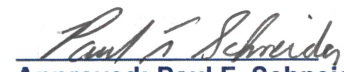


New Jersey Department of Transportation CORRECTIVE ACTION NOTICE

CAPITAL PROGRAM SUPPORT

Director: Paul F. Schneider Telephone: (609) 963-1821

CAN No. 086R


Approved: Paul F. Schneider
Date: 01/26/2024

Subject: NJDOT GUIDANCE ON MASH IMPLEMENTATION FOR BRIDGE RAILINGS AND OTHER BRIDGE RELATED SAFETY FEATURES

Bureau(s) Affected: All Bridge Design Consultants; Division of Bridge Engineering and Infrastructure Management, Division of Project Management, Division of Construction and Materials, Division of Highway and Traffic Design, Transportation Operations Systems and Support, County Engineer Offices, Division of Local Aid and Economic Development.

Description of Issue(s): As per the 2016 AASHTO/FHWA Joint Implementation Agreement for the AASHTO Manual for Assessing Safety Hardware (MASH), effective January 1, 2020, only bridge railings (and other roadside safety hardware) evaluated using MASH criteria will be allowed for permanent installations and full replacements on the National Highway System (NHS). The current *NJDOT Design Manual for Bridges and Structures* does not include updated criteria or guidance for MASH hardware. NJDOT is in the process of updating the existing Design Manual for Bridges and Structures and Standard Construction Details for bridge railings and bridge related safety features. The guidance contained herein is intended to provide general guidelines for projects on NHS and Non-NHS roadways with bridge railings and other safety features, including information on Approach Guide Rail Transition (AGT) attachments, aesthetic treatments, NJDOT bridge railing selection, and a list of NJDOT authorized MASH crashworthy bridge railing systems.

Corrective Action Plan: MASH Implementation for Bridge Railings and clarification of General Bridge Railing Information.

1. Guide for Interstate Highway, State Roadway, and Freeway Projects:

For all bridges and structures on interstate highways and freeways all bridge railings shall meet MASH compliance for minimum of Test Level 5 (TL-5). For all the bridges and structures on NJ state routes and NHS classified roadways other than interstate highways and freeways, MASH Test Level 4 (TL-4) bridge railings shall initially be considered as the minimum acceptable system for use. All bridge railing and hardware design concepts shall follow CAN086R at early stages of the design process, prior to submitting environmental permit applications.

For all projects, a MASH crash-tested system with an FHWA Eligibility Letter or MASH equivalent system with supporting evaluation documents shall be considered first. For a project with site constraints or special conditions where MASH bridge railings and safety features are not implementable, the Designer shall contact NJDOT Structural Engineering Services early in the design process to discuss the project, prior to submitting environmental permit applications.

TABLE 1 "List of MASH Crashworthy Bridge Railing Systems Authorized for Use by NJDOT" is located at the end of this document.

2. Guide for Local Aid Projects: All sections of this CAN apply to Local Aid Projects with additional clarification in Section 2.

- a. It is a goal of NJDOT Bridge Engineering and Infrastructure Management (BEIM) to have MASH compliant railing systems implemented throughout the state on all local, County, and State-owned bridge structures. A MASH crash-tested system with an FHWA Eligibility Letter or MASH Equivalent system shall be considered first.
- b. All Federally funded or Funds Exchange Program (TTF Swap) projects shall use MASH compliant bridge railings and comply with this CAN guidance.
- c. MASH crash tested or MASH evaluated/equivalent bridge railing systems and NJDOT's current standard bridge railing details (BCD series) are available for use along with the guidelines in this CAN until new NJDOT standard details are available.
- d. In the interim, NJDOT is recommending that bridge railing systems from Table 1 be considered for county use. In the case that this is not implementable see section 4.b.iii.
- e. For NHS Roadways, NJDOT requires MASH compliant railings.
- f. For Non-NHS Roadways not federally funded, MASH compliant railings are preferred. However, alternate railings with NCHRP 350 FHWA eligibility letters (See 4.b.ii) or NJDOT current Standard Details will be considered for county

approval upon designers providing justification (see bridge site conditions described in Justification below). For projects with high speed (design speed >45 mph) or there are 12 percent or more trucks in the project area or the traffic volume is greater than 15,000 vehicles, NCHRP 350 bridge railing systems should not be approved, and MASH systems should be used.

Examples of NCHRP 350 Justification:

- Bridge and roadway geometry and site conditions (roadway classification and NHS status, horizontal curvature, average daily traffic volume (ADT), average daily truck traffic volume (ADTT), source of ADT and ADTT, posted and design speeds, required/proposed Test Level (TL) for the bridge/structure, etc.)
 - The reason for use, the reason for any changes from details within an eligibility letter, and why the changes don't adversely affect the bridge railing's crashworthiness.
- g. All bridge railing and hardware design concepts shall follow CAN086R at early stages of the design process, prior to submitting environmental permit applications.

3. MASH Implementation Information Resources:

- Clarifications on Implementing MASH 2016 (aka MASH Q&A), the latest version
- AASHTO-FHWA Joint Implementation Agreement for MASH, 2016
- FHWA's Roadside Hardware Policy Memoranda and Guidance
- Federal-aid Eligibility Letters for Roadside Hardware
- *Manual for Assessing Safety Hardware* (MASH), 2016 Edition, in the AASHTO bookstore

The resources stated above as well as additional MASH Implementation information can be found within the link below.

[Roadside Safety – Committee on Design \(transportation.org\)](https://www.transportation.org/Roadside-Safety-Committee-on-Design)

4. Guide for Bridge Railing Selection:

- a. NJDOT Standard Bridge Construction Details
- i. Do not use Aluminum Railings or combination railings with aluminum bars/elements (Have been obsolete since previous CAN 086 was issued, Oct. 5, 2018).
 - ii. NJ Shape Bridge Median Barrier (BCD-507-10) is considered obsolete with this CAN document. Designers should design bridge median barriers using NJDOT standard F-shape configuration (BCD-507-9) back-to-back or split median barrier with $\frac{3}{4}$ " minimum gap using F-shape configuration (BCD-507-9) back-to-back. Additionally, designer can propose an alternative bridge median barrier (including MASH TL-3 NJ Shape) that is MASH compliant and has a FHWA Eligibility Letter. See Section 4.b below for guidance on bridge railing system eligibility letters.
- b. Bridge Railing Systems Eligibility Letters
- i. FHWA MASH Eligibility Letters for Longitudinal Barriers and Bridge Rails are available on FHWA's website at the link below.
MASH: [Longitudinal Barriers - Safety | Federal Highway Administration \(dot.gov\)](https://www.fhwa.gov/safety/mash/longitudinal-barriers-safety)
 - ii. Only Local Aid projects meeting the speed, truck percentage and ADT of this CAN document are allowed to use NCHRP 350 systems. FHWA NCHRP 350 Eligibility Letters for Longitudinal Barriers and Bridge Rails are available on FHWA's website at the link below.
NCHRP 350: [Longitudinal Barriers – NCHRP 350 - Safety | Federal Highway Administration \(dot.gov\)](https://www.fhwa.gov/safety/nchrp-350-longitudinal-barriers-safety)
 - iii. For MASH compliant bridge railings not in TABLE 1, Designer shall provide one of the following to NJDOT Structural Engineering Services for review and approval prior to submitting environmental permit applications:
 - FHWA Eligibility Letter
 - In the case that a FHWA MASH Eligibility Letter is not available, provide supporