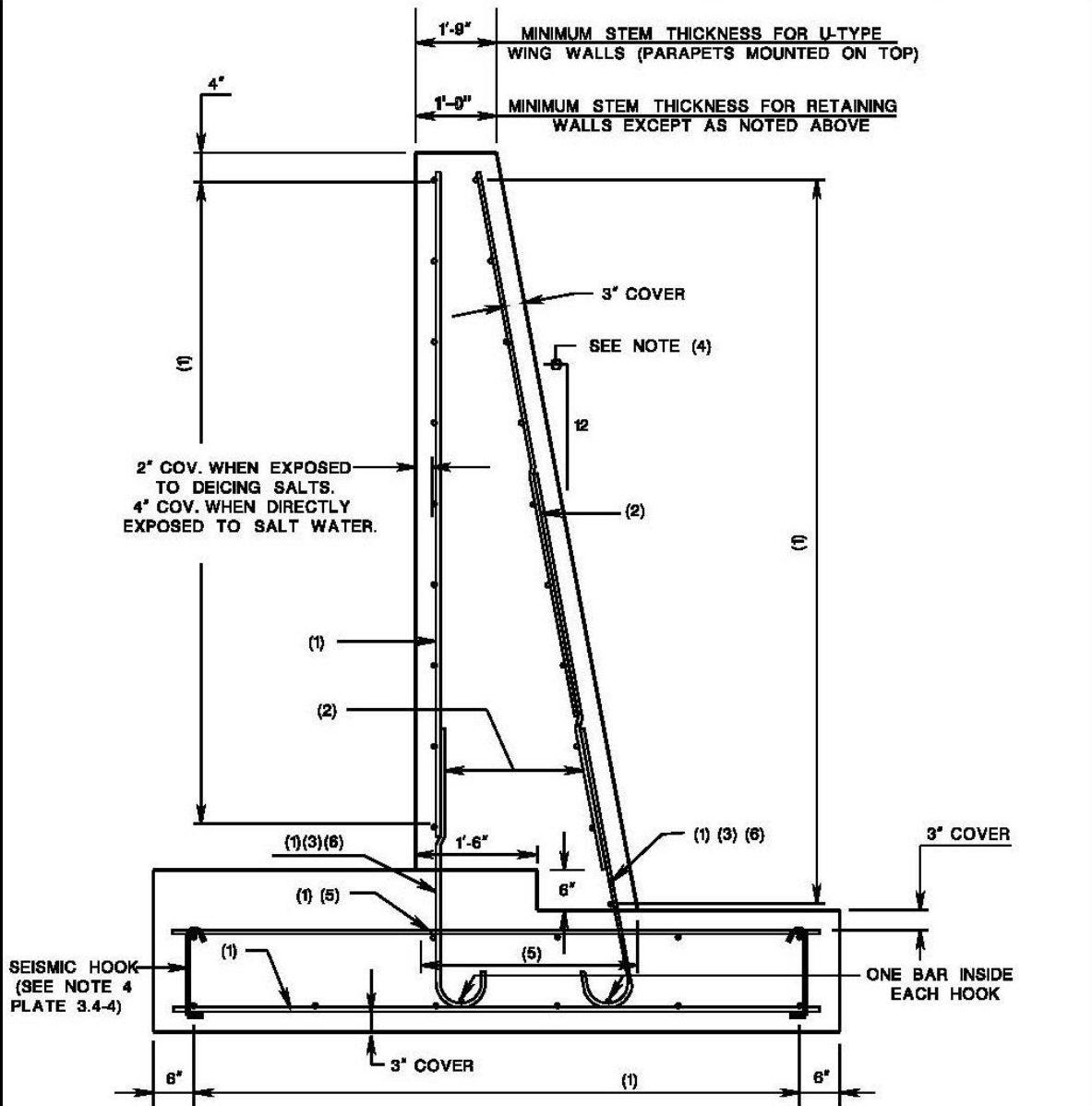
1. SPREAD FOOTINGS ON BORROW EXCAVATION, BRIDGE FOUNDATION TO BE DESIGNED FOR 2.5 TONS/SQ. FT. PRESSURE.
2. FOR FOOTINGS ON PILES, THE EMBANKMENT SHALL CONSIST OF BORROW EXCAVATION ZONE 3 MATERIAL WITH 2" MAXIMUM SIZE AGGREGATE. SCHEDULING OF PRE-BORED HOLES WHEN WARRANTED (THROUGH EMBANKMENT) AS A CONTRACT ITEM TO BE DETERMINED ON A PROJECT TO PROJECT BASIS. SEE SECTION 34 OF THIS MANUAL FOR GUIDANCE.
3. REFERENCE THE NJDOT STANDARD SPECIFICATIONS FOR CRITERIA ON EMBANKMENT AND BORROW EXCAVATION.
4. REFERENCE GUIDE PLATE 3.15-3 FOR MORE INFORMATION REGARDING THE LIMITS FOR BORROW EXCAVATION, BRIDGE FOUNDATION.



RETAINING WALL SECTION

ISSUED: 2016

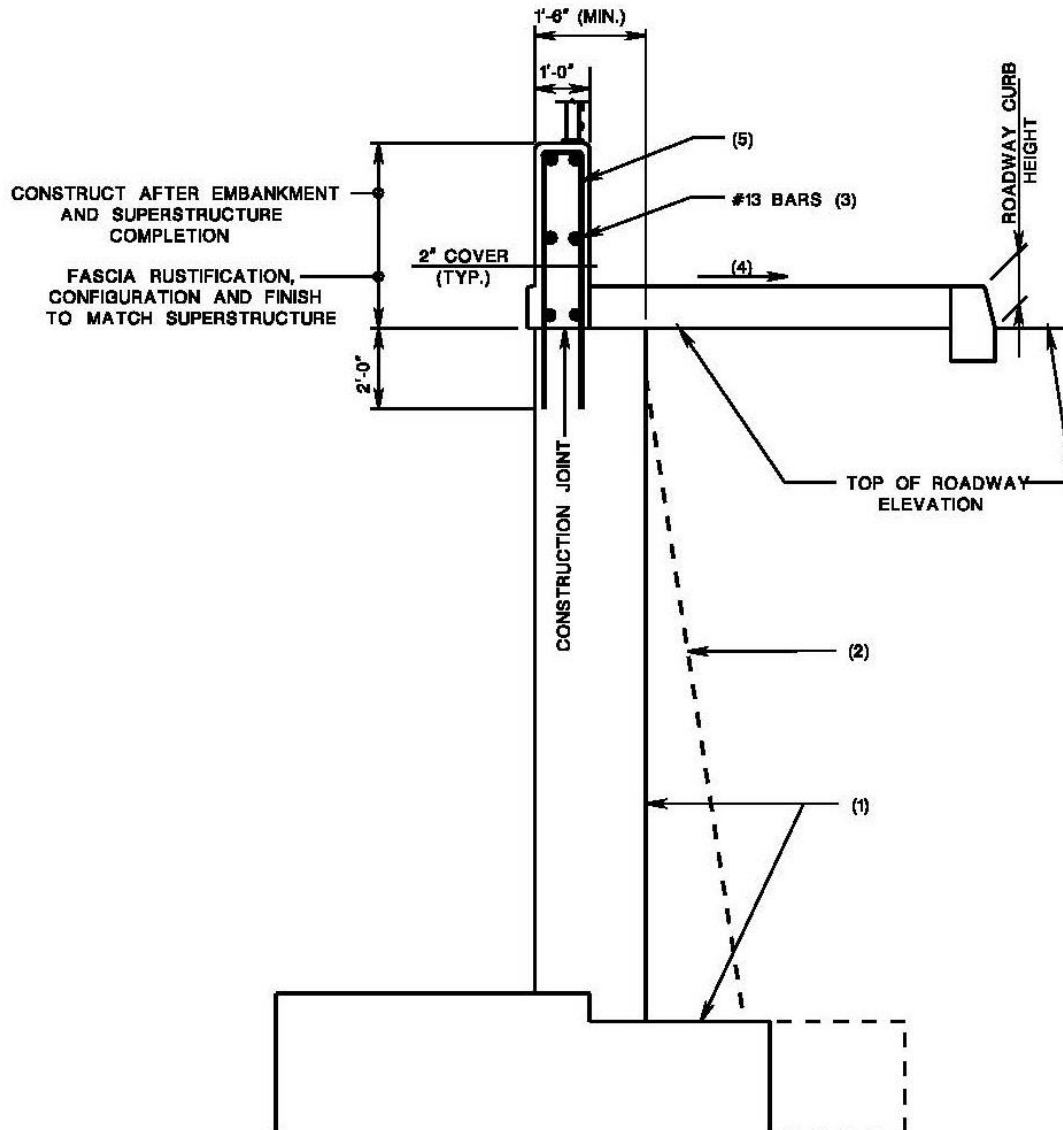
PLATE  
3.4-1



1. REINFORCEMENT NOT DESIGNATED SHALL BE AS REQUIRED BY DESIGN.
2. TENSION LAP SPLICE TO MEET AASHTO LRFD CLASS C SPLICE CRITERIA.
3. SEE PLATE 3.4-4 FOR ALTERNATE DOWEL DETAIL.
4. DESIGNER SHALL VERIFY THE NEED FOR BATTER FOR WALLS UNDER 10'-0". WALLS OVER 10'-0" SHALL HAVE A MINIMUM BATTER OF 12:1. THE HEIGHT OF THE WALL SHALL BE MEASURED FROM THE TOP OF THE HEEL OF THE FOOTING.
5. TRANSVERSE STEEL IN TOP OF FOOTING SHALL BE DEVELOPED IN TENSION.
6. CORROSION PROTECTED DOWELS IN CORROSIVE ENVIRONMENTS.

## U-TYPE WINGWALL WITH SIDEWALK

ISSUED: 2016

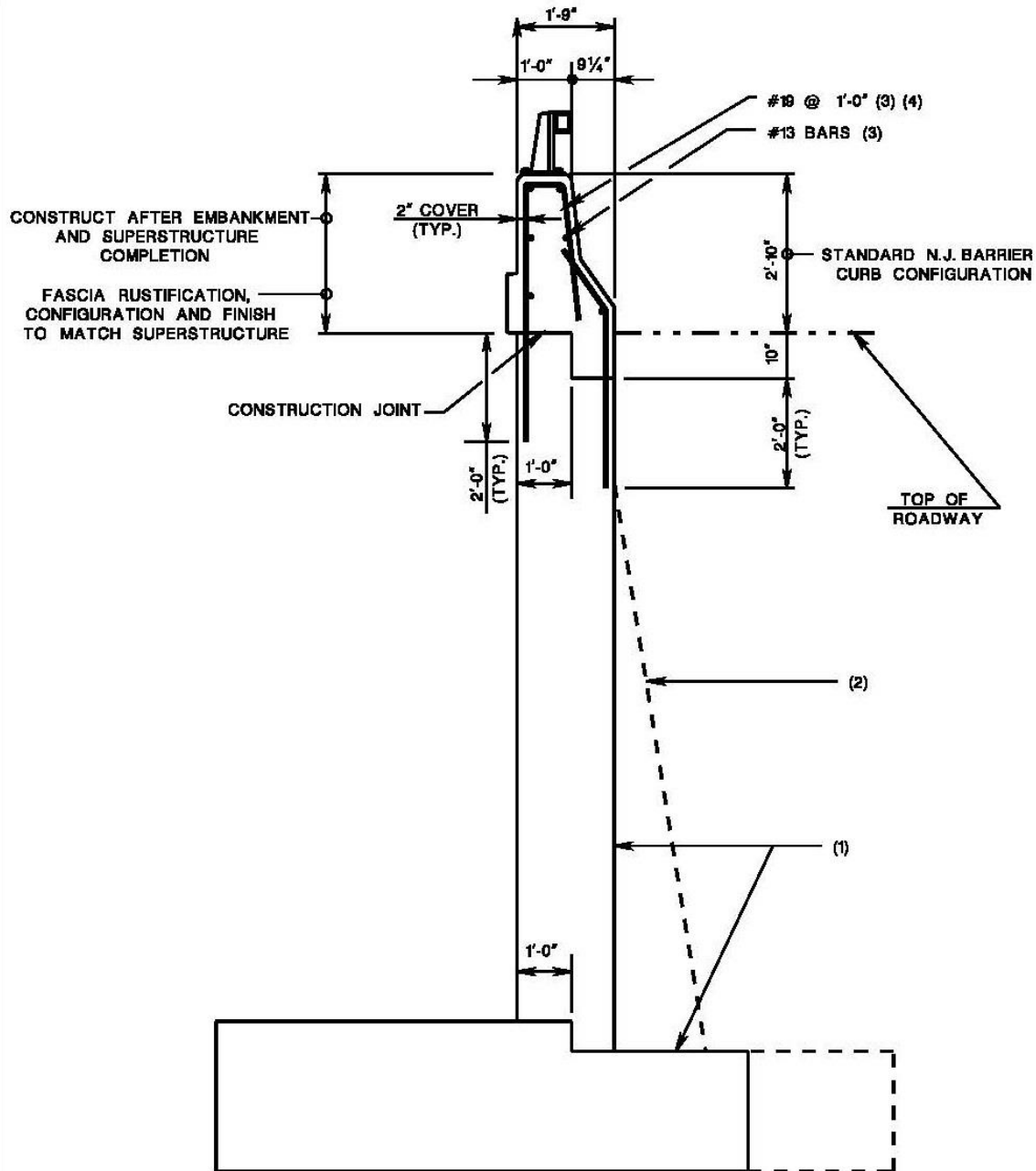
PLATE  
3.4-2

1. SEE PLATE 3.4-1 FOR TYPICAL REINFORCEMENT.
2. DESIGNER SHALL VERIFY THE NEED FOR BATTER FOR WALLS UNDER 10'-0". WALLS OVER 10'-0" SHALL HAVE A MINIMUM BATTER OF 12:1. THE HEIGHT OF THE WALL SHALL BE MEASURED FROM THE TOP OF THE HEEL OF THE FOOTING.
3. CORROSION PROTECTED REINFORCING STEEL.
4. SIDEWALK SHALL BE SLOPED 2 % FOR DRAINAGE.
5. REINFORCEMENT SHALL BE AS REQUIRED BY DESIGN.

U-TYPE WINGWALL  
WITH BARRIER CURB

ISSUED: 2016

PLATE  
3.4-3

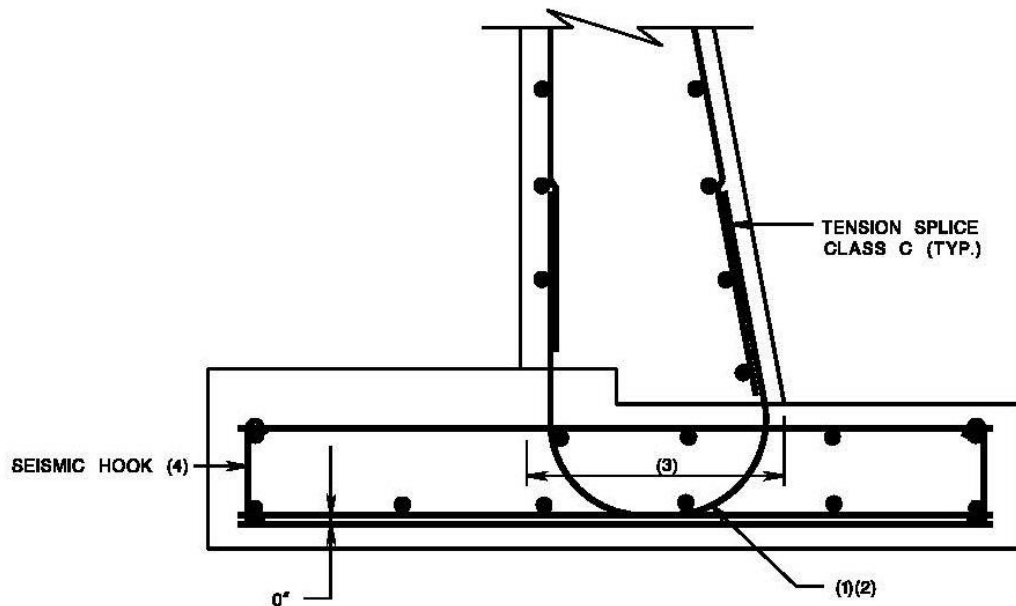


1. SEE PLATE 3.4-1 FOR TYPICAL REINFORCEMENT.
2. DESIGNER SHALL VERIFY THE NEED FOR BATTER FOR WALLS UNDER 10'-0". WALLS OVER 10'-0" SHALL HAVE A MINIMUM BATTER OF 12:1. THE HEIGHT OF THE WALL SHALL BE MEASURED FROM THE TOP OF THE HEEL OF THE FOOTING.
3. CORROSION PROTECTED REINFORCING STEEL.
4. ONE PIECE STIRRUP ARRANGEMENT MAY BE UTILIZED.



## ALTERNATE DOWEL DETAIL

ISSUED: 2016

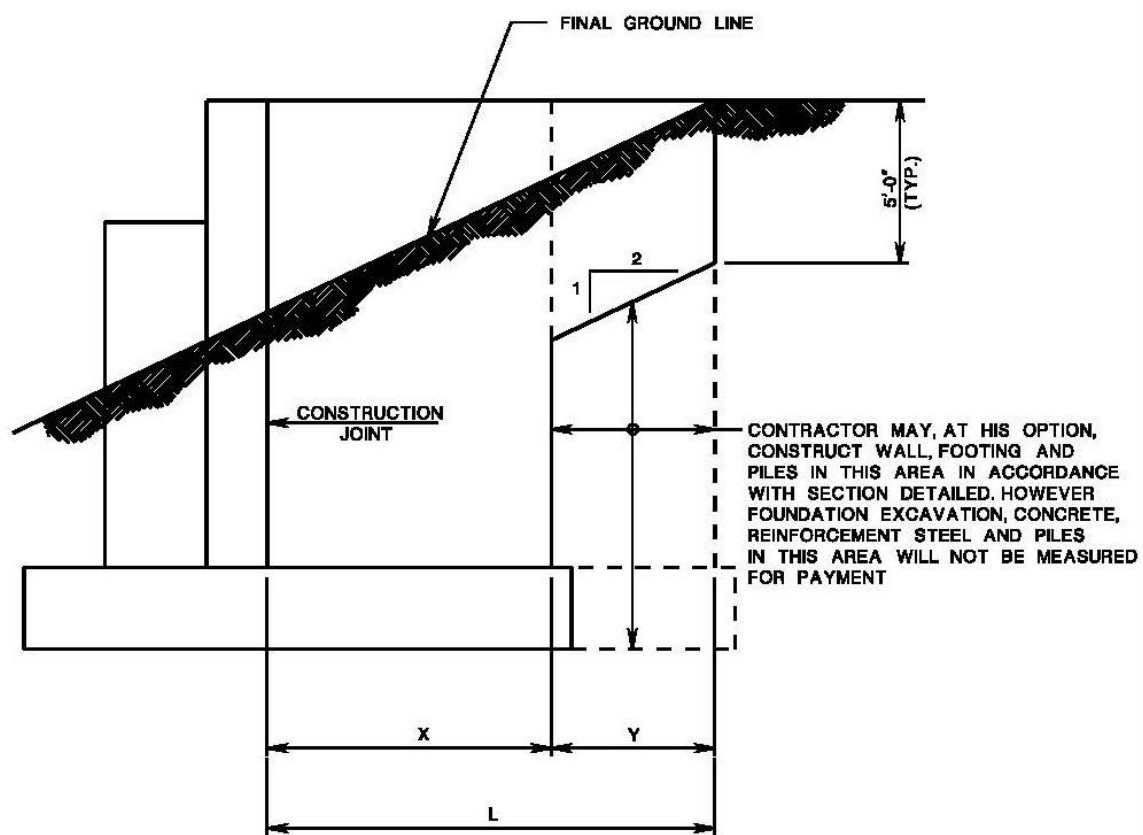
PLATE  
3.4-4

1. DOWEL CONFIGURATION SHALL BE THE SAME FOR ALL BRIDGES IN A CONTRACT.
2. CORROSION PROTECTED DOWELS SHALL BE USED IN SALT WATER ENVIRONMENTS.
3. TRANSVERSE STEEL IN TOP OF FOOTING SHALL BE DEVELOPED IN TENSION.
4. IN THE EVENT THAT SEISMIC FORCES GOVERN THE DESIGN OF THE FOOTING, #13 SIZE VERTICAL STIRRUPS WITH ALTERNATED 135° HOOKS AT ONE END AND 90° HOOKS AT THE OTHER END SHALL BE USED TO CONNECT THE TOP AND BOTTOM REINFORCEMENT MATS. SPACING SHALL BE A MINIMUM OF 48 INCHES.

WING STEM DETAILS

ISSUED: 2016

PLATE  
3.4-5



$Y = \frac{1}{3} L$  BUT NOT TO EXCEED 10'-0".

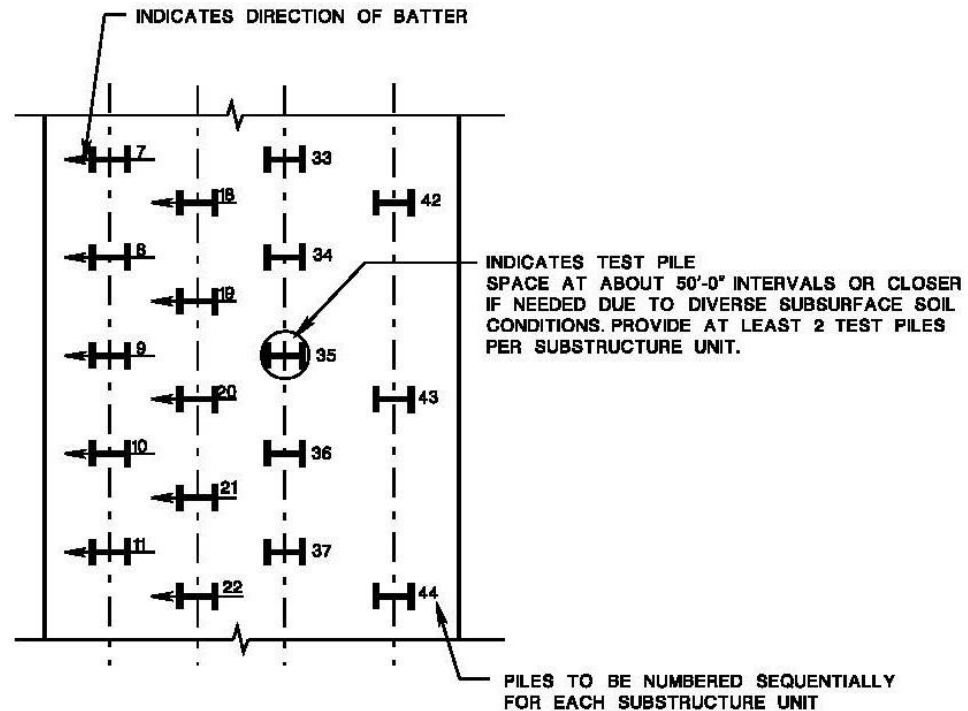
**NOTE TO DESIGNERS:**

SEE SUBSECTION 17.1.8 OF THIS MANUAL FOR FURTHER INFORMATION.

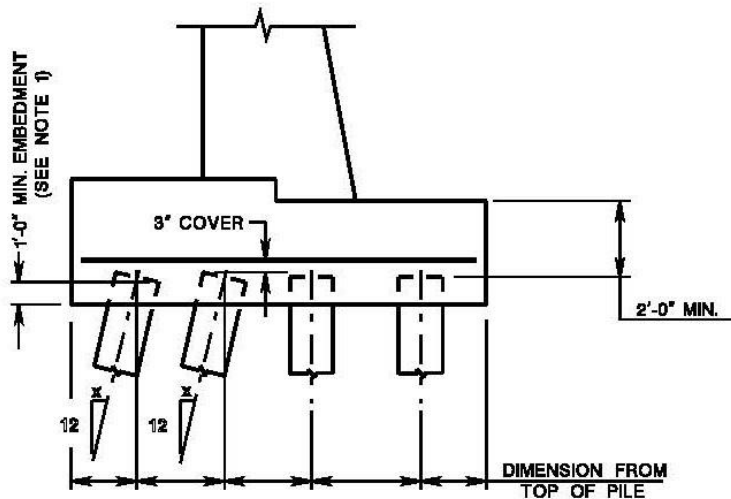
FOOTINGS ON PILES

ISSUED: 2016

PLATE  
3.4-6



**PLAN**



**SECTION**

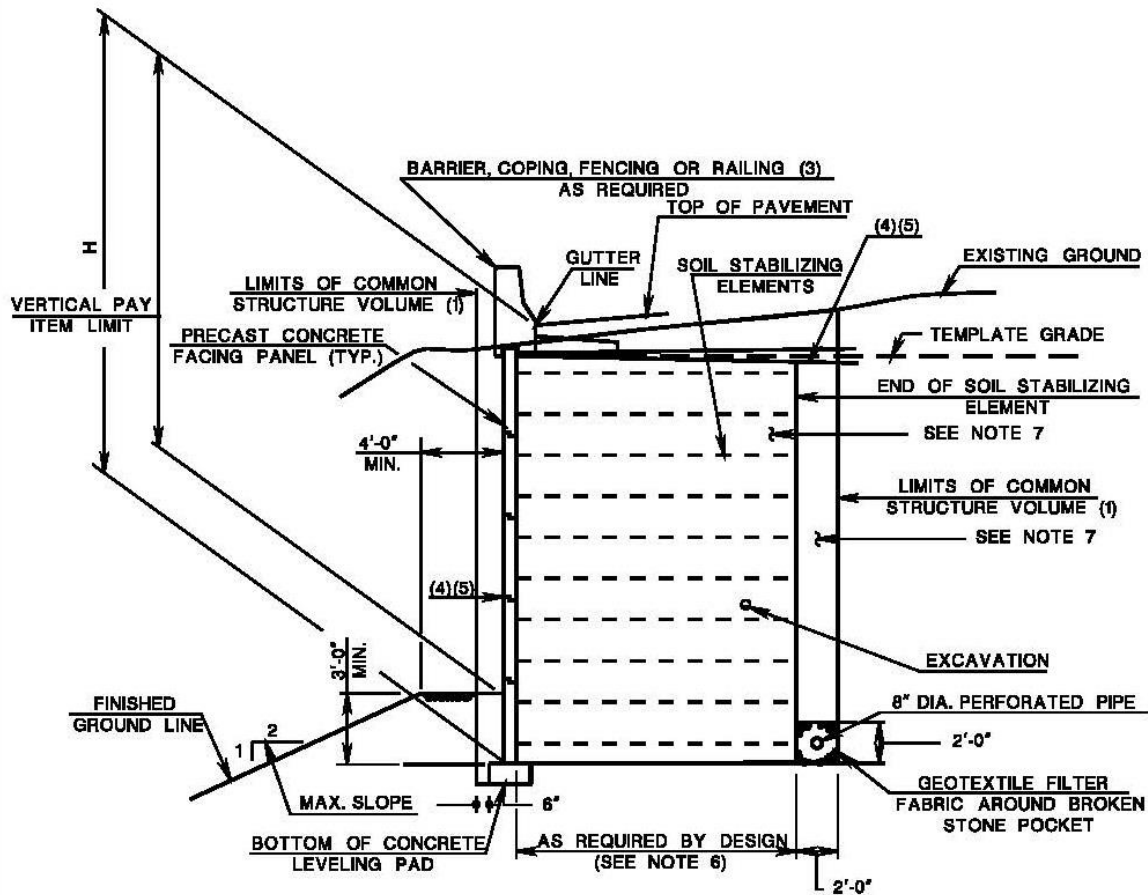
**NOTES:**

1. REFERENCE AASHTO LRFD PILE PENETRATION DESIGN REQUIREMENTS.
2. REFERENCE SECTION 16 FOR THE ORIENTATION OF PILES IN INTEGRAL ABUTMENTS.
3. REFER TO THE AASHTO LRFD BRIDGE DESIGN SPECIFICATIONS FOR CONCRETE PILE ANCHORAGE SEISMIC CRITERIA.

**MECHANICALLY STABILIZED EARTH WALL  
TYPICAL CUT SECTION**

ISSUED: 2016

**PLATE  
3.4-7**



**TYPICAL SECTION  
(CUT)**

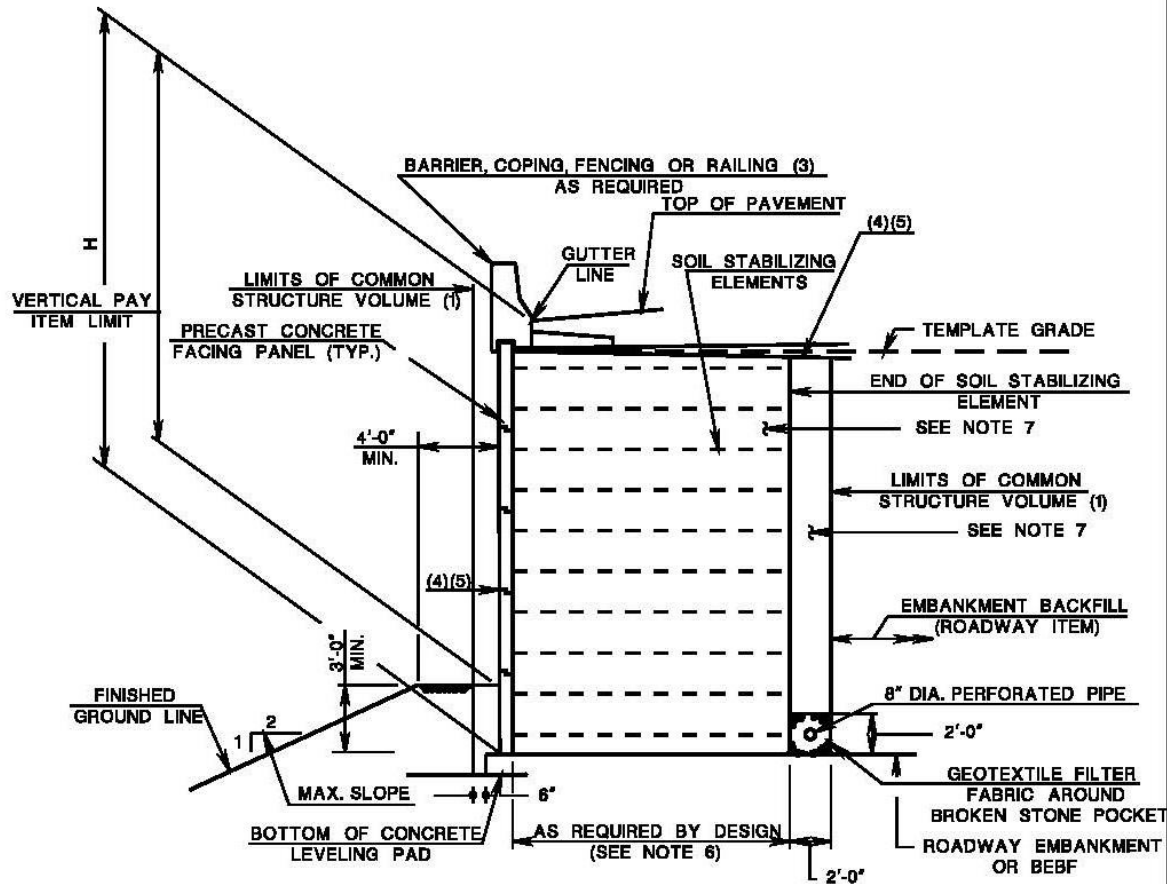
**MECHANICALLY STABILIZED EARTH WALL**

- (1) THE LIMIT OF COMMON STRUCTURE VOLUME BEHIND THE WALL SHALL BE GOVERNED BY THE NARROWEST LIMIT OF ALTERNATE WALL ALLOWED IN THE CONTRACT AT THAT LOCATION. THE DESIGNER SHALL CONTACT THE WALL MANUFACTURER TO DETERMINE THE WIDTH OF THE NEEDED CUT.
- (2) FOR WALLS BUILT IN PARTIAL CUT AND FILL AREAS, THE COMMON STRUCTURE VOLUME LIMITS FOR EACH SITUATION SHALL BE COMBINED INTO ONE TYPICAL SECTION.
- (3) PAYMENT FOR THIS ITEM IS BASED ON PROJECT TO PROJECT BASIS.
- (4) REFERENCE SECTION 17 OF THIS MANUAL FOR PROVISION OF AN IMPERVIOUS MEMBRANE UPON COMPLETION OF THE SPECIFIED BACKFILL PLACEMENT. ALSO, PROVISION OF FILLER MATERIAL OR FILTER FABRIC AT THE LOCATION OF VERTICAL AND HORIZONTAL JOINTS BETWEEN PANELS SHOULD BE VERIFIED WITH THE MANUFACTURER.
- (5) DRAINAGE REQUIREMENTS SHOULD BE ADHERED TO.
- (6) AS REQUIRED BY DESIGN, A MINIMUM OF  $0.7H$  SHALL BE USED TO SATISFY REINFORCEMENT LENGTH REQUIREMENTS.  $0.8H$  PLUS 2'-0" SHALL BE USED TO SATISFY COMMON STRUCTURE VOLUME REQUIREMENTS.
- (7) REFER TO THE NJDOT STANDARD SPECIFICATIONS AND SECTION 17 OF THIS MANUAL FOR PERMISSIBLE BACKFILL MATERIALS AND REQUIREMENTS FOR THE PLACEMENT OF GEOTEXTILE FILTER FABRIC MATERIAL.

**MECHANICALLY STABILIZED EARTH WALL**  
**TYPICAL FILL SECTION**

ISSUED: 2016

**PLATE**  
**3.4-8**

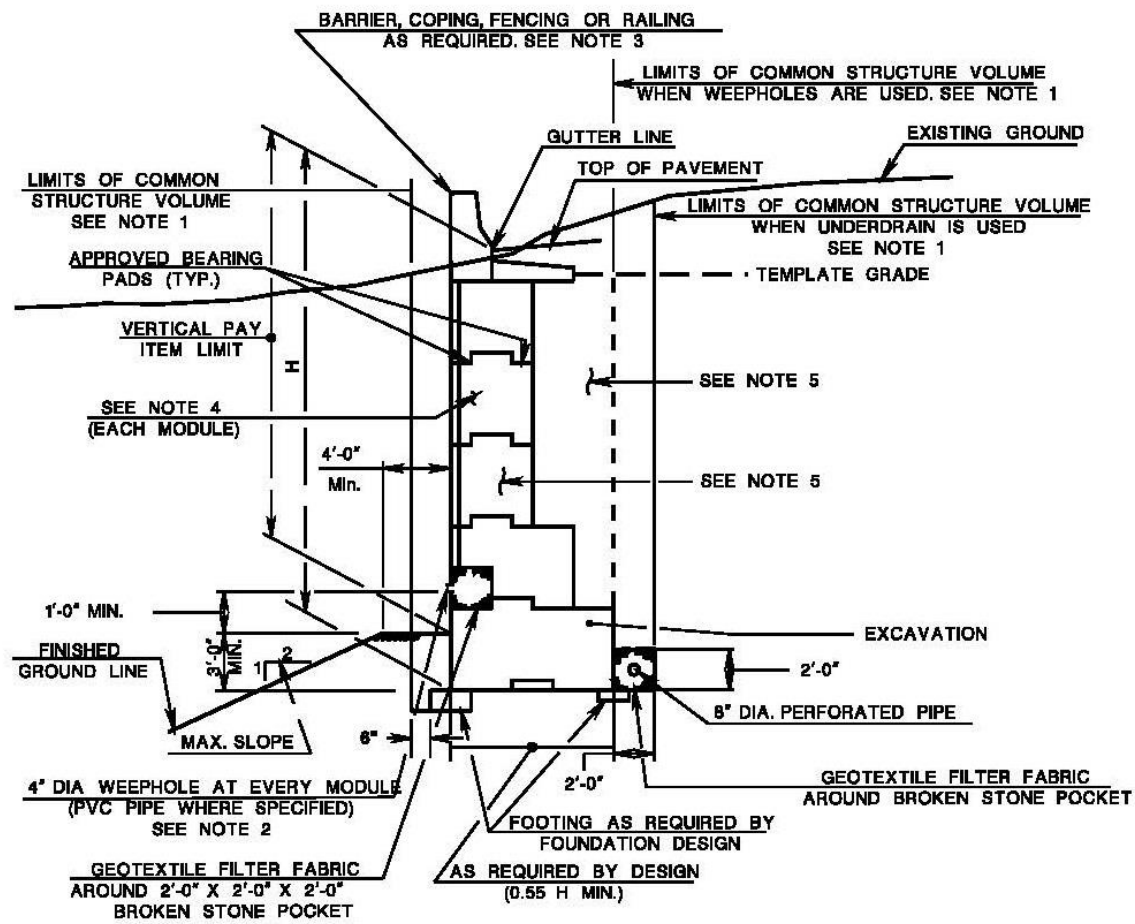


**TYPICAL SECTION**  
**(FILL)**

**MECHANICALLY STABILIZED EARTH WALL**

- (1) THE LIMIT OF COMMON STRUCTURE VOLUME BEHIND THE WALL SHALL BE GOVERNED BY THE WIDEST LIMIT OF ALTERNATE WALL ALLOWED IN THE CONTRACT AT THAT LOCATION. THE DESIGNER SHALL CONTACT THE WALL MANUFACTURER TO DETERMINE THE WIDTH OF THE NEEDED CUT.
- (2) FOR WALLS BUILT IN PARTIAL CUT AND FILL AREAS, THE COMMON STRUCTURE VOLUME LIMITS FOR EACH SITUATION SHALL BE COMBINED INTO ONE TYPICAL SECTION.
- (3) PAYMENT FOR THIS ITEM IS BASED ON PROJECT TO PROJECT BASIS.
- (4) REFERENCE SECTION 17 OF THIS MANUAL FOR PROVISION OF AN IMPERVIOUS MEMBRANE UPON COMPLETION OF THE SPECIFIED BACKFILL PLACEMENT. ALSO, PROVISION OF FILLER MATERIAL OR FILTER FABRIC AT THE LOCATION OF VERTICAL AND HORIZONTAL JOINTS BETWEEN PANELS SHOULD BE VERIFIED WITH THE MANUFACTURER.
- (5) DRAINAGE REQUIREMENTS SHOULD BE ADHERED TO.
- (6) AS REQUIRED BY DESIGN, A MINIMUM OF 0.7H SHALL BE USED TO SATISFY REINFORCEMENT LENGTH REQUIREMENTS. 0.8H PLUS 2'-0" SHALL BE USED TO SATISFY COMMON STRUCTURE VOLUME REQUIREMENTS.
- (7) REFER TO THE NJDOT STANDARD SPECIFICATIONS AND SECTION 17 OF THIS MANUAL FOR PERMISSIBLE BACKFILL MATERIALS AND REQUIREMENTS FOR THE PLACEMENT OF GEOTEXILE FILTER FABRIC MATERIAL.

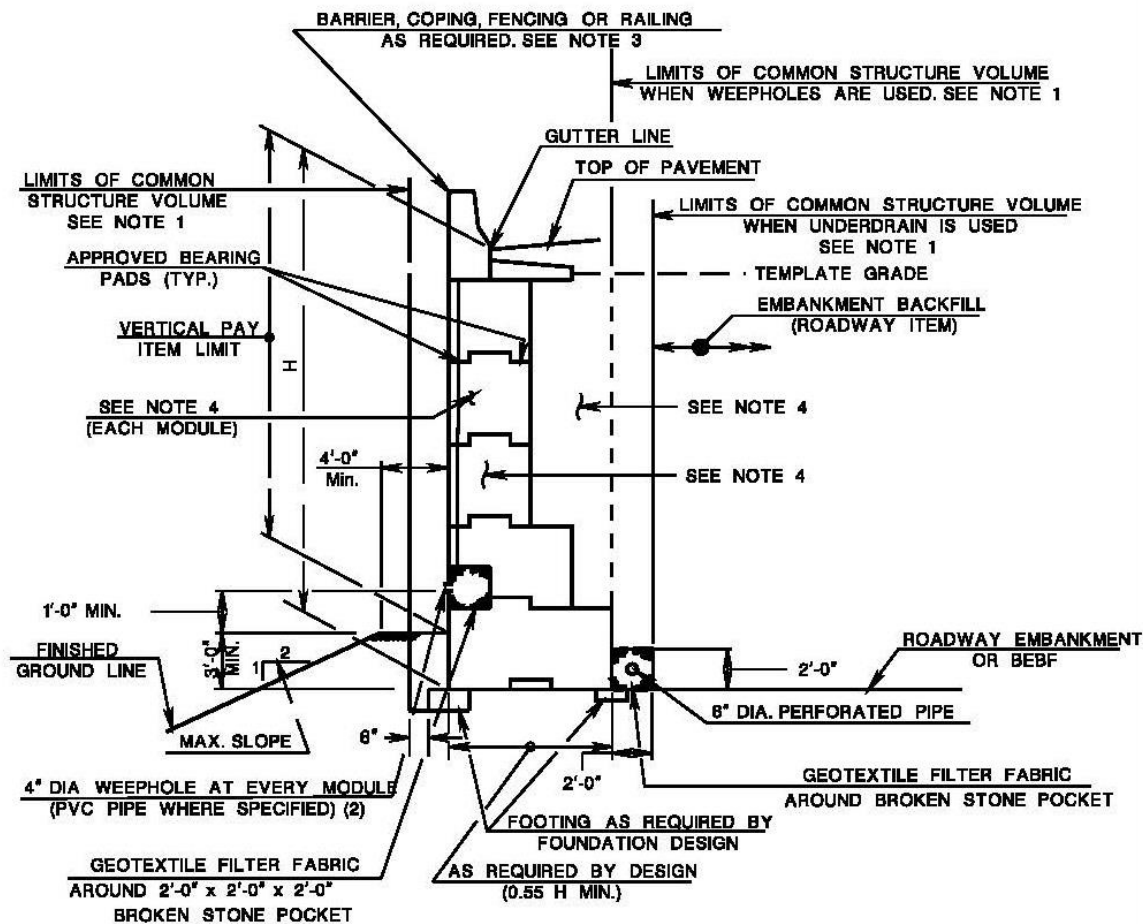
|   |                     |                        |
|---|---------------------|------------------------|
| <b>PREFABRICATED MODULAR WALL<br/>(DOUBLEWAL)<br/>TYPICAL CUT SECTION</b> | <b>ISSUED: 2016</b> | <b>PLATE<br/>3.4-9</b> |
|---|---------------------|------------------------|



**TYPICAL SECTION  
(CUT)  
PREFABRICATED MODULAR WALL**

- (1) THE LIMIT OF COMMON STRUCTURE VOLUME BEHIND THE WALL SHALL BE GOVERNED BY THE NARROWEST LIMIT OF ALTERNATE WALL ALLOWED IN THE CONTRACT AT THAT LOCATION. THE DESIGNER SHALL CONTACT THE WALL MANUFACTURER TO DETERMINE THE WIDTH OF THE NEEDED CUT.
- (2) DRAINAGE REQUIREMENTS SHOULD BE ADDRESSED.
- (3) PAYMENT FOR THIS ITEM IS BASED ON PROJECT TO PROJECT BASIS.
- (4) FOR WALLS BUILT IN PARTIAL CUT AND FILL AREAS, THE COMMON STRUCTURE VOLUME LIMITS FOR EACH SITUATION SHALL BE COMBINED INTO ONE TYPICAL SECTION.
- (5) REFER TO THE NJDOT STANDARD SPECIFICATIONS AND SECTION 17 OF THIS MANUAL FOR PERMISSIBLE BACKFILL MATERIALS AND REQUIREMENTS FOR THE PLACEMENT OF GEOTEXTILE FILTER FABRIC MATERIAL.

|  |                     |                         |
|--|---------------------|-------------------------|
| <b>PREFABRICATED MODULAR WALL<br/>(DOUBLEWAL) TYPICAL FILL SECTION</b> | <b>ISSUED: 2016</b> | <b>PLATE<br/>3.4-10</b> |
|--|---------------------|-------------------------|



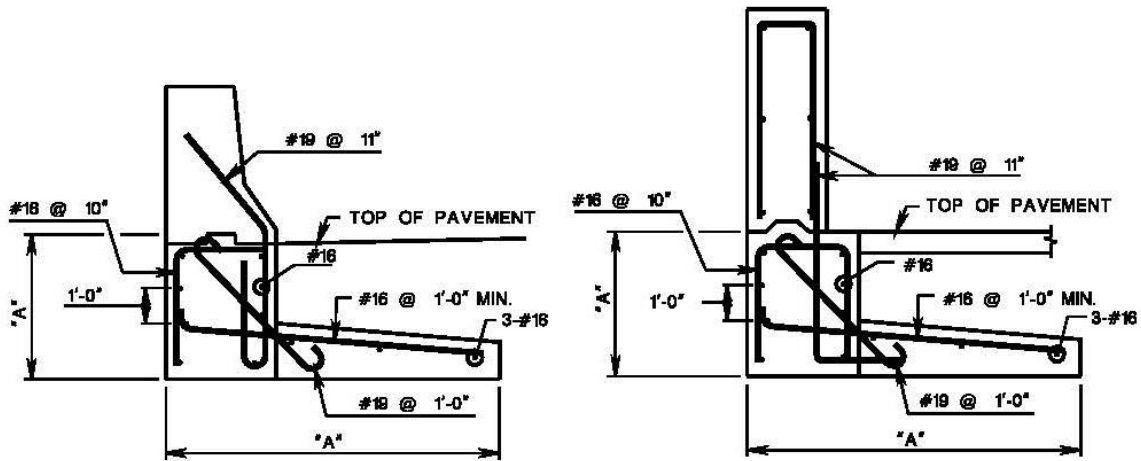
**TYPICAL SECTION  
(FILL)  
PREFABRICATED MODULAR WALL**

- (1) THE LIMIT OF COMMON STRUCTURE VOLUME BEHIND THE WALL SHALL BE GOVERNED BY THE WIDEST LIMIT OF ALTERNATE WALL ALLOWED IN THE CONTRACT AT THAT LOCATION. THE DESIGNER SHALL CONTACT THE WALL MANUFACTURER TO DETERMINE THE WIDTH OF THE NEEDED CUT.
- (2) DRAINAGE REQUIREMENTS SHOULD BE ADDRESSED.
- (3) PAYMENT FOR THIS ITEM IS BASED ON PROJECT TO PROJECT BASIS.
- (4) REFER TO THE NJDOT STANDARD SPECIFICATIONS AND SECTION 17 OF THIS MANUAL FOR PERMISSIBLE BACKFILL MATERIALS AND REQUIREMENTS FOR THE PLACEMENT OF GEOTEXTILE FILTER FABRIC MATERIAL.

PROPRIETARY WALLS - COPING DETAILS

ISSUED: 2016

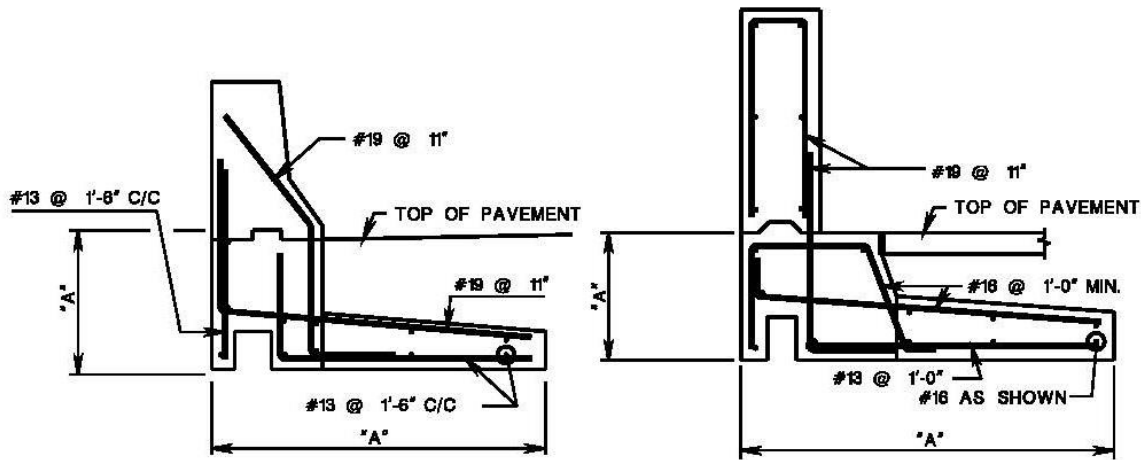
PLATE  
3.4-11



**STANDARD NEW JERSEY BARRIER**

**STANDARD 2'-8" PARAPET**

**PREFABRICATED MODULAR WALL**



**STANDARD NEW JERSEY BARRIER**

**STANDARD 2'-8" PARAPET**

WHEN DESIGNING MSE WALL SYSTEMS, REFER TO SECTION 11 OF THE AASHTO LRFD BRIDGE DESIGN SPECIFICATIONS FOR TREATMENT OF TRAFFIC LOADS AND OF THE BARRIER AND PARAPET LOADS.

**MECHANICALLY STABILIZED EARTH WALL**

**NOTES:**

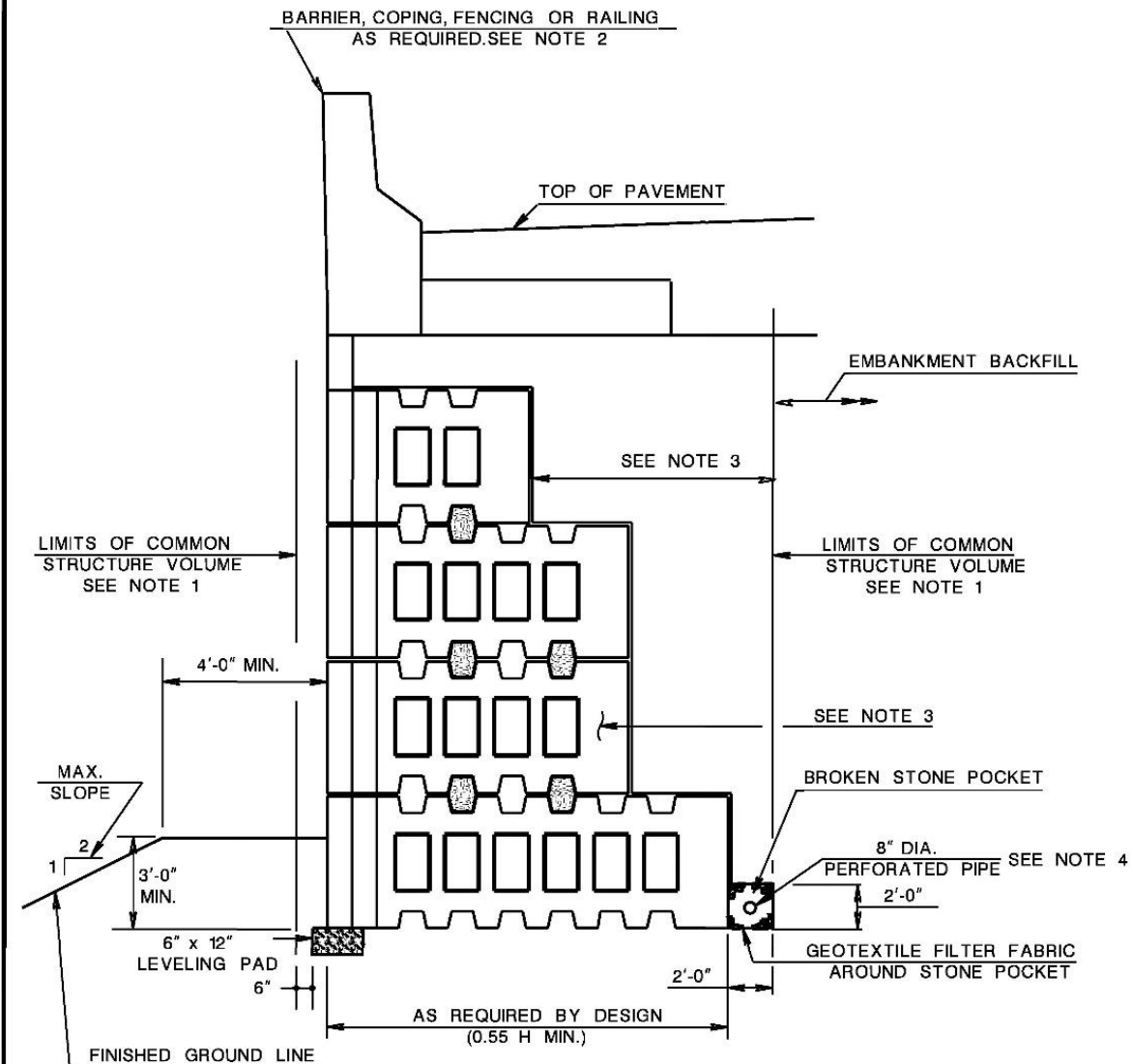
1. ALL DETAILED REINFORCEMENT SHALL BE CORROSION PROTECTED.
2. "A" DIMENSIONS SET FOR SPECIFIC SITE BY WALL MANUFACTURER.
3. REFER TO SECTION 3 OF THIS MANUAL FOR ANCHOR SLAB DESIGN GUIDANCE.



T - WALL  
TYPICAL SECTION

ISSUED: 2016

PLATE  
3.4-12

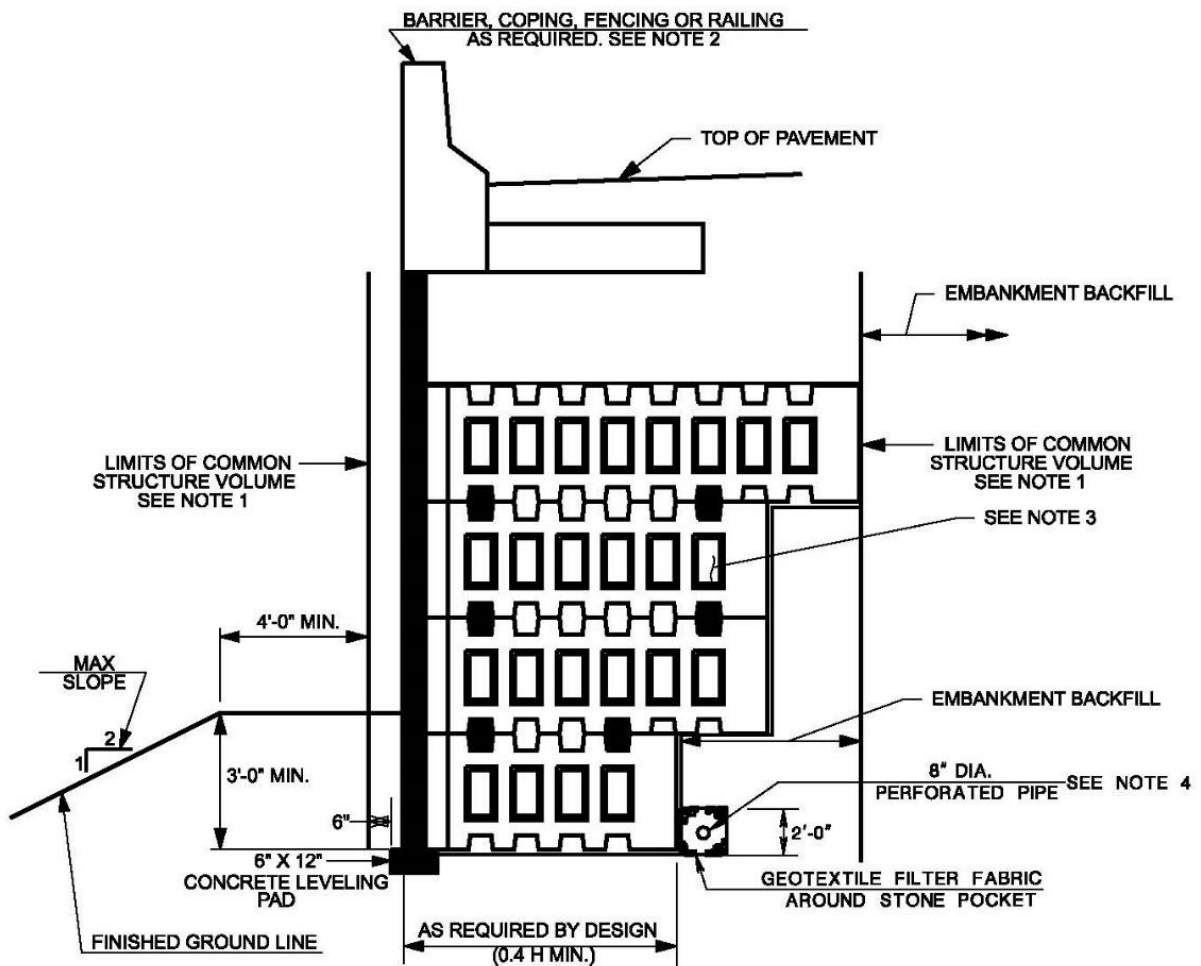


- (1) THE LIMIT OF COMMON STRUCTURE VOLUME BEHIND THE WALL SHALL BE GOVERNED BY THE WIDEST LIMIT FOR FILL SECTION AND THE NARROWEST LIMIT FOR CUT SECTION OF ALTERNATE WALL ALLOWED IN THE CONTRACT AT THAT LOCATION. THE DESIGNER SHALL CONTACT THE WALL MANUFACTURER TO DETERMINE THE WIDTH OF THE NEEDED FILL.
- (2) PAYMENT FOR THIS ITEM IS BASED ON PROJECT TO PROJECT BASIS.
- (3) REFER TO THE NJDOT STANDARD SPECIFICATIONS AND SECTION 17 OF THIS MANUAL FOR PERMISSIBLE BACKFILL MATERIALS AND REQUIREMENTS FOR THE PLACEMENT OF GEOTEXTILE FILTER FABRIC MATERIAL.
- (4) DRAINAGE SYSTEM IS ONLY APPLICABLE WITH THE USE OF A NON-PERMEABLE BACKFILL MATERIAL (i.e. GEOFOAM, CONTROLLED LOW-STRENGTH MATERIAL, etc.) OR AN ENVIRONMENT SUBJECT TO EXCESSIVE FLOODING.

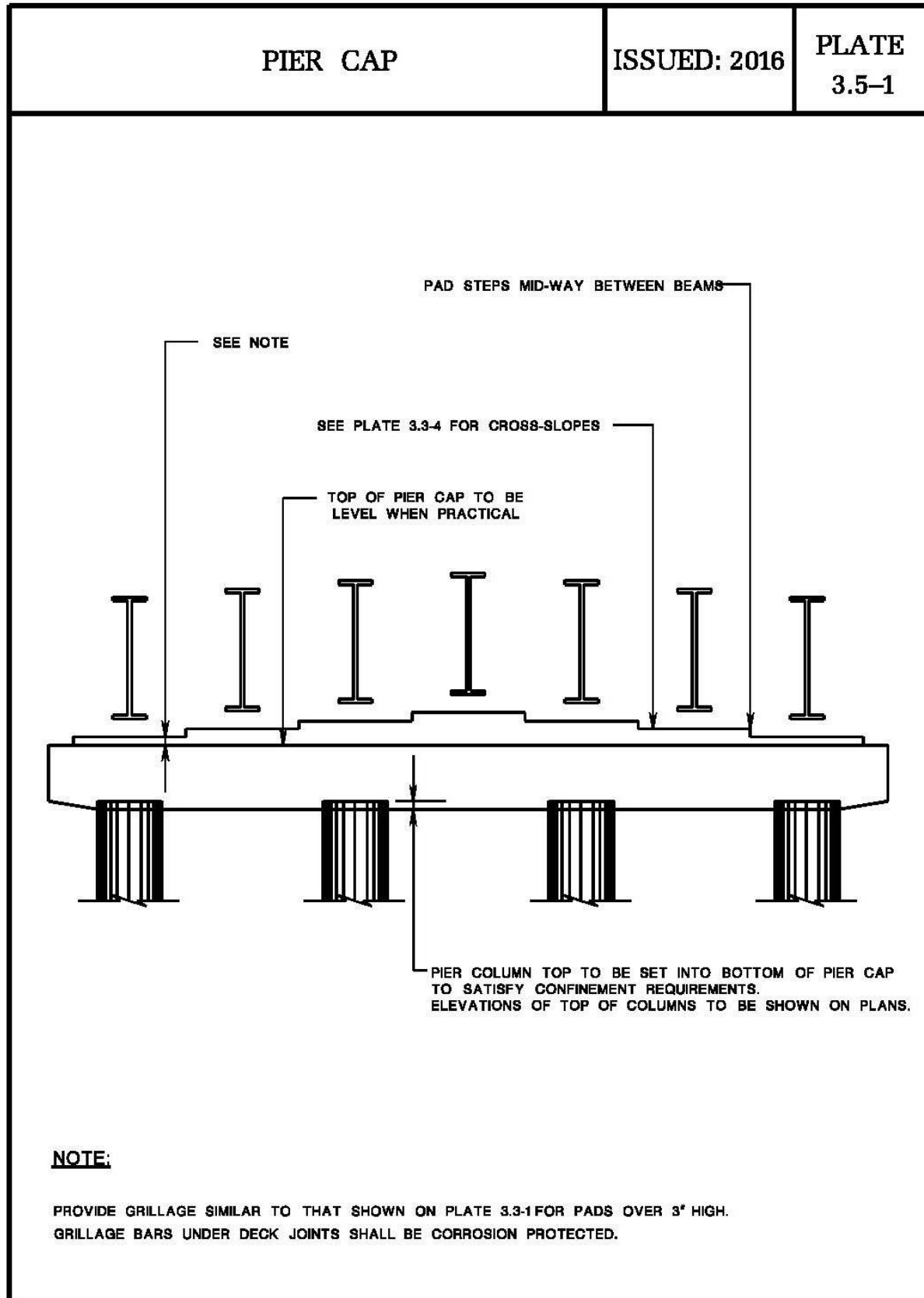
INVERTED T-WALL  
TYPICAL SECTION

ISSUED: 2018

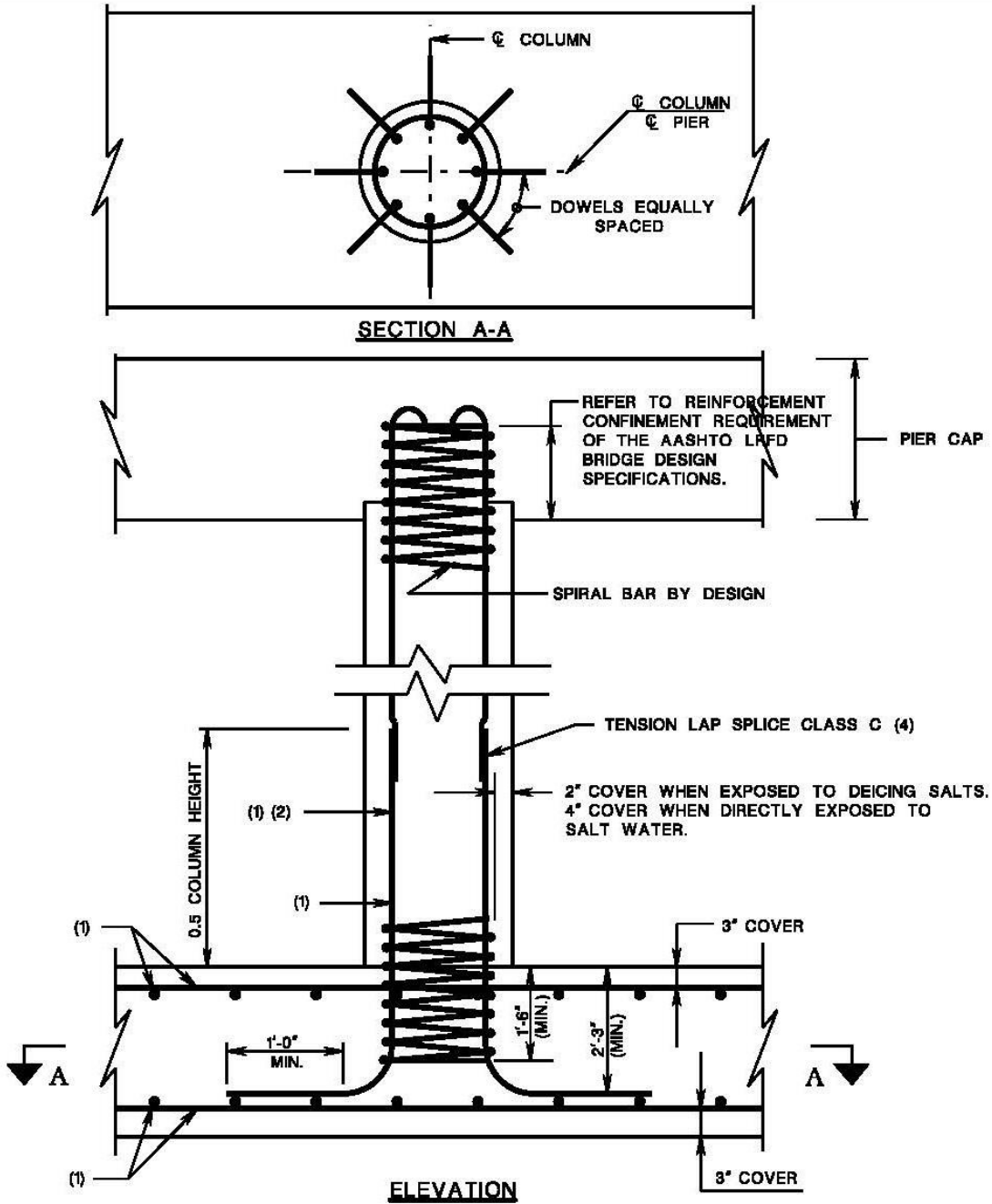
PLATE  
3.4-13



1. THE LIMIT OF COMMON STRUCTURE VOLUME BEHIND THE WALL SHALL BE GOVERNED BY THE WIDEST LIMIT FOR FILL SECTION AND THE NARROWEST LIMIT FOR CUT SECTION OF ALTERNATE WALL ALLOWED IN THE CONTRACT AT THAT LOCATION. THE DESIGNER SHALL CONTACT THE WALL MANUFACTURER TO DETERMINE THE WIDTH OF THE NEEDED FILL.
2. PAYMENT FOR THIS ITEM IS BASED ON PROJECT TO PROJECT BASIS.
3. REFER TO THE NJDOT STANDARD SPECIFICATIONS AND SECTION 17 OF THIS MANUAL FOR PERMISSIBLE BACKFILL MATERIALS AND REQUIREMENTS FOR THE PLACEMENT OF GEOTEXTILE FILTER FABRIC MATERIAL.
4. DRAINAGE SYSTEM IS ONLY APPLICABLE WITH THE USE OF A NON-PERMEABLE BACKFILL MATERIAL (i.e. GEOFOAM, CONTROLLED LOW-STRENGTH MATERIAL, etc.) OR AN ENVIRONMENT SUBJECT TO EXCESSIVE FLOODING\*



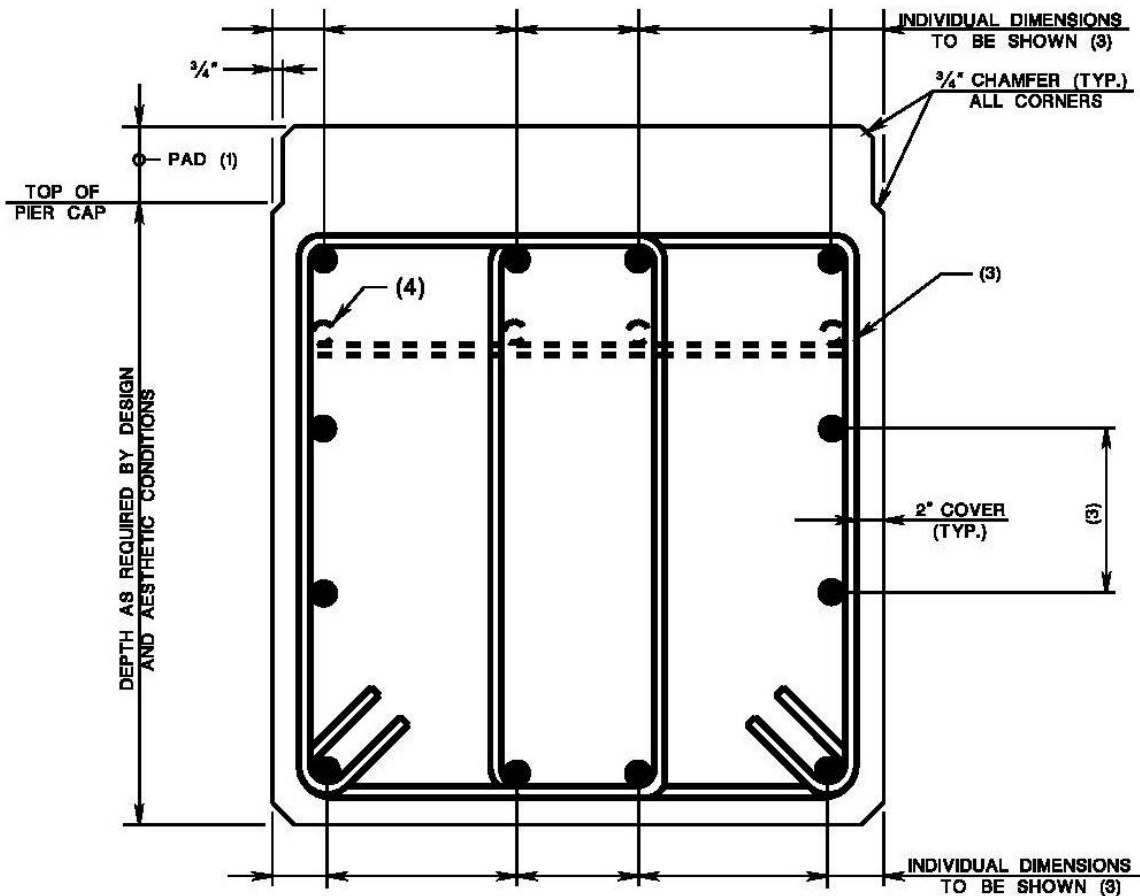
|                                   |                     |                        |
|-----------------------------------|---------------------|------------------------|
| <b>ROUND COLUMN REINFORCEMENT</b> | <b>ISSUED: 2016</b> | <b>PLATE<br/>3.5-2</b> |
|-----------------------------------|---------------------|------------------------|



1. REINFORCEMENT STEEL AS REQUIRED BY DESIGN.
2. CORROSION PROTECTED DOWEL BARS IN CORROSIVE ENVIRONMENTS.
3. COLUMN DESIGN SHALL CONFORM TO AASHTO GUIDE SPECIFICATIONS FOR LRFD SEISMIC BRIDGE DESIGN AND THIS MANUAL.
4. STEEL REINFORCEMENT SPLICES SHALL BE IN ACCORDANCE WITH THE AASHTO GUIDE SPECIFICATIONS SEISMIC DESIGN REQUIREMENTS.

## PIER CAP SECTION

ISSUED: 2016

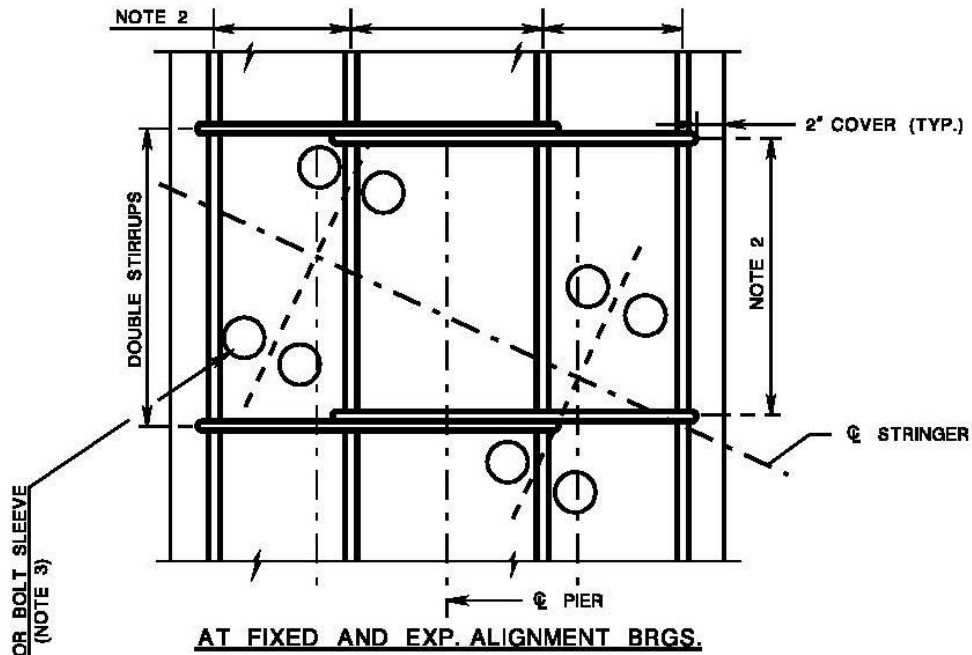
PLATE  
3.5-3

1. PROVIDE GRILLAGE SIMILAR TO THAT SHOWN ON PLATE 3.3-1 FOR PADS OVER 3' HIGH. GRILLAGE BARS UNDER DECK JOINTS SHALL BE CORROSION PROTECTED.
2. SEE SUBSECTION 19.4. ( INDIVIDUAL PIER CAP SECTIONS SHALL BE SHOWN FOR EACH CHANGE IN SIZE AND/OR SPACING OF BARS ).
3. REINFORCEMENT STEEL SIZE AND SPACING AS REQUIRED BY DESIGN.
4. USE 2 OR MORE ROWS IF REQUIRED BY DESIGN OR AS REQUIRED TO FACILITATE PLACING OF CONCRETE AND/OR ANCHOR BOLT SLEEVES.
5. PIER CAPS UNDER DECK JOINTS SHALL BE TREATED WITH EPOXY WATERPROOFING SEAL COAT, LIMITS OF TREATMENT SHALL BE AS INDICATED ON BRIDGE CONSTRUCTION DETAILS.

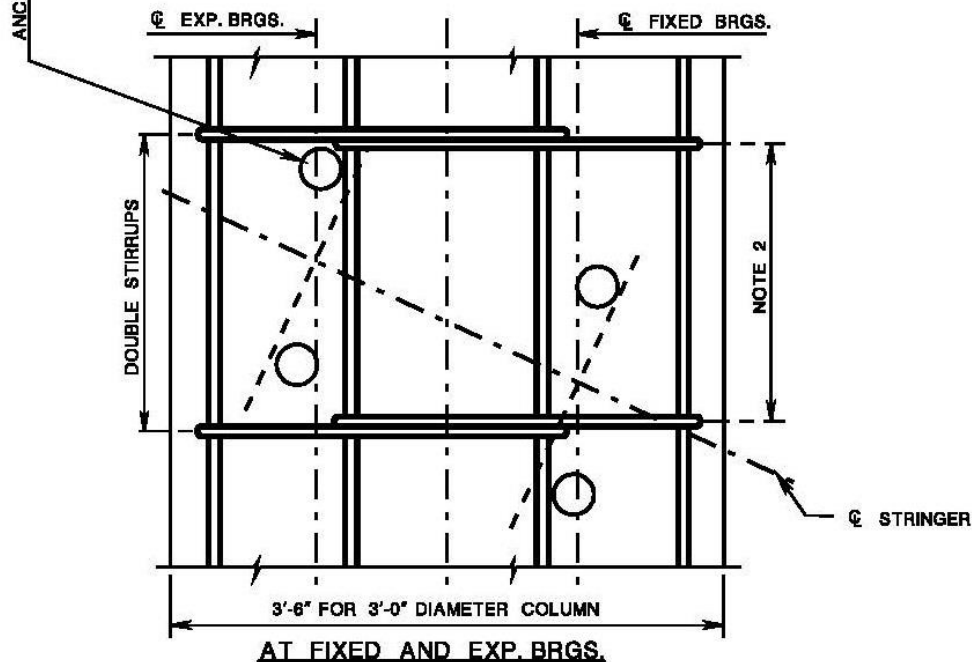
ANCHOR BOLT LAYOUT

ISSUED: 2016

PLATE  
3.5-4



**AT FIXED AND EXP. ALIGNMENT BRGS.**



**AT FIXED AND EXP. BRGS.**

**PLAN - PIER CAP REINFORCEMENT LAYOUT**

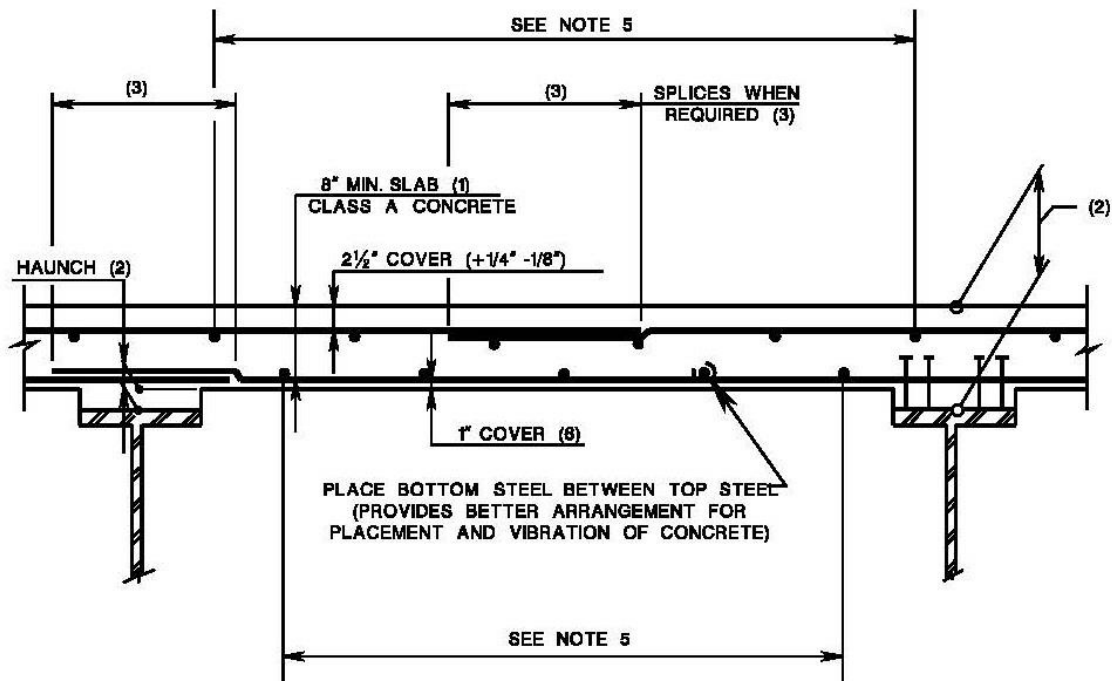
**NOTES:**

1. THE ABOVE ILLUSTRATES LAYOUT THAT IS REQUIRED ON CONTRACT PLANS.
2. REINFORCEMENT STEEL SIZE AND SPACING AS REQUIRED BY DESIGN.
3. LOCATION AND NUMBER BY DESIGN.

DECK SLAB: ONE COURSE CONSTRUCTION REINFORCEMENT DETAILS

ISSUED: 2016

PLATE  
3.6-1



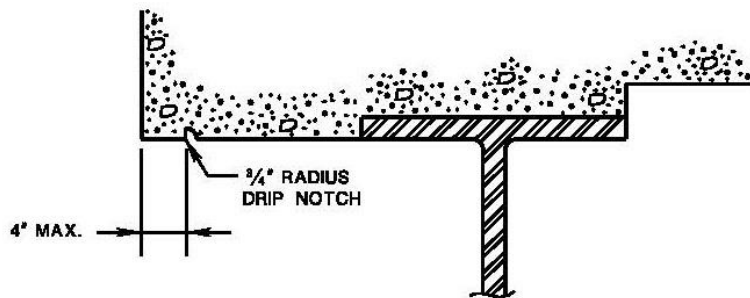
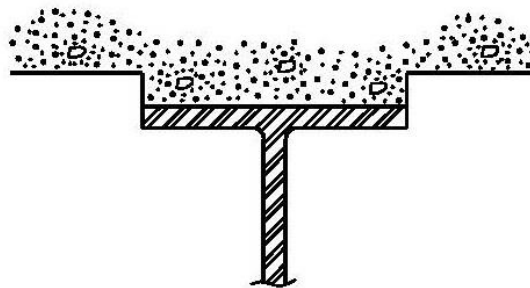
TYPICAL SLAB SECTION

**NOTES:**

1. SEE SUBSECTION 20.8 OF THIS MANUAL.
2. SEE SUBSECTION 20.8 OF THIS MANUAL.
3. THE SPLICES IN BOTTOM TRANSVERSE BARS SHALL BE ALTERNATED OVER ADJACENT BEAMS. THE SPLICES IN TOP TRANSVERSE BARS SHALL ALTERNATE OVER THE CENTERS OF ADJACENT BEAMS.
4. ALL REINFORCING STEEL SHALL BE CORROSION PROTECTED.
5. FOR DECK SLABS THAT MEET THE DESIGN CRITERIA OF APPENDIX A4 OF THE AASHTO LRFD SPECIFICATIONS, THE TOP AND BOTTOM LONGITUDINAL REINFORCEMENT SHALL BE AS PER THE TABLE OF SUBSECTION 20.5 OF THIS MANUAL. OTHERWISE, THE REINFORCEMENT SHALL BE DESIGNED ACCORDING TO AASHTO LRFD MINIMUM SPACING REQUIREMENTS.
6. PROVIDE 1½" BOTTOM COVER IN BRIDGE STRUCTURES THAT ARE LOCATED IN A MARINE ENVIRONMENT.

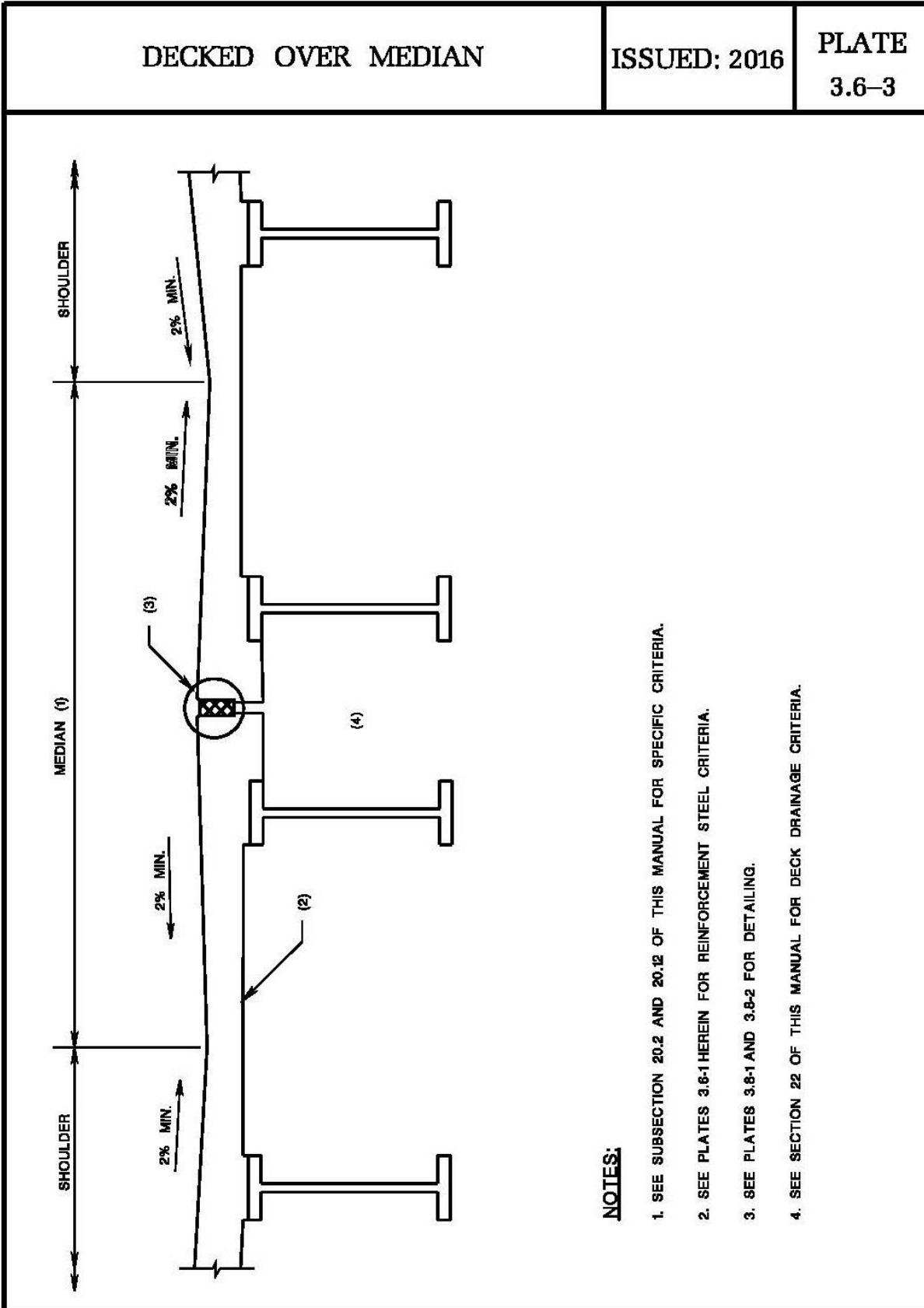
## HAUNCH FOR DECK SLAB

ISSUED: 2016

PLATE  
3.6-2HAUNCH - FASCIA BEAMSHAUNCH - INTERIOR BEAMSNOTE TO DESIGNER:

SEE SUBSECTION 20.8 OF THIS MANUAL FOR FURTHER INFORMATION.



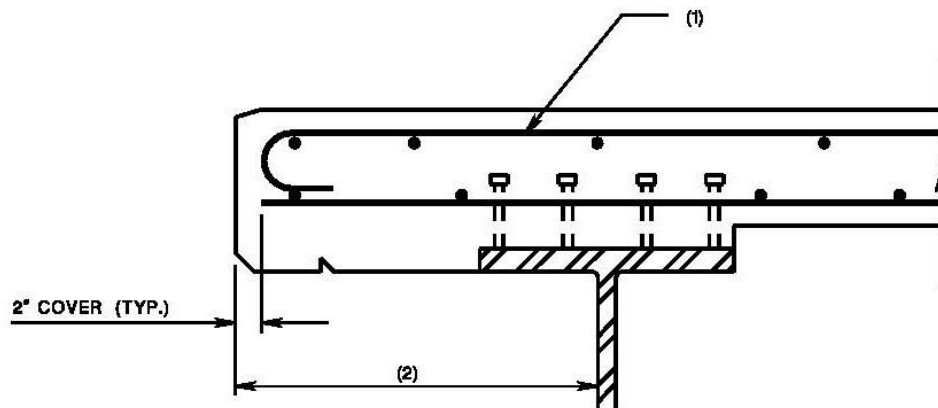


**NOTES:**

1. SEE SUBSECTION 20.2 AND 20.12 OF THIS MANUAL FOR SPECIFIC CRITERIA.
2. SEE PLATES 3.6-1 HEREIN FOR REINFORCEMENT STEEL CRITERIA.
3. SEE PLATES 3.8-1 AND 3.8-2 FOR DETAILING.
4. SEE SECTION 22 OF THIS MANUAL FOR DECK DRAINAGE CRITERIA.

DECK SLAB REINFORCEMENT,  
DETAILS AT FASCIA

ISSUED: 2016

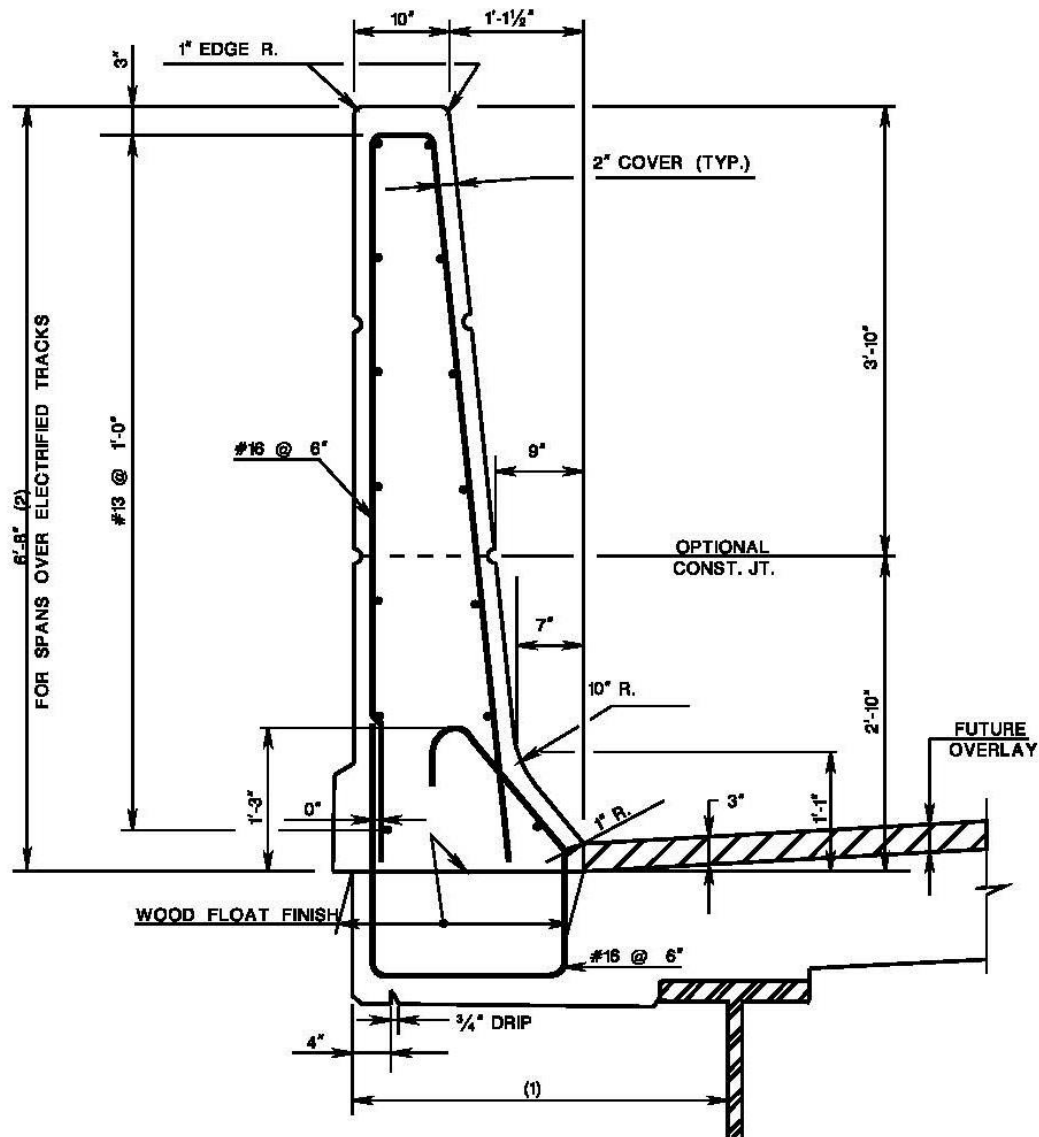
PLATE  
3.6-4**NOTES:**

1. THE OVERHANG PORTION OF THE DECK SHALL BE DESIGNED ACCORDING TO CANTILEVER SLAB CRITERIA OF THE AASHTO LRFD BRIDGE DESIGN SPECIFICATIONS.
2. OVERHANG LENGTH SHALL NOT EXCEED 4'-6". REFER TO NJDOT STIPULATIONS TO AASHTO LRFD CRITERIA IN CHAPTER 3 OF THIS MANUAL. PERMANENT METAL STAY-IN-PLACE FORMS NOT PERMITTED IN THIS AREA.

6'-8" HIGH PARAPET WITH  
BARRIER CURB

ISSUED: 2016

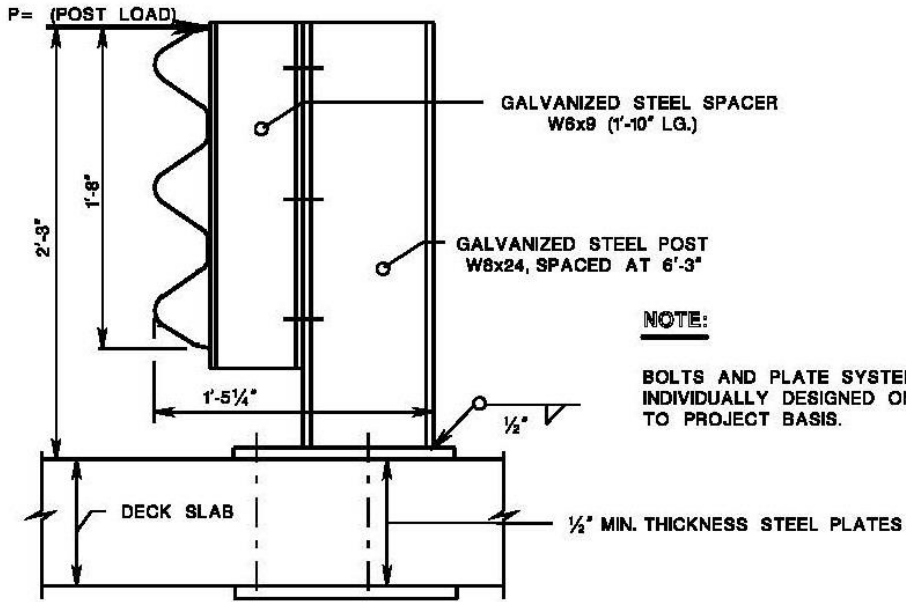
PLATE  
3.7-1



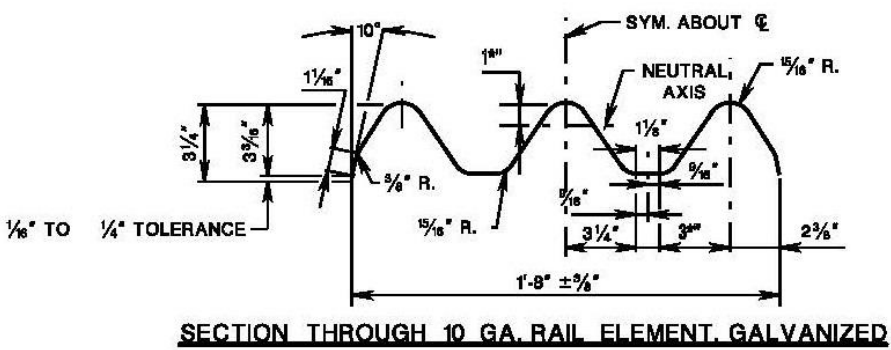
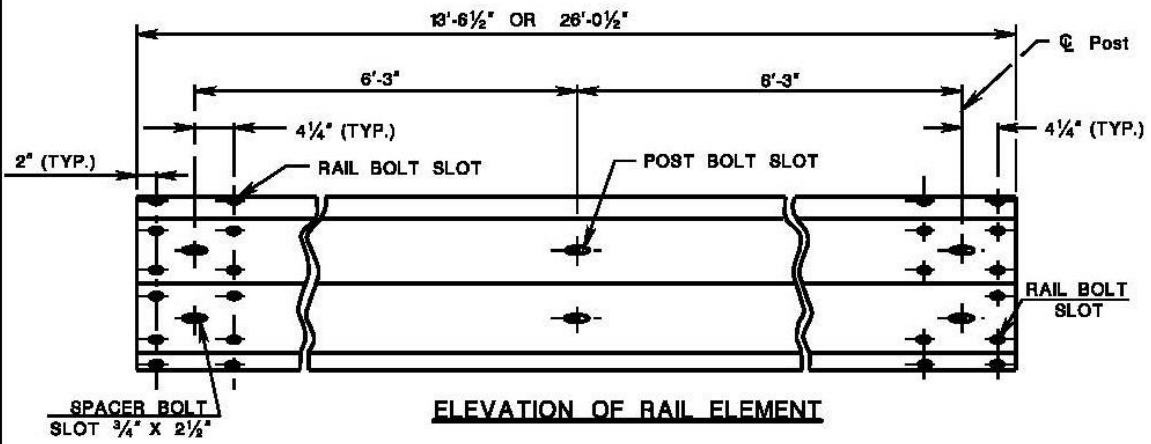
**NOTES:**

1. PREFERRED MAXIMUM OVERHANG IS 2'-6".
2. FACIA RUSTICATION AND/OR CONFIGURATION SUBJECT TO STUDY AND DEVELOPMENT ON AN INDIVIDUAL BRIDGE BASIS.
3. SEE SUBSECTION 20.12 OF THIS MANUAL FOR LOCATION OF CONTRACTION AND OPEN JOINTS IN PARAPET AND BARRIER CURB.
4. ALL REINFORCING STEEL SHALL BE CORROSION PROTECTED.
5. PROVIDE ADDITIONAL REINFORCEMENT IN THE VICINITY OF PARAPET JOINTS TO PREVENT CRACKING IN THE DECK OVERHANG. REFER TO STANDARD BRIDGE CONSTRUCTION DETAIL.

|                                  |                     |                        |
|----------------------------------|---------------------|------------------------|
| <p>TEMPORARY BARRIER, BRIDGE</p> | <p>ISSUED: 2016</p> | <p>PLATE<br/>3.7-2</p> |
|----------------------------------|---------------------|------------------------|



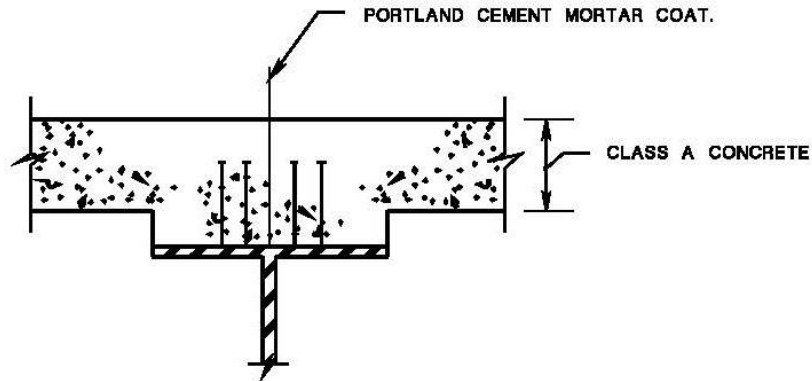
**NOTE:**  
BOLTS AND PLATE SYSTEM TO BE INDIVIDUALLY DESIGNED ON PROJECT TO PROJECT BASIS.



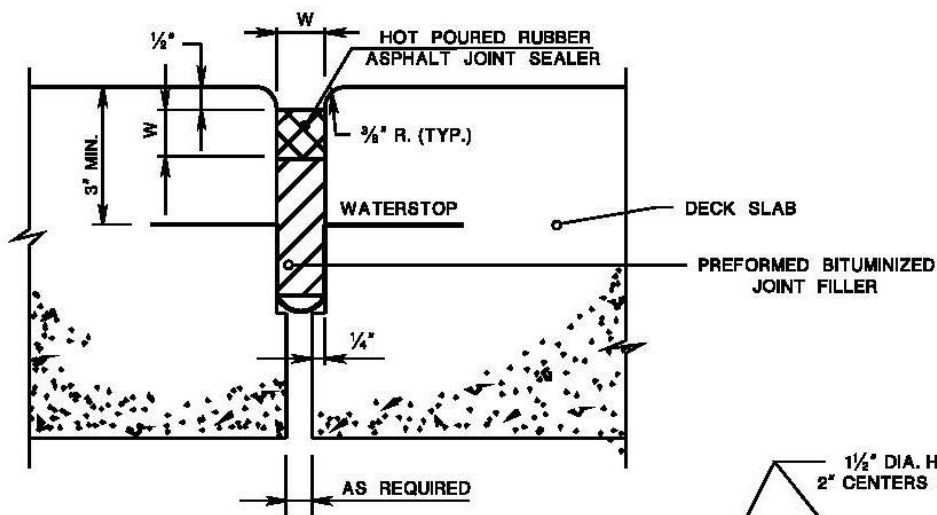
**LONGITUDINAL JOINTS IN DECK SLAB  
(ONE-COURSE CONSTRUCTION)**

**ISSUED: 2016**

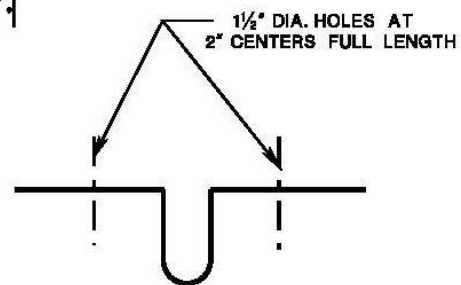
**PLATE  
3.8-1**



**DETAIL No. 1  
LONGITUDINAL CONSTRUCTION  
JOINT IN DECK SLAB**



**DETAIL No. 2  
LONGITUDINAL EXPANSION  
JOINT IN DECK SLAB**



**COPPER WATERSTOP DETAIL**

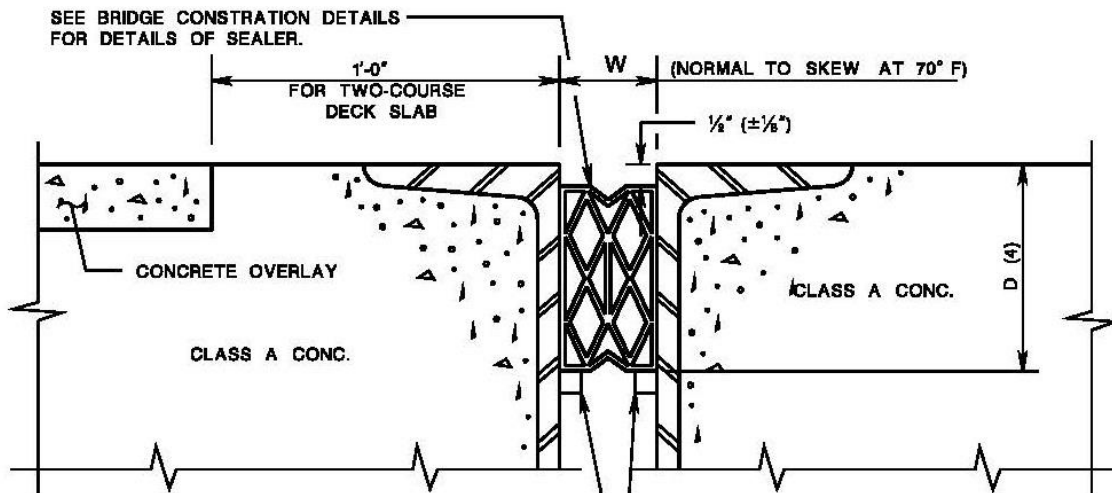
**NOTE TO DESIGNER:**

- (1) SEE SUBSECTION 21.3 OF THIS MANUAL FOR FURTHER INFORMATION.
- (2) SEE PLATE 3.8-2 WHEN LONGITUDINAL JOINTS USE PREFORMED ELASTOMERIC SEAL DETAILS.

**JOINT SEALER SEAT DEPTH DETAILS**  
(SHEET 1)

ISSUED: 2016

PLATE  
3.8-2

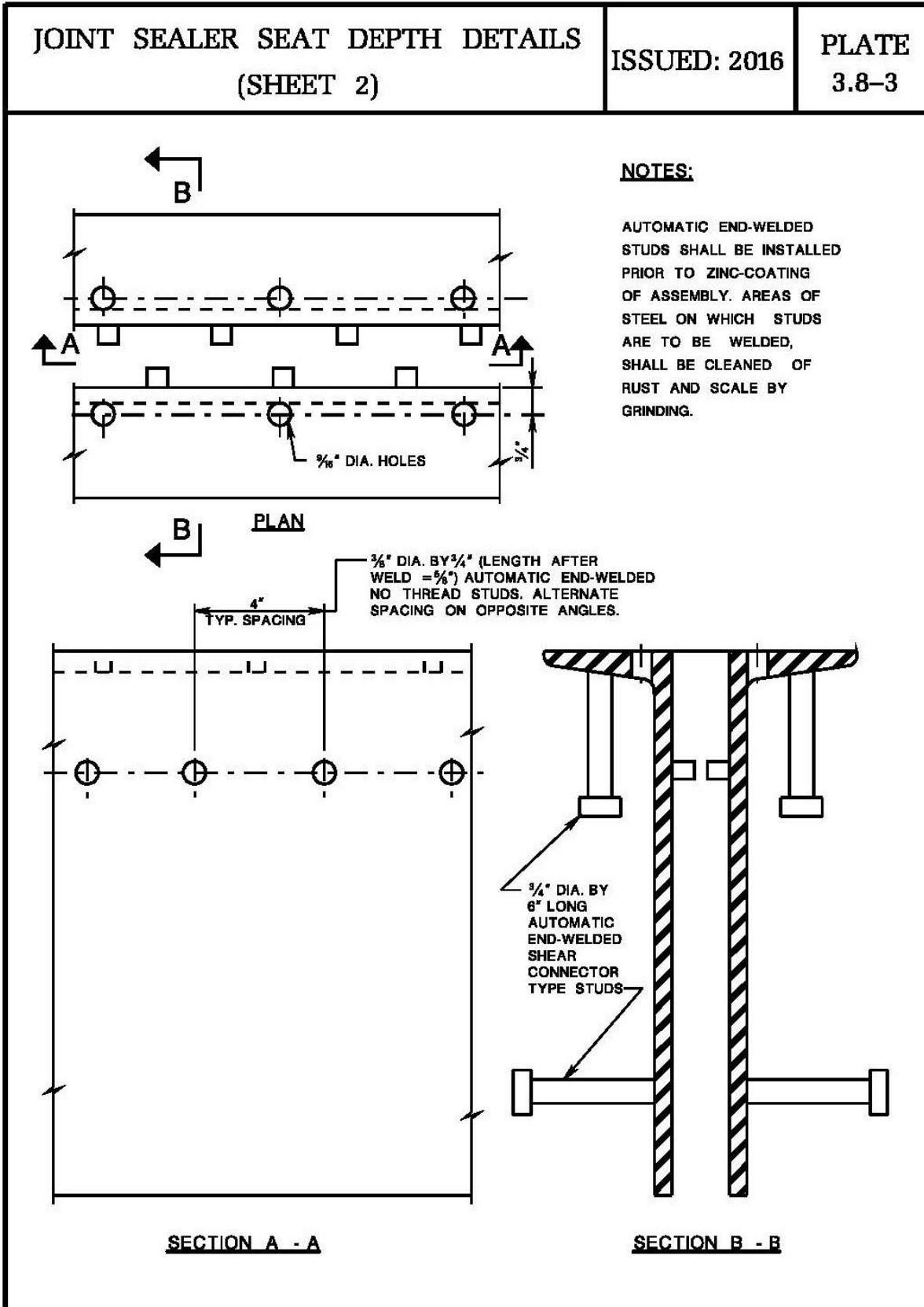


| NOMINAL SEALER SIZE (2) (3) |            | W      | D   |
|-----------------------------|------------|--------|-----|
| WIDTH                       | HEIGHT (1) |        |     |
| 1 3/4"                      | 1 3/4"     | 1"     | (4) |
| 2 1/2"                      | 2 1/2"     | 1 3/8" | (4) |
| 4"                          | 4"         | 2 5/8" | (4) |

3/8" DIA. BY 3/4" AUTOMATIC END-WELDED NO THREAD TYPE STUD (LENGTH AFTER WELDING=3/4"). SEE GUIDE SHEET PLATE 3.8-3 FOR ADDITIONAL DETAILS.

**NOTES:**

1. THE NOMINAL HEIGHT OF COMPRESSION SEALS MAY VARY BASED UPON MANUFACTURER'S SPECIFICATIONS.
2. THE COMPRESSION SEAL HEIGHT TO WIDTH RATIO SHALL NOT BE LESS THAN 90 %.
3. THE WIDTH OF SEALER SHALL NOT BE LESS THAN NOMINAL SIZE. THE HEIGHT MAY EXCEED THE NOMINAL MANUFACTURER'S SEALER HEIGHT BY NOT MORE THAN 1/4".
4. "D" DIMENSION IS EQUAL TO COMPRESSED SEAL HEIGHT PER MANUFACTURER'S SPECIFICATIONS PLUS 1/2" (±1/8"). DIMENSION "D" SHALL BE SET IN THE SHOP BY THE FABRICATOR.
5. SEE SUBSECTION 21.2 OF THIS MANUAL.



**STRUCTURAL STEEL  
GENERAL NOTES**

ISSUED: 2016

**PLATE  
3.9-1**

**NOTES TO DESIGNERS**

- A. PROVIDE MATERIALS AND WORKMANSHIP CONFORMING TO THE AASHTO LRFD BRIDGE CONSTRUCTION SPECIFICATIONS, AND AASHTO/AWS D1.5 WELDING CODE.
- B. REFER TO SECTION 24 IN THIS MANUAL FOR ADDITIONAL NOTES THAT ARE TO BE SHOWN ON CONTRACT PLANS:
- C. FILLET WELD SIZES AS REQUIRED BY DESIGN TO BE SHOWN ON PLANS.
- D. DO NOT CHANGE WIDTH OF TOP FLANGE PLATE IN SIMPLE SPAN GIRDERS.
- E. MINIMUM CHANGE OF THICKNESS OF FLANGE PLATES SHALL BE  $\frac{1}{2}$ ".
- F. THE FOLLOWING TABLE PROVIDES GUIDELINES IN THE SELECTION OF FLANGE PLATES:

| T2<br>(IN)       | T1a<br>(IN)    | T1b<br>(IN)    | T1c<br>(IN)    | T1d<br>(IN)    | T1e<br>(IN)    |
|------------------|----------------|----------------|----------------|----------------|----------------|
| $2\frac{3}{4}$ * | $2\frac{1}{4}$ | 2              | $1\frac{3}{4}$ | $1\frac{1}{2}$ | -              |
| $2\frac{1}{2}$   | $1\frac{3}{4}$ | $1\frac{1}{2}$ | $1\frac{1}{2}$ | $1\frac{1}{2}$ | -              |
| $2\frac{1}{4}$   | $1\frac{1}{2}$ | $1\frac{1}{2}$ | $1\frac{1}{2}$ | $1\frac{1}{4}$ | $1\frac{1}{8}$ |
| 2                | $1\frac{1}{2}$ | $1\frac{1}{8}$ | $1\frac{1}{4}$ | $1\frac{1}{8}$ | -              |
| $1\frac{3}{4}$   | $1\frac{1}{4}$ | $1\frac{1}{4}$ | $1\frac{1}{8}$ | 1              | -              |
| $1\frac{1}{2}$   | $1\frac{1}{8}$ | 1              | $\frac{7}{8}$  | $\frac{3}{4}$  | -              |
| $1\frac{1}{2}$   | 1              | $\frac{7}{8}$  | $\frac{3}{4}$  | -              | -              |
| $1\frac{1}{8}$   | $\frac{7}{8}$  | $\frac{3}{4}$  | -              | -              | -              |
| $1\frac{1}{4}$   | $\frac{3}{4}$  | -              | -              | -              | -              |

\* NOT RECOMMENDED FOR TENSION FLANGES.

(1) SELECT FLANGE PLATE THICKNESS T2 FOR MAXIMUM MOMENT.

(2) SELECT T1 FROM AVAILABLE CHOICES T1a THRU T1e.

(3) USE T1 TO ENTER T2 COLUMN FOR RANGE OF POSSIBILITIES FOR NEXT SPLICE. CONTINUE UNTIL T1 MINIMUM IS OBTAINED.

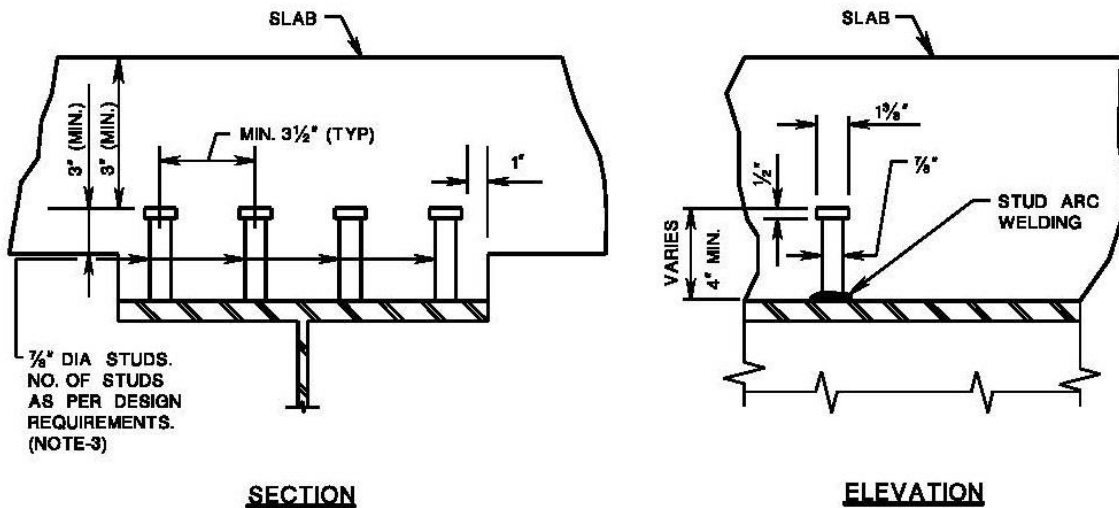
(NOTE: SEE GUIDE PLATE 3.9-4 FOR THICKNESS DESIGNATIONS)

- G. MINIMUM LENGTH OF FLANGE PLATES SHOULD BE ABOUT 15 FEET. PLATE LENGTHS SHOULD BE PROPORTIONED TO MINIMIZE, AS MUCH AS PRACTICAL, NUMBER OF BUTT JOINTS IN THE TOTAL SPAN LENGTH.
- H. FLANGE PLATE THICKNESS OF THE COMPONENT PLATES SHOULD BE STANDARDIZED AS MUCH AS PRACTICAL IN EACH CONTRACT TO MINIMIZE EXCESSIVE VARIABILITY IN THE ORDER MATERIAL AND TO MAXIMIZE USE OF THE ORDER MATERIAL.
- I. CHANGES IN FLANGE AREAS MAY BE ACCOMPLISHED BY VARYING THE THICKNESS AND WIDTH (EXCEPT SEE NOTE D) OF ADJACENT FLANGE PLATES. HOWEVER, A DESIGN MAINTAINING THE SAME WIDTH OF FLANGE AND CHANGING ONLY THE THICKNESS IS PREFERRED IN ORDER TO IMPROVE THE "STRESS FLOW" CHARACTERISTICS OF THE JOINT.
- J. SEE SUBSECTION 24.4 OF THIS MANUAL ABOUT "ECONOMICS OF STRINGER DESIGN".
- K. LOCATE ALL INTERMEDIATE STIFFENERS ON OPPOSITE SIDE OF WEB FROM LONGITUDINAL STIFFENERS WHEN POSSIBLE.
- L. WHEN A BEARING STIFFENER IS USED AS A CONNECTION PLATE, WELD TO TOP AND BOTTOM FLANGE MEMBERS, WELD AND PLATE SIZES SHOWN IN PLATES 3.9-2 THRU 3.9-25 ARE FOR STRAIGHT GIRDERS WITH MAXIMUM GIRDER SPACING OF 10'-0" AND FOR SKEW ANGLES UP TO 20°.
- N. THE DETAILS SHOWN IN PLATES 3.9-2 THRU 3.9-25 ARE VALID FOR SKEW ANGLES 0° TO 20°. PROVIDE SPECIAL DETAILS FOR SKEW ANGLES GREATER THAN 20°.
- O. PROVIDE INTERMEDIATE DIAPHRAGMS NORMAL TO THE MAIN MEMBERS FOR SKEWS > 20°.
- P. THE DIAPHRAGMS SHOWN IN PLATES 3.9-2 THRU 3.9-25 ARE FOR STRAIGHT GIRDERS ONLY AND DO NOT INCLUDE WIND LOAD TRANSFERRED THROUGH CONNECTIONS.
- Q. SEE GUIDE PLATE 3.9-26 FOR "NOTES TO BE SHOWN ON CONTRACT PLANS".



## STUD SHEAR CONNECTORS

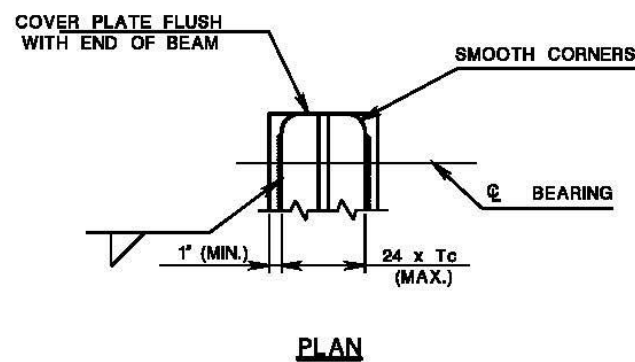
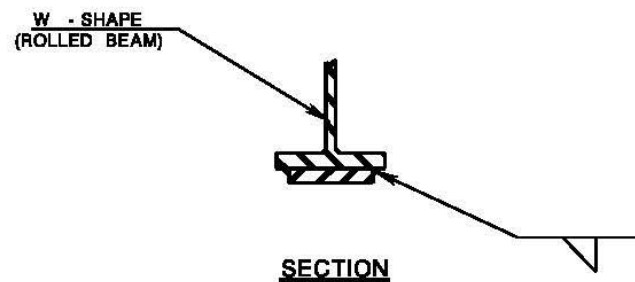
ISSUED: 2016

PLATE  
3.9-2**NOTES:**

1. SPACING REQUIREMENTS ARE TO BE BASED ON AASHTO LRFD SPECIFICATION REQUIREMENTS.
2. HEIGHT OF STUD DEPENDS ON CONCRETE DECK THICKNESS AND THE HAUNCH DIMENSION. THE USE OF THE SAME HEIGHT STUD ON ANY ONE BRIDGE IS PREFERRED. REFERENCE SUBSECTION 24.6 OF THIS MANUAL FOR MORE INFORMATION.
3. THE DESIGNER SHALL CHECK FOR SHEAR STUD AVAILABILITY.
4. WHEN HAUNCH IS GREATER THAN 4", REFER TO SUBSECTION 20.7.6.

## COVER PLATE DETAILS

ISSUED: 2016

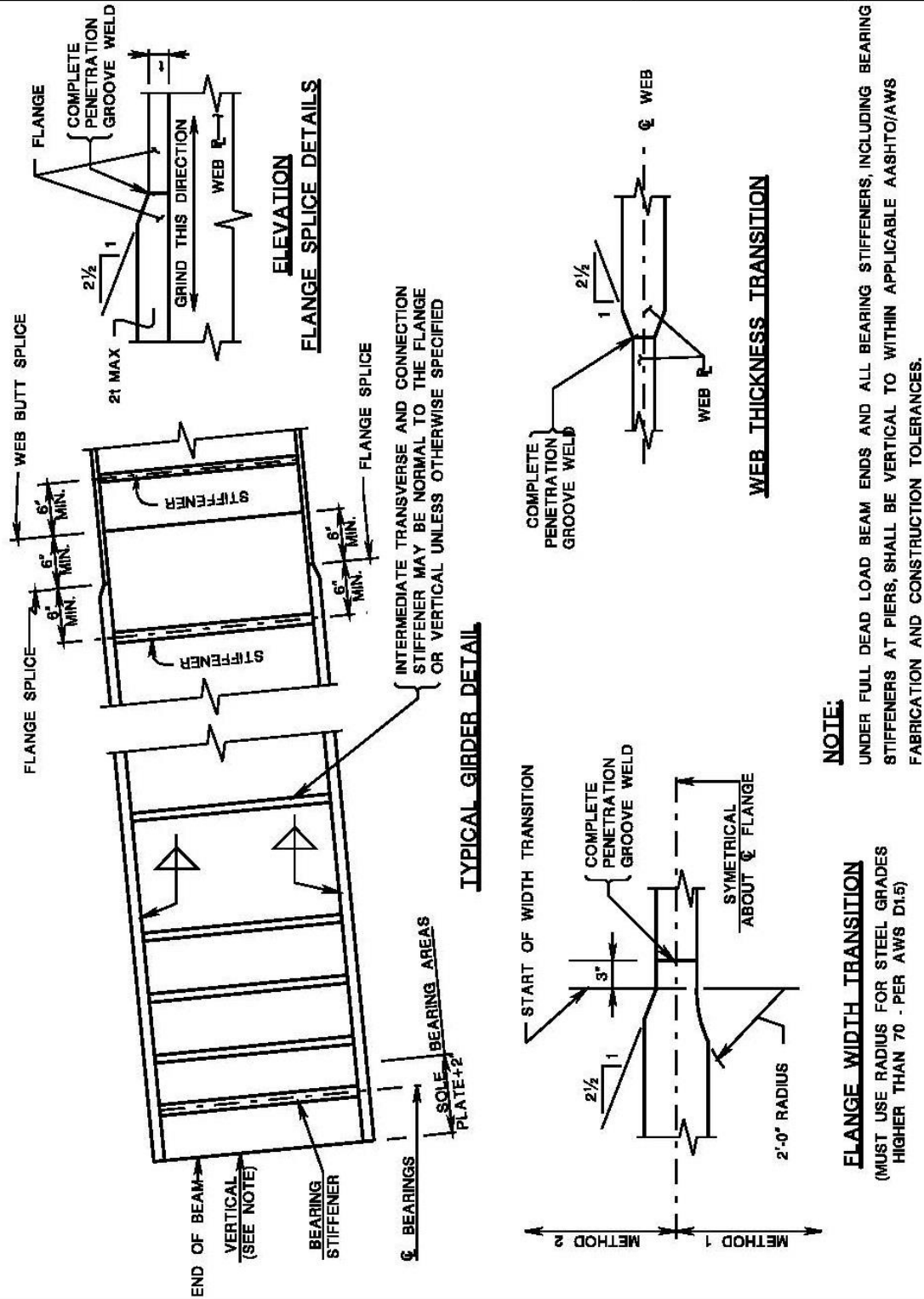
PLATE  
3.9-3**NOTE TO DESIGNERS:**

USE OF COVER PLATE DETAILS REQUIRES APPROVAL FROM NJDOT.

GIRDER WELDED SPLICE DETAILS

ISSUED: 2016

PLATE  
3.9-4



**NOTE:**

UNDER FULL DEAD LOAD BEAM ENDS AND ALL BEARING STIFFENERS, INCLUDING BEARING STIFFENERS AT PIERS, SHALL BE VERTICAL TO WITHIN APPLICABLE AASHTO/AWS FABRICATION AND CONSTRUCTION TOLERANCES.

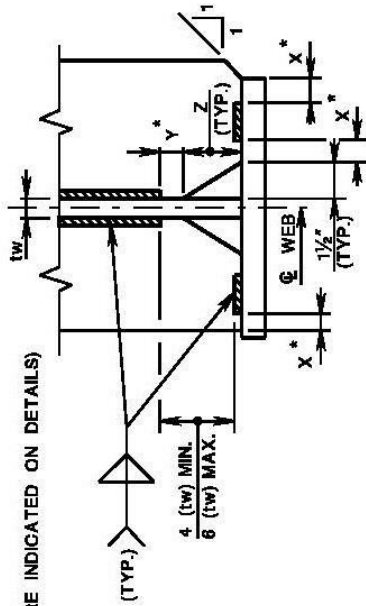
**FLANGE WIDTH TRANSITION**

(MUST USE RADIUS FOR STEEL GRADES HIGHER THAN 70 - PER AWS D1.5)

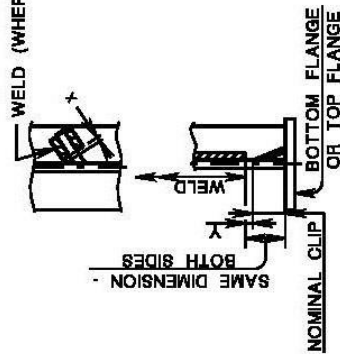
**INTERMEDIATE AND BEARING STIFFENER DETAILS**  
(1 OF 2)

ISSUED: 2016

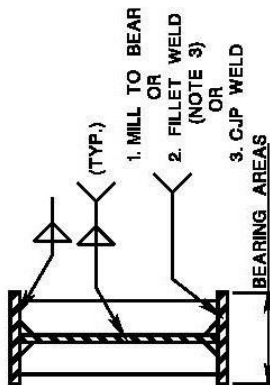
PLATE  
3.9-5



**DETAIL @ END OF STIFFENER OR CONNECTION PLATE**



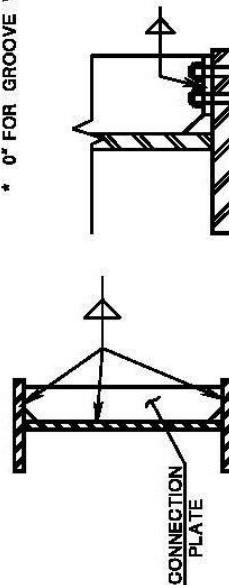
**STIFFENER WELDING DETAIL (FOR SKEWED STIFFENERS)**



**BEARING STIFFENER**

• SHOW STIFFENER PLATE AND FILLET WELD SIZES ON THE PLAN

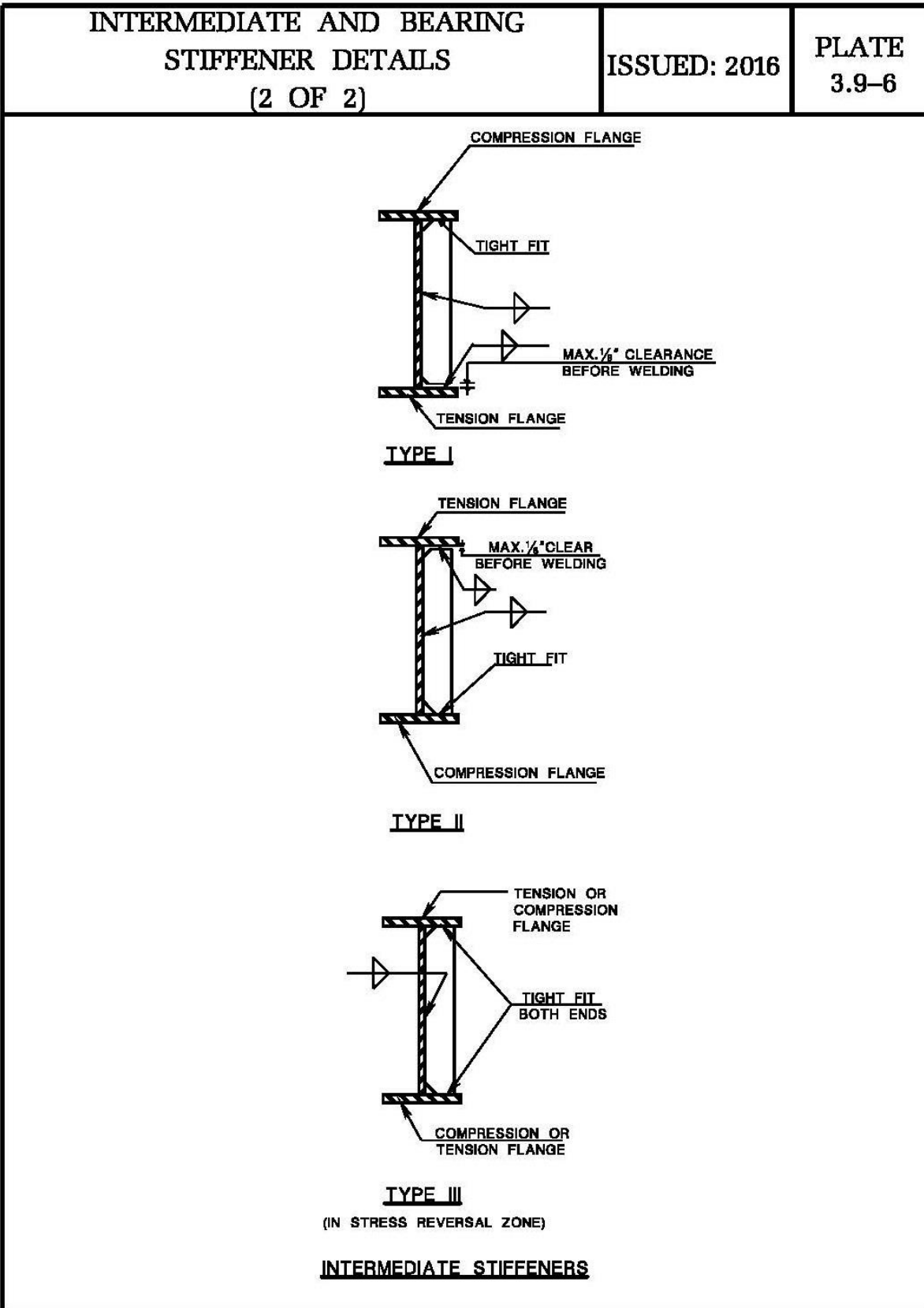
- X =  $\frac{9}{16}'' \pm \frac{1}{8}''$
- Y =  $\frac{9}{16}'' \pm \frac{3}{16}''$
- Z =  $2\frac{1}{2}''$  FOR  $\frac{1}{2}''$  WEB
- 3" FOR  $\frac{3}{4}''$  WEB
- 4" FOR  $\frac{9}{16}''$  WEB
- \* 0" FOR GROOVE WELD.

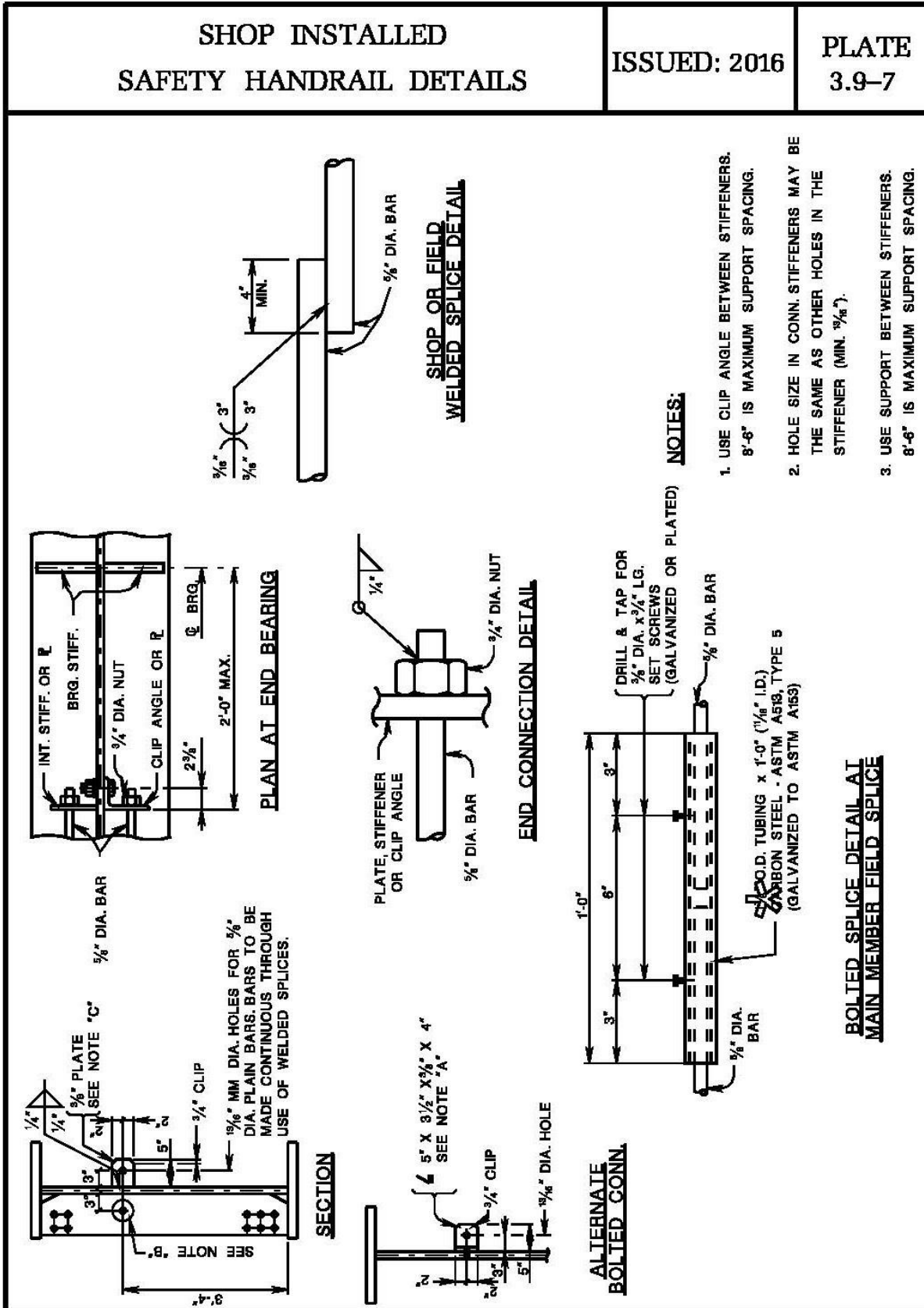


**ALTERNATE DETAIL @ TENSION FLANGE WHERE STRESS RANGE EXCEEDS CATEGORY C**

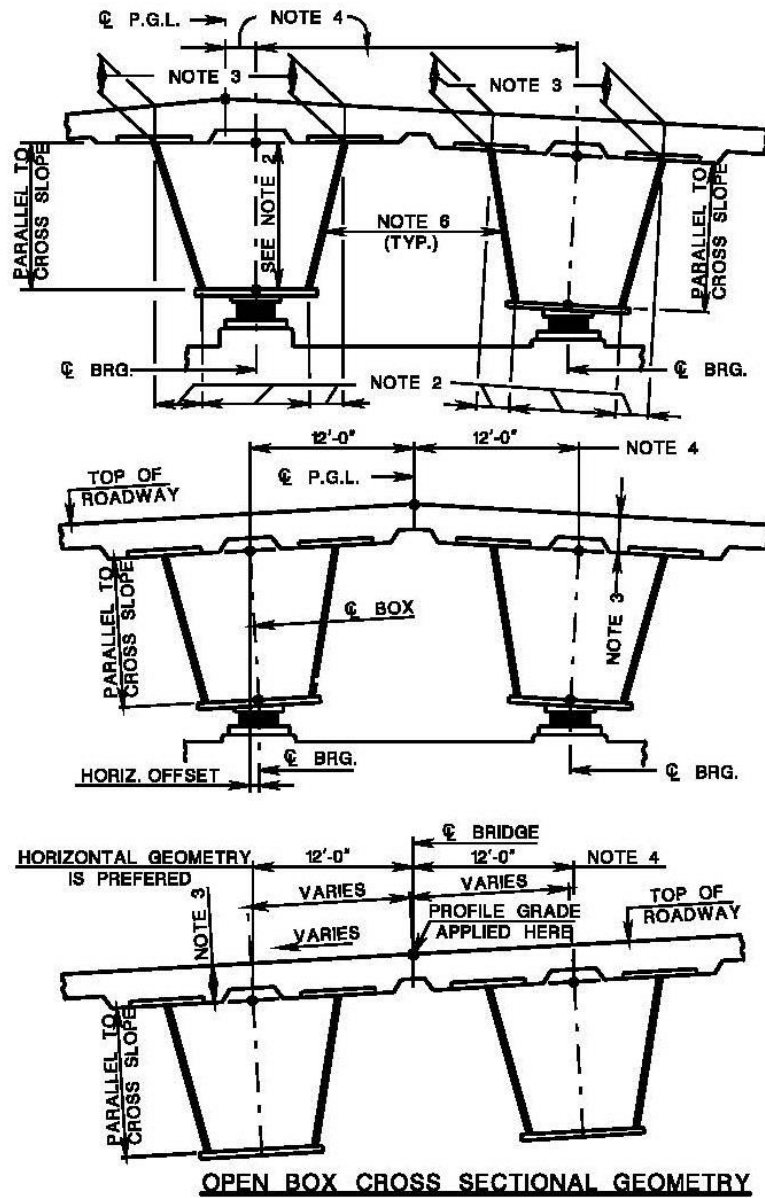
**CONNECTION PLATE**

- NOTES:**
1. STIFFENER SIZE MUST BE SHOWN ON PLANS.
  2. FILLET WELD SIZE SHALL BE SHOWN ON PLANS UNLESS MINIMUM WELD SIZE AS PER AASHTO/AWS D1.5 IS TO BE USED.
  3. IF A BEARING STIFFENER IS USED AS A CONNECTION PLATE FOR CROSS FRAMES FILLET WELDS ARE REQUIRED IN ADDITION TO MILL TO BEAR. INVESTIGATE LOAD FOR REQUIREMENT OF C-J.P. WELDS.
  4. WHEN LONGITUDINAL STIFFENERS ARE REQUIRED, PLACE ALL TRANSVERSE STIFFENERS ON ONE SIDE OF WEB AND PLACE THE LONGITUDINAL STIFFENER ON OPPOSITE SIDE.





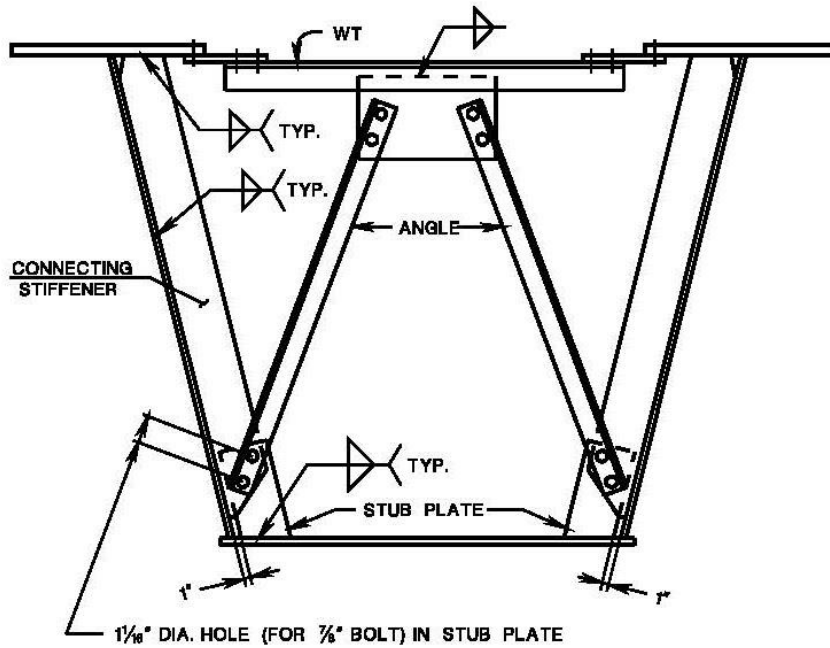
|   |              |                |
|---|--------------|----------------|
| <b>TUB GIRDER (OPEN BOX) DETAILS</b><br>(SHEET 1 OF 3)<br><b>CROSS SECTIONAL GEOMETRY</b> | ISSUED: 2016 | PLATE<br>3.9-8 |
|---|--------------|----------------|



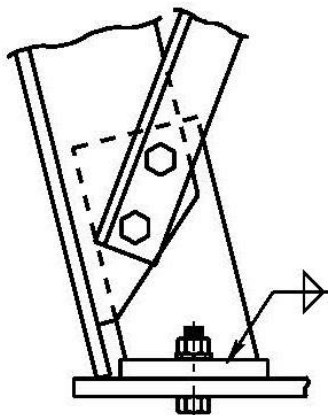
**NOTES:**

1. ROTATE BOX WITH CROSS SLOPE.
2. MAINTAIN CONSTANT TRAPEZOIDAL SHAPE (DEPTH MAY VARY WITH HAUNCH).
3. MAINTAIN CONSTANT CONCRETE HAUNCH.
4. HORIZONTAL STATION OFFSETS PREFERRED.
5. FOLLOW CENTERLINE ALIGNMENT EVEN THROUGH A SPIRAL CURVE.
6. THE WEB INCLINATION SHALL NOT EXCEED 1 TO 4 (1:4).

|   |                     |                        |
|---|---------------------|------------------------|
| <p>TUB GIRDER (OPEN BOX) DETAILS<br/>(SHEET 2 OF 3)<br/>INTERIOR CROSSFRAME</p> | <p>ISSUED: 2016</p> | <p>PLATE<br/>3.9-9</p> |
|---|---------------------|------------------------|



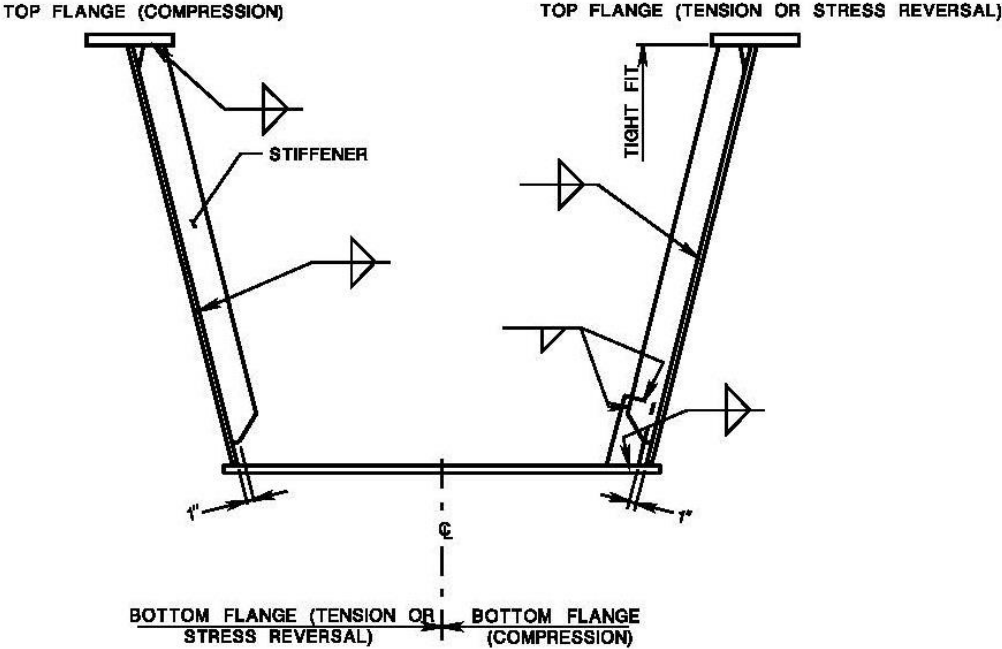
**BOTTOM FLANGE (COMPRESSION OR TENSION)  
INTERIOR CROSSFRAME**



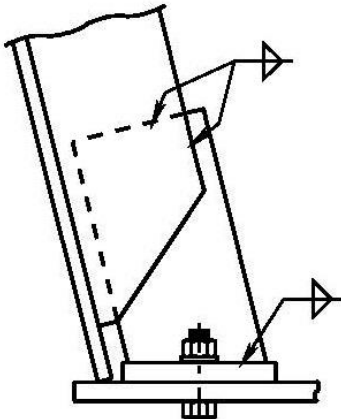
**ALTERNATE DETAIL AT TENSION FLANGES**



|  |                     |                         |
|--|---------------------|-------------------------|
| <p>TUB GIRDER (OPEN BOX) DETAILS<br/>(SHEET 3 OF 3)<br/>TRANSVERSE STIFFENER</p> | <p>ISSUED: 2016</p> | <p>PLATE<br/>3.9-10</p> |
|--|---------------------|-------------------------|

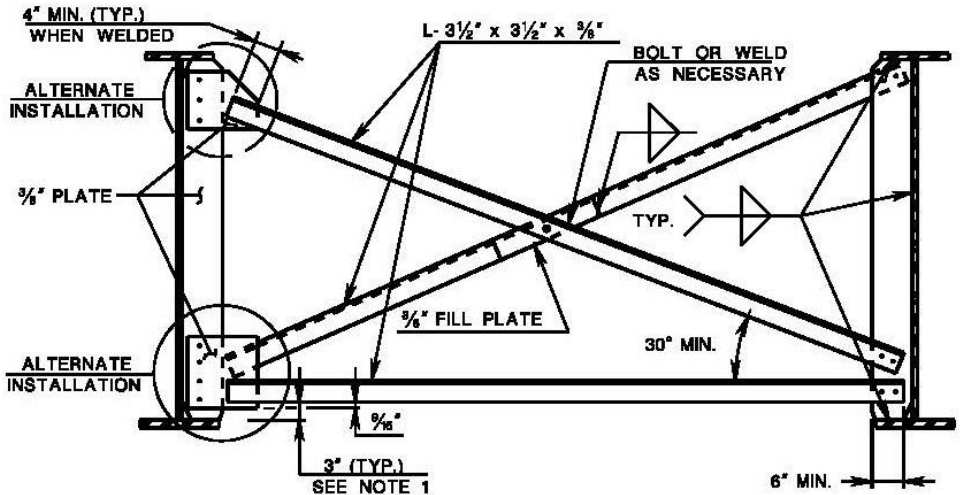


TUB GIRDER TRANSVERSE STIFFENER DETAILS

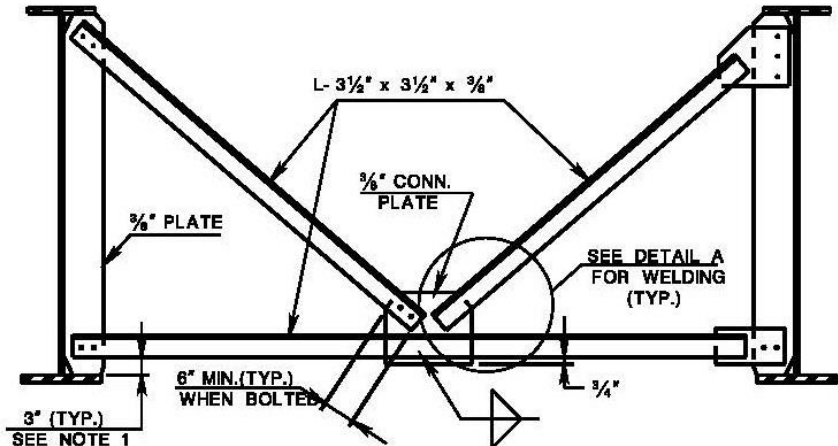


ALTERNATE DETAIL AT TENSION FLANGES

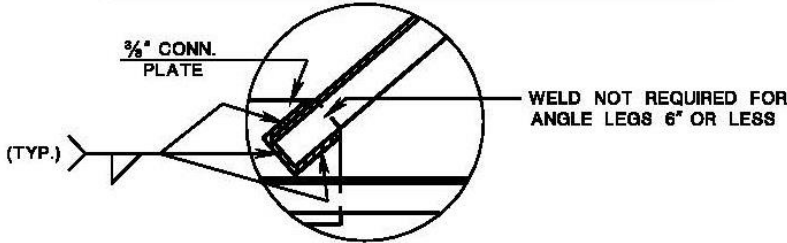
|  |                     |                               |
|--|---------------------|-------------------------------|
| <b>CROSSFRAME DETAILS</b><br>(SHEET 1 OF 3)<br><b>INTERMEDIATE DIAPHRAGM</b> | <b>ISSUED: 2016</b> | <b>PLATE</b><br><b>3.9-11</b> |
|--|---------------------|-------------------------------|



**INTERMEDIATE DIAPHRAGM DETAIL**



**ALTERNATE INTERMEDIATE DIAPHRAGM DETAIL**



**DETAIL A**  
(TYPICAL FOR ALL WELDED CONNECTIONS)

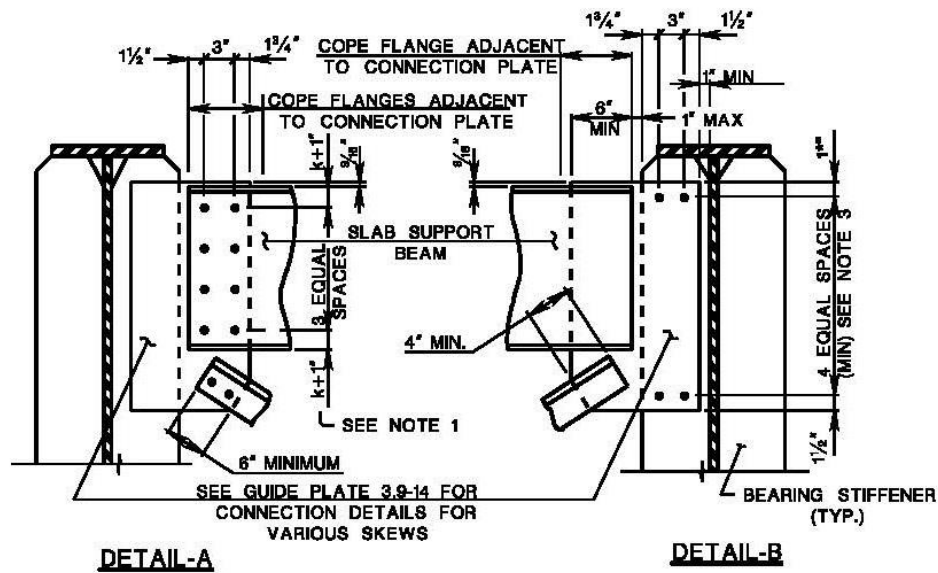
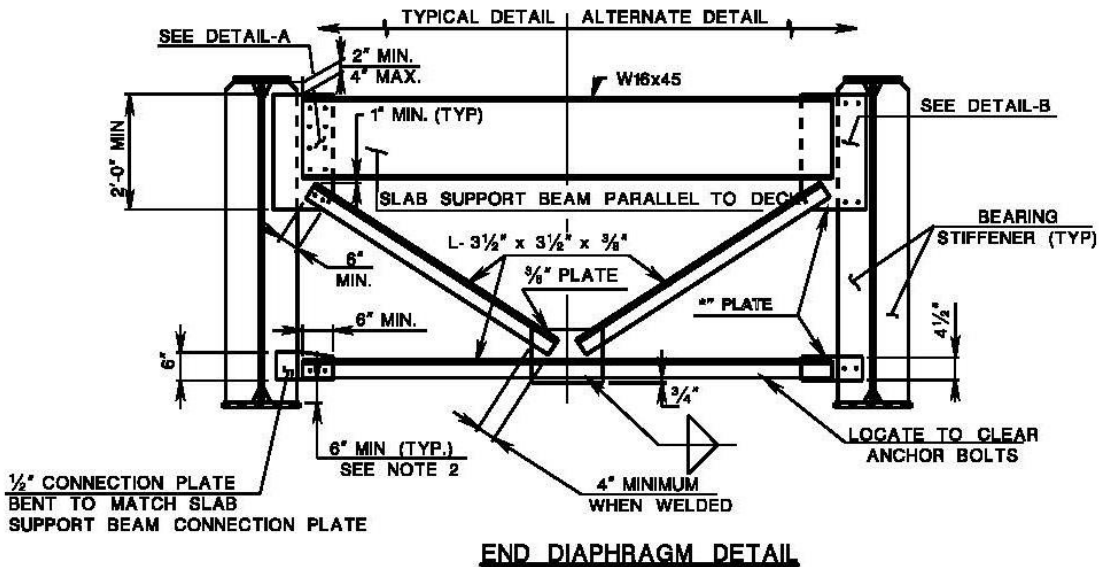
**NOTE:**

- 1. MODIFY THE DISTANCE BETWEEN THE BOTTOM GIRDER FLANGE AND THE LOWER DIAPHRAGM COMPONENT WHEN LOWER LATERAL BRACING IS USED.

CROSSFRAME DETAILS  
 (SHEET 2 OF 3)  
 END DIAPHRAGM

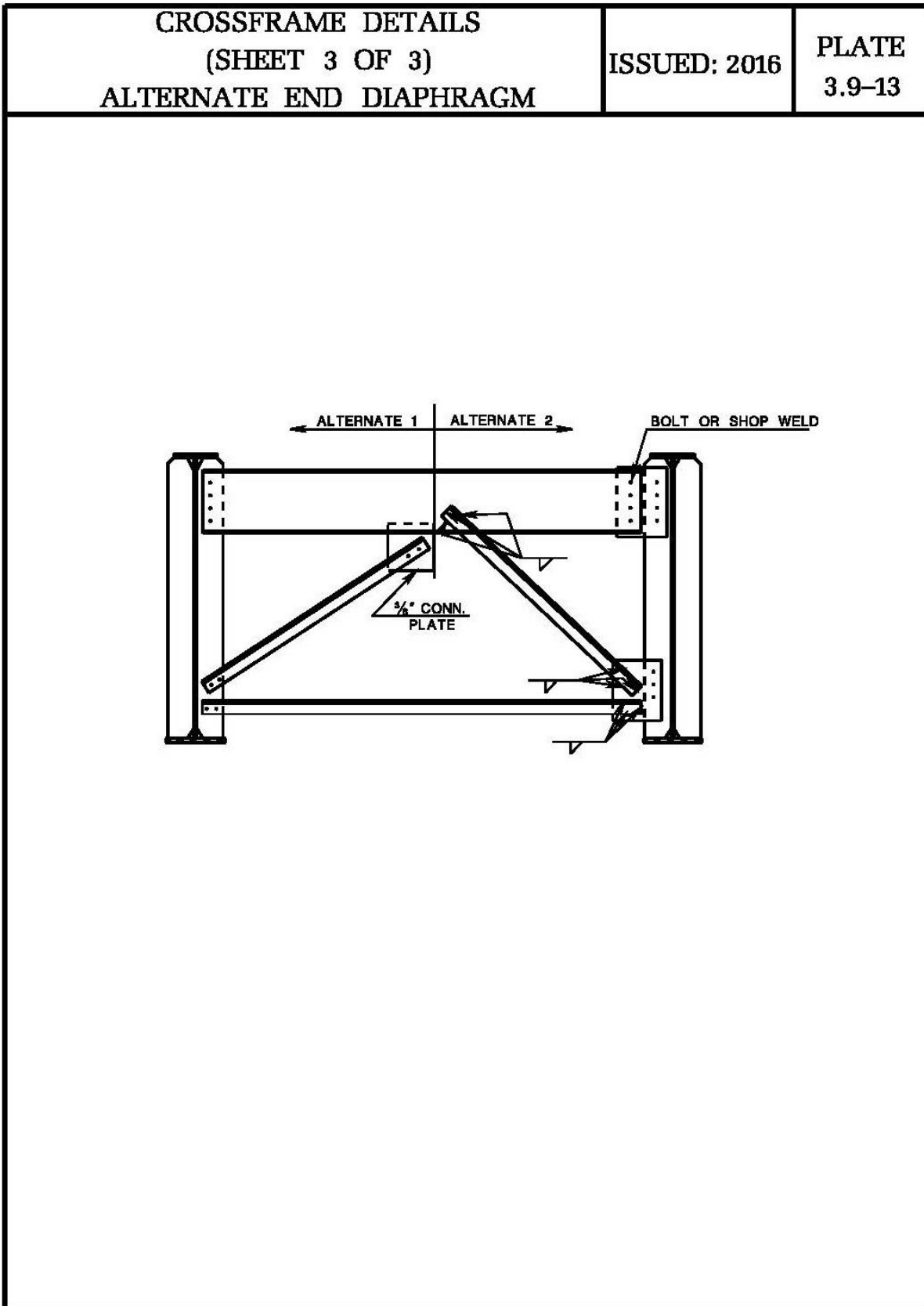
ISSUED: 2016

PLATE  
 3.9-12

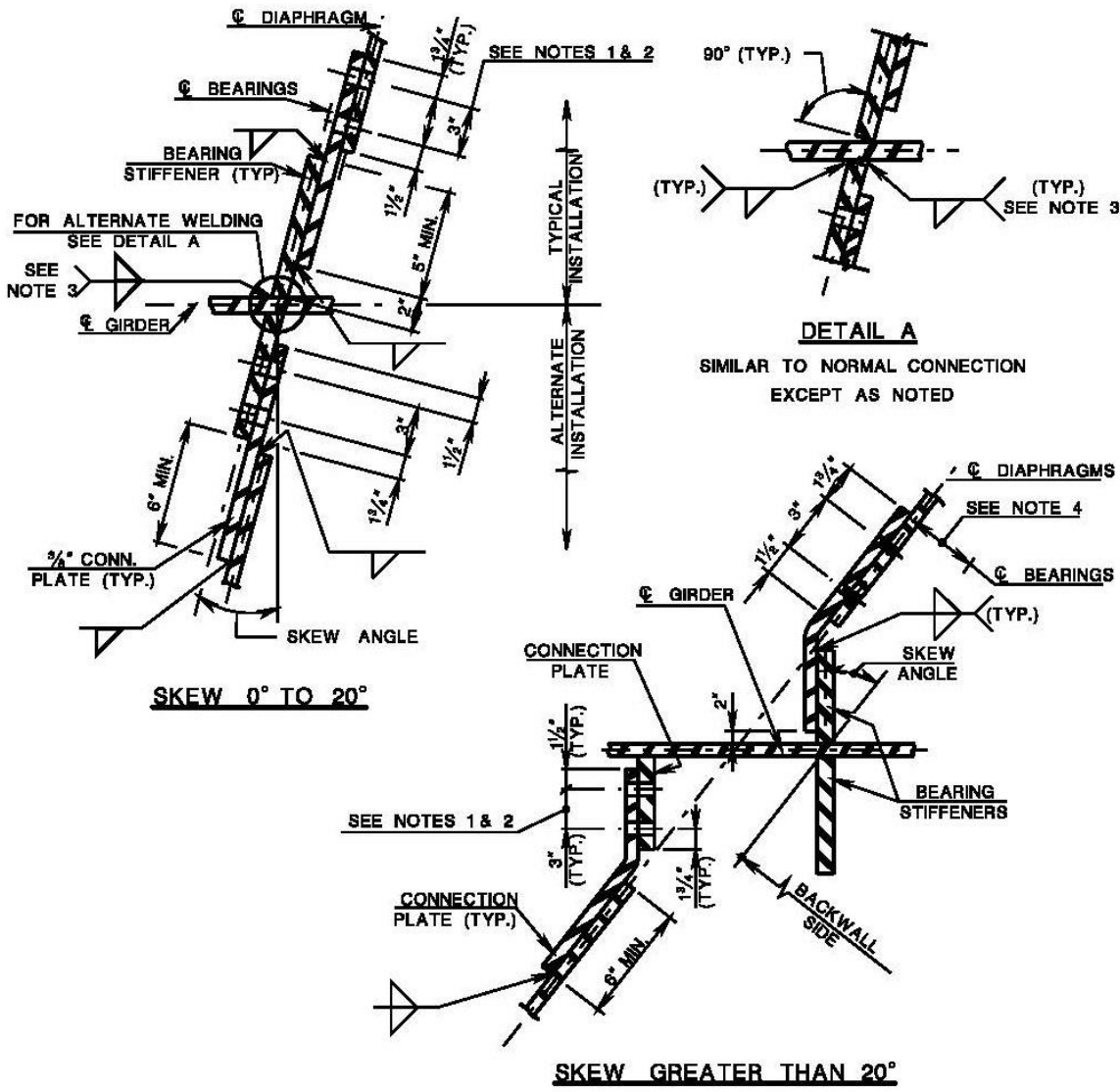


**NOTES:**

1.  $k$  = FLANGE THICKNESS + FILLET, AS INDICATED IN AISC TABLES OF BEAM DIMENSIONS
2. MODIFY THE DISTANCE BETWEEN THE BOTTOM GIRDER FLANGE AND THE LOWER DIAPHRAGM COMPONENT WHEN LOWER LATERAL BRACING IS USED. INDICATE MODIFICATIONS ON THE DESIGN DRAWINGS.
3. 1/16" DIAMETER HOLE IN BEARING STIFFENERS; 5/16" DIAMETER HOLE IN CONNECTION PLATE FOR 5/8" DIAMETER ASTM A325 BOLTS STD. SIZE HOLES ARE PERMITTED. UNTHREADED SHANK OF BOLT SHALL BE OF SUFFICIENT LENGTH TO NOT ALLOW ANY THREADS TO EXIST IN THE PLANE BETWEEN THE TWO CONNECTED PARTS.



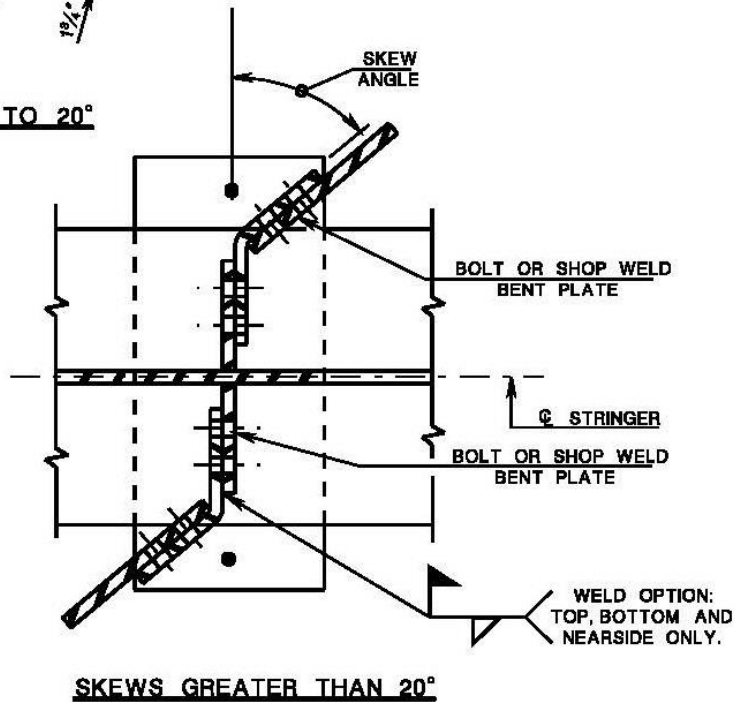
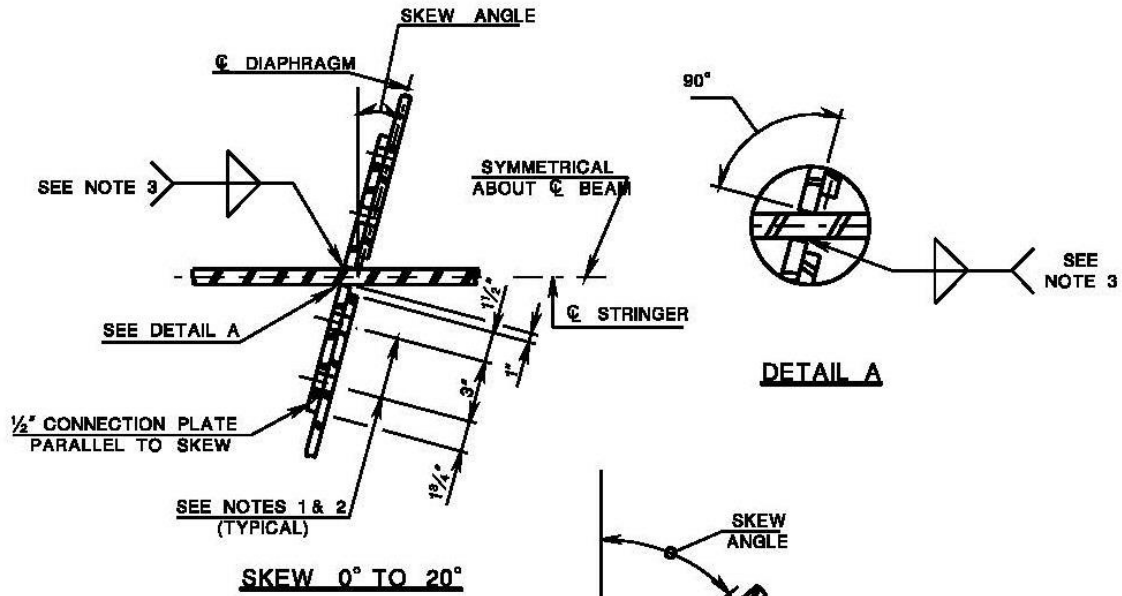
|  |                     |                         |
|--|---------------------|-------------------------|
| <p>CONNECTION PLATE DETAILS<br/>(SHEET 1 OF 2)<br/>CONNECTION PLATE FOR GIRDER</p> | <p>ISSUED: 2016</p> | <p>PLATE<br/>3.9-14</p> |
|--|---------------------|-------------------------|



**NOTES:**

1. 1/16" DIAMETER HOLE IN CONNECTION PLATE; 3/16" DIAMETER HOLE IN CONNECTING MEMBER FOR 3/8" DIAMETER ASTM A325 BOLTS STD. SIZE HOLES ARE PERMITTED.
2. USE 7/8" DIAMETER ASTM A325 BOLTS HAVING AN UNTHREADED SHANK OF SUFFICIENT LENGTH TO NOT ALLOW ANY THREADS TO EXIST IN THE PLANE BETWEEN THE TWO CONNECTED PARTS (SHEAR PLANE).
3. WELD SIZE MUST BE IN ACCORDANCE WITH AWS D1.5, SECTION 2.
4. POSITION DIAPHRAGM CONNECTION COMPONENTS SO AS TO CREATE MINIMUM OFFSET FROM CENTER LINE OF BEARINGS. DIAPHRAGM CONNECTION PLATE MAY BE PLACED BEHIND THE BEARING STIFFENER TO MINIMIZE OFFSET.

|   |              |                 |
|---|--------------|-----------------|
| <b>CROSSFRAME DETAILS</b><br>(SHEET 2 OF 2)<br><b>CONNECTION PLATE FOR STRINGER</b> | ISSUED: 2016 | PLATE<br>3.9-15 |
|---|--------------|-----------------|



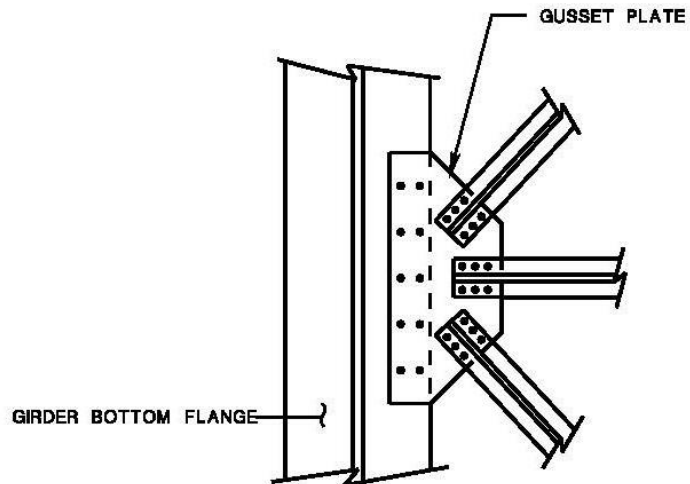
**NOTES:**

1. 1 1/8" DIAMETER HOLE IN CONNECTION PLATE; 1 5/16" DIAMETER HOLE IN CONNECTING MEMBER FOR 3/8" DIAMETER ASTM A325 BOLTS STD. SIZE HOLES ARE PERMITTED.
2. USE 3/8" DIAMETER ASTM A325 BOLTS HAVING AN UNTHREADED SHANK OF SUFFICIENT LENGTH TO NOT ALLOW ANY THREADS TO EXIST IN THE PLANE BETWEEN THE TWO CONNECTED PARTS (SHEAR PLANE).
3. WELD SIZE MUST BE IN ACCORDANCE WITH AWS D1.6, SECTION 2.
4. POSITION DIAPHRAGM CONNECTION COMPONENTS SO AS TO CREATE MINIMUM OFFSET FROM CENTER LINE OF BEARINGS. DIAPHRAGM CONNECTION PLATE MAY BE PLACED BEHIND THE BEARING STIFFENER TO MINIMIZE OFFSET.

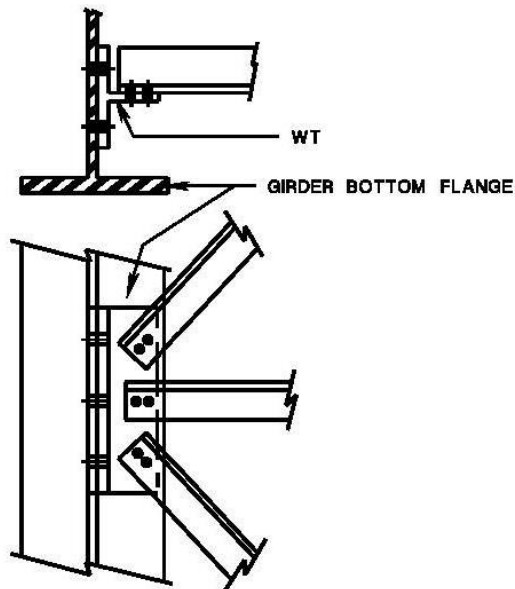
LATERAL BRACING DETAILS

ISSUED: 2016

PLATE  
3.9-16

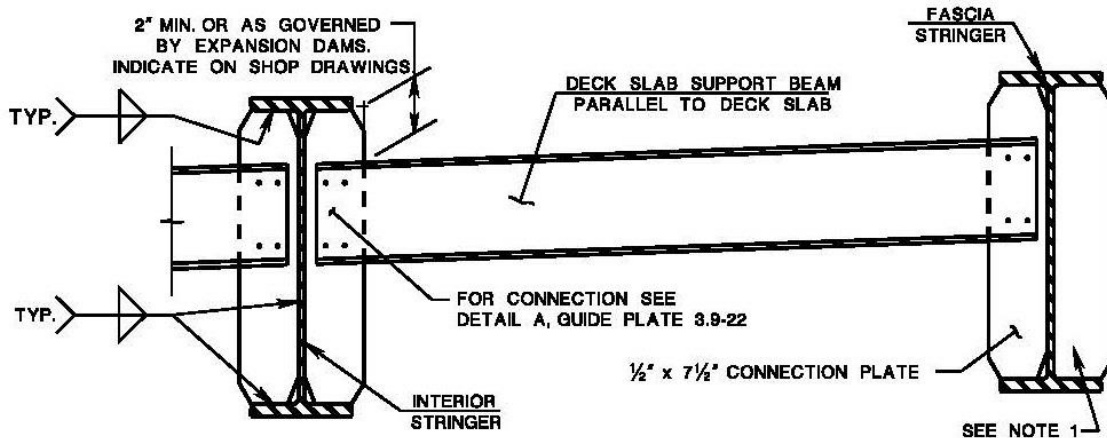


**BOLTED ATTACHMENT**  
(CATEGORY B )

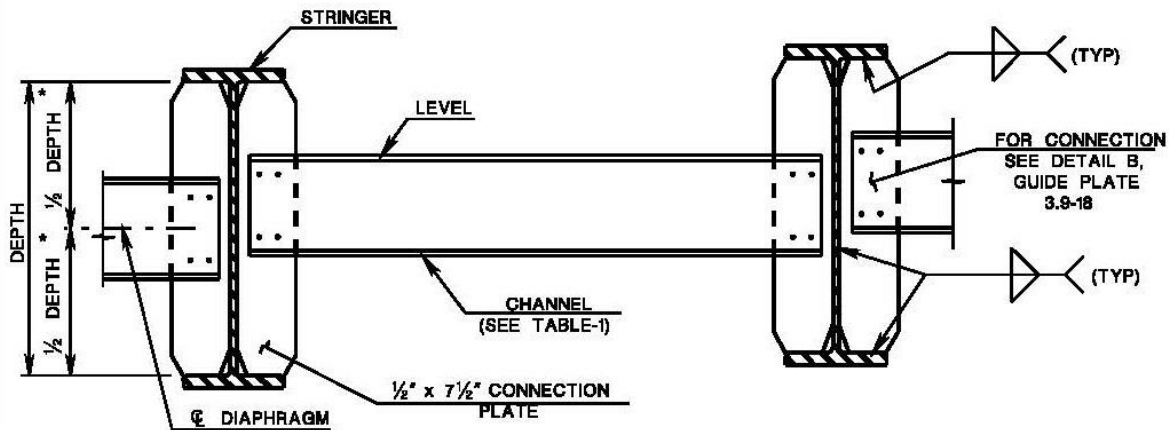


**ALTERNATE BOLTED ATTACHMENT**  
(CATEGORY B)

|  |                     |                         |
|--|---------------------|-------------------------|
| <b>ROLLED BEAM<br/>INTERMEDIATE DIAPHRAGM DETAILS<br/>(SHEET 1 OF 2)</b> | <b>ISSUED: 2016</b> | <b>PLATE<br/>3.9-17</b> |
|--|---------------------|-------------------------|



**END DIAPHRAGM**  
FOR ROLLED SECTIONS



\* - WHEREVER POSSIBLE

**INTERMEDIATE DIAPHRAGM**

FOR ROLLED SECTIONS  
(SEE NOTE 2)

**TABLE-1**

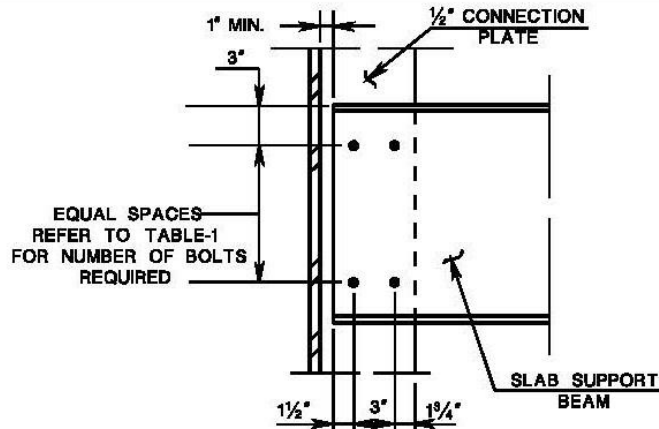
| STRINGER SIZE     | DIAPHRAGM SIZE | NO. OF BOLTS |
|-------------------|----------------|--------------|
| ➤ 2'-3" DEPTH     | C 16x33.9      | 8            |
| UP TO 2'-0" DEPTH | C 12x25        | 6            |

**NOTES:**

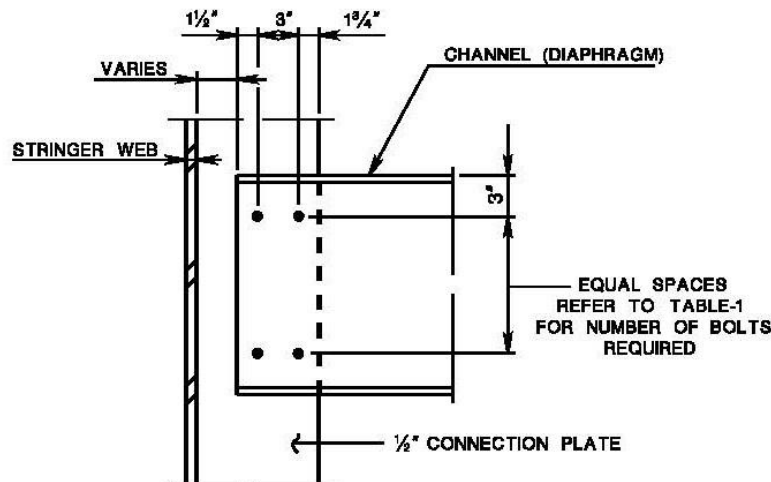
1. PROVIDE CONNECTION PLATE ON THE OUTSIDE FACE ALSO FOR TWO OR THREE GIRDER SYSTEMS.
2. INTERMEDIATE DIAPHRAGMS DETAILED ON GUIDE PLATE 3.9-11 ARE AN ACCEPTABLE ALTERNATE.



|  |                     |                         |
|--|---------------------|-------------------------|
| <b>ROLLED BEAM<br/>INTERMEDIATE DIAPHRAGM DETAILS<br/>(SHEET 2 OF 2)</b> | <b>ISSUED: 2016</b> | <b>PLATE<br/>3.9-18</b> |
|--|---------------------|-------------------------|



**DETAIL-A**  
END DIAPHRAGM  
(SEE NOTES 1 & 2)



**DETAIL B**  
INTERMEDIATE DIAPHRAGM  
(SEE NOTE 1)

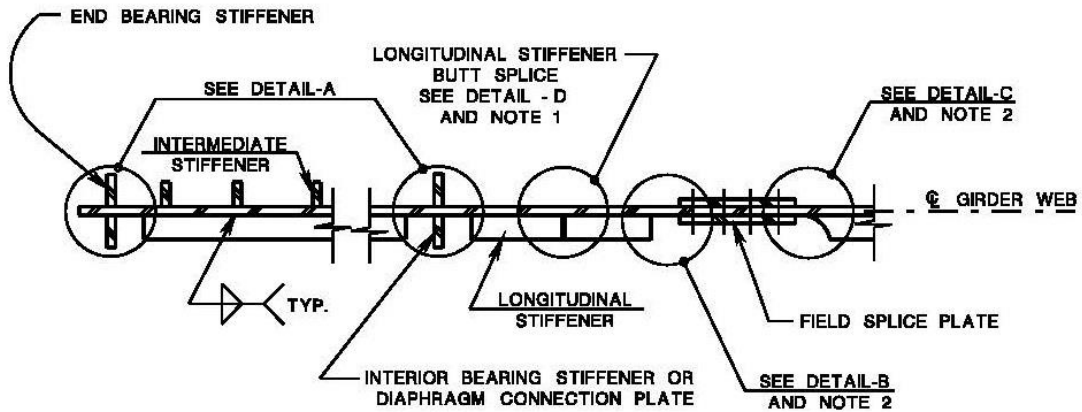
**TABLE-1**

| STRINGER SIZE     | DIAPHRAGM SIZE | NO. OF BOLTS |
|-------------------|----------------|--------------|
| ➤ 2'-3" DEPTH     | C 15x33.8      | 8            |
| UP TO 2'-0" DEPTH | C 12x25        | 6            |

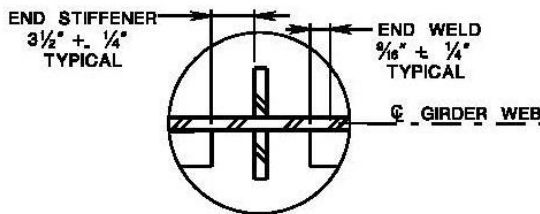
**NOTES:**

1. 1/16" DIAMETER HOLE IN CONNECTION PLATE; 1/8" DIAMETER HOLE IN CONNECTING MEMBER FOR 3/8" DIAMETER ASTM A325 BOLTS. STD. SIZE HOLES ARE PERMITTED.
2. USE 3/8" DIAMETER ASTM A325 BOLTS HAVING AN UNTHREADED SHANK OF SUFFICIENT LENGTH TO NOT ALLOW ANY THREADS TO EXIST IN THE PLANE BETWEEN THE TWO CONNECTED PARTS (SHEAR PLANE).

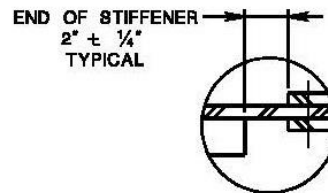
|   |                     |                         |
|---|---------------------|-------------------------|
| <b>LONGITUDINAL/TRANSVERSE STIFFENER<br/>INTERSECTION DETAILS</b> | <b>ISSUED: 2016</b> | <b>PLATE<br/>3.9-19</b> |
|---|---------------------|-------------------------|



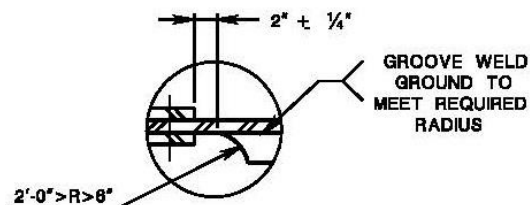
**PLAN VIEW**



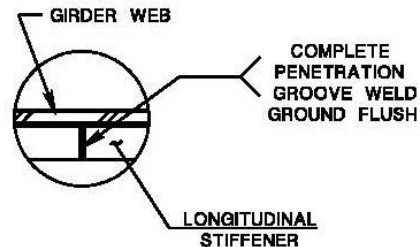
**DETAIL-A**



**DETAIL-B**



**DETAIL-C**



**DETAIL-D  
(SEE NOTE 1)**

**NOTES:**

1. PERFORM NON-DESTRUCTIVE TESTING ON LONGITUDINAL STIFFENER BUTT WELDS PRIOR TO ATTACHMENT TO GIRDER.
2. USE DETAIL-C. DETAILS A AND B ARE APPLICABLE ONLY IN THE COMPRESSION ZONE. THERE SHALL BE NO CATEGORY D, E, OR E' DETAILS IN TENSION ZONE.

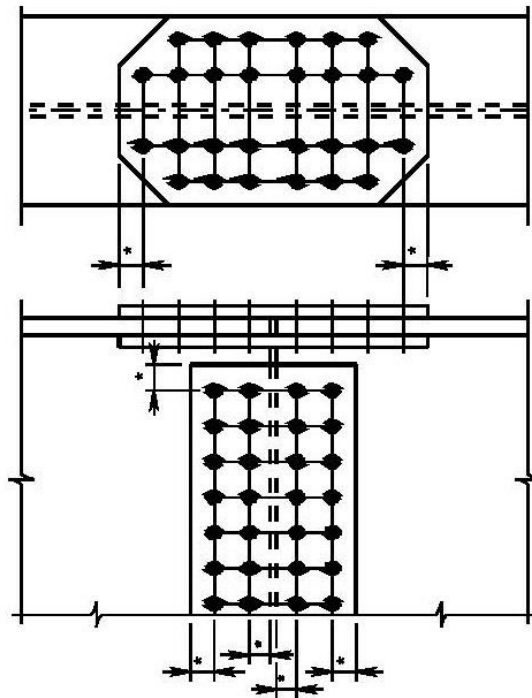
MAIN MEMBER EDGE DISTANCE

ISSUED: 2016

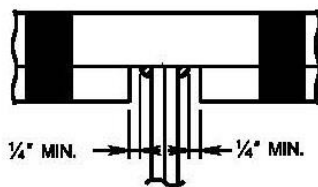
PLATE  
3.9-20

**NOTE**

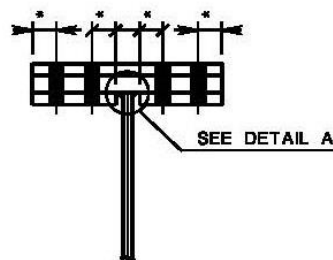
EDGES NOTED THUS: \* TO BE 1 3/4" FOR 3/8" DIA. BOLTS & 2" FOR 1" DIA. BOLTS



**TYPICAL FIELD SPLICE**



**DETAIL A**

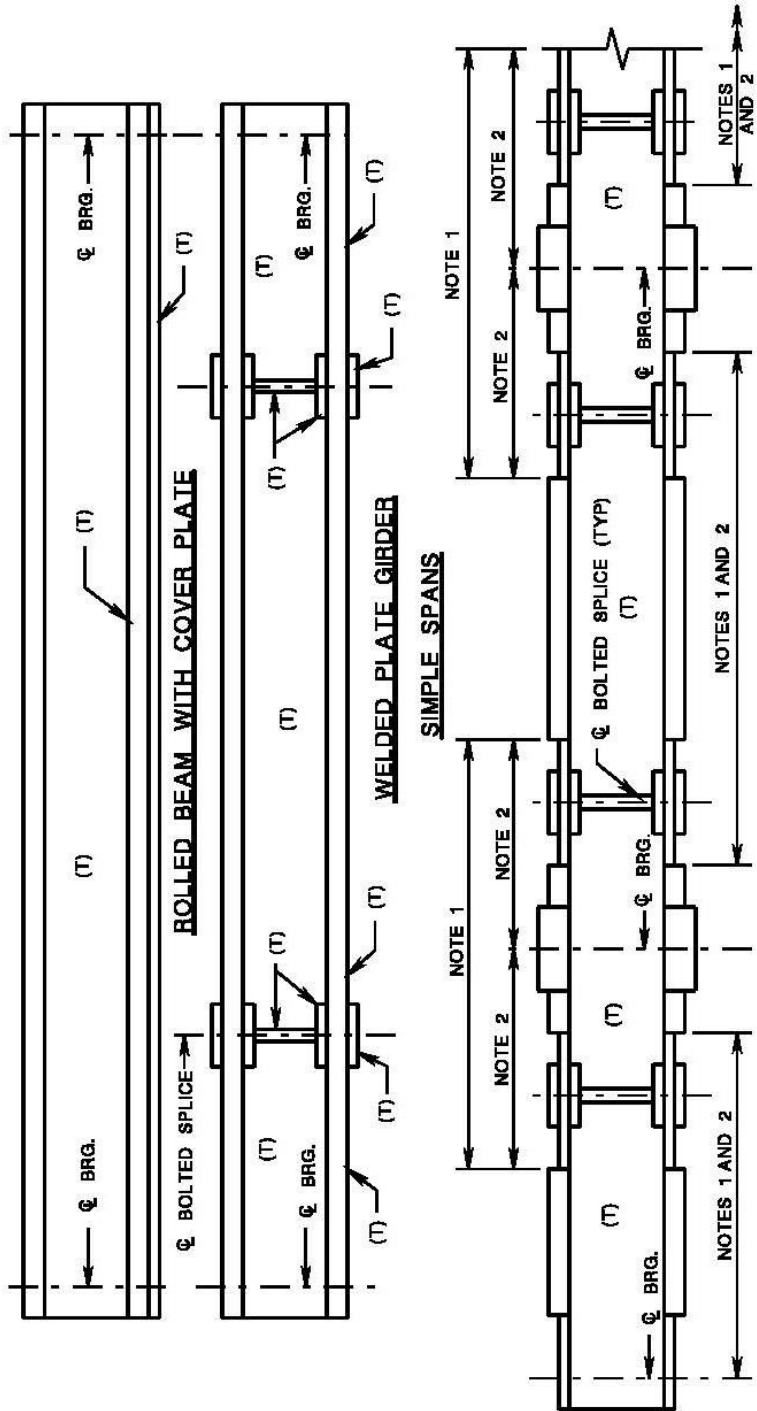


**NOTE**

ALL MAIN LOAD CARRYING CONNECTIONS SHOULD BE DESIGNED WITH A MINIMUM OF 1/4" (1/4" PREFERRED) ADDITIONAL EDGE DISTANCE BEYOND THE AASHTO MINIMUM REQUIREMENTS. THIS WILL PROVIDE A TOLERANCE FOR PUNCHING, DRILLING & REAMING.

|   |                     |                         |
|---|---------------------|-------------------------|
| <b>TOUGHNESS REQUIREMENTS,<br/>CHARPY V-NOTCH TESTS</b> | <b>ISSUED: 2016</b> | <b>PLATE<br/>3.9-21</b> |
|---|---------------------|-------------------------|

REFERENCE SUBSECTION 24.2.4 AND 24.2.5 OF THIS MANUAL AND NJDOT STANDARD SPECIFICATIONS.



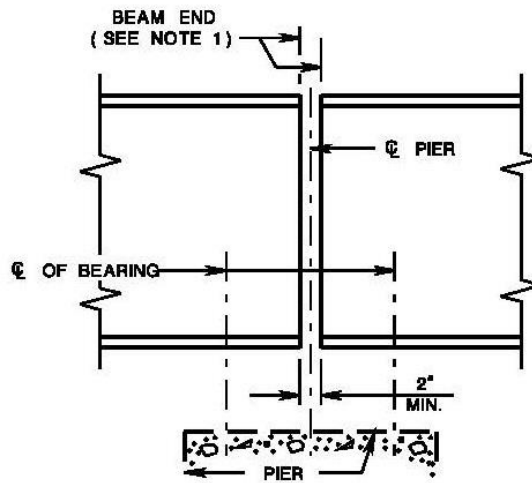
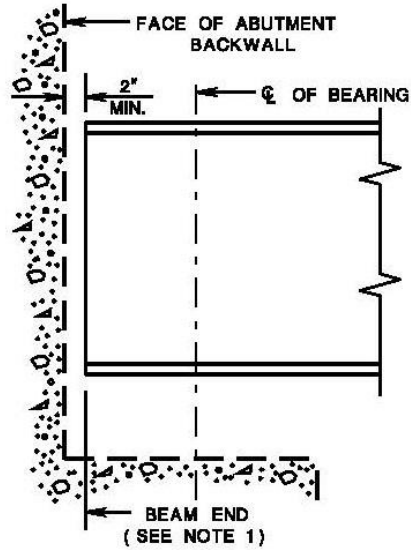
**NOTES:**

1. (T) DESIGNATION SHALL BE SHOWN FOR ALL TOP OR BOTTOM FLANGE PLATES, WEB PLATES, WEB SPLICE PLATES AND TOP OR BOTTOM FLANGE SPLICE PLATES WITHIN THESE LIMITS THAT ARE UNDER TENSION FROM D.L., OR L.L. OR BOTH. WHEN AN OPTIONAL BOLTED FIELD SPLICE IS SHOWN ON THE PLANS IN THIS AREA, ADD: "IF THE OPTIONAL BOLTED FIELD SPLICE IS NOT USED, TOUGHNESS REQUIREMENTS SPECIFIED ARE MANDATORY FOR THE TOP FLANGE PLATE."
2. DESIGNER SHALL FURNISH DIMENSIONS AT THESE LOCATIONS TO DEFINE TENSION LIMITS.

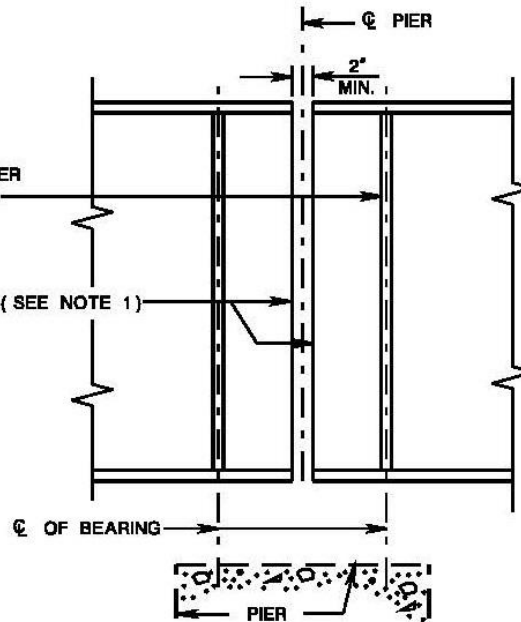
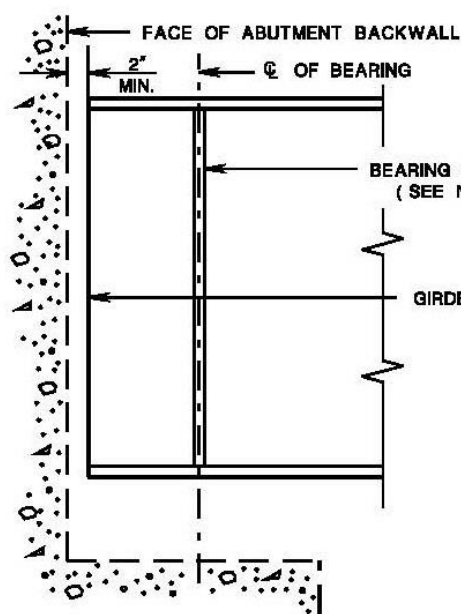
FASCIA BEAM END CLEARANCES

ISSUED: 2016

PLATE  
3.9-22



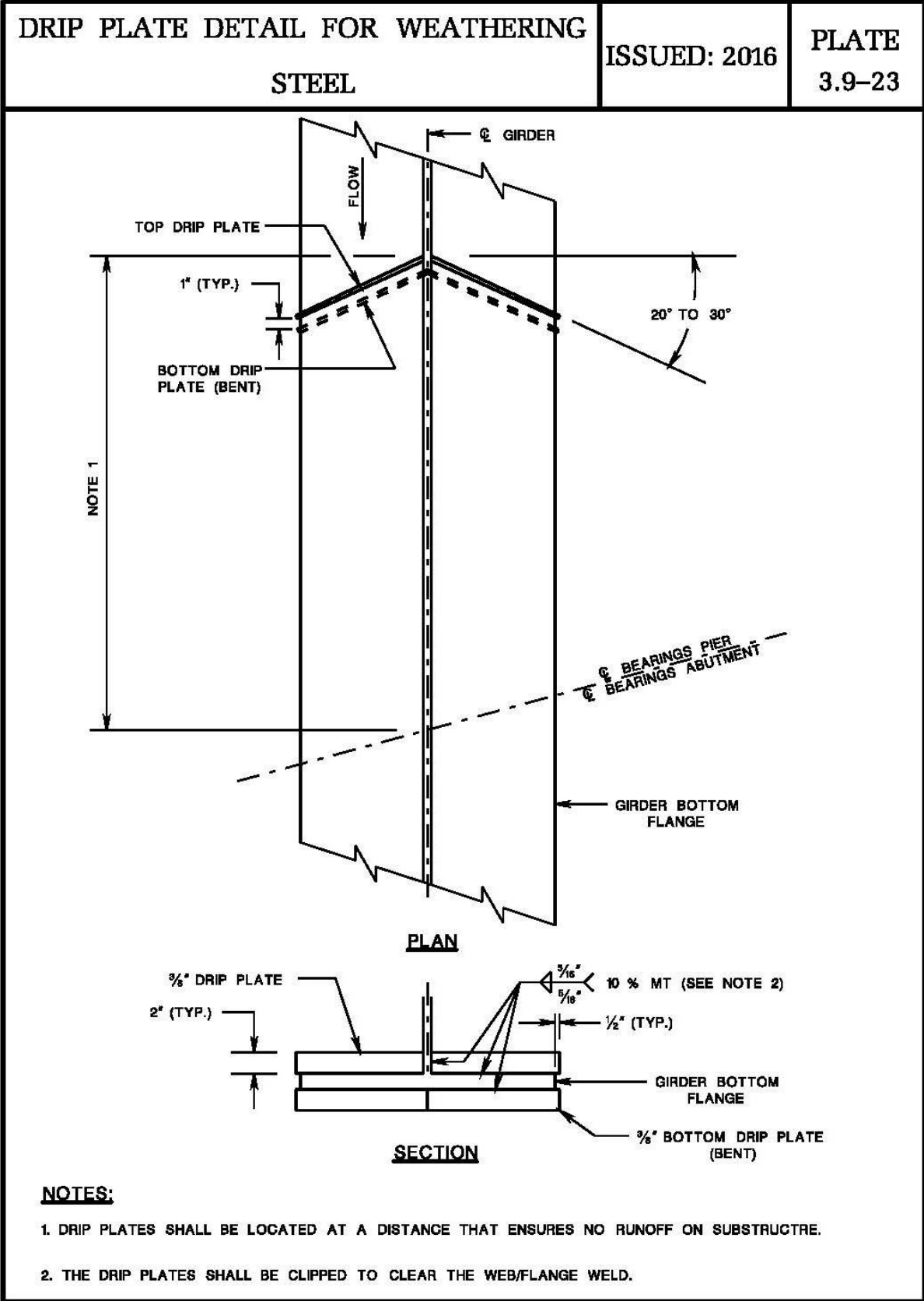
**ROLLED BEAMS**



**WELDED GIRDERS**

**NOTES:**

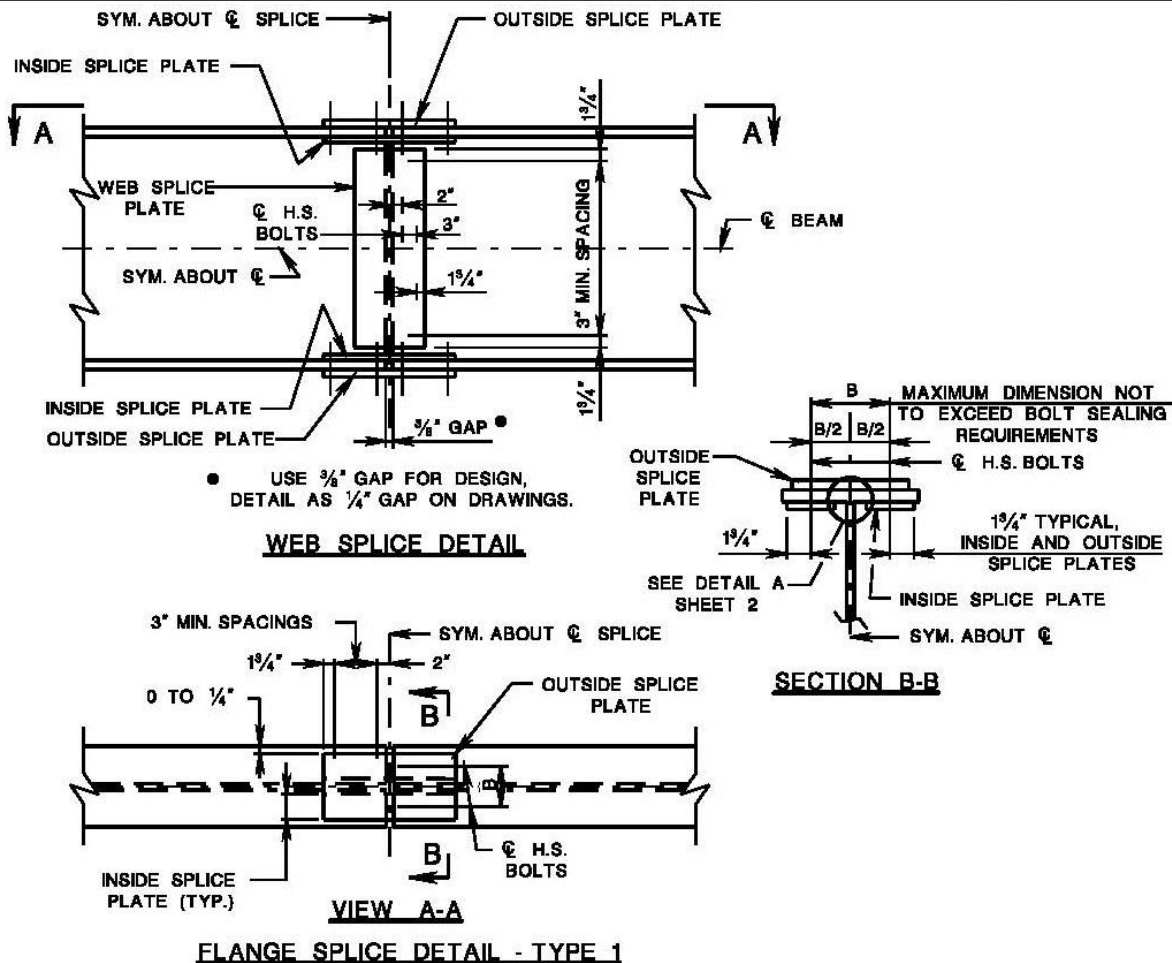
1. BEAM ENDS, GIRDER ENDS AND BEARING STIFFENERS SHALL BE NORMAL TO FLANGE.
2. FOR PRESTRESSED BEAMS, PROVIDE MINIMUM CLEARANCE OF 4" BETWEEN BEAM END AND ABUTMENT BACKWALL AND 3" BETWEEN BEAM ENDS AT PIER LOCATIONS.



**BOLTED FIELD SPLICE DETAILS**  
(SHEET 1 OF 2)

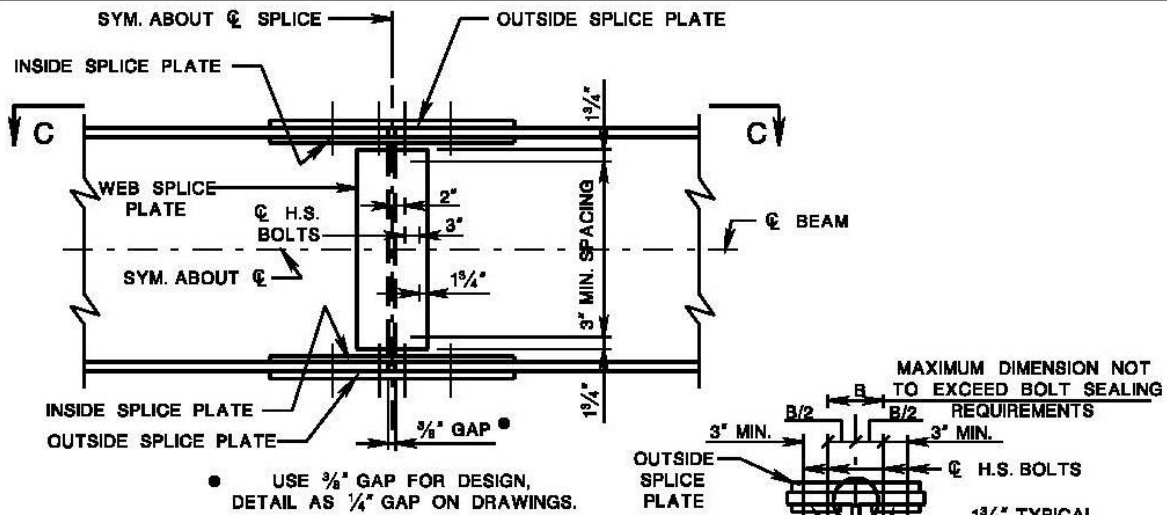
ISSUED: 2016

PLATE  
3.9-24

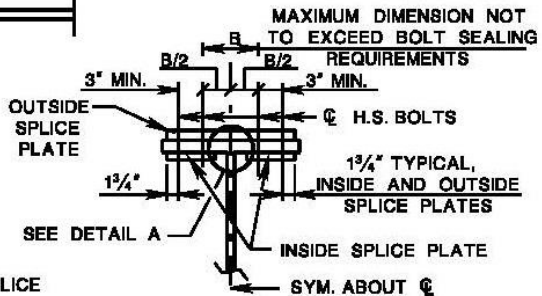
**NOTES:**

1. DETAILS SHOWN ARE FOR  $\frac{7}{8}$ " DIAMETER HIGH STRENGTH BOLTS.
2. BOLT SPACINGS SHOWN ARE PREFERRED MINIMUMS.
3. EDGE DISTANCES SHOWN ARE MINIMUMS BASED ON SHEARED OR GAS CUT EDGES PLUS AN ADDITIONAL  $\frac{1}{4}$ " CLEARANCE TO PROVIDE A TOLERANCE FOR PUNCHING, DRILLING AND REAMING.
4. FOR THE MINIMUM EDGE DISTANCES, THE BEARING CAPACITY OF THE WEB PLATE, ESPECIALLY THIN WEB PLATES, MAY BE SIGNIFICANTLY LESS THAN THE BOLT SHEAR CAPACITY RESULTING IN THE PLATE BEARING CAPACITY CONTROLLING THE DESIGN. THE DESIGNER SHOULD ADJUST THE WEB EDGE DISTANCES, INCREASING THE PLATE BEARING CAPACITY, TO MINIMIZE THE NUMBER OF GAGE LINES OF WEB BOLTS. THE DESIGNER SHOULD INCREASE THE WEB EDGE DISTANCE TO OBTAIN A DESIGN WITH THE TYPICAL 2 OR 3 ROWS OF WEB SPLICE BOLTS.
5. DESIGNER TO VERIFY INSTALLATION CLEARANCES AS ILLUSTRATED IN AISC MANUAL OF STEEL CONSTRUCTION.
6. DESIGNER TO INDICATE WHETHER OR NOT THE BOLTS ARE DESIGNED FOR THREADS EXCLUDED FROM SHEAR PLANE.
7. CAPACITY OF COMPONENT SPLICE PLATE TO EQUAL CAPACITY OF COMPONENT. COMPONENT BEING TOP FLANGE, WEB OR BOTTOM FLANGE.
8. CHECK GIRDER CAPACITY FOR REDUCTION DUE TO BOLT HOLES IN THE TENSION FLANGE USING THE EFFECTIVE NET AREA.
9. THE EFFECTIVE COMPRESSION FLANGE AREA SHALL BE TAKEN EQUAL TO THE GROSS AREA OF THE COMPRESSION FLANGE.
10. DESIGNER TO VERIFY THAT BOLT SPACINGS FOR FLANGE SPLICES AND WEB SPLICES DO NOT EXCEED BOLT SPACING REQUIREMENTS.

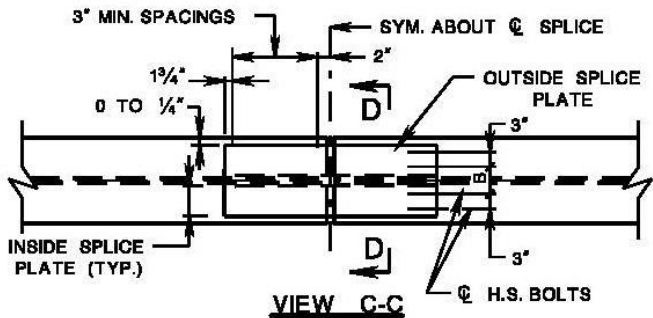
|  |                     |                               |
|--|---------------------|-------------------------------|
| <b>BOLTED FIELD SPLICE DETAILS</b><br>(SHEET 2 OF 2) | <b>ISSUED: 2016</b> | <b>PLATE</b><br><b>3.9-25</b> |
|--|---------------------|-------------------------------|



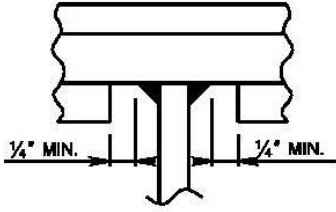
**WEB SPLICE DETAIL**



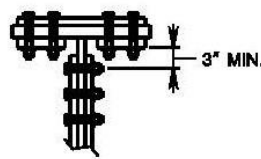
**SECTION D-D**



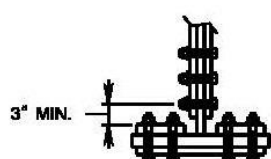
**FLANGE SPLICE DETAIL - TYPE 2**



**DETAIL A**

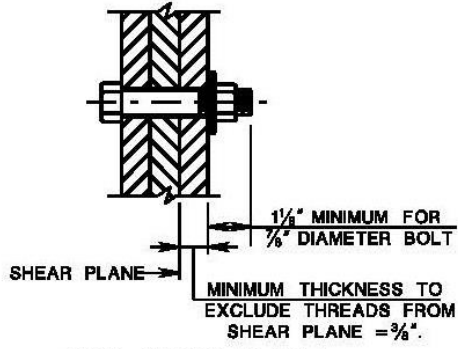


**TOP FLANGE**



**BOTTOM FLANGE**

**7/8" DIAMETER BOLT CENTERING AND TIGHTENING CLEARANCES**



**BOLT SHEAR PLANE**  
MINIMUM PLATE THICKNESS IS 3/8 inch.

**NOTE:**  
BASED ON 1 1/2 inch THREAD LENGTH FOR 7/8 inch DIAMETER BOLT

**NOTE:**  
SEE SHEET 1 FOR GENERAL NOTES.

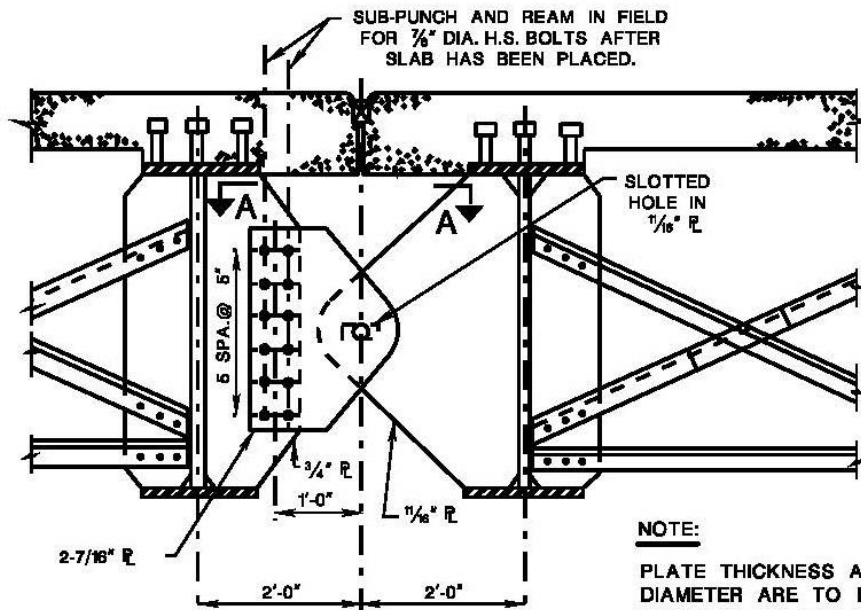


| <p style="text-align: center;"><b>STRUCTURAL STEEL NOTES</b></p> <p style="text-align: center;"><b>TO BE SHOWN ON CONTRACT PLANS</b></p>  | <p style="text-align: center;"><b>ISSUED: 2016</b></p> | <p style="text-align: center;"><b>PLATE</b></p> <p style="text-align: center;"><b>3.9-26</b></p> |
|---|--|--|
| <p>1. WELDING SHALL CONFORM TO THE CURRENT AASHTO/AWS D1.5 WELDING CODE WITH NJDOT AMENDMENTS. WELDING AND NONDESTRUCTIVE TESTING SYMBOLS SHALL CONFORM TO AWS A2.4 SYMBOLS FOR WELDING, BRAZING AND NONDESTRUCTIVE EXAMINATION.</p> <p>2. JOINT WELDING PROCEDURES, OVERALL FABRICATION METHODS, AND QUALITY CONTROL INSPECTION PROCEDURE SHALL BE INCLUDED AS WRITTEN PROCEDURE SPECIFICATIONS WITH THE SHOP PLAN SUBMISSION.</p> <p>3. FLANGE AND WEB SHOP SPLICES SHALL BE LOCATED WHERE SHOWN ON PLANS. MINOR CHANGES IN LOCATION, TOGETHER WITH ANY ADDITIONAL SPLICES REQUESTED, SHALL BE SUBJECT TO THE APPROVAL OF THE ENGINEER. LENGTHS OF PLATES SHALL BE CONSISTENT WITH LENGTHS OF PLATES AVAILABLE FROM THE MILL. LOCATION SHALL BE AT POINTS OF REDUCED TENSILE STRESS. WEB SPLICES SHALL BE AT LEAST 12' FROM FLANGE SPLICES AND/OR TRANSVERSE INTERMEDIATE STIFFENER AND/OR CONNECTION PLATES FOR DIAPHRAGMS.</p> <p>4. WHEN FLANGES ARE DETAILED ON THE CONTRACT PLANS AS A SERIES OF VARYING THICKNESS PLATES, THE CONTRACTOR MAY, FOR THE PURPOSE OF ELIMINATING BUTT WELDS, EXTEND THE LENGTH OF THE THICKER PLATE TO THE END OF THE NEXT THINNER PLATE OR TO THE END OF THE MEMBER, PROVIDED THE MAXIMUM PLATE THICKNESS DOES NOT EXCEED 1.5 TIMES THE THICKNESS OF THE THINNER PLATE PLUS <math>\frac{3}{8}</math>", SUBJECT TO APPROVAL BY THE ENGINEER. IF THE CONTRACTOR INCREASES THE THICKNESS OF THE BOTTOM FLANGE PLATE AT A BEARING LOCATION, HE SHALL MAINTAIN THE ORIGINAL GIRDER ELEVATION BY MAKING SUITABLE CHANGES IN THE ELEVATION OF THE CONCRETE MASONRY.</p> <p>5. ALLOWANCES SHALL BE MADE IN THE SHOP FOR SHRINKAGE DUE TO WELDING AND BURNING. IF UNEVEN SHRINKAGE IS ANTICIPATED, CAMBER ORDINATES SHALL BE ADJUSTED ACCORDINGLY.</p> <p>6. FLANGE AND WEB SHOP SPLICES ARE TO BE COMPLETED AND WELDMENTS INSPECTED BEFORE FITTING AND WELDING FLANGES TO WEBS. FABRICATION METHODS WHICH MAY BE REQUIRED FOR SPECIAL CONDITIONS, SHALL BE INCLUDED IN THE WRITTEN WELDING AND PROCEDURE SPECIFICATIONS OF THE SHOP PLANS.</p> |  |  |

**SHEAR LOCK AT LONGITUDINAL  
OPEN JOINTS IN DECK SLAB**

**ISSUED: 2016**

**PLATE  
3.9-27**

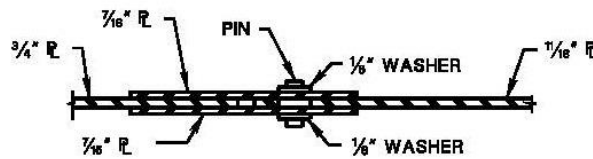


**NOTE:**

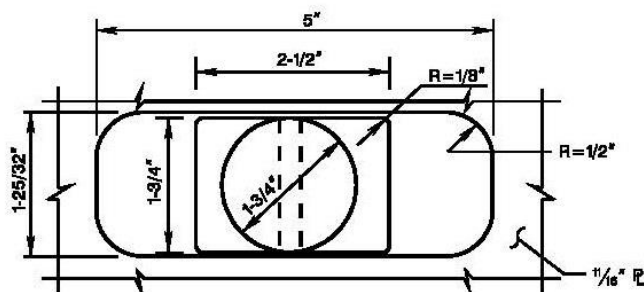
PLATE THICKNESS AND PIN DIAMETER ARE TO BE AS REQUIRED BY DESIGN.

**ELEVATION**

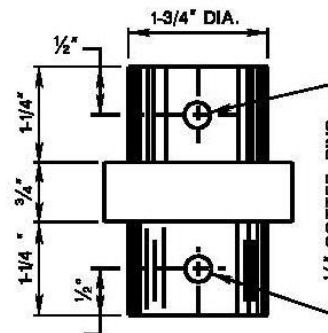
INCLUDE IN QUANTITY OF STRUCTURAL STEEL



**SECTION A - A**



**SLOTTED HOLE DETAIL**

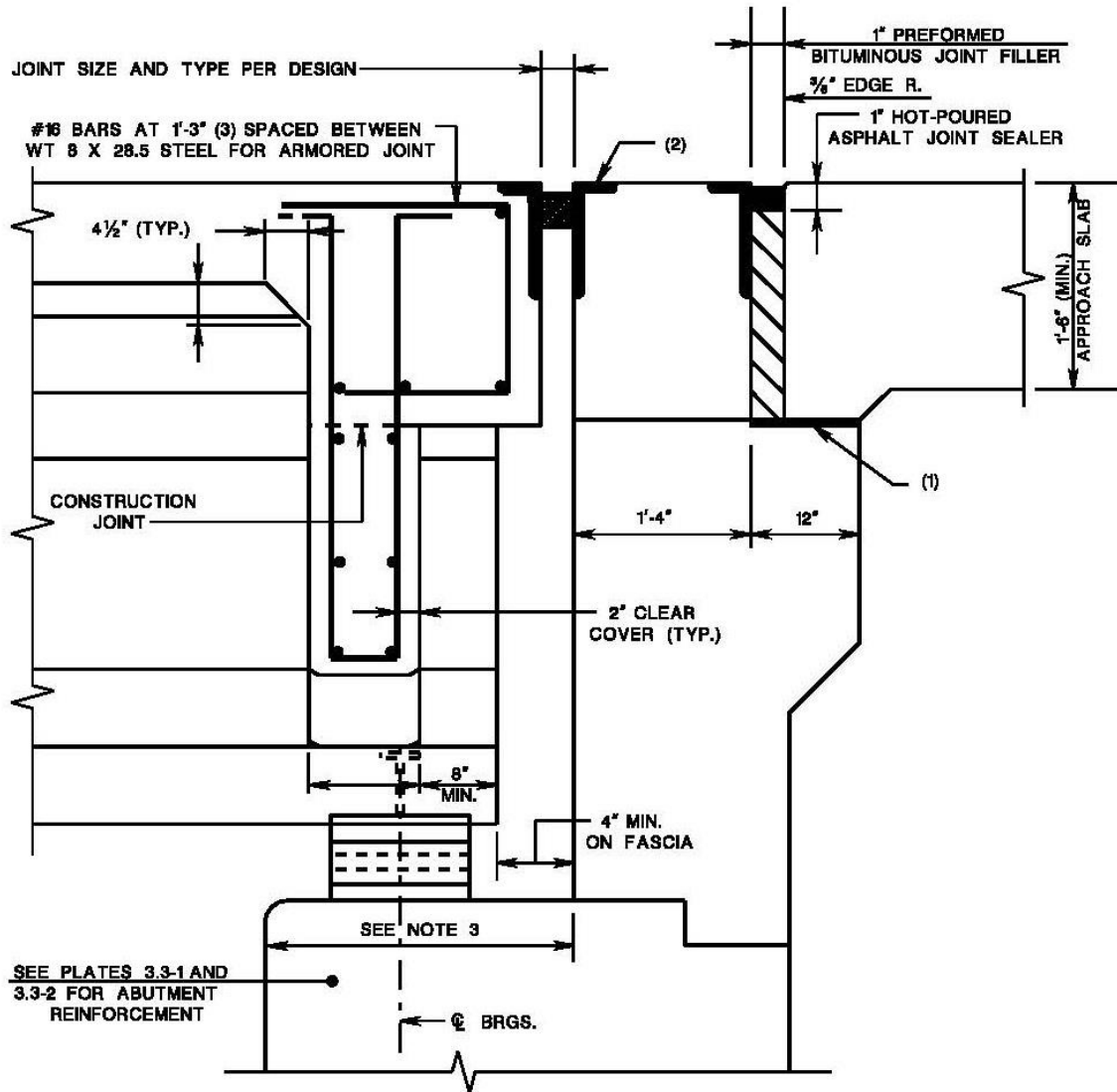


**DETAIL OF PIN**

SECTION AT ABUTMENT, PC I-BEAMS

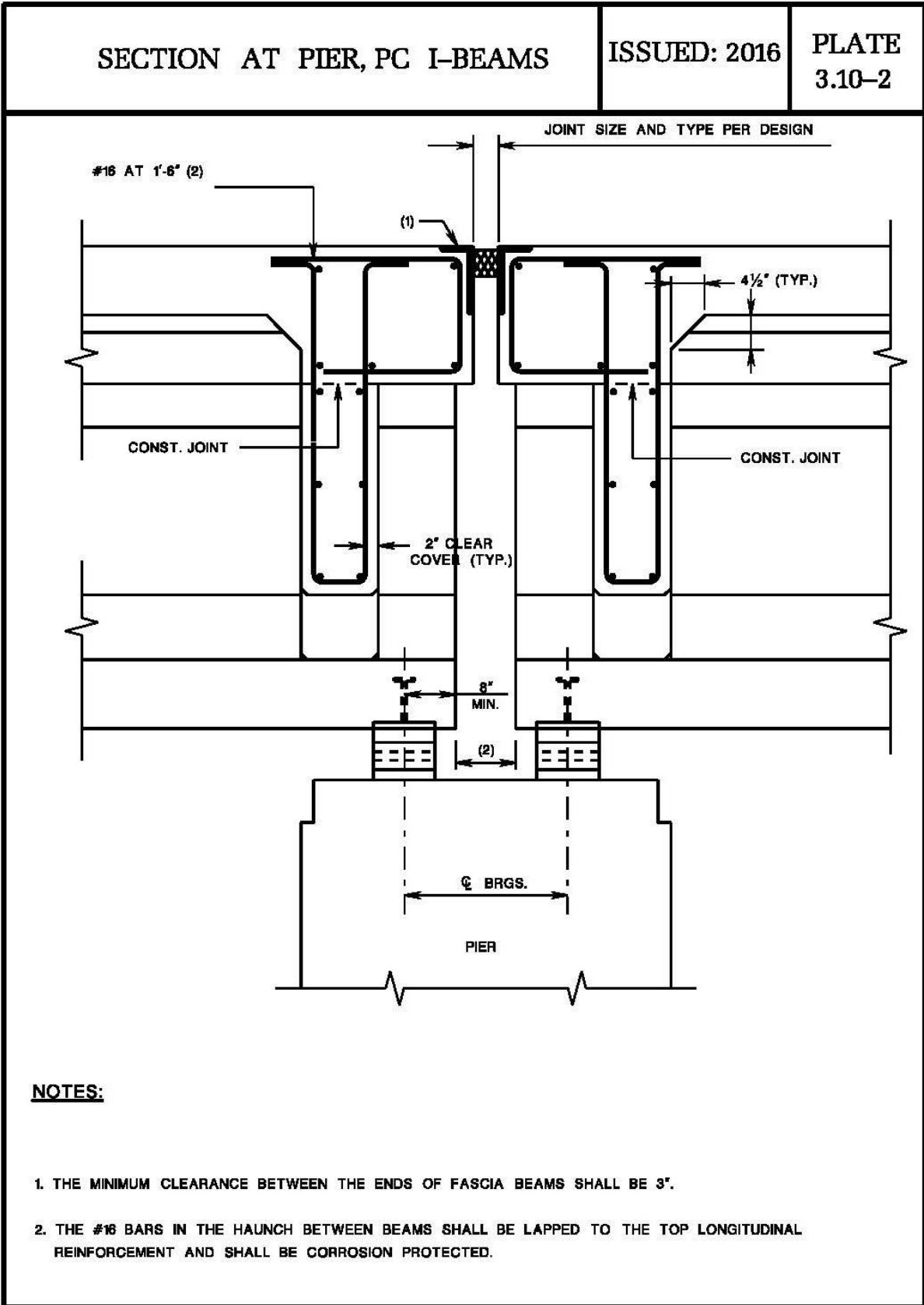
ISSUED: 2016

PLATE  
3.10-1

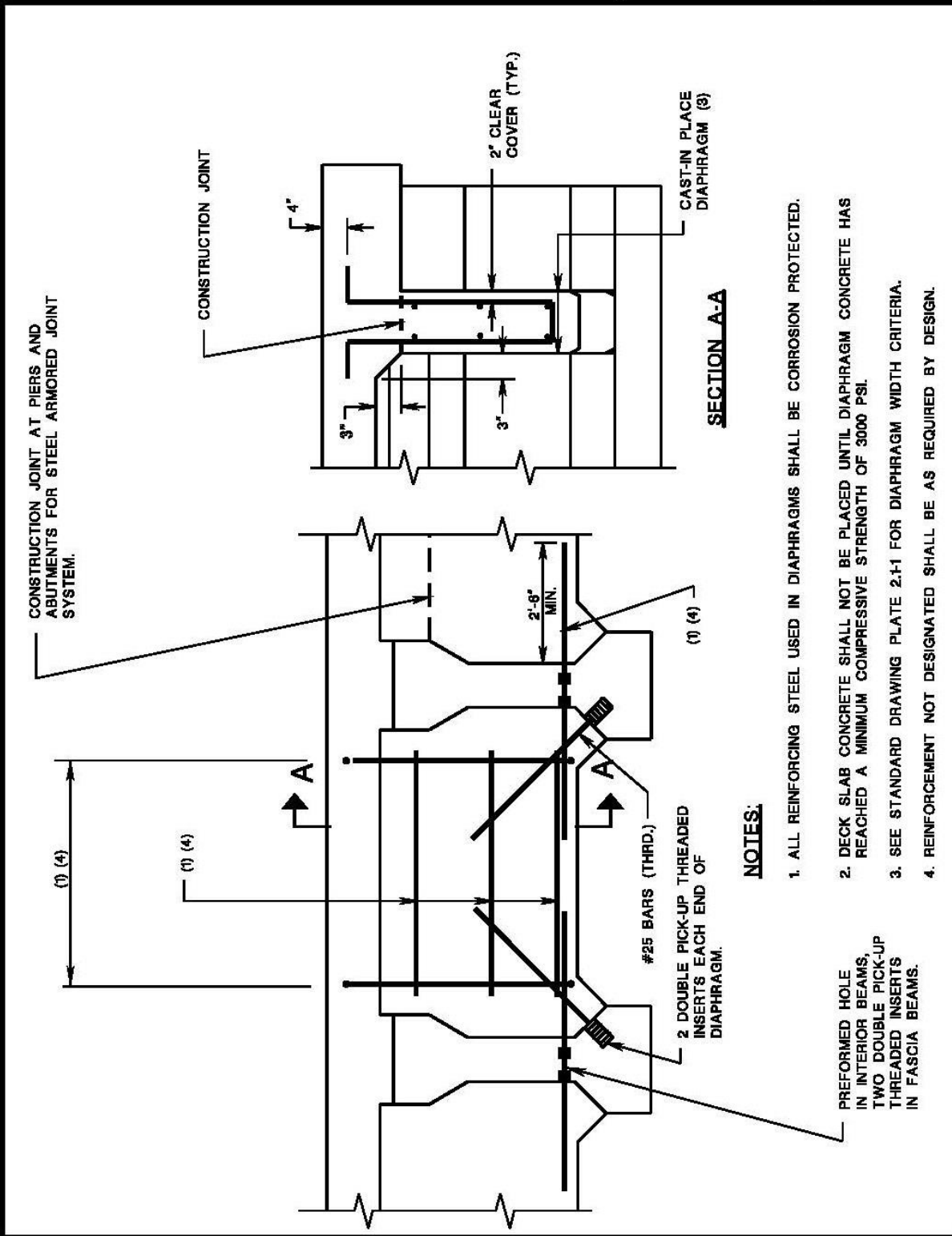


**NOTES:**

1. A 1/4" THICK PIECE OF PREFORMED BITUMINOUS JOINT FILLER SHALL BE LAID IN AND COVERED WITH ASPHALT ROOFING CEMENT ON THE SURFACE WHERE THE APPROACH SLAB SHALL REST.
2. THE #16 REINFORCEMENT STEEL IN THE HAUNCH BETWEEN BEAMS SHALL BE LAPPED TO THE TOP LONGITUDINAL REINFORCEMENT AND SHALL BE CORROSION PROTECTED.
3. SEAT LENGTH SHALL SATISFY SEISMIC DESIGN REQUIREMENTS.



|   |                     |                         |
|---|---------------------|-------------------------|
| <b>CAST-IN-PLACE END DIAPHRAGM FOR<br/>PC I-BEAMS AT BEARINGS</b> | <b>ISSUED: 2016</b> | <b>PLATE<br/>3.10-3</b> |
|---|---------------------|-------------------------|

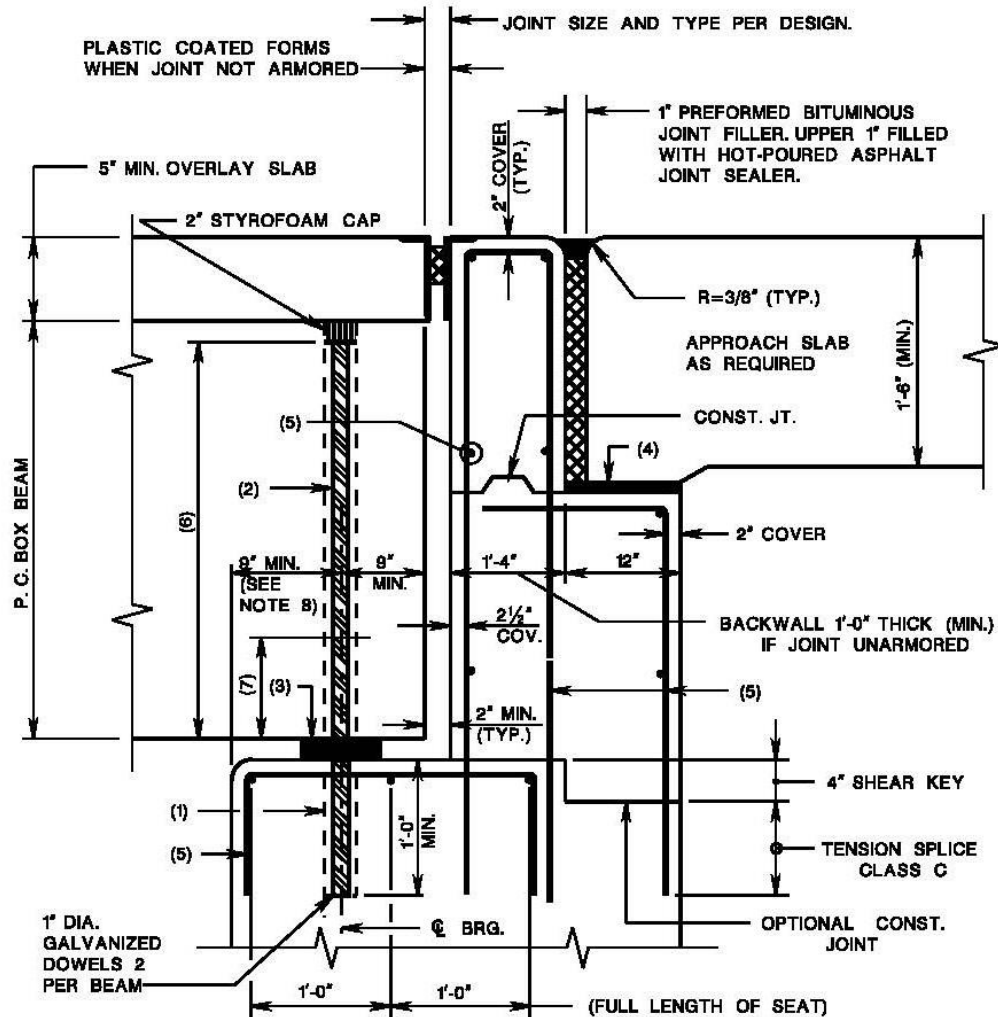


**SECTION AT ABUTMENT, PC ADJACENT  
SLAB AND BOX BEAMS**

ISSUED: 2016

PLATE  
3.10-4

NOTE: ARMORING NOT REQUIRED FOR SPANS LESS THAN 55'-0".



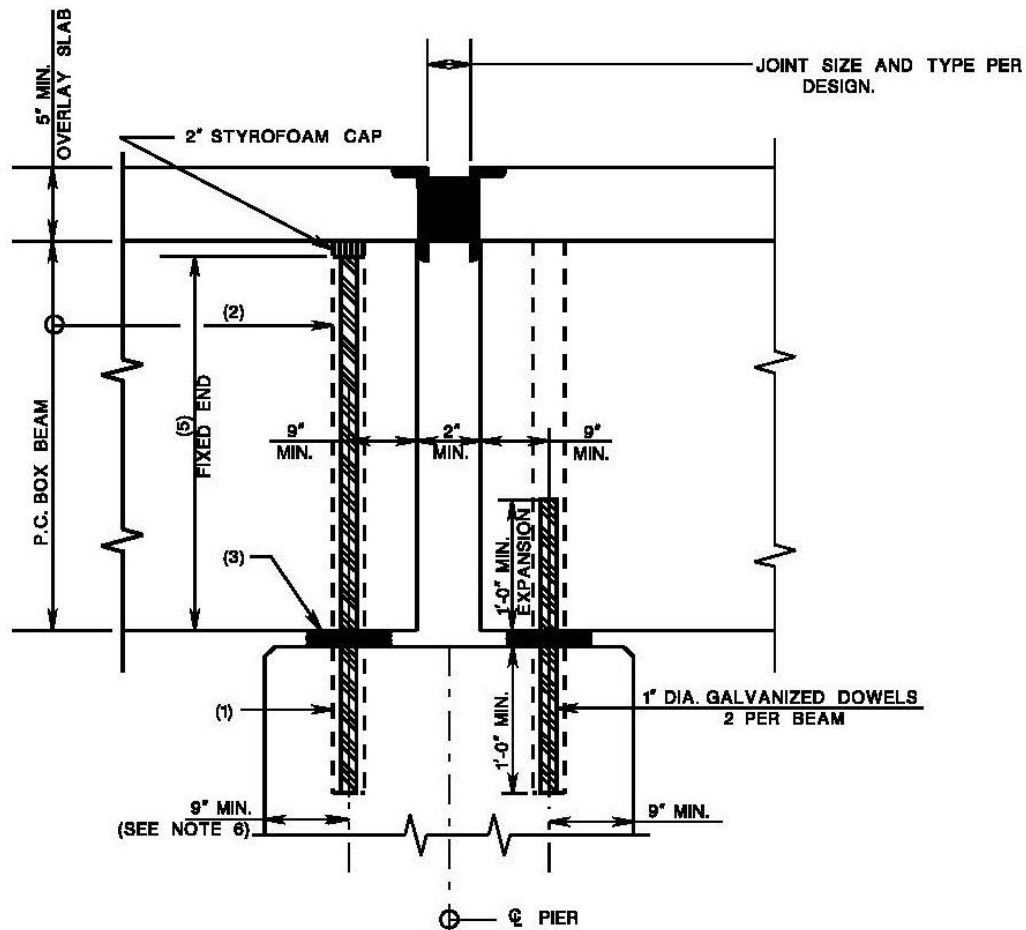
**NOTES:**

1. 2" DIA. HOLES IN ABUTMENT SEAT TO BE CORED AFTER BEAMS ARE ERECTED AND THE TRANSVERSE TIES ARE TENSIONED, FILLED WITH NON-SHRINK GROUT.
2. FILL WITH MASTIC OR HOT-POURED RUBBER ASPHALT JOINT SEALER AT THE EXPANSION BEARINGS. FILL WITH NON-SHRINK GROUT OR LOW MODULUS EPOXY MORTAR AT THE FIXED BEARINGS.
3. REFERENCE PLATE 3.10-9 FOR REINFORCED ELASTOMERIC BEARING PAD DETAILS.
4. A 1/4" THICK PIECE OF PREFORMED BITUMINOUS JOINT FILLER SHALL BE LAID IN AND COVERED WITH ASPHALT ROOFING CEMENT ON THE SURFACE WHERE THE APPROACH SLAB SHALL REST.
5. CORROSION PROTECTED REINFORCEMENT.
6. DOWELS CUT 2" TO ALLOW FOR STYROFOAM CAP FOR FIXED BEARING.
7. 1'-0" MINIMUM LENGTH FOR EXPANSION BEARING.
8. SEAT LENGTH SHALL SATISFY SEISMIC DESIGN REQUIREMENTS.

SECTION AT FIXED PIER, PC ADJACENT  
SLAB AND BOX BEAMS

ISSUED: 2016

PLATE  
3.10-5

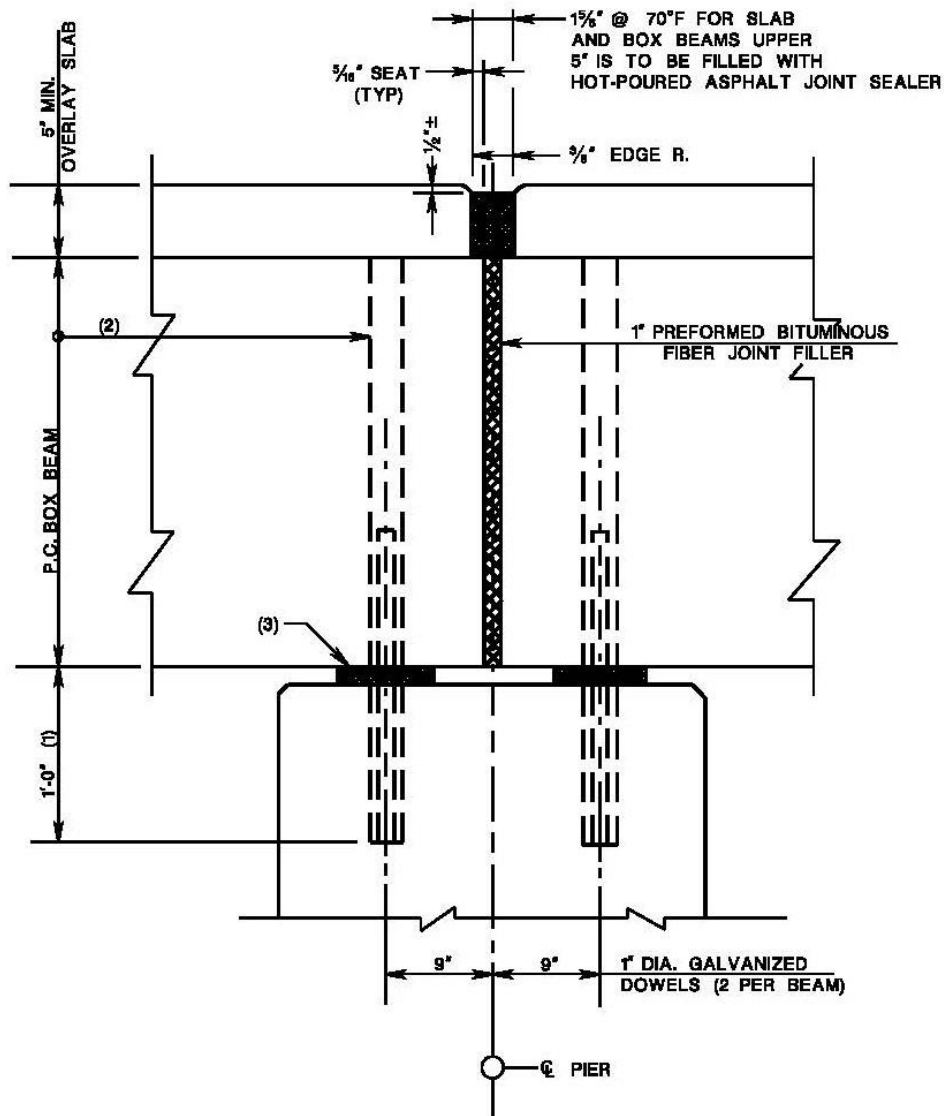
**NOTES:**

1. 2" DIA. HOLES IN PIER SEAT TO BE CORED AFTER BEAMS ARE ERECTED AND TIE RODS TIGHTENED, EXCEPT FOR RIGID FRAME AND HAMMERHEAD PIERS IN WHICH CASE ANCHOR BOLTS SHALL BE SET IN 3" DIA. SLEEVES, FILLED WITH NON-SHRINK GROUT.
2. FILL WITH MASTIC OR HOT-POURED RUBBER ASPHALT JOINT SEALER AT EXPANSION BEARINGS. FILL WITH NON-SHRINK GROUT OR LOW MODULUS EPOXY MORTAR AT FIXED BEARINGS.
3. FOR ELASTOMERIC BEARING PAD DETAILS SEE PLATE 3.10-8.
4. PIER CAP REINFORCING STEEL SHALL BE CORROSION PROTECTED.
5. DOWELS CUT 2" TO ALLOW FOR STYROFOAM CAP FOR FIXED BEARINGS.
6. SEAT LENGTH SHALL SATISFY SEISMIC DESIGN REQUIREMENTS.

SECTION AT PIER, PC ADJACENT SLAB  
AND BOX BEAMS, SPANS < 55 FEET

ISSUED: 2016

PLATE  
3.10-6

**NOTES:**

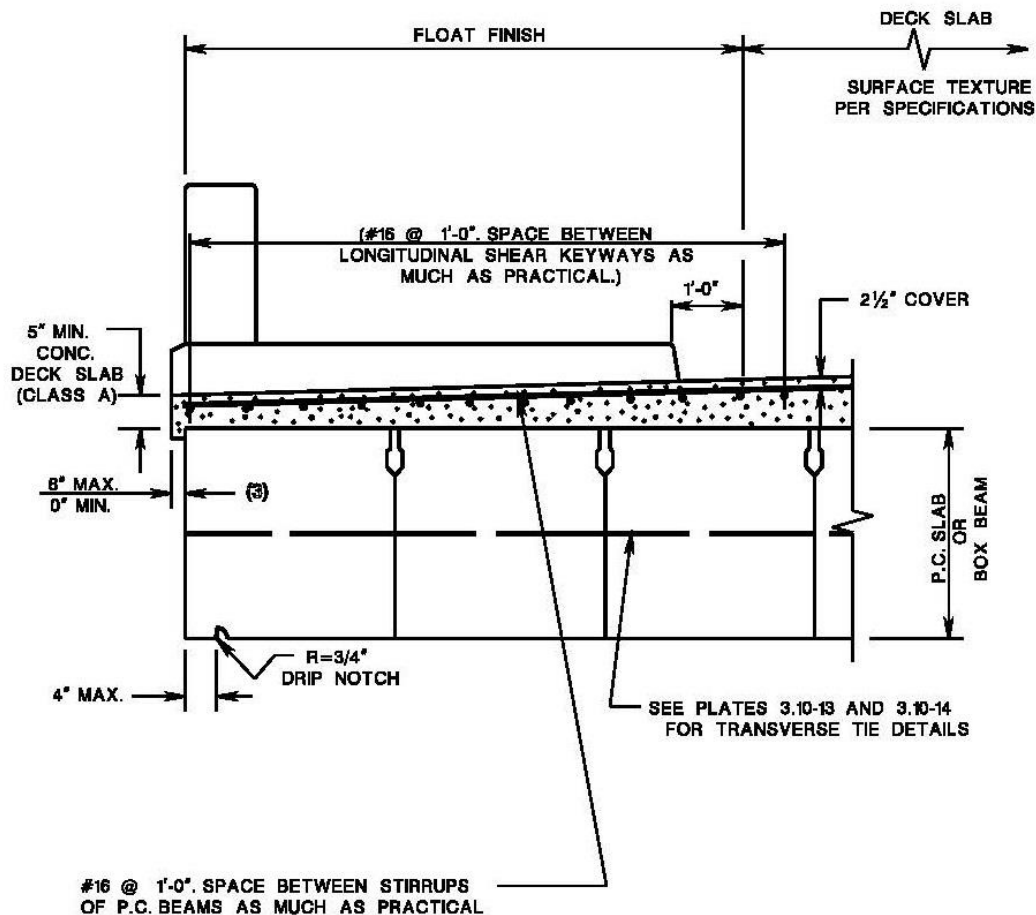
1. 2" DIA. HOLES IN ABUTMENT SEAT TO BE DRILLED OR CORED AFTER BEAMS ARE ERECTED AND TIE RODS TIGHTENED. FILL WITH NON-SHRINK GROUT.
2. FILL WITH MASTIC OR HOT-POURED RUBBER ASPHALT JOINT SEALER AT EXPANSION END. FILL WITH NON-SHRINK GROUT OR LOW MODULUS EPOXY MORTAR AT FIXED END.
3. FOR ELASTOMERIC BEARING PAD SEE PLATE 3.10-9.



PRESTRESSED CONCRETE SLAB AND  
BOX BEAMS - DECK OVERLAY DETAILS

ISSUED: 2016

PLATE  
3.10-7



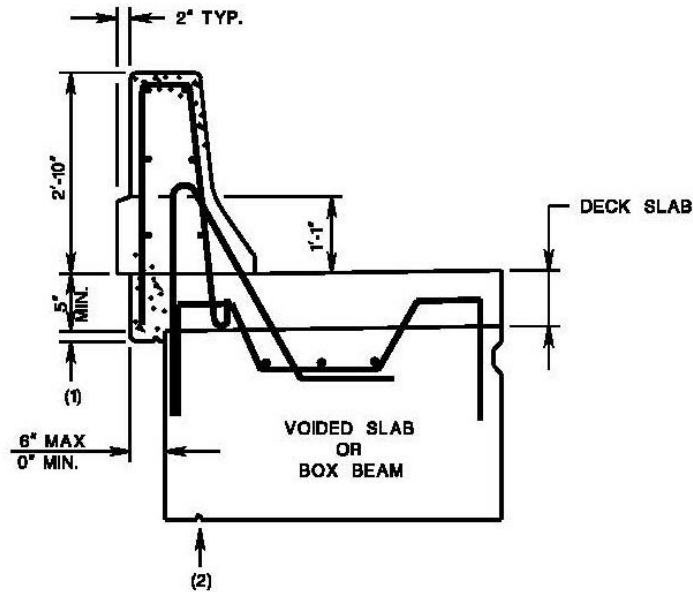
**NOTES:**

1. REFERENCE SUBSECTION 25.10 OF THIS MANUAL FOR THE APPLICATION LIMITS OF EPOXY WATERPROOFING SEAL COAT.
2. PROVIDE 3/4" DRIP NOTCH ON FASCIA BEAMS.
3. OVERHANGS LARGER THAN 6" SHALL BE APPROVED BY THE ENGINEER AT THE PRELIMINARY SUBMISSION.
4. REFERENCE PLATE 3.10-8 FOR FURTHER DETAILS.
5. ALL REINFORCING STEEL SHALL BE CORROSION PROTECTED.

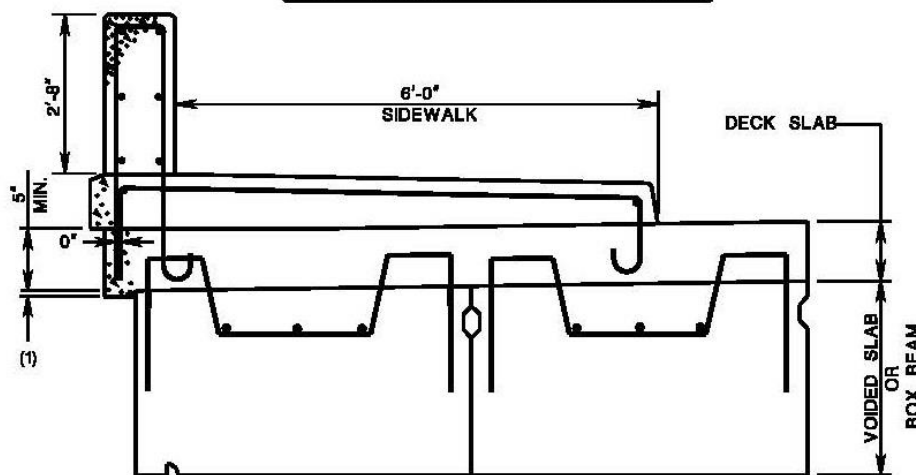
PRESTRESSED CONCRETE SLAB AND  
BOX BEAMS – PARAPET DETAILS

ISSUED: 2016

PLATE  
3.10-8



**NEW JERSEY SHAPED PARAPET**



**2'-8" PARAPET WITH SIDEWALK**

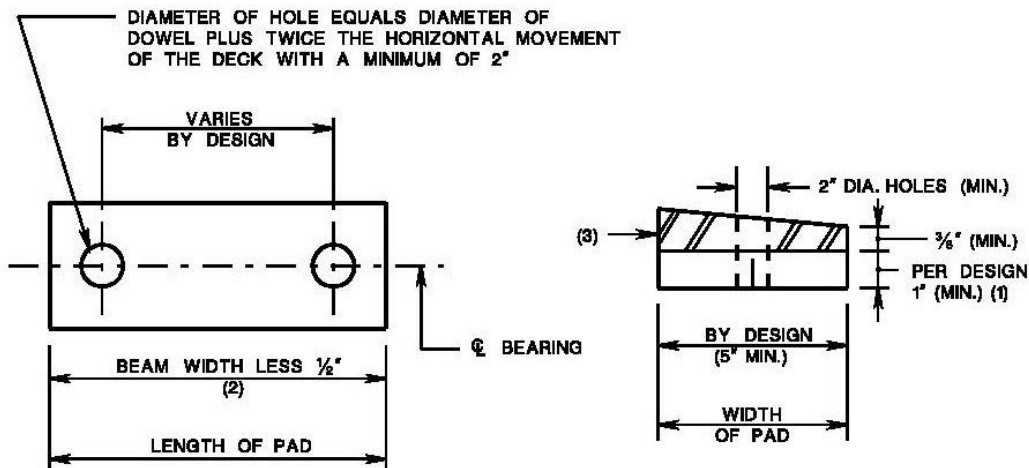
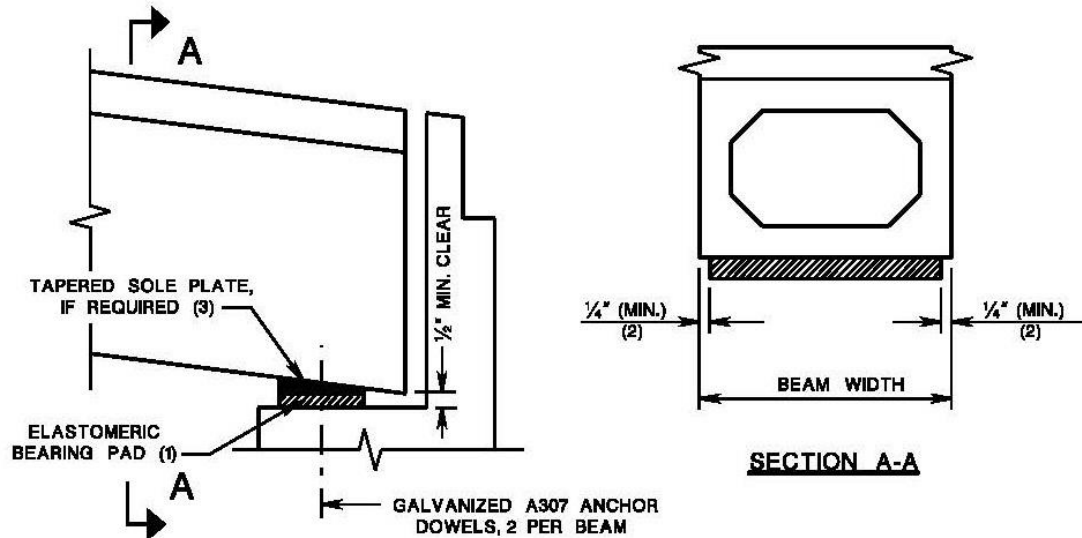
**NOTES:**

1. 1" MINIMUM THICKNESS FOR OVERHANGS GREATER THAN 3". PROVIDE  $\frac{3}{4}$ " DRIP NOTCH AS NEEDED ON UNDERSIDE FOR OVERHANGS LARGER THAN 4".
2. PROVIDE  $\frac{3}{4}$ " DRIP NOTCH ON FASCIA BEAMS.
3. PROVIDE ADEQUATE REINFORCEMENT IN SLAB OVERHANG, #10 BARS MINIMUM.
4. SEE BRIDGE CONSTRUCTION DETAILS FOR MORE DETAILS ON PARAPETS.

ELASTOMERIC BEARING PADS FOR  
PRESTRESSED CONCRETE BOX BEAMS

ISSUED: 2016

PLATE  
3.10-9

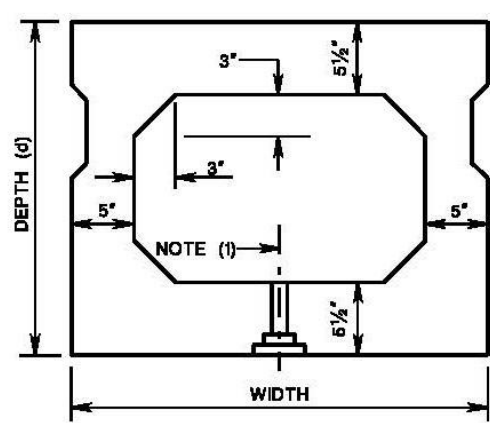


**SECTION THROUGH  
REINFORCED BEARING PAD**

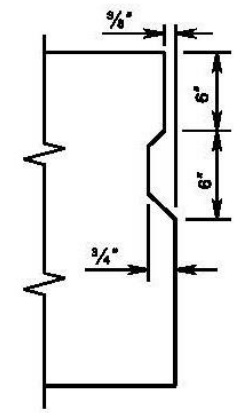
**NOTES:**

1. THE TAPERING OF ELASTOMER LAYERS IS NOT PERMITTED FOR LAMINATED (REINFORCED) ELASTOMERIC BEARING PADS. TAPERED EXTERNAL SOLE PLATES OR GROUT PADS MAY BE UTILIZED IF NECESSARY. REINFORCED ELASTOMERIC BEARING PADS SHALL BE DESIGNED IN ACCORDANCE WITH THE CURRENT AASHTO LRFD BRIDGE DESIGN SPECIFICATIONS. HOLES SHALL BE DEDUCTED WHEN COMPUTING THE SHAPE FACTOR.
2. SMALLER LENGTH BEARING PADS MAY BE UTILIZED PER DESIGN REQUIREMENTS, EXCEPT THAT THE EDGES OF THE BEAM SHALL NOT OVERHANG THE BEARING PAD BY MORE THAN 6".
3. TAPERED SOLE PLATE SHALL BE BONDED TO THE ELASTOMERIC BEARING PAD AND SHALL BE GALVANIZED. MINIMUM THICKNESS OF SOLE PLATE SHALL BE 3/8".

|   |                     |                          |
|---|---------------------|--------------------------|
| <b>PRESTRESSED CONCRETE BOX BEAMS<br/>STANDARD SECTIONS</b> | <b>ISSUED: 2016</b> | <b>PLATE<br/>3.10-10</b> |
|---|---------------------|--------------------------|

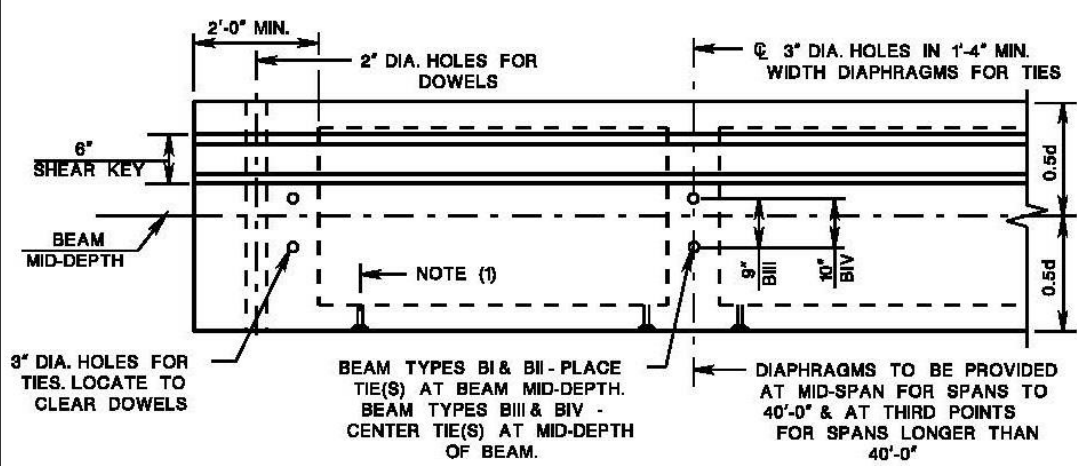


**TYPICAL BOX BEAM SECTION**



**TYPICAL KEYWAY DETAIL**  
(OMIT ON OUTSIDE FACE OF FASCIA BEAM)

NOTE: KEYWAYS SHALL BE FILLED WITH GROUT IN ACCORDANCE WITH 1.25.6.1.b.



**TYPICAL BOX BEAM ELEVATION**

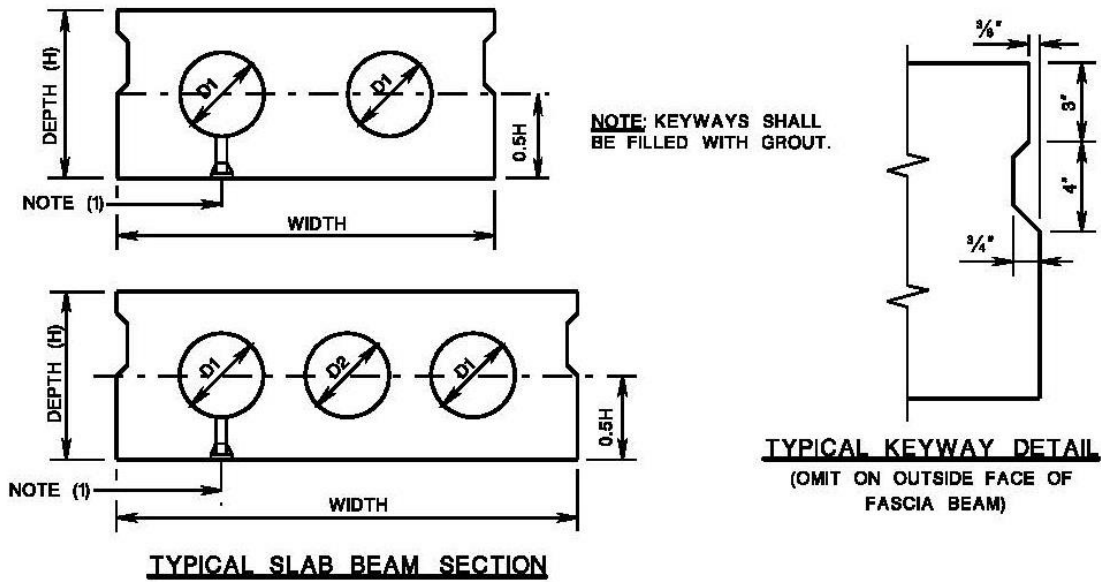
| TYPICAL SECTION PROPERTIES |            |            |                 |                             |                                   |                     |                                   |                                   |
|----------------------------|------------|------------|-----------------|-----------------------------|-----------------------------------|---------------------|-----------------------------------|-----------------------------------|
| TYPE                       | WIDTH (FT) | DEPTH (IN) | WEIGHT (LBS/FT) | NET AREA (IN <sup>2</sup> ) | I <sub>x</sub> (IN <sup>4</sup> ) | Y <sub>b</sub> (IN) | S <sub>b</sub> (IN <sup>3</sup> ) | I <sub>t</sub> (IN <sup>3</sup> ) |
| BI-36                      | 3          | 27         | 584             | 561                         | 50,334                            | 13.35               | 3770                              | 3687                              |
| BII-36                     | 3          | 33         | 647             | 621                         | 85,153                            | 16.29               | 5227                              | 5086                              |
| BIV-36                     | 3          | 39         | 708             | 681                         | 131,145                           | 19.25               | 6813                              | 6640                              |
| BIII-36                    | 3          | 42         | 740             | 711                         | 158,644                           | 20.73               | 7653                              | 7459                              |
| BI-48                      | 4          | 27         | 722             | 693                         | 65,941                            | 13.37               | 4932                              | 4838                              |
| BII-48                     | 4          | 33         | 784             | 753                         | 110,499                           | 16.33               | 6767                              | 6629                              |
| BIII-48                    | 4          | 39         | 847             | 813                         | 168,367                           | 19.29               | 8728                              | 8542                              |
| BIV-48                     | 4          | 42         | 878             | 843                         | 203,088                           | 20.78               | 9773                              | 9571                              |

NOTE (1): 1" ID NON-METALLIC VOID DRAINING DEVICE. BOTH ENDS OF EACH VOID (TYPICAL). LOCATE TO CLEAR STRANDS AND AT LOWEST ELEVATION. } NOTE AND TYPICAL LOCATION TO BE SHOWN ON CONTRACT PLANS. VERIFY ON SHOP PLANS ACCORDINGLY.

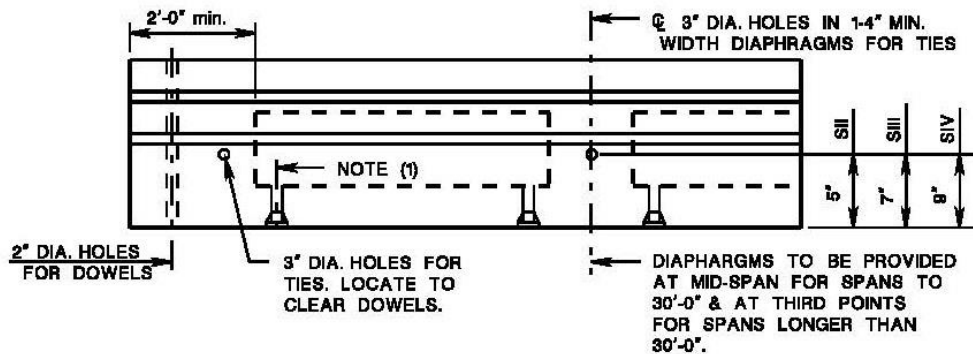
**PRESTRESSED CONCRETE SLAB BEAMS  
STANDARD SECTIONS**

**ISSUED: 2016**

**PLATE  
3.10-11**



NOTE (1): 1" ID NON-METALLIC VOID DRAINING DEVICE. BOTH ENDS OF EACH VOID (TYPICAL). LOCATE TO CLEAR STRANDS AND AT LOWEST ELEVATION. } NOTE AND TYPICAL LOCATION TO BE SHOWN ON CONTRACT PLANS. VERIFY ON SHOP PLANS ACCORDINGLY.

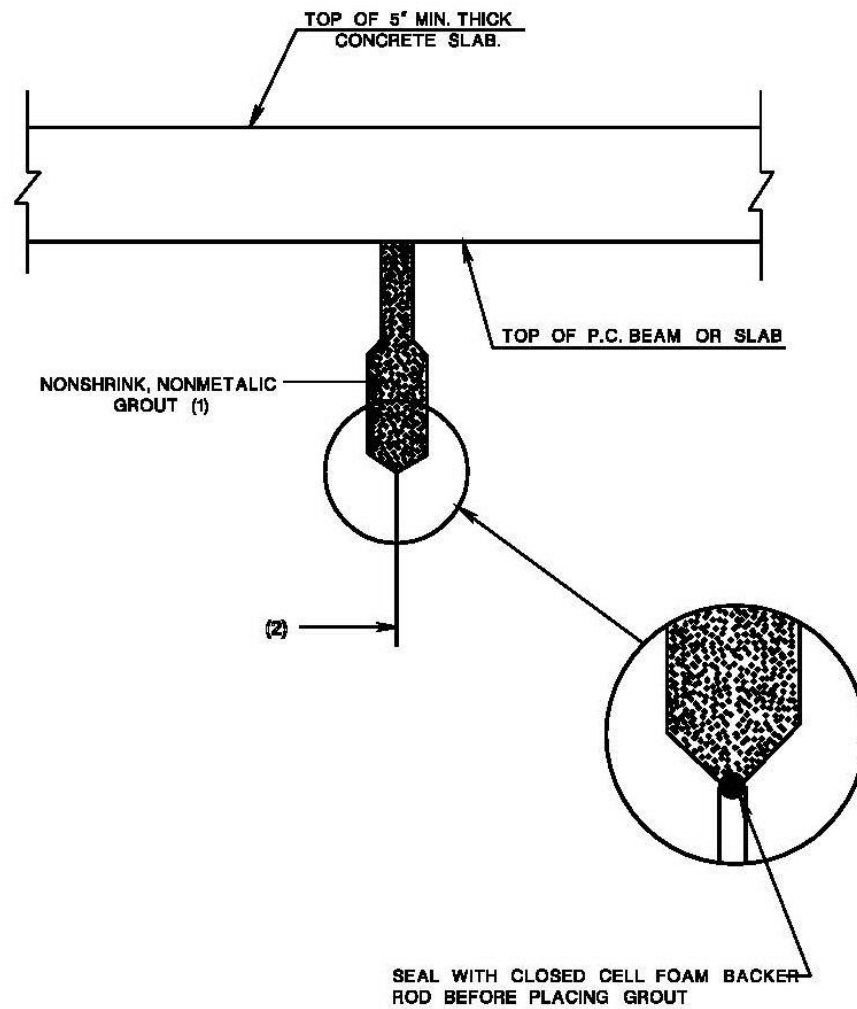


| TYPICAL SECTION PROPERTIES |           |           |              |               |    |                 |                           |                                 |                    |
|----------------------------|-----------|-----------|--------------|---------------|----|-----------------|---------------------------|---------------------------------|--------------------|
| TYPE                       | WIDTH FT. | DEPTH IN. | NO. OF VOIDS | VOID DIA. IN. |    | WEIGHT LBS./FT. | NET AREA IN. <sup>2</sup> | I <sub>x</sub> IN. <sup>4</sup> | S IN. <sup>3</sup> |
|                            |           |           |              | D1            | D2 |                 |                           |                                 |                    |
| SII-38                     | 3         | 15        | 2            | 8             | -  | 457             | 439                       | 9.725                           | 1296               |
| SIII-36                    | 3         | 18        | 2            | 10            | -  | 511             | 491                       | 16.614                          | 1835               |
| SIV-36                     | 3         | 21        | 2            | 12            | -  | 562             | 530                       | 25.747                          | 2462               |
| SII-48                     | 4         | 15        | 3            | 8             | 8  | 593             | 569                       | 12.897                          | 1720               |
| SIII-48                    | 4         | 18        | 3            | 10            | 10 | 654             | 628                       | 21.855                          | 2428               |
| SIV-48                     | 4         | 21        | 3            | 12            | 10 | 733             | 703                       | 34.517                          | 3287               |

PRESTRESSED CONCRETE SLAB AND BOX  
BEAMS, GROUTED KEY WAY DETAILS

ISSUED: 2016

PLATE  
3.10-12



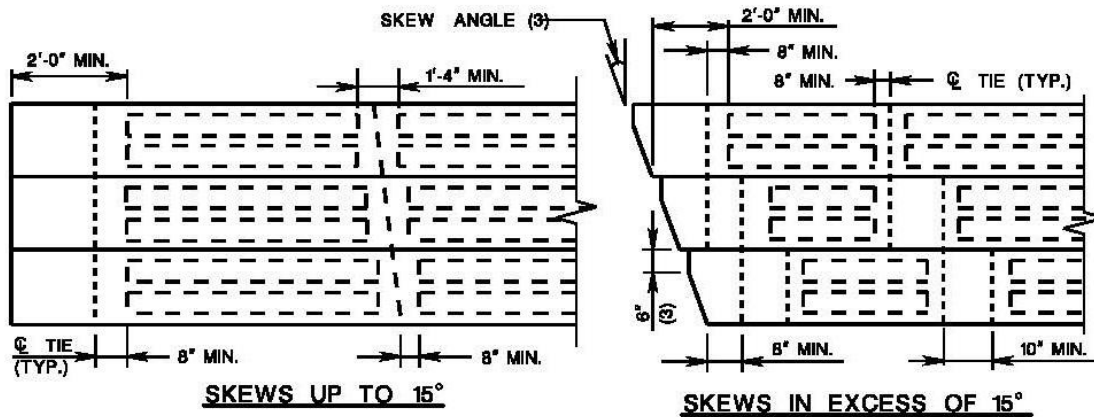
**NOTES:**

1. FILL SHEAR KEY WITH NONMETALLIC, NONSHRINK GROUT.
2. THE BOTTOM JOINT OPENING BETWEEN ADJACENT BOX BEAMS SHALL NOT EXCEED  $\frac{1}{2}$ ".

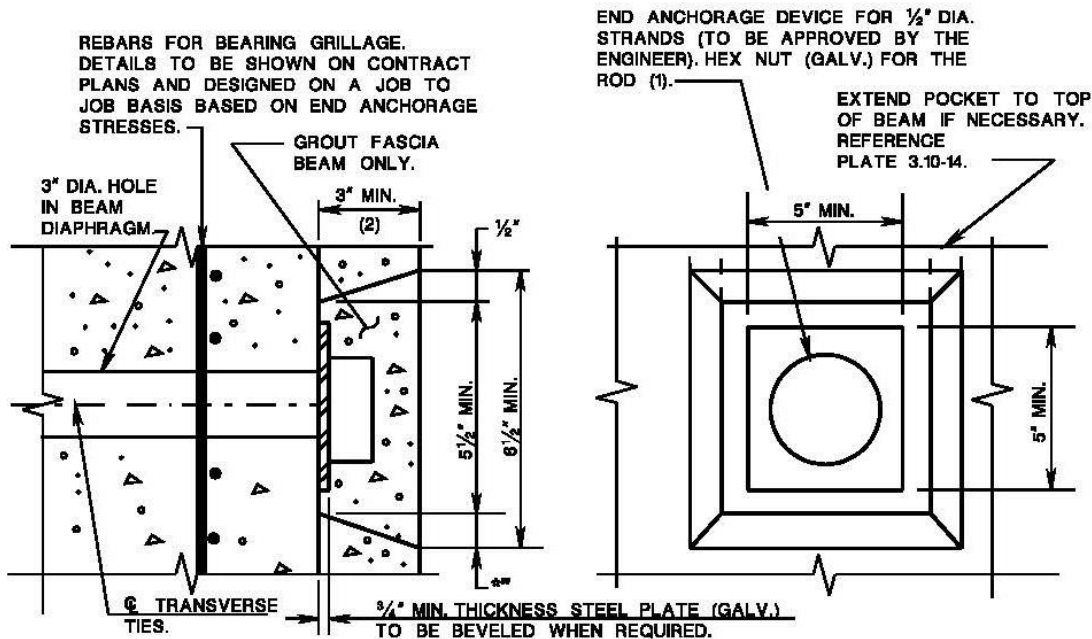
**PRESTRESSED CONCRETE VOIDED SLAB  
BEAMS, TRANSVERSE TIE DETAILS**

ISSUED: 2016

PLATE  
3.10-13



**PART PLANS OF DECK**



**DETAILS OF END ANCHORAGE AND POCKET**

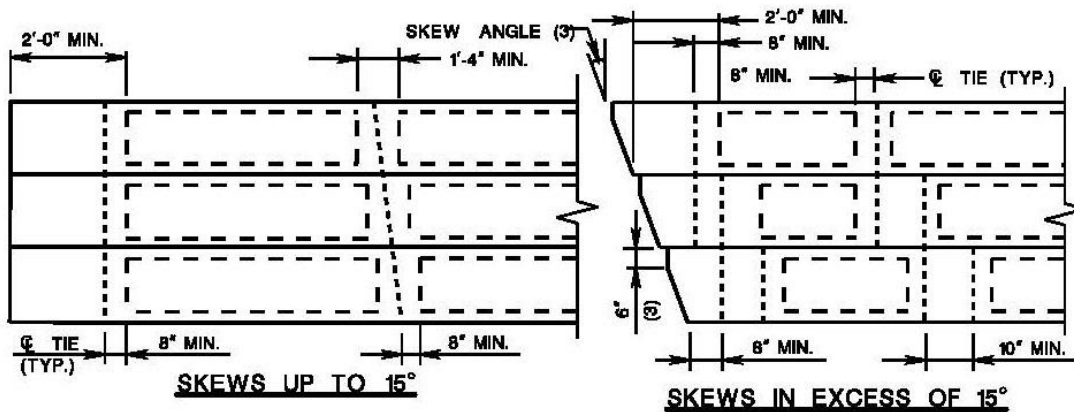
**NOTES:**

1. TRANSVERSE TIES SHALL BE 1/2" DIA. 270 KSI POLYSTRAND OR EQUIVALENT OR HIGH TENSILE STRENGTH STEEL ALLOY TIE RODS. THE APPLICATION OF TENSION TO TRANSVERSE TIES, GROUTING OF THE LONGITUDINAL KEYWAYS AND THE COMPUTATION OF THE REQUIRED FORCE PER DUCT SHALL BE ACCORDING TO SECTION 25 OF THIS MANUAL. RECESSED POCKETS AT FASCIA BEAMS TO BE FILLED WITH NONMETALLIC, NONSHRINK GROUT AFTER TENSIONING OF TIES.  
END ANCHORAGE DEVICE FOR 1/2" DIA. TIE STRANDS TO BE APPROVED BY THE ENGINEER.
2. STEEL PLATE AND HAND HOLE SIZE MAY VARY FROM THE DIMENSIONS SHOWN DEPENDING UPON LOADING, SKEW OR THE END ANCHORAGE DEVICE SELECTED.
3. ACUTE CORNERS OF BEAMS MAY BE SQUARED OFF AS SHOWN FOR SKEWS OVER 20°.

**PRESTRESSED CONCRETE BOX BEAMS,  
TRANSVERSE TIE DETAILS**

**ISSUED: 2016**

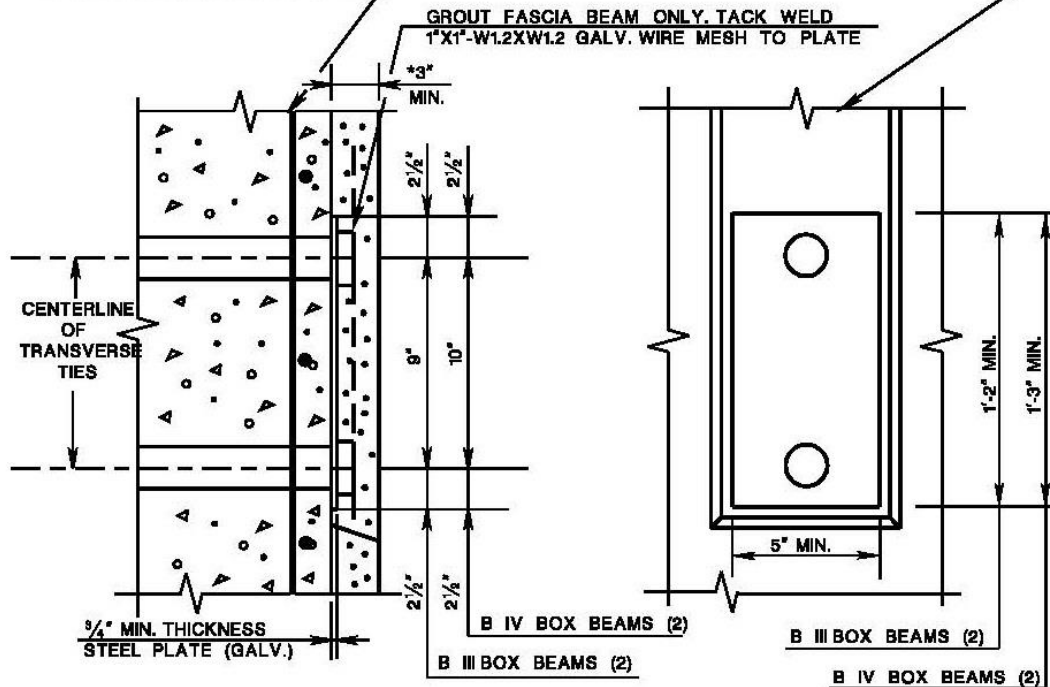
**PLATE  
3.10-14**



**PART PLAN OF DECK**

REBARS FOR BEARING GRILLAGE. DETAILS TO BE SHOWN ON CONTRACT PLANS AND DESIGNED ON A JOB TO JOB BASIS BASED ON END ANCHORAGE STRESSES.

EXTEND POCKET TO TOP OF BEAM ON INTERIOR BEAMS, IF NECESSARY. POCKET SHALL NOT BE EXTENDED ON EXTERIOR OF FASCIA BEAMS.



\* STEEL PLATE AND HAND HOLE SIZE MAY VARY FROM THE DIMENSIONS SHOWN DEPENDING UPON THE LOADING, SKEW OR THE END ANCHORAGE DEVICE SELECTION.

**DETAILS OF END ANCHORAGE AND POCKET**

**NOTES:**

1. SEE PLATE 3.10-13 FOR ALL OTHER NOTES AND DETAILS.
2. FOR B I AND B II BOX BEAMS REFER TO PLATE 3.10-13.
3. ACUTE CORNERS OF BEAMS MAY BE SQUARED OFF AS SHOWN FOR SKEWS OVER 20°.

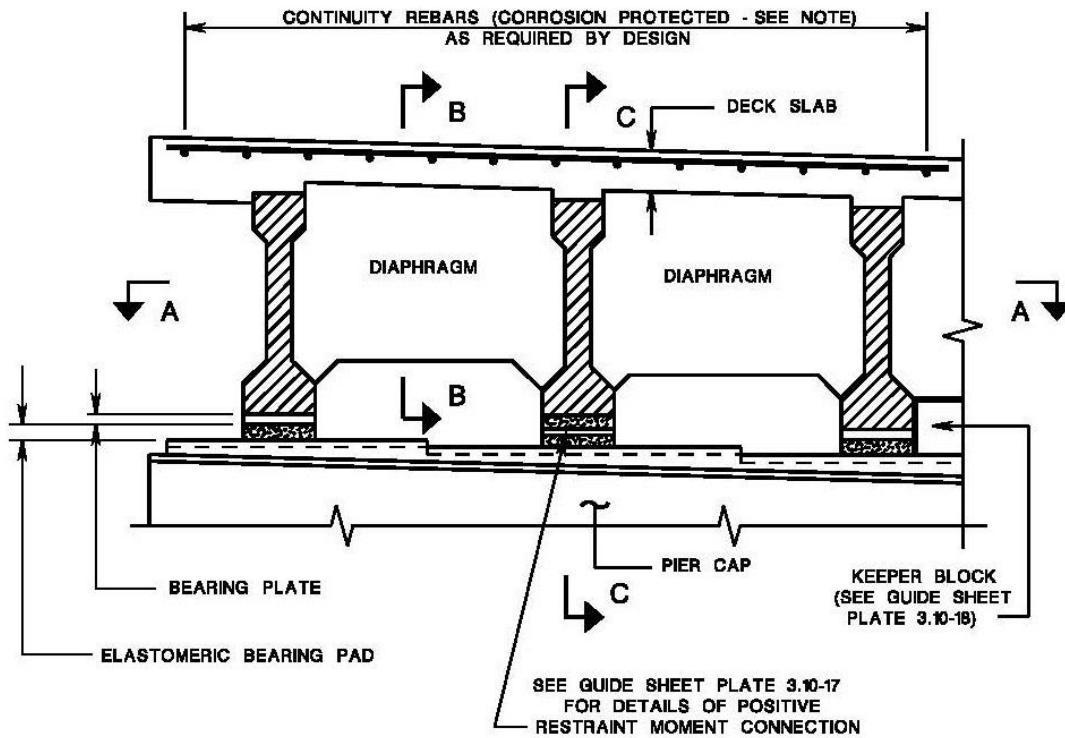
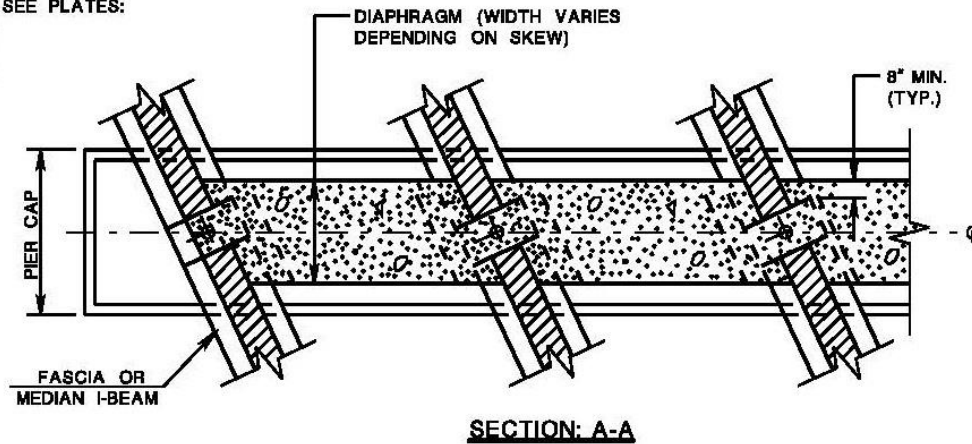


CONTINUITY DESIGN FOR LIVE LOAD,  
PC I-BEAM DIAPHRAGMS

ISSUED: 2016

PLATE  
3.10-15

ALSO SEE PLATES:  
3.10-16  
3.10-17  
3.10-18

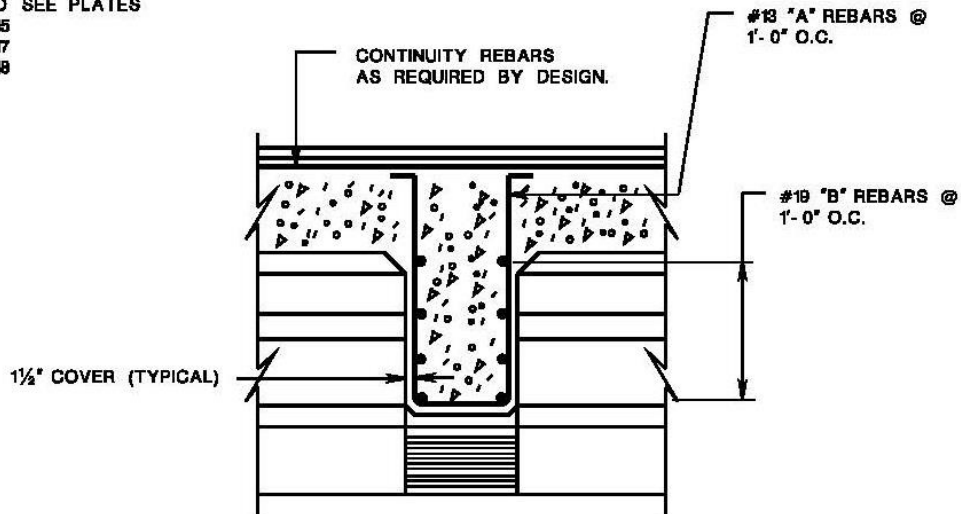


**CONTINUITY DESIGN FOR LIVE LOAD, PC  
I-BEAM DIAPHRAGM REINFORCEMENT  
( SHEET 1 OF 2 )**

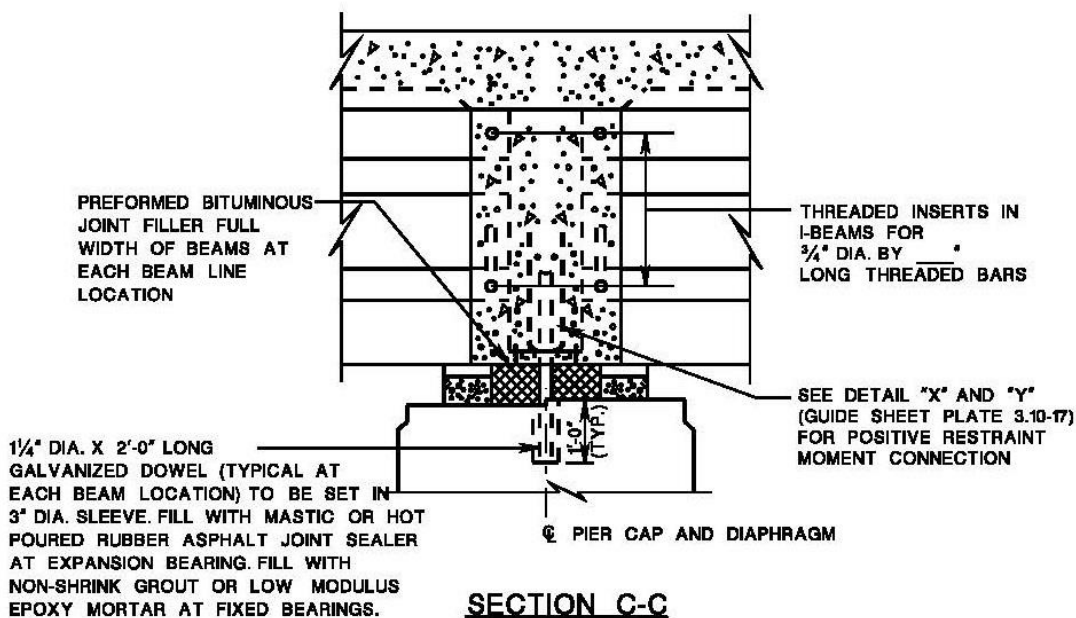
**ISSUED: 2016**

**PLATE  
3.10-16**

ALSO SEE PLATES  
3.10-15  
3.10-17  
3.10-18



**SECTION B-B**



**SECTION C-C**

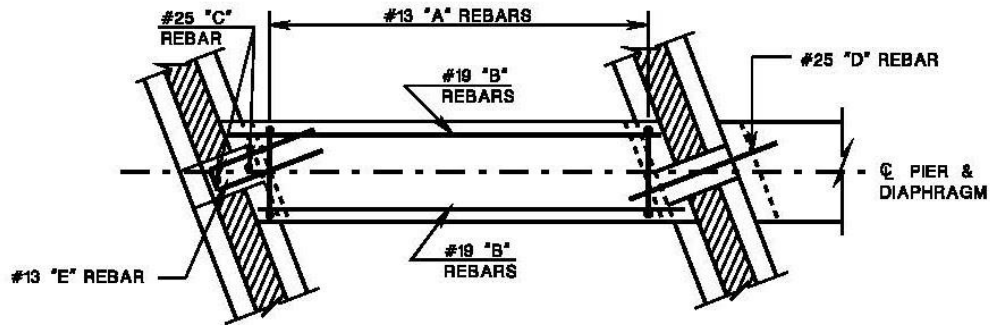
(NOTE TO DESIGNER:  
DETAILS AND NOTES TO BE SHOWN ON PIER PLANS)

CONTINUITY DESIGN FOR LIVE LOAD, PC  
I-BEAM DIAPHRAGM REINFORCEMENT  
( SHEET 2 OF 2 )

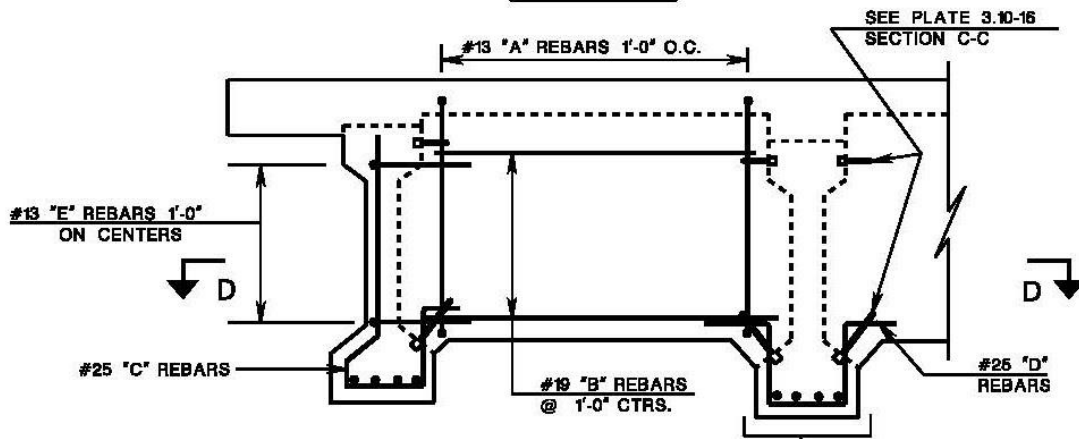
ISSUED: 2016

PLATE  
3.10-17

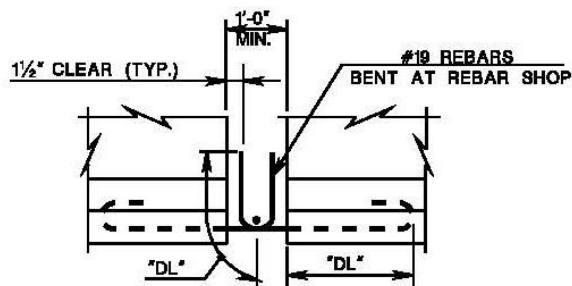
ALSO SEE PLATES  
3.10-15  
3.10-16  
3.10-18



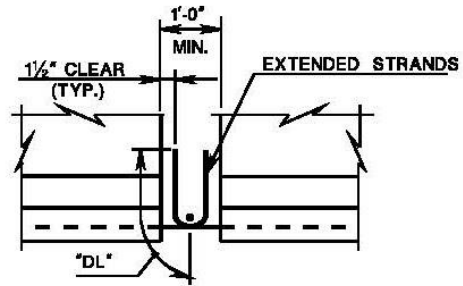
SECTION D-D



SECTIONAL ELEVATION



DETAIL "X"



DETAIL "Y"

POSITIVE RESTRAINT MOMENT CONNECTION

NOTE: DETAIL "X" OR "Y" (CONTRACTOR'S OPTION) TO BE SHOWN ON SHOP DRAWINGS.

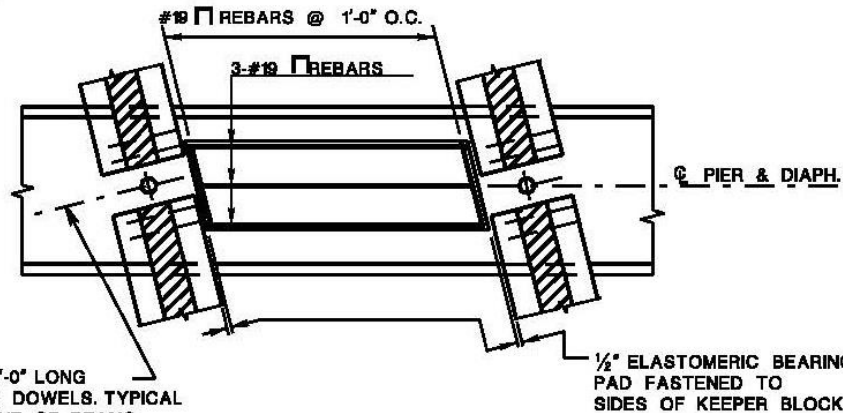
NOTE TO DESIGNER: BOTH DETAILS TO BE SHOWN ON PLANS TOGETHER WITH DIMENSION "DL" (DEVELOPMENT LENGTH) AND NUMBER OF REBARS OR STRANDS AS REQUIRED BY DESIGN.

CONTINUITY DESIGN FOR LIVE LOAD,  
PC I-BEAM KEEPER BLOCKS

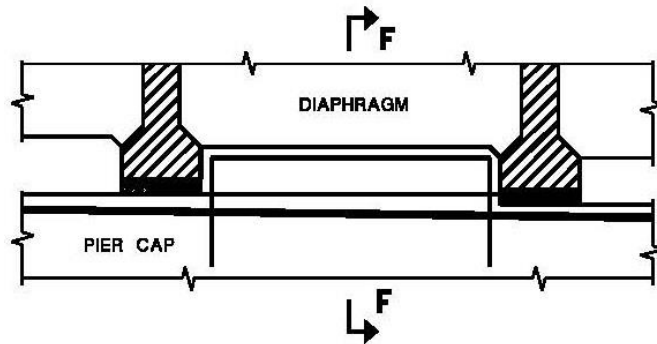
ISSUED: 2016

PLATE  
3.10-18

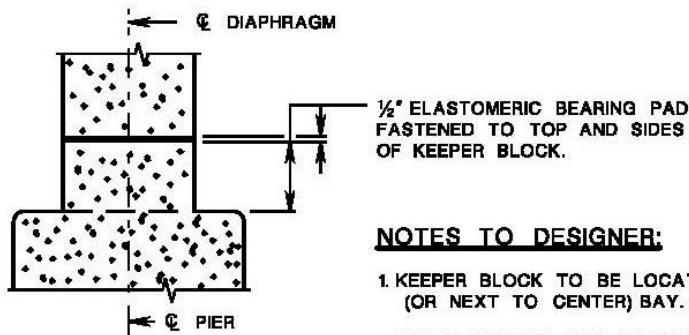
ALSO SEE PLATES  
3.10-15  
3.10-16  
3.10-17



**TYPICAL TOP VIEW**  
(DIAPHRAGMS NOT SHOWN)



**TYPICAL ELEVATION**



**SECTION F-F**

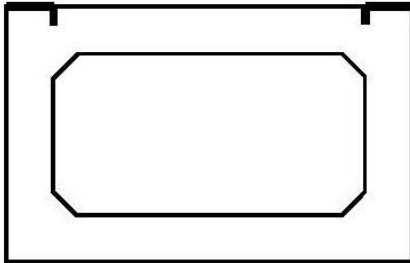
**NOTES TO DESIGNER:**

1. KEEPER BLOCK TO BE LOCATED IN CENTER (OR NEXT TO CENTER) BAY.
2. THESE DETAILS MAY BE UTILIZED IN THE SEISMIC RETROFIT OF APPLICABLE PROJECTS.

**P.C. SPREAD BOX BEAMS  
DESIGN DETAILS**

**ISSUED: 2016**

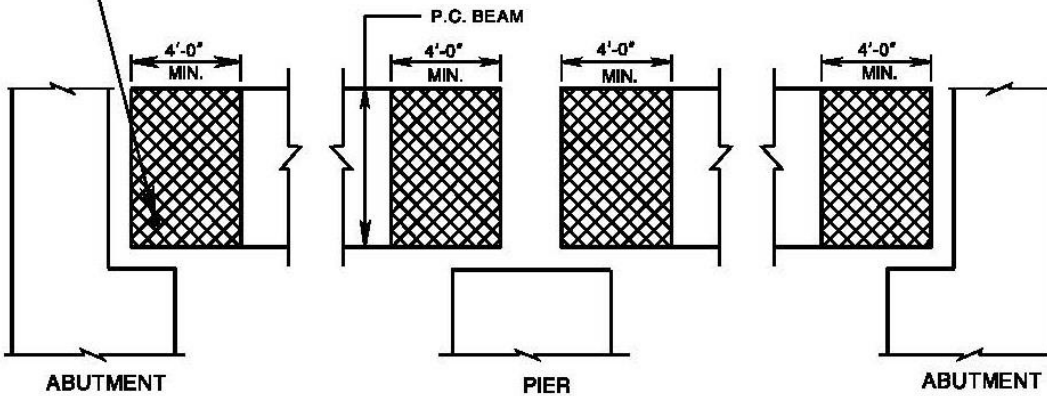
**PLATE  
3.10-19**



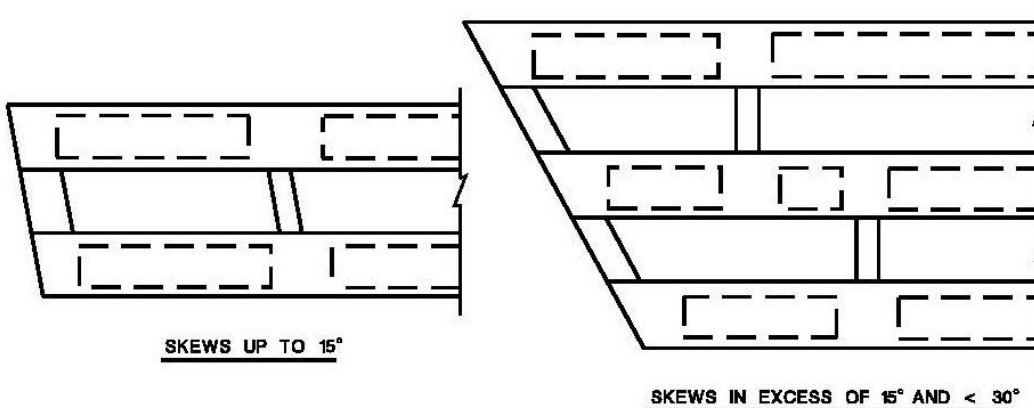
ZINC-COATED (GALVANIZED) WELD ANCHORS EMBEDDED IN CONCRETE AT 1'-8" C.C. MAXIMUM. ANGLES CARRYING S.I.P. FORMS ARE WELDED TO EMBEDDED ANCHORS. REFERENCE NJDOT BRIDGE CONSTRUCTION DETAILS FOR MORE INFORMATION.

**WELD ANCHORS FOR S.I.P. FORMS**

COAT ENDS, BOTTOMS AND SIDES OF FASCIA BEAMS WITH EPOXY WATER-PROOFING SEAL COAT. DO NOT COAT TOP OF BEAMS, DIAPHRAGM CONNECTION AREAS AND BEARING AREAS. REFERENCE SUBSECTION 1.25.10 FOR MORE INFORMATION.



**LIMITS FOR EPOXY WATERPROOFING SEAL COAT**

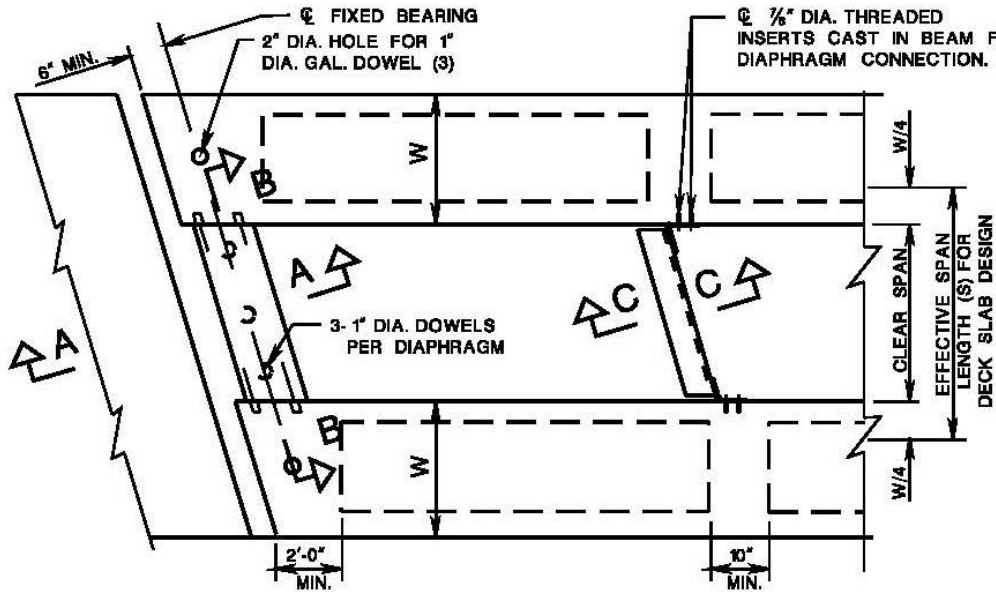


**DIAPHRAGM ARRANGEMENT (N.T.S.)**

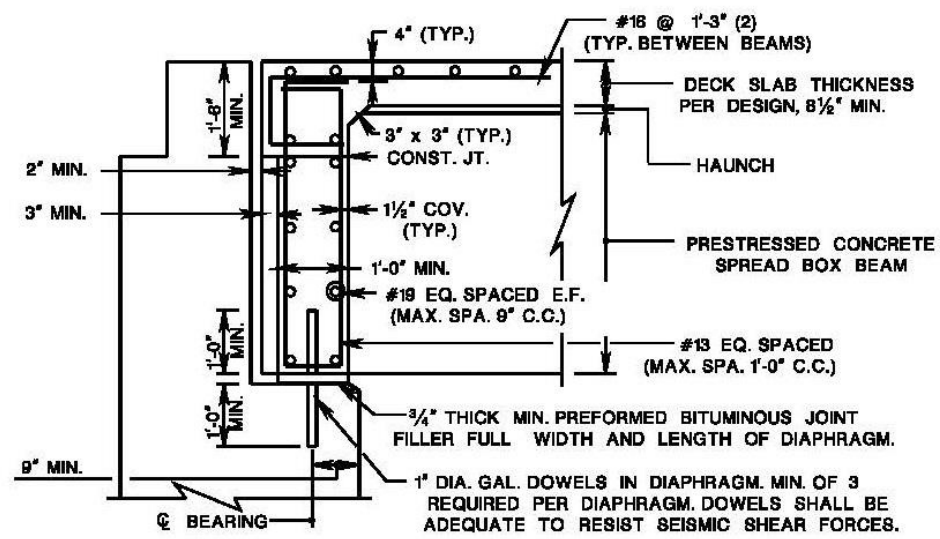
**NOTE:**

REFERENCE SECTION 25.7 OF THIS MANUAL FOR DESIGN REQUIREMENTS.

|   |                     |                                |
|---|---------------------|--------------------------------|
| <b>P.C. SPREAD BOX BEAMS</b><br><b>DIAPHRAGM DETAILS (SHEET 1 OF 3)</b> | <b>ISSUED: 2016</b> | <b>PLATE</b><br><b>3.10-20</b> |
|---|---------------------|--------------------------------|



**PLAN**

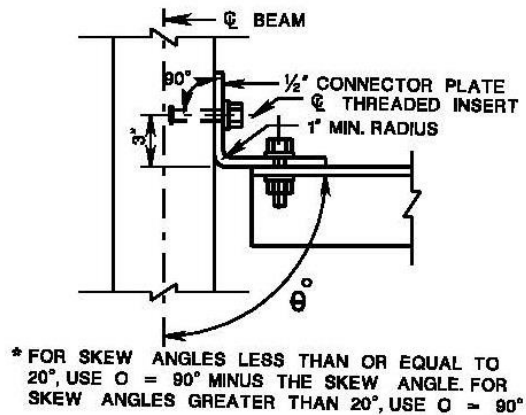
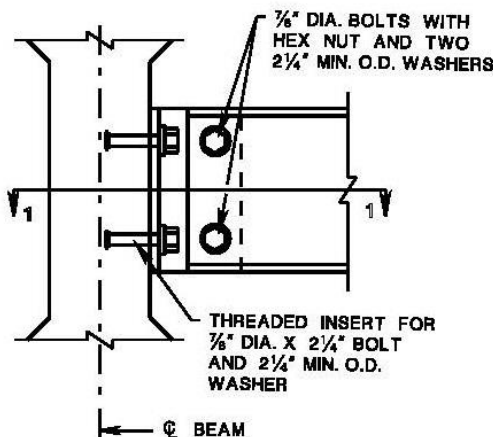
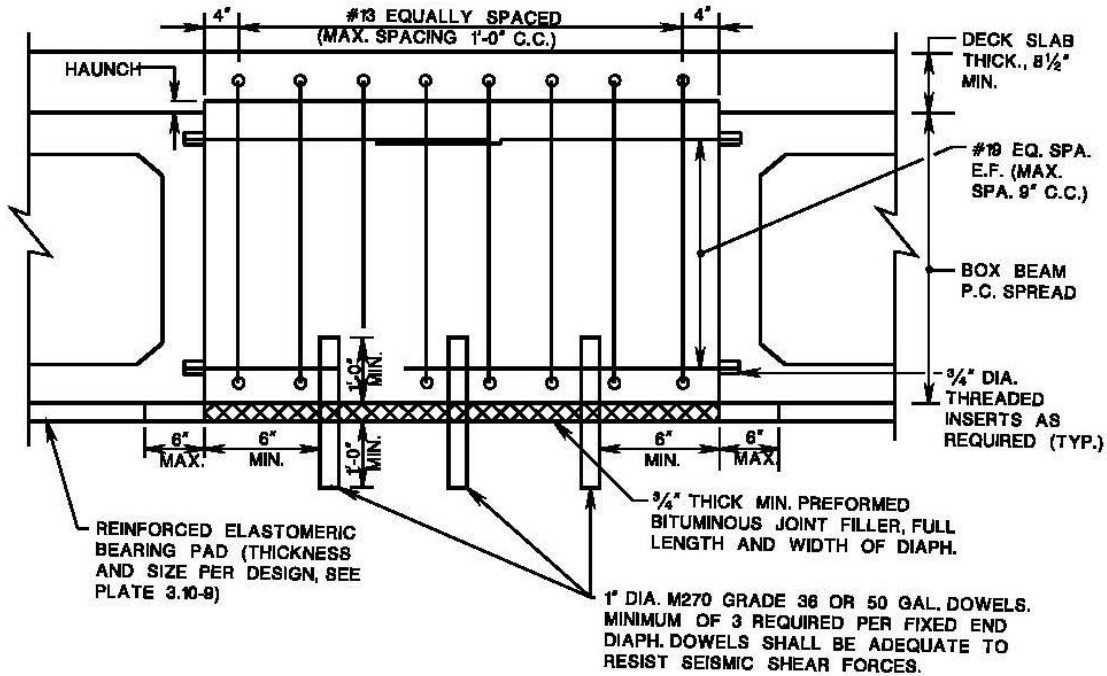


**SECTION A-A, FULL DEPTH FIXED END DIAPHRAGM**

**NOTES:**

1. ALL REINFORCING STEEL, DOWELS AND DIMENSIONS SHOWN ARE MINIMUM. MODIFY DETAILS AS REQUIRED BY DESIGN.
2. THE #18 BARS IN THE HAUNCH BETWEEN BEAMS SHALL BE LAPPED TO THE TOP LONGITUDINAL REINFORCEMENT AND SHALL BE CORROSION PROTECTED.
3. REFERENCE NOTES 1 AND 2 ON GUIDE SHEET PLATES 3.10-4, 3.10-5 AND 3.10-6 FOR THE CORING AND FILLING OF DOWEL HOLES IN ABUTMENTS AND PIER SEATS.
4. ALL REINFORCING STEEL IN END DIAPHRAGMS SHALL BE CORROSION PROTECTED.
5. INTERMEDIATE DIAPHRAGMS SHALL BE STEEL.
6. END DIAPHRAGMS SHALL BE CAST IN PLACE CONCRETE.

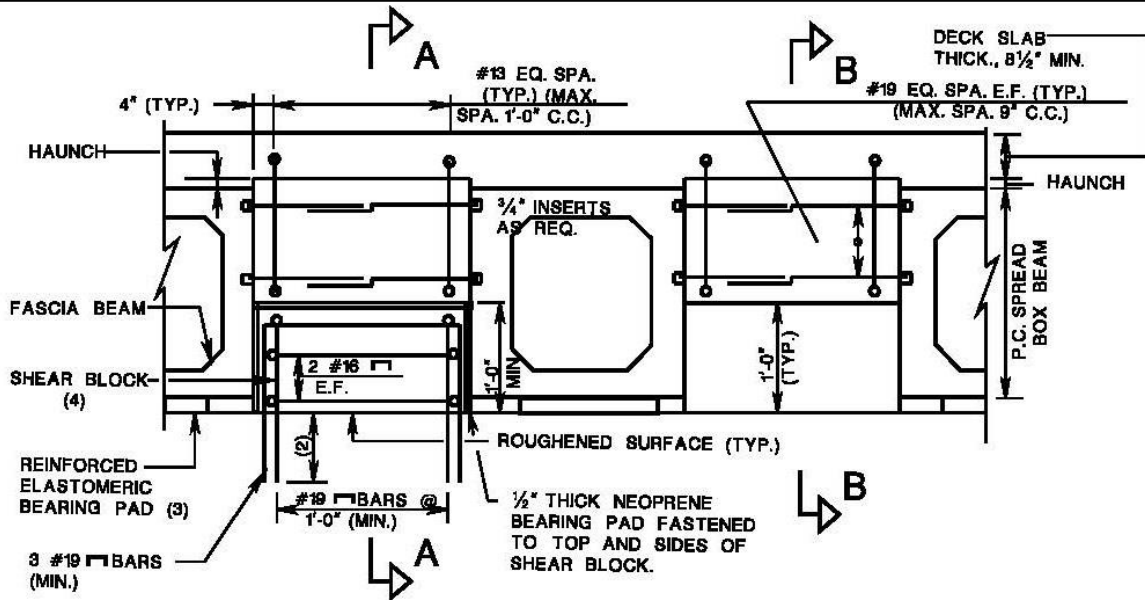
|   |                     |                          |
|---|---------------------|--------------------------|
| <b>P.C. SPREAD BOX BEAMS<br/>DIAPHRAGM DETAILS (SHEET 2 OF 3)</b> | <b>ISSUED: 2016</b> | <b>PLATE<br/>3.10-21</b> |
|---|---------------------|--------------------------|



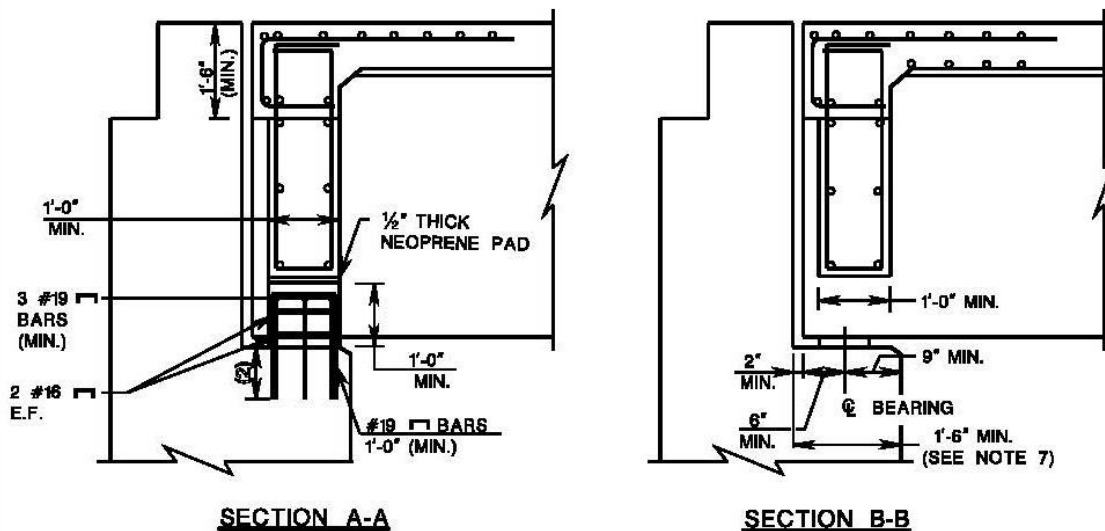
**NOTES:**

1. REFERENCE SECTION 25.7 OF THIS MANUAL FOR DESIGN REQUIREMENTS.
2. REFERENCE NOTES 1 AND 2 ON GUIDE SHEET PLATES 3.10-4, 3.10-5 AND 3.10-6 FOR CRITERIA ON THE CORING AND FILLING OF DOWEL HOLES IN ABUTMENTS AND PIER SEATS.
3. WHEN UTILITIES MUST BE LOCATED BETWEEN THE BEAMS INTERMEDIATE DIAPHRAGMS MAY BE REDUCED IN HEIGHT TO 1'-6\"/>

|   |                     |                          |
|---|---------------------|--------------------------|
| <b>P.C. SPREAD BOX BEAMS<br/>DIAPHRAGM DETAILS (SHEET 3 OF 3)</b> | <b>ISSUED: 2016</b> | <b>PLATE<br/>3.10-22</b> |
|---|---------------------|--------------------------|



**TYPICAL DIAPHRAGM AT ABUTMENT OR PIER (EXPANSION)**



**NOTES:**

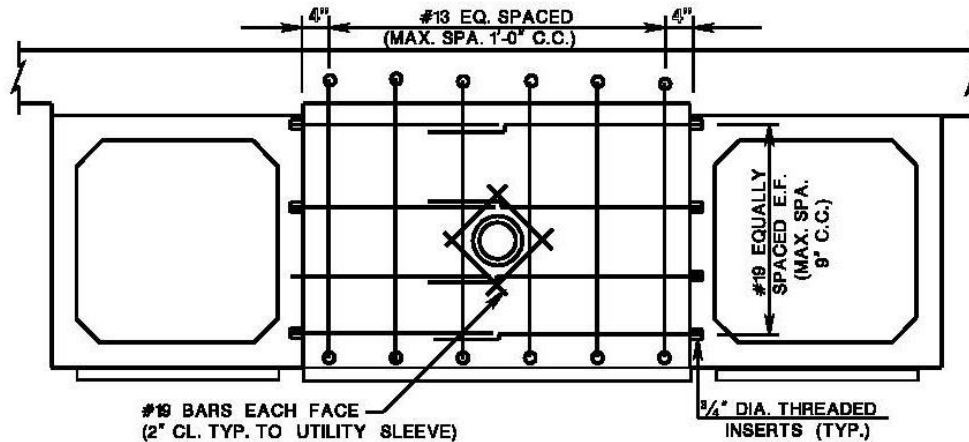
1. ALL REINFORCING IN END DIAPHRAGMS AND SHEAR BLOCKS SHALL BE CORROSION PROTECTED.
2. EMBEDMENT LENGTH PER DESIGN REQUIREMENTS SHALL BE SHOWN ON THE PLANS.
3. THE THICKNESS AND SIZE OF REINFORCED ELASTOMERIC BEARING PADS SHALL BE DETERMINED PER DESIGN REQUIREMENTS.
4. SHEAR BLOCKS ARE REQUIRED AS A MINIMUM BETWEEN EACH FASCIA AND THE FIRST INTERIOR BEAM. PROVIDE ADDITIONAL OR LARGER SHEAR BLOCKS AS REQUIRED FOR SEISMIC DESIGN CONSIDERATIONS AND FOR HIGHLY SKEWED STRUCTURES.
5. REFERENCE GUIDE SHEET PLATE 3.10-20 FOR OTHER NOTES AND DETAILS.
6. ALL REINFORCING STEEL, DOWELS AND DIMENSIONS SHOWN ARE MINIMUM. MODIFY DETAILS AS REQUIRED BY DESIGN.
7. SEAT LENGTH SHALL SATISFY SEISMIC DESIGN REQUIREMENTS.



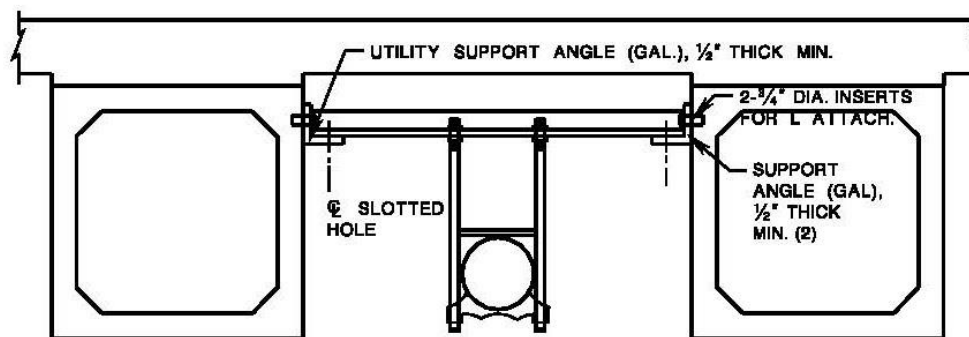
P.C. SPREAD BOX BEAMS  
UTILITY DETAILS

ISSUED: 2016

PLATE  
3.10-23



UTILITY AT FULL DEPTH DIAPHRAGM



TYPICAL INTERMEDIATE UTILITY SUPPORT

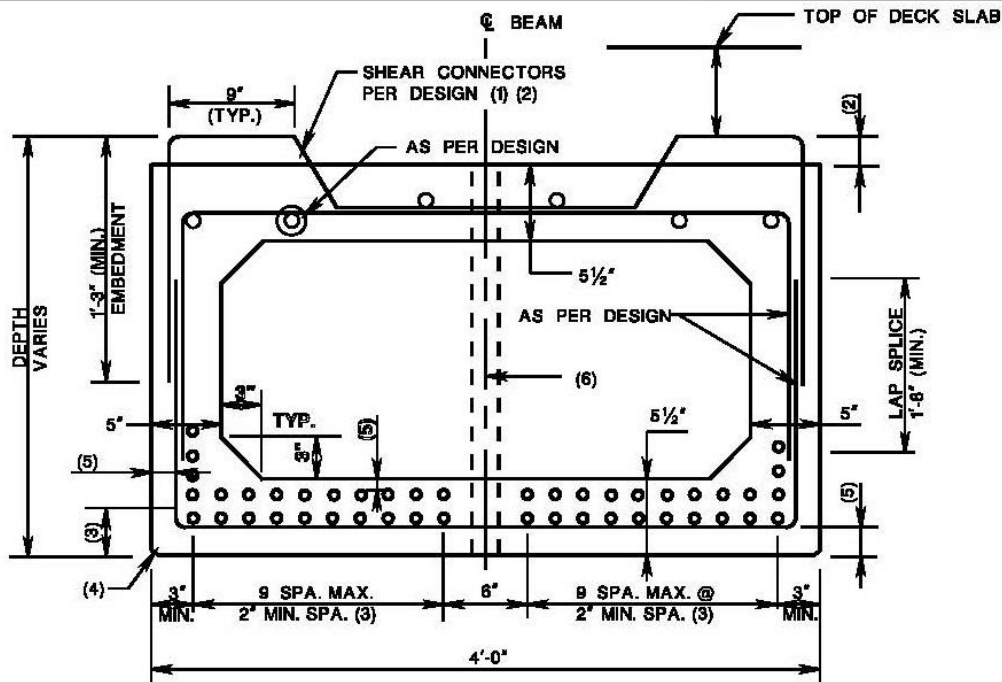
**NOTES:**

1. UTILITIES SHALL NOT PROTRUDE BELOW THE BOTTOM OF THE BEAMS.
2. THE SUPPORT ANGLES SHALL BE ATTACHED TO EACH BOX BEAM WITH 2-1/4" DIA. BOLTS (MIN.). THREADED INSERTS SHALL BE PROVIDED IN THE BOX BEAMS FOR ANGLE ATTACHMENTS. THE UTILITY SUPPORT ANGLE SHALL BE SUPPLIED WITH SLOTTED HOLES FOR HORIZONTAL FIELD ADJUSTMENT.
3. A FULL DEPTH SLEEVED DIAPHRAGM MAY BE USED AT INTERMEDIATE DIAPHRAGM LOCATIONS AS LONG AS THE UTILITY IS APPROXIMATELY CENTERED IN THE DIAPHRAGM AND THE UTILITY IS LESS THAN HALF THE DEPTH OF THE DIAPHRAGM. OTHER DETAILS ARE ACCEPTABLE PENDING APPROVAL BY THE MANAGER, BUREAU OF STRUCTURAL ENGINEERING.

P.C. SPREAD BOX BEAMS  
REINFORCEMENT DETAILS

ISSUED: 2016

PLATE  
3.10-24



**SPREAD BOX BEAM SECTION (N.T.S.)**

**NOTES:**

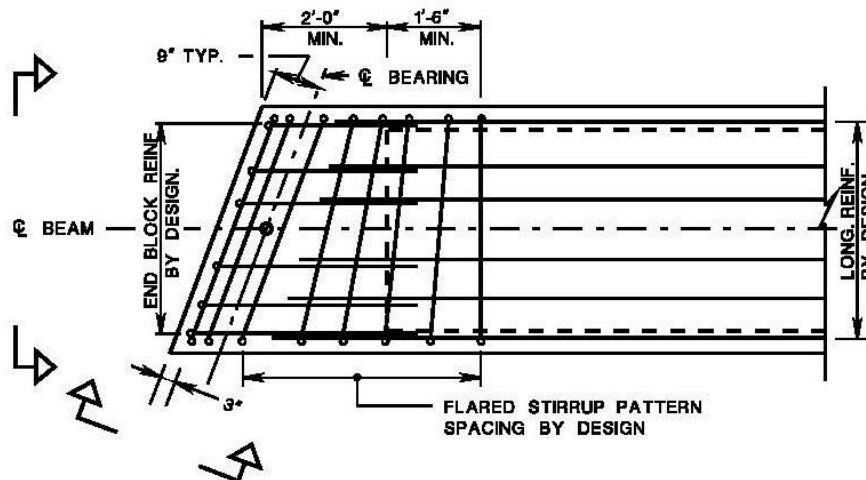
1. SHEAR CONNECTORS SHALL BE CORROSION PROTECTED.
2. SHEAR CONNECTORS SHALL PENETRATE AT LEAST 2" ABOVE THE BOTTOM OF THE DECK SLAB, HOWEVER, THE TOP OF THE SHEAR CONNECTOR SHALL BE 3" MINIMUM BELOW THE TOP OF THE DECK SLAB.
3. NUMBER AND ARRANGEMENT OF PRESTRESSING STRANDS PER DESIGN REQUIREMENTS. THE CENTER OF GRAVITY OF PRESTRESSING STRANDS SHALL BE NOTED ON THE PLANS.
4. BOTTOM CORNERS OF ALL BEAMS SHALL HAVE  $\frac{3}{4}$ " CHAMFERS. EXTERIOR BEAMS SHALL HAVE  $\frac{3}{4}$ " RADIUS DRIP NOTCH (REFERENCE GUIDE SHEET PLATE 3.10-7).
5. MINIMUM CONCRETE COVER:
 

|                    |               |
|--------------------|---------------|
| TOP SLAB AND SIDES | - 2" MINIMUM  |
| BOTTOM SLAB        | - 1½" MINIMUM |
| INSIDE VOID        | - 1" MINIMUM  |
| END                | - 1½" MINIMUM |
6. CENTER LINE 2" DIAMETER DOWEL HOLE LOCATED IN BEAM END AND 1" DIAMETER NONMETALIC VOID DRAINING DEVICE LOCATED AT THE END OF EACH VOID (TYPICAL). ON BRIDGES WITH SLOPING BEARING SEATS THE VOID DRAINING DEVICE SHALL BE LOCATED IN THE LOW POINT OF EACH VOID, IF POSSIBLE. LOCATE DOWEL HOLES AND VOID DRAIN HOLES TO CLEAR STRANDS AND MILD REINFORCING STEEL. NOTE AND TYPICAL LOCATION TO BE SHOWN ON CONTRACT PLANS. VERIFY ON SHOP PLANS ACCORDINGLY.
7. REFERENCE GUIDE SHEET PLATE 3.10-25 TYPICAL END BLOCK REINFORCEMENT.
8. AT A MINIMUM 6 #16 BARS SHALL BE PROVIDED TO WITHSTAND THE REQUIRED STRAND TENSIONING. THE DESIGNER SHALL VERIFY IF THIS STEEL DISTRIBUTION IS SUFFICIENT TO OVERCOME POTENTIAL CONCRETE CRACKING AT THIS LOCATION.

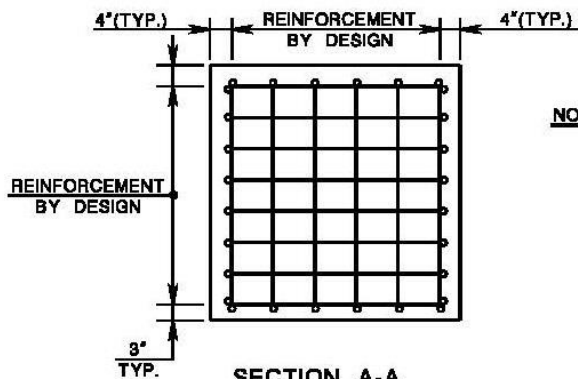
**P.C. SPREAD BOX BEAMS, END BLOCK  
REINFORCEMENT DETAILS**

**ISSUED: 2016**

**PLATE  
3.10-25**



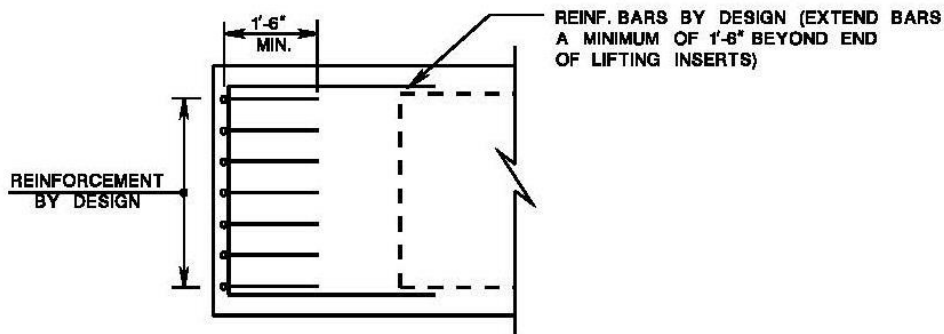
**PLAN BEAM REINFORCEMENT**



**NOTE:** MINIMUM COVER ON THE ENDS OF THE BEAM SHALL BE 1½".

**SECTION A-A**

**END BLOCK REINFORCEMENT SECTION**



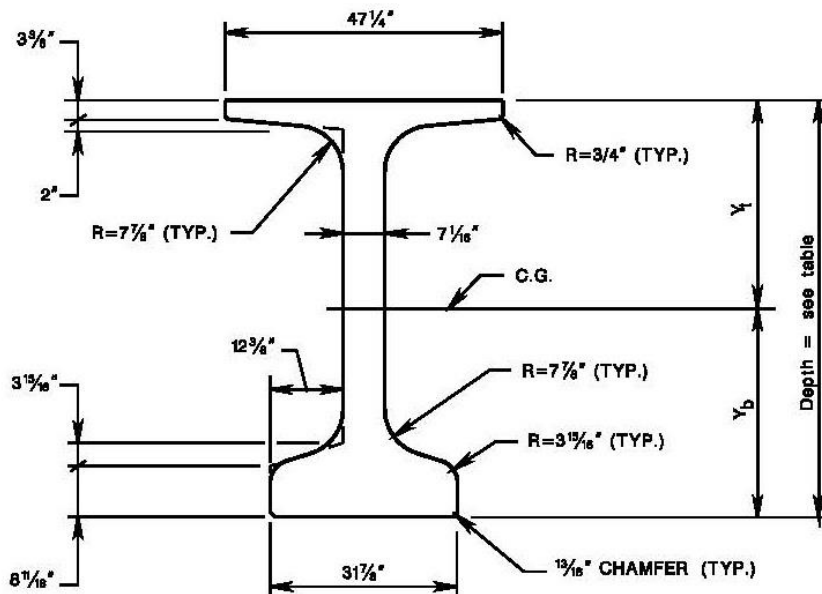
**SECTION B-B**

**END BLOCK REINFORCEMENT ELEVATION**

NEW ENGLAND BULB-TEE GIRDERS  
STANDARD SECTIONS

ISSUED: 2016

PLATE  
3.10-26



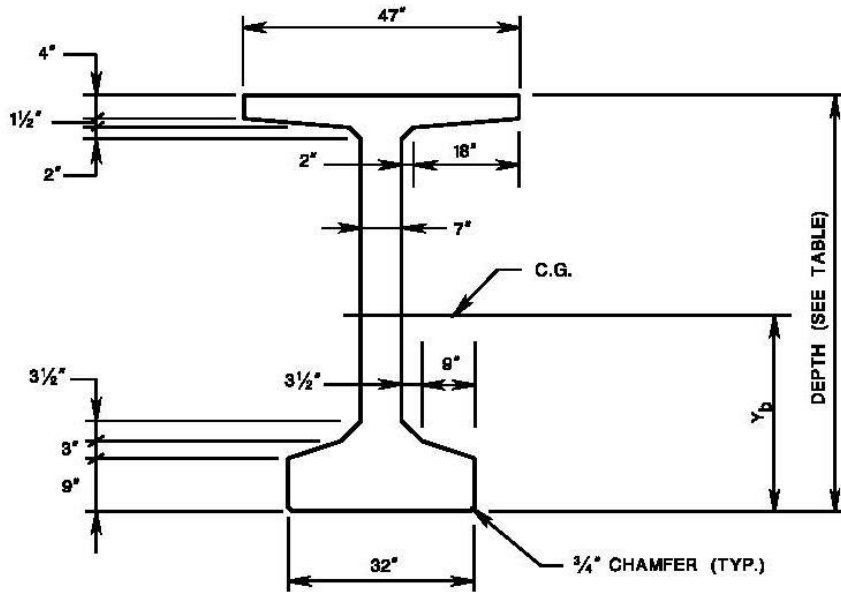
TYPICAL BEAM SECTION

| TYPICAL SECTION PROPERTIES |            |                |                         |   |   |                     |                     |   |   |
|----------------------------|------------|----------------|-------------------------|---|---|---------------------|---------------------|---|---|
| BEAM TYPE                  | DEPTH (IN) | WEIGHT (LB/FT) | AREA (IN <sup>2</sup> ) | I <sub>x</sub> -c.g. (IN <sup>4</sup> x 10 <sup>6</sup> ) | I <sub>y</sub> -c.g. (IN <sup>4</sup> x 10 <sup>6</sup> ) | Y <sub>t</sub> (IN) | Y <sub>b</sub> (IN) | S <sub>t</sub> (IN <sup>3</sup> x 10 <sup>6</sup> ) | S <sub>b</sub> (IN <sup>3</sup> x 10 <sup>6</sup> ) |
| NEBT 1400                  | 55 1/8"    | 894            | 857                     | 352.97  | 62.23   | 28 7/8"             | 26 1/4"             | 12.202  | 13.397  |
| NEBT 1600                  | 63"        | 952            | 913                     | 492.03  | 62.47   | 31"                 | 30"                 | 14.894  | 16.425  |
| NEBT 1800                  | 70 7/8"    | 1010           | 969                     | 660.45  | 62.71   | 37 7/8"             | 33 11/16"           | 17.754  | 19.618  |

PCEF BULB-TEE GIRDERS  
STANDARD SECTIONS

ISSUED: 2016

PLATE  
3.10-27



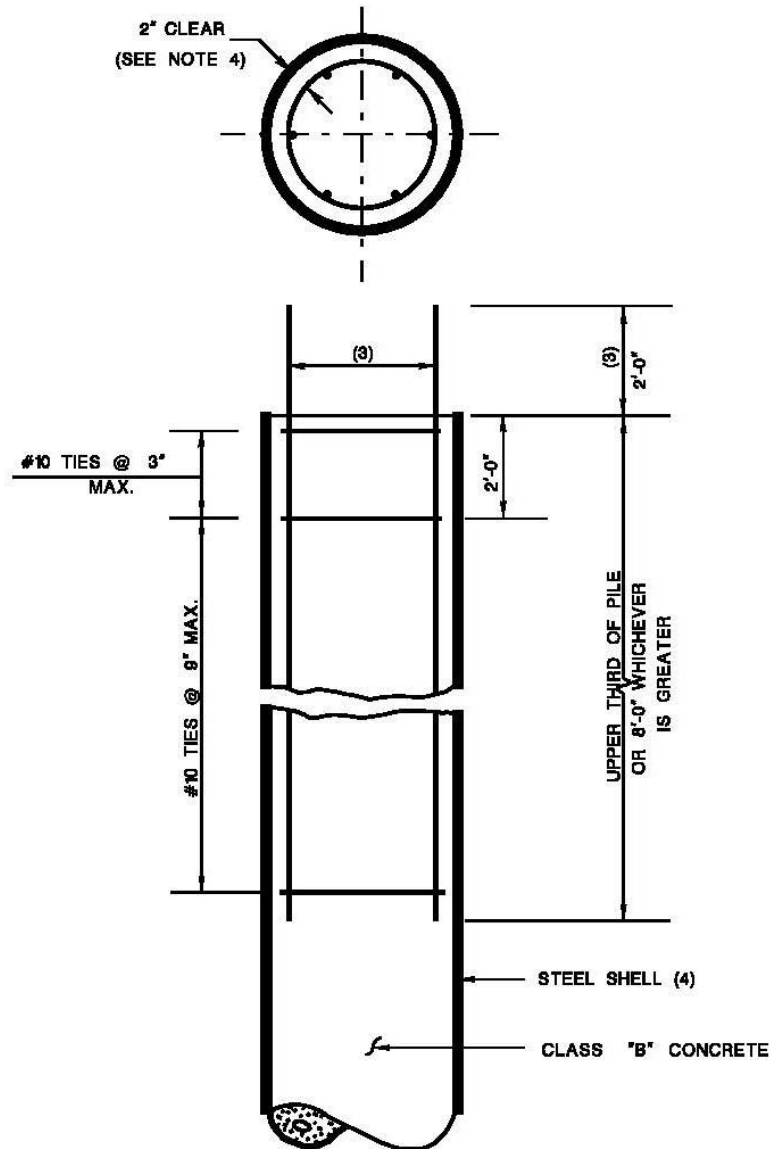
TYPICAL BEAM SECTION

| TYPICAL SECTION PROPERTIES |            |                |                         |   |                     |
|----------------------------|------------|----------------|-------------------------|---|---------------------|
| BEAM TYPE                  | DEPTH (IN) | WEIGHT (LB/FT) | AREA (IN <sup>2</sup> ) | I <sub>x</sub> -c.g. (IN <sup>4</sup> × 10 <sup>3</sup> ) | Y <sub>b</sub> (IN) |
| XB 55 47                   | 55         | 903            | 966.7                   | 355.8   | 26.07               |
| XB 63 47                   | 63         | 961            | 922.7                   | 500.0   | 29.77               |
| XB 71 47                   | 71         | 1020           | 976.7                   | 673.6   | 33.51               |

REINFORCEMENT STEEL FOR  
CAST-IN-PLACE CONCRETE PILES

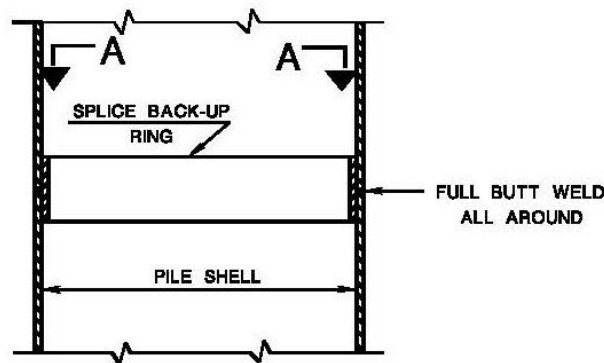
ISSUED: 2016

PLATE  
3.11-1

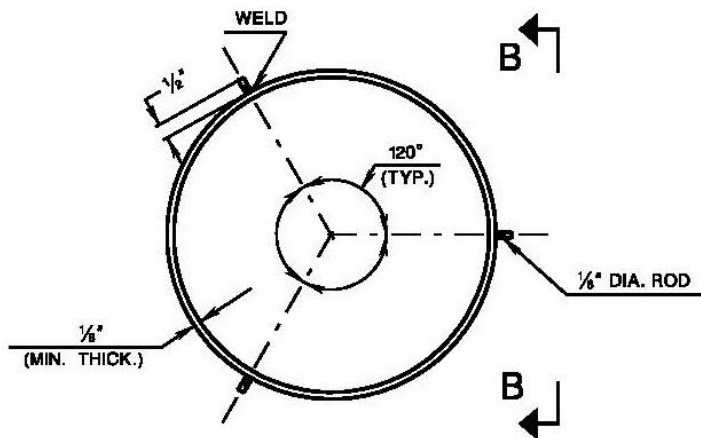
**NOTES:**

1. SEE CONTRACT DRAWINGS FOR DIMENSIONS OF PILE.
2. APPROVED METAL SPACERS SHALL BE ATTACHED TO THE TOP AND BOTTOM TIES TO INSURE THAT THE REQUIRED CLEAR DISTANCE TO THE SHELL IS MAINTAINED.
3. STEEL MATERIAL SHELL SHALL BE IN CONFORMANCE WITH THE NJDOT STANDARD SPECIFICATIONS.
4. ALSO SEE AASHTO LRFD DESIGN SPECIFICATIONS AND LRFD CONSTRUCTION SPECIFICATIONS

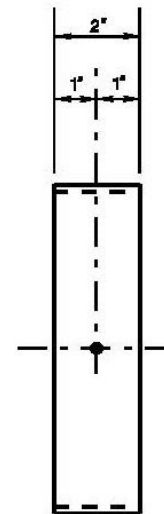
|   |                     |                         |
|---|---------------------|-------------------------|
| <b>PILE SPLICE FOR CAST-IN-PLACE<br/>CONCRETE PILES</b> | <b>ISSUED: 2016</b> | <b>PLATE<br/>3.11-2</b> |
|---|---------------------|-------------------------|



**SPLICE DETAIL**



**SECTION A-A**

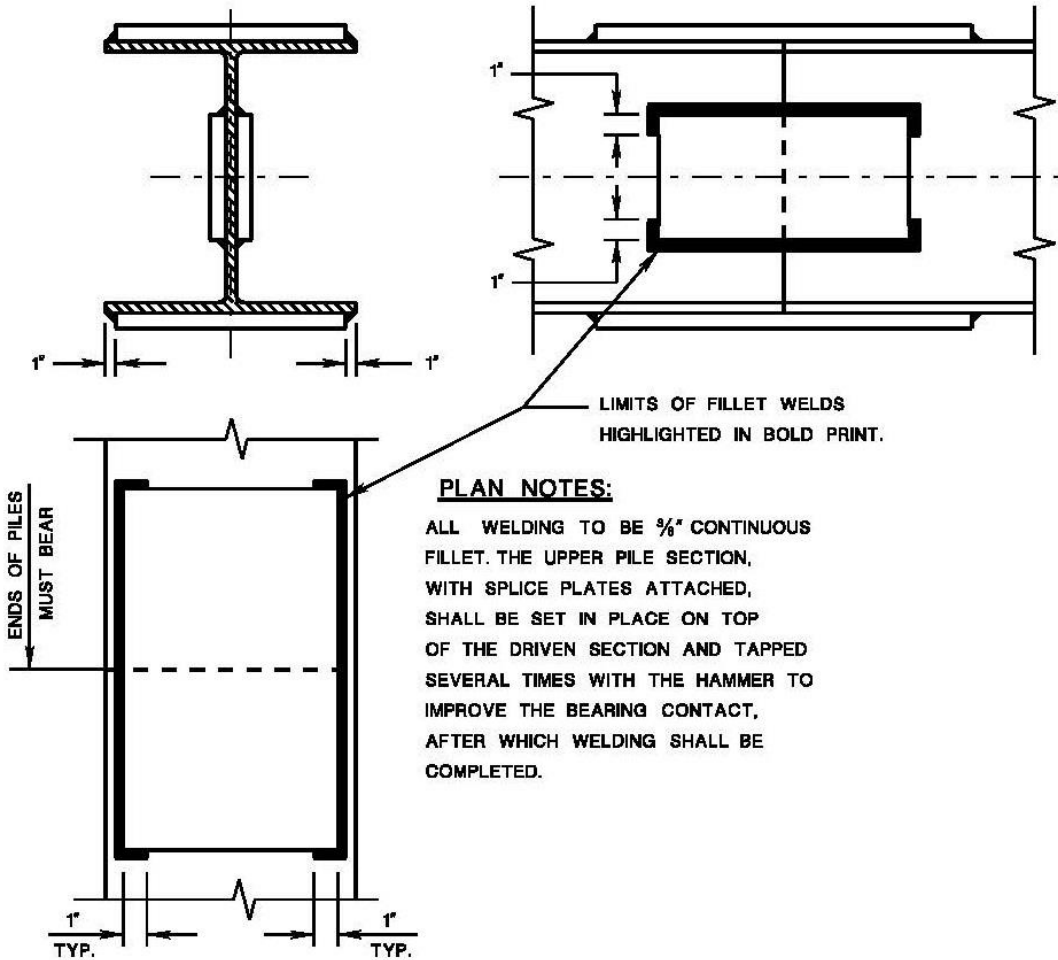


**SECTION B - B**

**NOTES:**

1. APPROVED COMMERCIAL PILE SPLICE BACK-UP RING MAY BE USED IN LIEU OF THE TYPE DETAILED. BACK-UP RING SHALL HAVE A TIGHT FIT.
2. WELDING SHALL BE AS PER A.W.S. REQUIREMENTS.

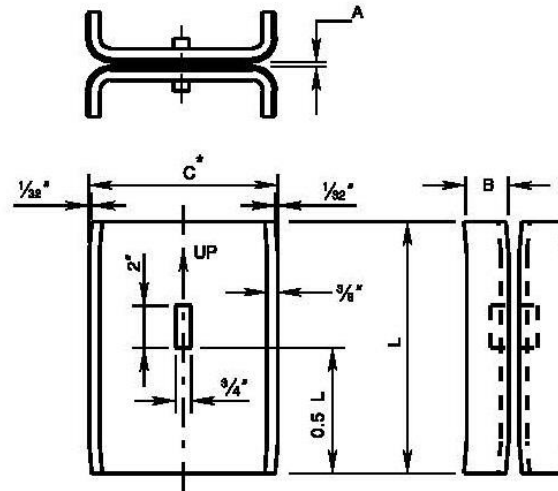
|                                       |                     |                         |
|---------------------------------------|---------------------|-------------------------|
| <b>STEEL PILE SPLICE, ALTERNATE 1</b> | <b>ISSUED: 2016</b> | <b>PLATE<br/>3.11-3</b> |
|---------------------------------------|---------------------|-------------------------|



| H-PILE SECTIONS | FLANGE PLATES                        |        | WEB PLATES                          |         |
|-----------------|--------------------------------------|--------|-------------------------------------|---------|
|                 | SIZE                                 | LENGTH | SIZE                                | LENGTH  |
| HP10x42         | 8" X $\frac{5}{8}$ "                 | 1'- 2" | 5" X $\frac{1}{2}$ "                | 0'- 9"  |
| HP10x57         | 8" X $\frac{3}{4}$ "                 | 1'- 5" | 6" X $\frac{1}{2}$ "                | 1'- 0"  |
| HP12x53         | 10" X $\frac{5}{8}$ "                | 1'- 8" | 5 $\frac{1}{4}$ " X $\frac{1}{2}$ " | 0'- 11" |
| HP12x74         | 10" X 1"                             | 2'- 0" | 6" X $\frac{3}{8}$ "                | 1'- 3"  |
| HP14x73         | 12 $\frac{1}{4}$ " X $\frac{3}{4}$ " | 2'- 1" | 6" X $\frac{1}{2}$ "                | 1'- 1"  |
| HP14x89         | 12 $\frac{3}{8}$ " X $\frac{7}{8}$ " | 2'- 5" | 7" X $\frac{5}{8}$ "                | 1'- 8"  |
| HP14x102        | 12 $\frac{3}{8}$ " X 1"              | 2'- 9" | 7" X $\frac{3}{4}$ "                | 1'- 8"  |
| HP14x117        | 12 $\frac{5}{8}$ " X 1"              | 3'- 1" | 8" X $\frac{3}{4}$ "                | 1'- 11" |



|   |                     |                        |
|---|---------------------|------------------------|
| <b>STEEL PILE SPLICE, ALTERNATE 2</b><br>(SHEET 1 OF 2) | <b>ISSUED: 2016</b> | <b>PLATE</b><br>3.11-4 |
|---|---------------------|------------------------|



| DETAIL OF STEEL BEARING H-PILE SPLICER |                 |                    |  |         |          |         |
|--|-----------------|--------------------|--|---------|----------|---------|
| HP-PILE                                |                 |                    | SPLICER SLEEVE-3/8" THICK ASTM A36 STEEL |         |          |         |
| NOMINAL SIZE (IN.)                     | WEIGHT LBS./FT. | METAL THICK. (IN.) | A (IN.)                                  | B (IN.) | C* (IN.) | L (IN.) |
| 14                                     | 117             | 19/16              | 19/16                                    | 2 3/4   | 12 7/16  | 16      |
| 14                                     | 102             | 1 1/16             | 19/16                                    | 2 3/4   | 12 7/16  | 16      |
| 14                                     | 89              | 5/8                | 1 1/16                                   | 2 3/4   | 12 7/16  | 16      |
| 14                                     | 73              | 1/2                | 5/8                                      | 2 3/4   | 12 7/16  | 16      |
| 12                                     | 84              | 1 1/16             | 3/4                                      | 2 1/2   | 10 3/4   | 14      |
| 12                                     | 74              | 5/8                | 1 1/16                                   | 2 1/2   | 10 3/4   | 14      |
| 12                                     | 63              | 1/2                | 3/8                                      | 2 1/2   | 10 3/4   | 14      |
| 12                                     | 53              | 7/16               | 1/2                                      | 2 1/2   | 10 3/4   | 14      |
| 10                                     | 57              | 9/16               | 5/8                                      | 2       | 8 3/4    | 12      |
| 10                                     | 42              | 7/16               | 1/2                                      | 2       | 8 3/4    | 12      |
| 8                                      | 36              | 3/8                | 1/2                                      | 1 3/4   | 7        | 10      |

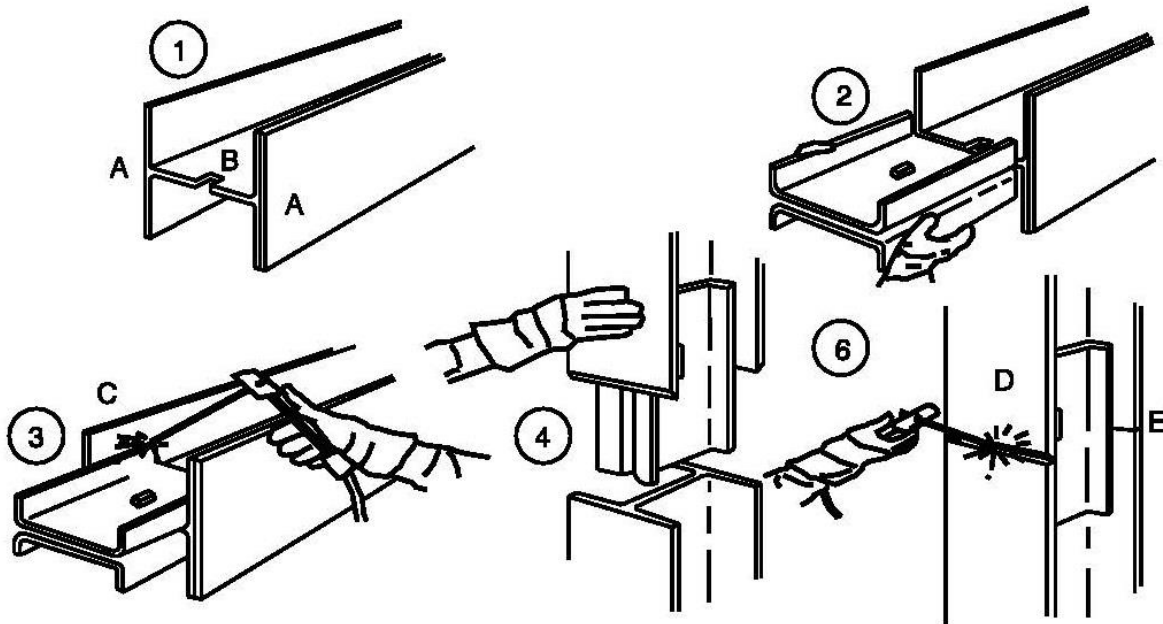
\* TOLERANCE 1/16" ±

STEEL PILE SPLICE, ALTERNATE 2  
(SHEET 2 OF 2)

ISSUED: 2016

PLATE  
3.11-5

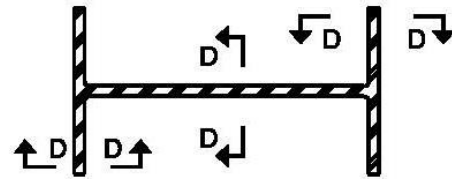
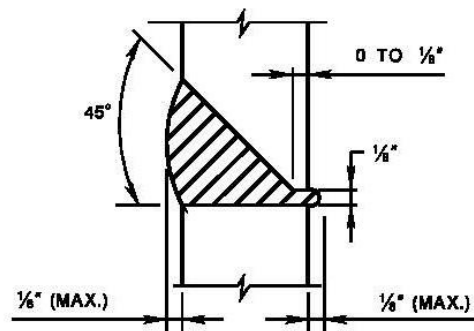
DETAILS OF ASSEMBLY



1. WITH THE PILE IN A HORIZONTAL POSITION ON THE GROUND, SCARF OUTSIDE EDGES OF FLANGES (A) AND TORCH CUT A NOTCH ( $7/8 \times 2\frac{1}{8}$ ) IN THE WEB (B) TO ACCOMMODATE THE KEY.
2. START SPLICER SLEEVE ON THE WEB AND FORCE THE SLEEVE ON UNTIL THE KEY SEATS IN THE NOTCH.
3. TACK WELD THE FLANGE OF THE SLEEVE (C) TO THE PILE ON BOTH SIDES AS NEEDED.
4. WHEN THE SPLICE IS TO BE MADE HOIST A PREPARED SECTION INTO THE LEADS, GUIDE THE SLEEVE INTO POSITION AND FORCE TO CLOSE CONTACT.
5. WELD ALL AROUND THE SPLICER SLEEVE TO THE PILE WEB AND FLANGES. USE  $\frac{3}{8}$ " FILLET WELD FOR BOTH SIDES.
6. WELD OUTSIDE FLANGES OF BUTTING SECTIONS (D) AND (E). DRIVE WHEN CONVENIENT.

STEEL PILE SPLICE, ALTERNATE 3

ISSUED: 2016

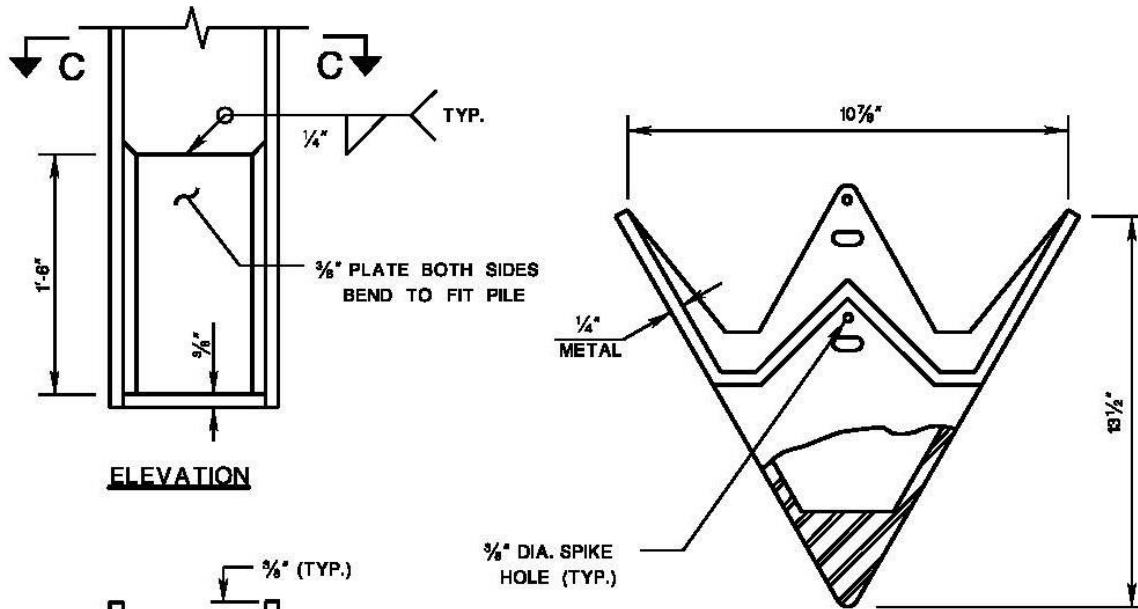
PLATE  
3.11-6SECTION AT JOINTSECTION D-D100% BUTT WELDED PILE SPLICENOTES:

1. WELDING SHALL BE AS PER A.W.S. REQUIREMENTS.

PILE TIPS (SHEET 1 OF 2)

ISSUED: 2016

PLATE  
3.11-7

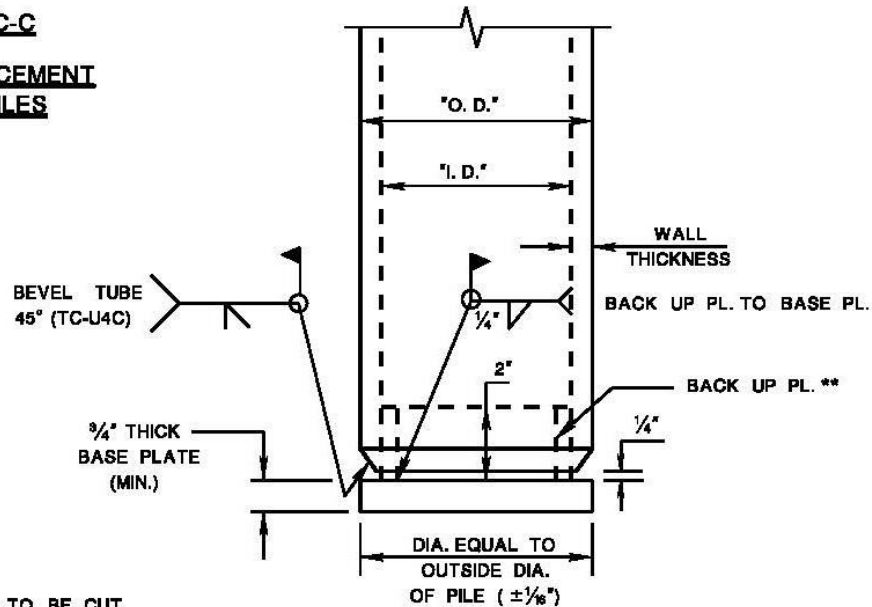
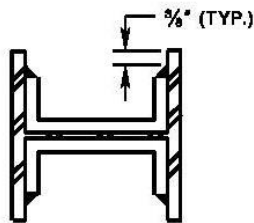


**ELEVATION**

**METAL PILE SHOE  
FOR TIMBER PILES**

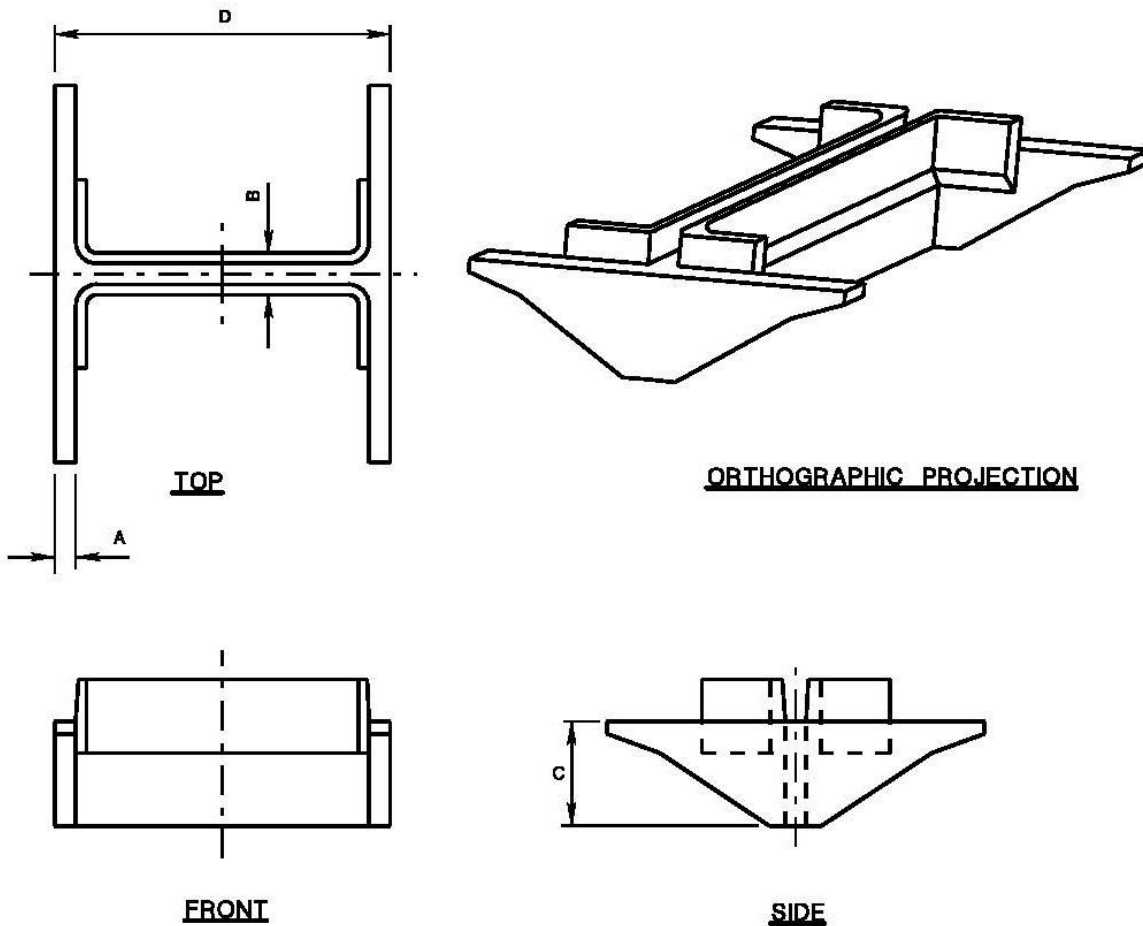
**SECTION C-C**

**PILE TIP REINFORCEMENT  
FOR STEEL PILES**



**CLOSURE PLATE FOR STEEL  
PIPE PILING & METAL SHELLS**

\*\* BACK UP PLATE: TO BE CUT FROM PILE AND BENT TO FIT "I. D." TIGHTLY ALL AROUND. BACK UP PLATE TO BE WELDED TO BASE PLATE.

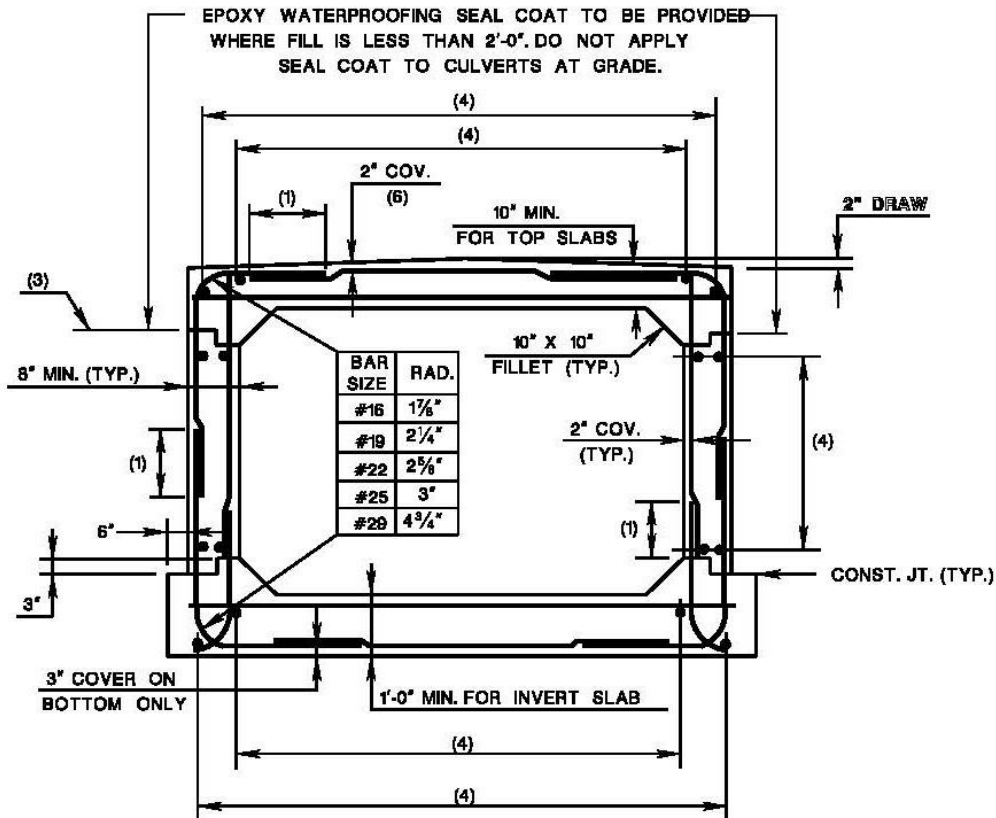


| DEPTH<br>D | A    | B    | C      | WEIGHT<br>LBS. |
|------------|------|------|--------|----------------|
| 10"        | 3/4" | 3/4" | 3"     | 17             |
| 12"        | 3/4" | 3/4" | 3 1/2" | 24             |
| 14"        | 1"   | 1"   | 4"     | 41             |

**NOTES:**

1. MATERIAL - CAST STEEL (AASHTO M103 (ASTM - A27) GRADE 65-35, CLASS 2).
2. ALL FILLETS = 3/8"
3. ALL WELDS BETWEEN H-PILE AND POINT TO BE IN ACCORDANCE WITH ANSI/AASHTO/AWS BRIDGE WELDING CODE D1.5 SPECIFICATION (LATEST EDITION). WELD FLANGES TO FITTINGS ON OUTSIDE FACES.

|   |                     |                         |
|---|---------------------|-------------------------|
| <b>SINGLE CELL BOX CULVERT,<br/>CAST-IN-PLACE</b> | <b>ISSUED: 2016</b> | <b>PLATE<br/>3.12-1</b> |
|---|---------------------|-------------------------|



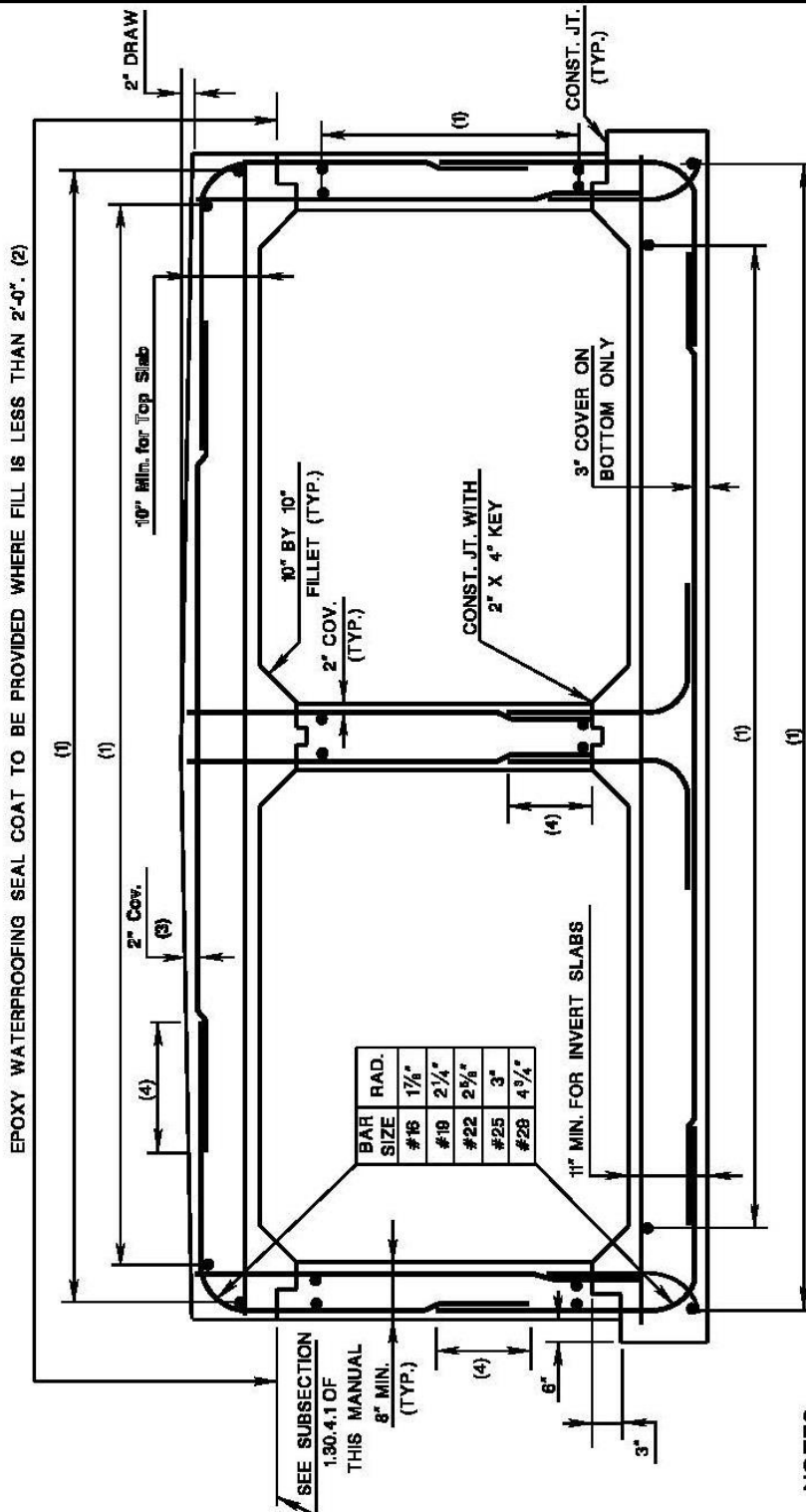
**NOTES:**

1. LAP SPLICE AND DEVELOPMENT LENGTHS SHALL BE DETERMINED BY THE DESIGNER.
2. WALL AND SLAB THICKNESSES SHOWN ABOVE ARE BASED ON AN 8'-0" WIDE BY 4'-0" HEIGHT CULVERT. INVERT SLAB THICKNESS IS EQUAL TO TOP SLAB THICKNESS PLUS 1".
3. SEE SUBSECTION 1.29.4.1 OF THIS MANUAL FOR JOINT REQUIREMENTS.
4. SIZE AND SPACING OF REBARS NOT DESIGNATED SHALL BE AS DETERMINED BY DESIGN. TOP MAT REINFORCING IN THE TOP SLAB SHALL BE CORROSION PROTECTED IF THE FILL OVER THE CULVERT IS LESS THAN 2'-0".
5. MINIMUM COVER SHALL BE 2 1/4" IF CULVERT IS AT GRADE. 1/2" SHALL BE DEDUCTED FROM THE TOP SLAB THICKNESS IN THE DESIGN CALCULATIONS AS AN ALLOWANCE FOR THE DEPTH OF SAWCUT GROOVED FINISH AND WEAR.
6. FOR BEVEL INFORMATION SEE SECTION 28.4.8 OF THIS MANUAL.

TWIN CELL BOX CULVERT,  
CAST-IN-PLACE

ISSUED: 2016

PLATE  
3.12-2



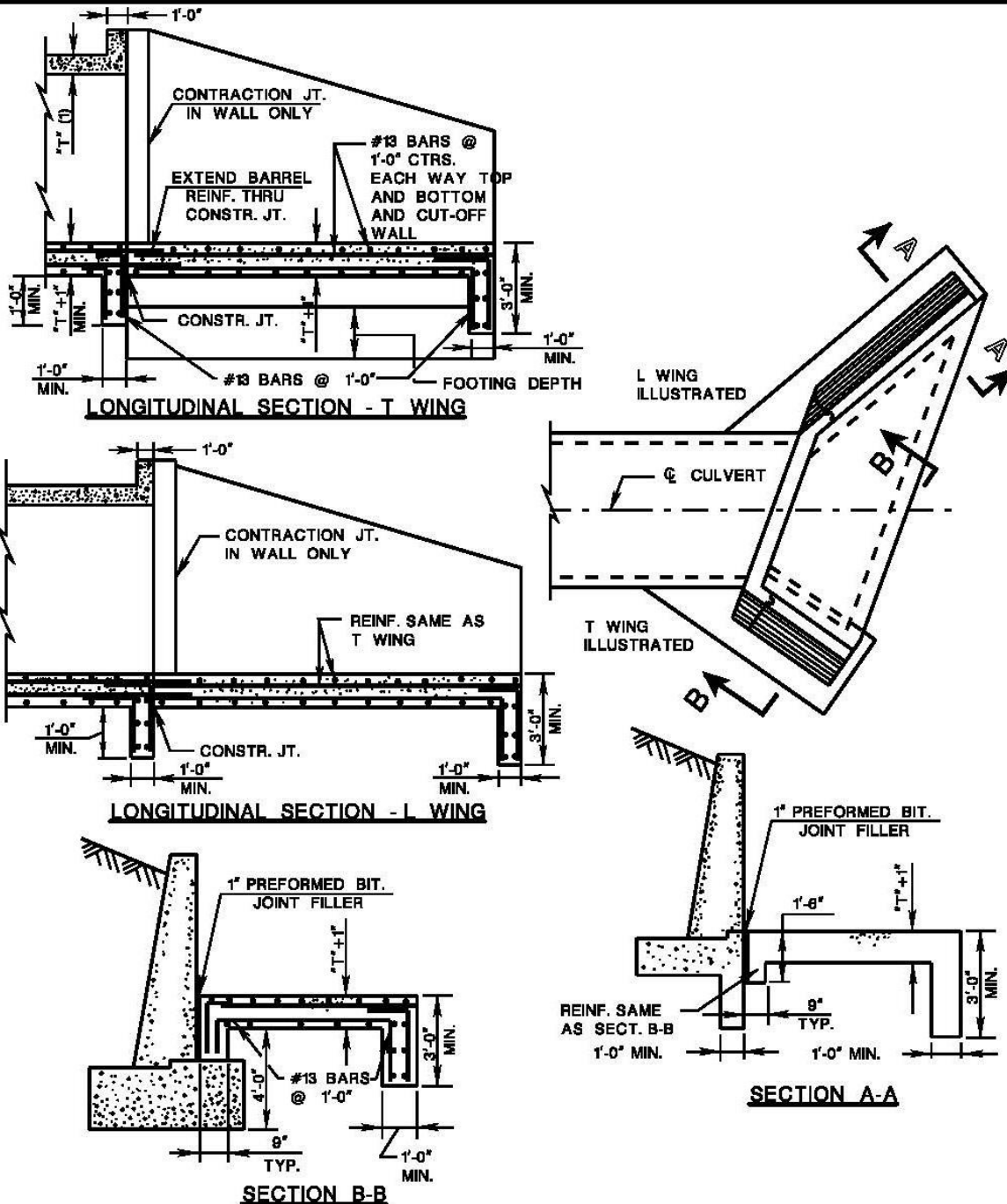
**NOTES:**

1. SIZE AND SPACING OF REBARS NOT DESIGNATED SHALL BE DETERMINED BY DESIGN.
2. DO NOT APPLY SEAL COAT TO CULVERTS AT GRADE. TOP MAT REINFORCING IN THE TOP SLAB SHALL BE CORROSION PROTECTED IF THE FILL OVER THE CULVERT IS LESS THAN 2'-0".
3. MINIMUM COVER SHALL BE 2 1/2" IF CULVERT IS AT GRADE. 1/2" SHALL BE DEDUCTED FROM THE TOP SLAB THICKNESS IN THE DESIGN CALCULATION AS AN ALLOWANCE FOR THE DEPTH OF SAWCUT GROOVED FINISH AND WEAR.
4. LAP SPLICE AND DEVELOPMENT LENGTHS SHALL BE DETERMINED BY THE DESIGNER.
5. WALL AND SLAB THICKNESSES SHOWN ABOVE ARE BASED ON AN 8'-0" WIDE BY 4'-0" HEIGHT FOR EACH CELL. INVERT SLAB THICKNESS IS EQUAL TO TOP SLAB THICKNESS PLUS 1".
6. FOR BEVEL INFORMATION SEE SECTION 29.4.8.

PAVED APRONS FOR BOX CULVERTS

ISSUED: 2016

PLATE  
3.12-3



**NOTES:**

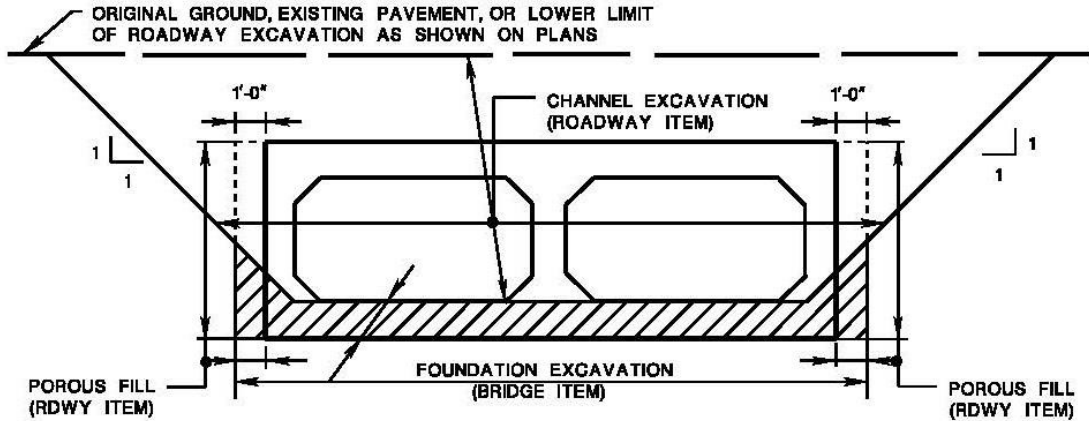
1.  $T$  IS EQUAL TO THE TOP SLAB THICKNESS.
2. A MINIMUM 3'-0" DEEP CUT OFF WALL (CURTAIN WALL) IS REQUIRED WHEN CULVERT DOES NOT HAVE A PAVED APRON.
3. A WATER STOP SHALL BE PROVIDED IN THE CONTRACTION JOINT IN THE RETAINING WALL.



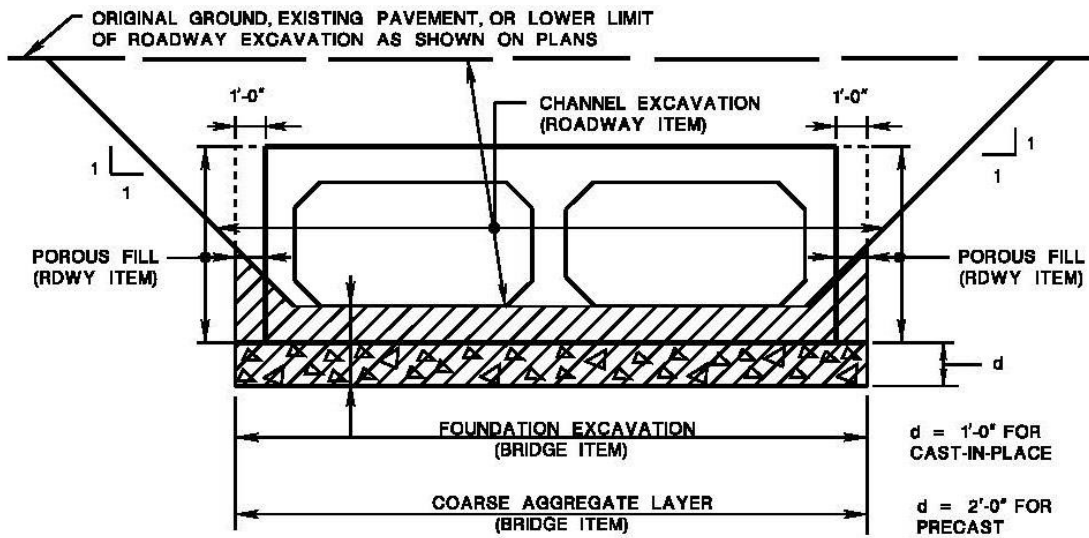
**PAYMENT LIMITS FOR EXCAVATION  
AT CULVERT**

**ISSUED: 2016**

**PLATE  
3.12-4**



**CONDITION 1:** NO REMOVAL OF UNSUITABLE MATERIAL REQUIRED FOR CULVERT FOUNDATION (AS DETERMINED BY SOILS ENGINEER)

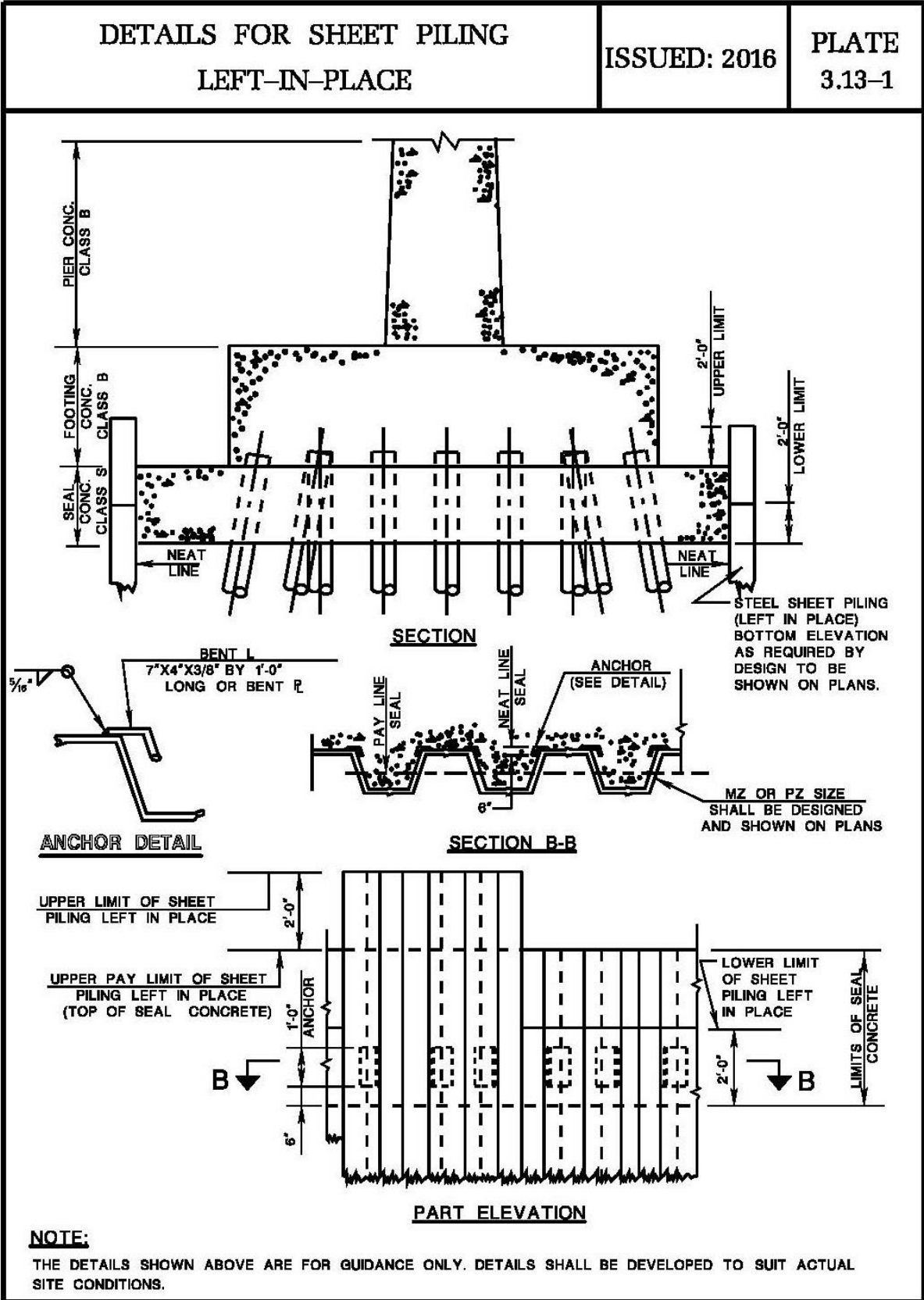


**CONDITION 2:** NO REMOVAL OF UNSUITABLE MATERIAL REQUIRED; HOWEVER COARSE AGGREGATE LAYER REQUIRED FOR WATER PROBLEMS ANTICIPATED DURING CONSTRUCTION (AS DETERMINED BY BRIDGE ENGINEER / SOILS ENGINEER).

**CONDITION 3:** NO TYPICAL ILLUSTRATION SHOWN. WHERE SOILS ENGINEER DETERMINES THAT UNSUITABLE MATERIAL MUST BE REMOVED TO AN EXTENT AS NECESSARY FOR ROADWAY AND STRUCTURE DESIGN, IT SHALL BE THE RESPONSIBILITY OF THE BRIDGE ENGINEER TO COORDINATE A MEETING OF ALL PARTIES CONCERNED IN ORDER THAT THE ROADWAY AND BRIDGE PLANS ARE CONSISTENT IN EVERY DETAIL PRIOR TO SUBMISSION OF FINAL PLANS.

**NOTE:**

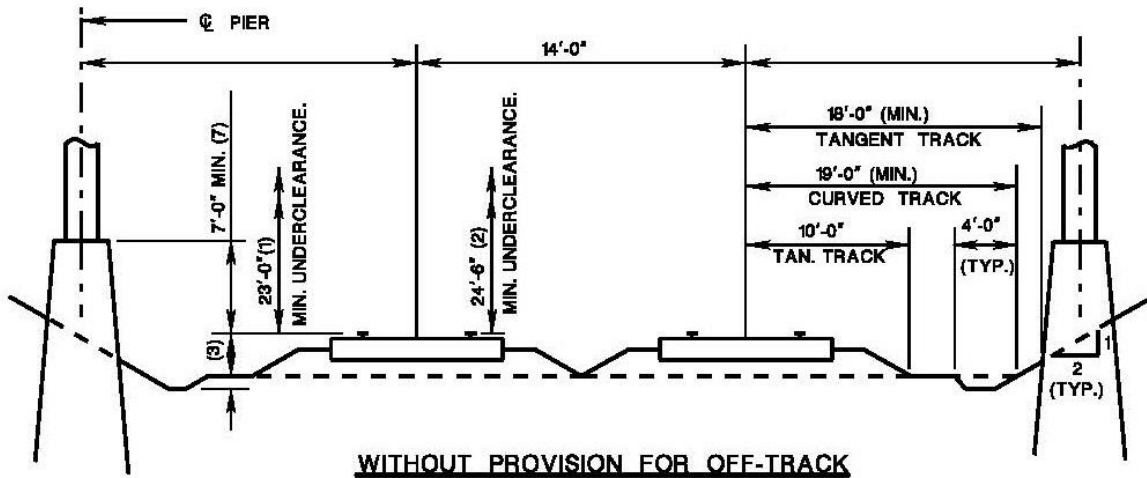
THE ABOVE ILLUSTRATIONS ARE INTENDED FOR USE AS GUIDELINES AND NOT AS CONTRACT PLAN STANDARD DETAILS. EACH CONTRACT AND EACH SITUATION SHOULD BE EXAMINED ON AN INDIVIDUAL BASIS.



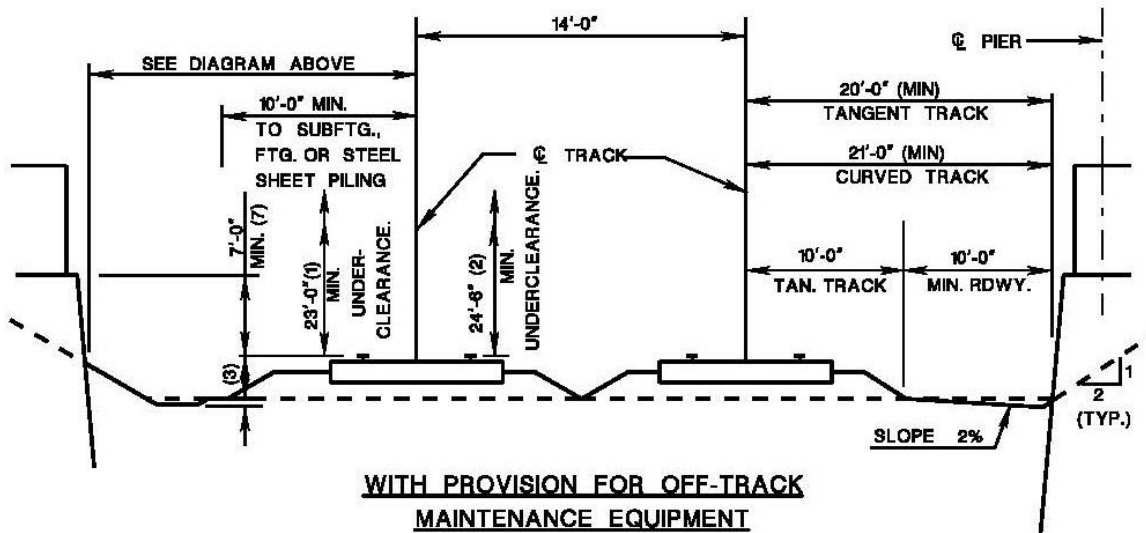
**RAILROAD SIDE CLEARANCE, DOUBLE TRACK UNDER NEW CONSTRUCTION**

**ISSUED: 2016**

**PLATE  
3.14-1**



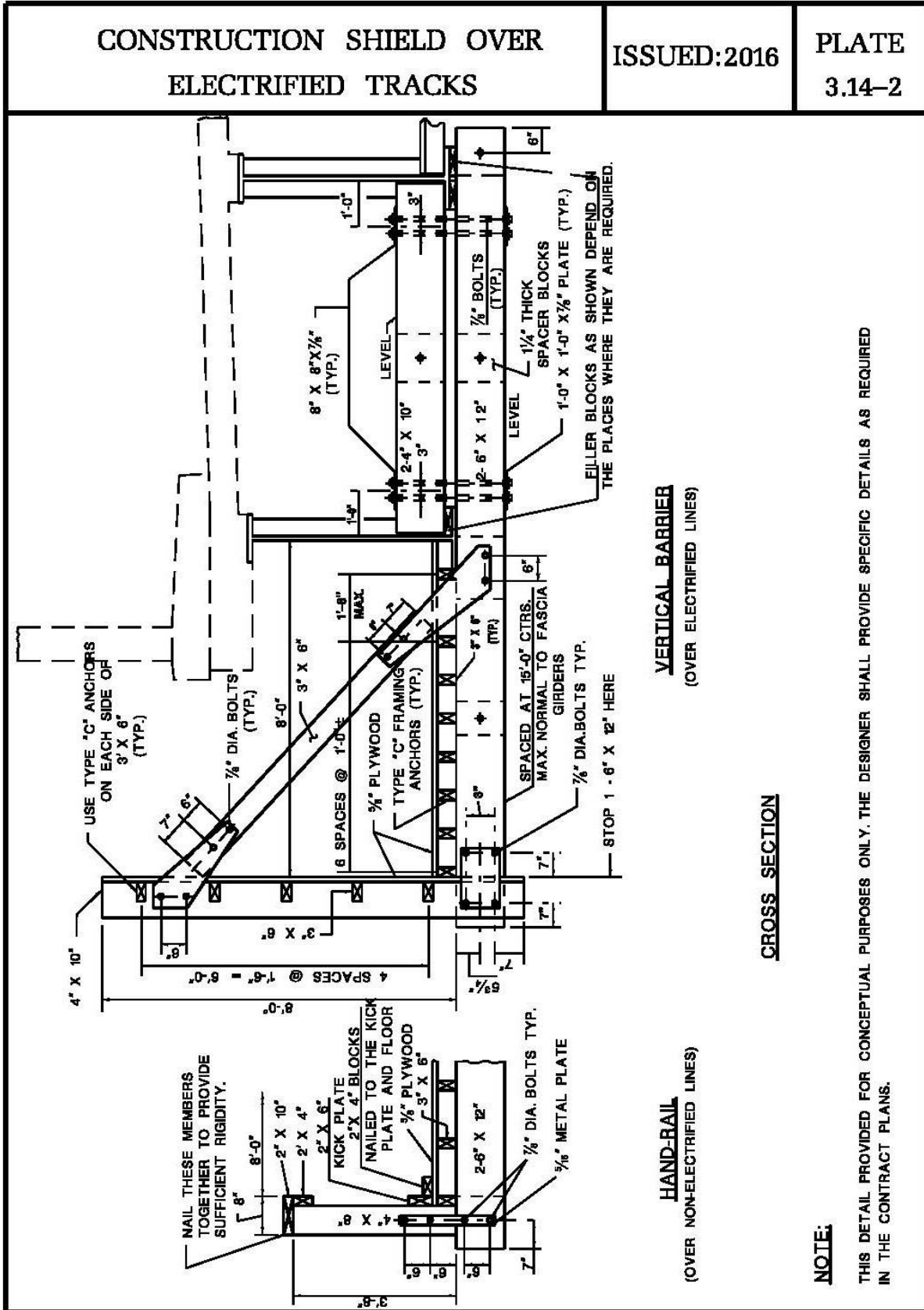
**WITHOUT PROVISION FOR OFF-TRACK MAINTENANCE EQUIPMENT**



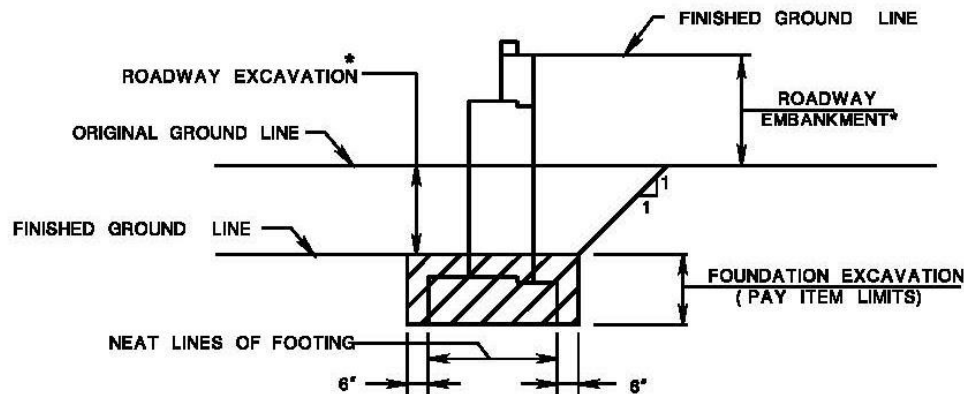
**WITH PROVISION FOR OFF-TRACK MAINTENANCE EQUIPMENT**

**NOTES:**

1. MINIMUM VERTICAL UNDERCLEARANCE MEASURED FROM THE TOP OF RAIL FOR NON-ELECTRIFIED TRACKS SHALL BE 23'-0".
2. MINIMUM VERTICAL UNDERCLEARANCE MEASURED FROM THE TOP OF RAIL FOR ELECTRIFIED TRACKS SHALL BE 24'-6".
3. THIS DIMENSION IS VARIABLE.
4. ALL DIMENSIONS SHOWN ARE AT RIGHT ANGLES TO THE TRACK.
5. CLEARANCE FOR RECONSTRUCTION WORK OR FOR ALTERATIONS ARE DEPENDENT ON THE EXISTING PHYSICAL CONDITIONS AND WHERE REASONABLY POSSIBLE SHOULD BE IMPROVED TO MEET THE REQUIREMENTS OF NEW CONSTRUCTION.
6. THE DIAGRAMS ABOVE ILLUSTRATE AREMA MINIMUM LATERAL CLEARANCE REQUIREMENTS FOR NEW CONSTRUCTION.
7. THE 7'-0" MINIMUM VERTICAL CLEARANCE INCLUDES THE FUTURE BALASTING REQUIREMENTS.



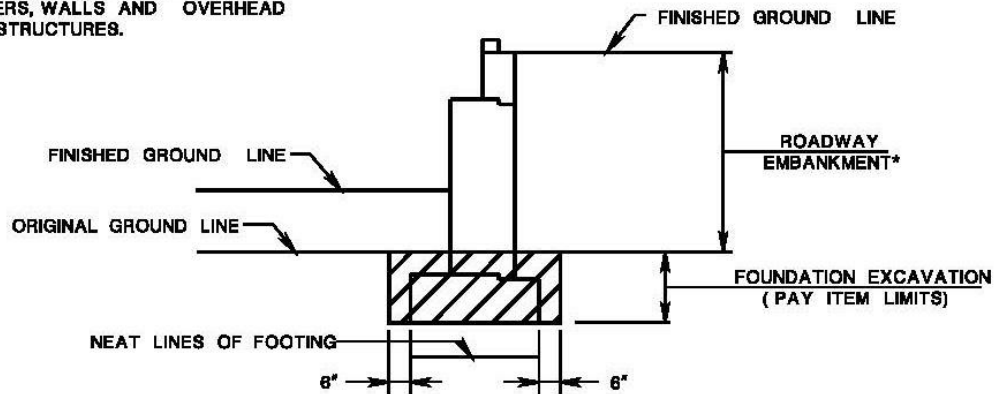
|   |                    |                               |
|---|--------------------|-------------------------------|
| <b>PAYMENT LIMITS FOR EXCAVATION</b><br><b>( SHEET 1 OF 5 )</b> | <b>ISSUED:2016</b> | <b>PLATE</b><br><b>3.15-1</b> |
|---|--------------------|-------------------------------|



**CASE 1 ( PRIOR ROADWAY EXCAVATION SCHEDULED )**

**NOTE:**

HIGH ABUTMENT ILLUSTRATED. SIMILAR SKETCHES REQUIRED FOR PIERS, WALLS AND OVERHEAD SIGN STRUCTURES.



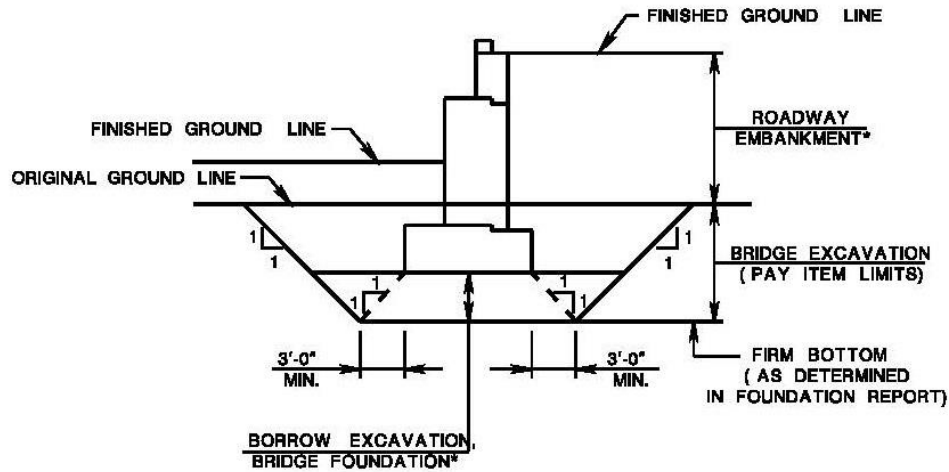
**CASE 2 ( NO ROADWAY EXCAVATION SCHEDULED )**

**NOTES:**

1. PAY ITEM LIMITS MUST BE SHOWN ON BRIDGE PLANS. THIS CAN BE ACCOMPLISHED BY USING SCHEMATIC DRAWINGS AS SHOWN ABOVE, OR MAY BE INDICATED ON THE DETAIL SECTIONS.
2. THE BRIDGE DESIGN ENGINEER, SHALL REVIEW THE ROADWAY PLANS AND X-SECTIONS PRIOR TO SUBMISSION OF FINAL PLANS TO DETERMINE THAT EXCAVATION PAYMENT LIMITS FOR ROADWAY AND BRIDGE WORK ARE COMPATIBLE.

\* INDICATES ROADWAY PAY ITEM OF WORK.

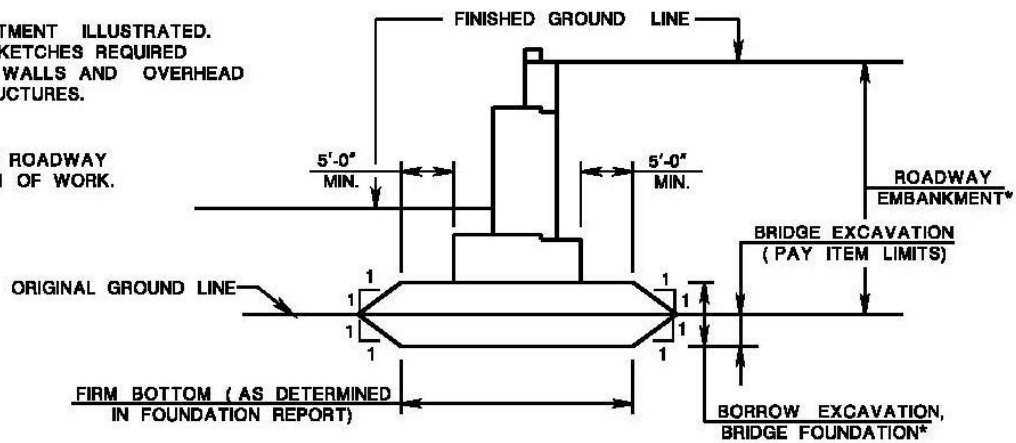
|   |                     |                               |
|---|---------------------|-------------------------------|
| <b>PAYMENT LIMITS FOR EXCAVATION</b><br><b>( SHEET 2 OF 5 )</b> | <b>ISSUED: 2016</b> | <b>PLATE</b><br><b>3.15-2</b> |
|---|---------------------|-------------------------------|



**NOTE:**

HIGH ABUTMENT ILLUSTRATED. SIMILAR SKETCHES REQUIRED FOR PIERS, WALLS AND OVERHEAD SIGN STRUCTURES.

\*INDICATES ROADWAY PAY ITEM OF WORK.



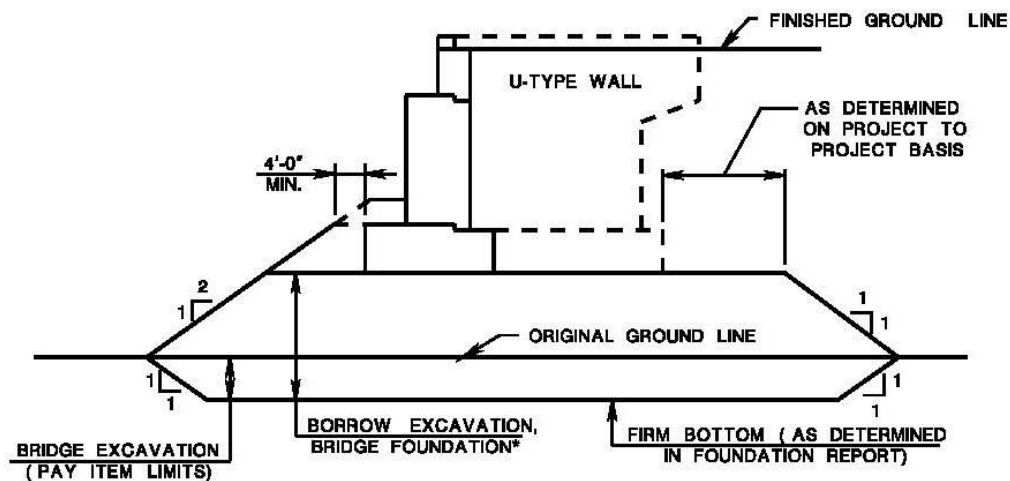
**NOTES:**

1. SEE GUIDE SHEET PLATE 3.15-1 NOTE 1.
2. SEE GUIDE SHEET PLATE 3.15-1 NOTE 2.
3. BRIDGE EXCAVATION IS CONSIDERED FOR SCHEDULING AS A PAY ITEM, WHERE UNSUITABLE MATERIAL IS NOT BEING REMOVED UNDER ROADWAY EXCAVATION ITEMS OF WORK, DEPTH OF EXCAVATION TO REACH SUITABLE MATERIAL IS MINIMAL, AND PILE FOUNDATIONS ARE NOT REQUIRED-AS DETERMINED IN FOUNDATION REPORT.
4. ALSO, SEE GUIDE SHEET PLATE 3.3-2.

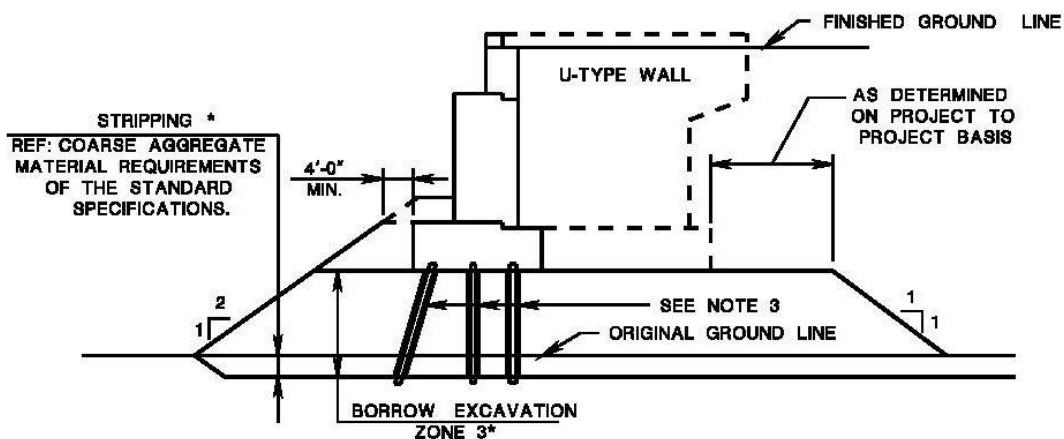
**PAYMENT LIMITS FOR EXCAVATION  
( SHEET 3 OF 5 )**

**ISSUED: 2016**

**PLATE  
3.15-3**



**CASE 5 (STUB ABUTMENT WITHOUT PILES)**



**CASE 6 (STUB ABUTMENT ON PILES)**

**NOTES:**

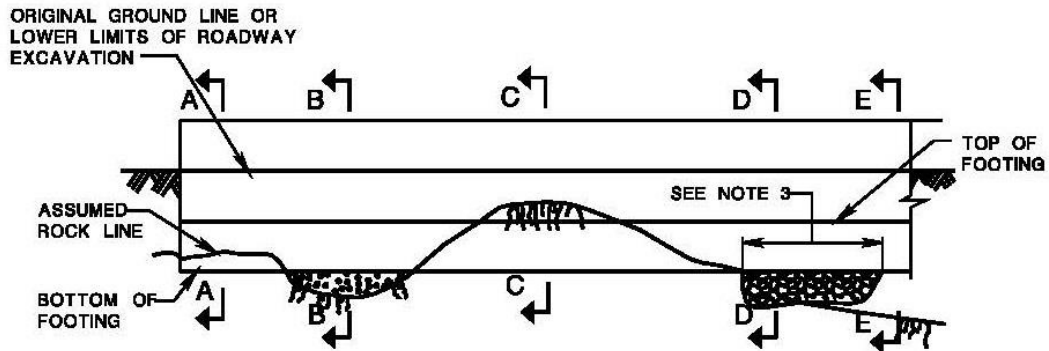
1. SEE GUIDE SHEET PLATE 3.15-1 NOTE 1.
2. SEE GUIDE SHEET PLATE 3.15-1 NOTE 2
3. PREBORED HOLES, WHEN REQUIRED BY THE FOUNDATION REPORT. SEE PILE CONSTRUCTION REQUIREMENTS OF THE NJDOT STANDARD SPECIFICATIONS AND SECTION 34 OF THIS MANUAL.
4. ALSO, SEE GUIDE SHEET PLATE 3.3-3.
5. FOUNDATION EXCAVATION, PAY ITEM NOT TO BE SCHEDULED.

\* INDICATES ROADWAY PAY ITEM OF WORK

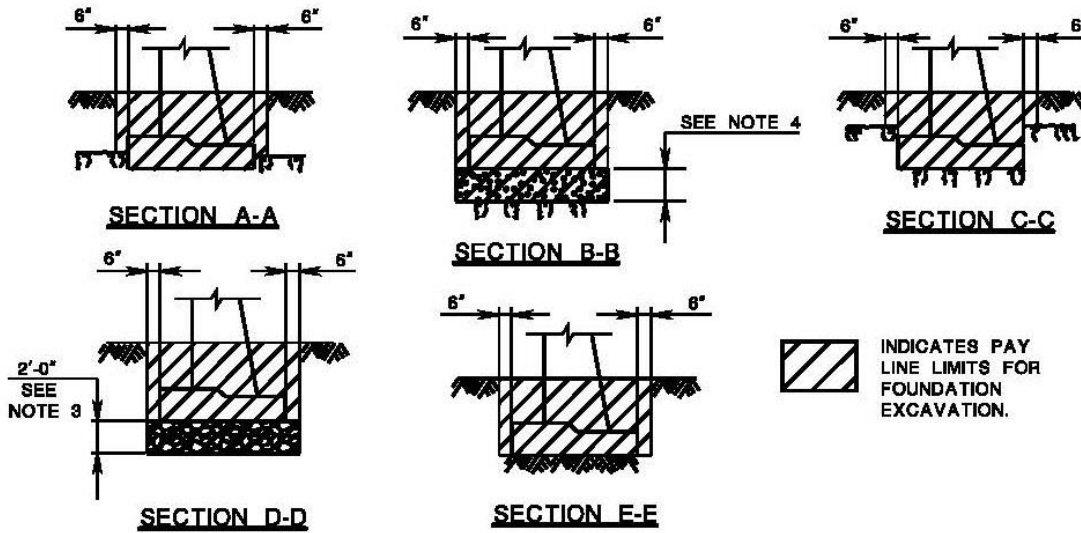
**PAYMENT LIMITS FOR EXCAVATION  
( SHEET 4 OF 5 )**

**ISSUED: 2016**

**PLATE  
3.15-4**



**ELEVATION-ABUTMENTS, WALLS, PIERS  
(FOOTING PARTLY ON ROCK AND EARTH)**

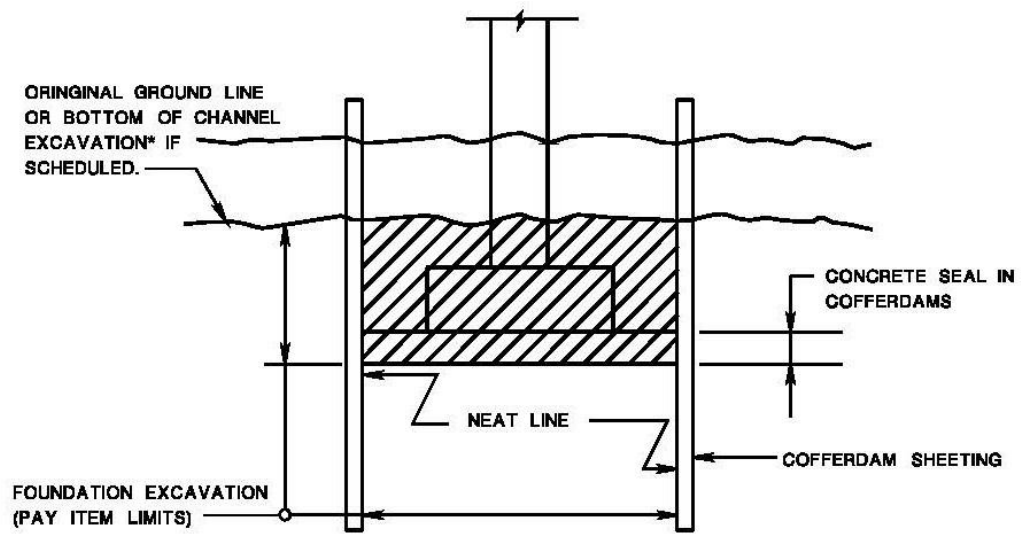


**NOTES:**

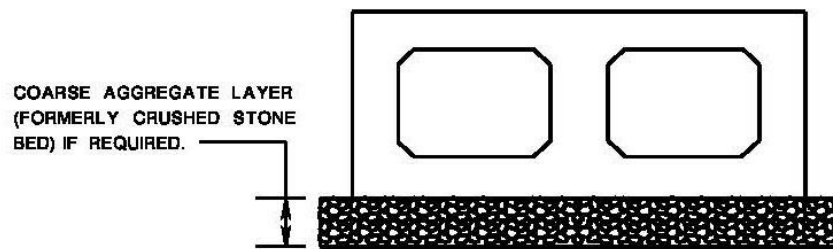
1. SEE GUIDE SHEET PLATE 3.15-1, NOTE 1.
2. SEE GUIDE SHEET PLATE 3.15-1, NOTE 2.
3. EXCAVATE ROCK, BACKFILL AND COMPACT COARSE AGGREGATE LAYER AS PER THE NJDOT STANDARD SPECIFICATION. LENGTH AS DETERMINED ON PROJECT TO PROJECT BASIS.
4. PLACE CLASS B CONCRETE, INCLUDE PARAGRAPH IN SPECIAL PROVISIONS THAT THE VOLUME OF CONCRETE WILL BE INCLUDED FOR PAYMENT UNDER CONCRETE IN FOOTINGS.
5. IF THE ASSUMED ROCK LINE IS MORE THAN 2'-0" ABOVE OR BELOW THE BOTTOM OF FOOTING, CONSIDER "STEPPING" OF THE FOOTING, AS AN ALTERNATIVE TO THE ABOVE DETAILS.



|   |                     |                         |
|---|---------------------|-------------------------|
| <b>PAYMENT LIMITS FOR EXCAVATION<br/>( SHEET 5 OF 5 )</b> | <b>ISSUED: 2016</b> | <b>PLATE<br/>3.15-5</b> |
|---|---------------------|-------------------------|



**FOOTINGS IN COFFERDAMS**



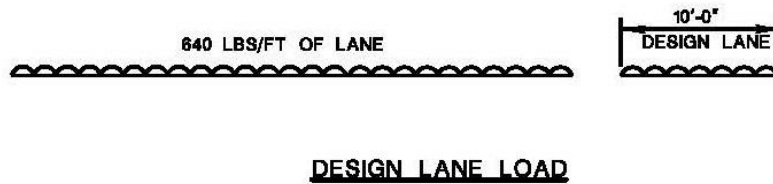
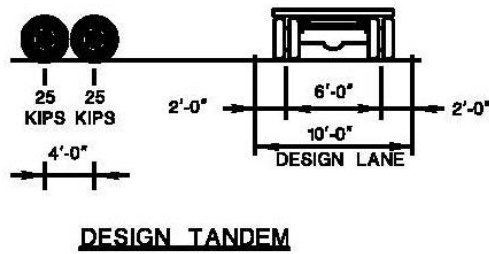
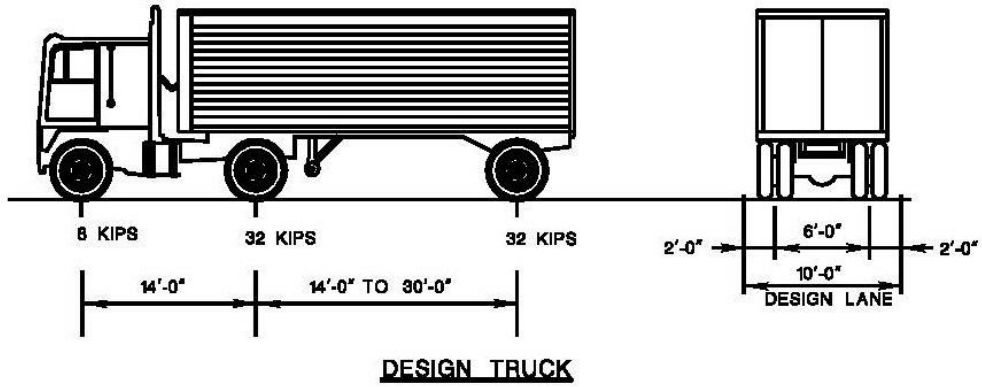
**CULVERTS**

(SEE GUIDE SHEET PLATE 3.12-4 FOR EXCAVATION PAY ITEM LIMITS)

**NOTES:**

1. SEE GUIDE SHEET PLATE 3.15-1, NOTE 1.
  2. SEE GUIDE SHEET PLATE 3.15-1, NOTE 2.
- \* INDICATES ROADWAY PAY ITEM OF WORK

|               |              |                 |
|---------------|--------------|-----------------|
| HL-93 LOADING | ISSUED: 2016 | PLATE<br>3.16-1 |
|---------------|--------------|-----------------|



\* VARIABLE SPACING - 14'-0" TO 30'-0" INCLUSIVE. SPACING TO BE USED IS THAT WHICH PRODUCES MAXIMUM LOAD EFFECTS.

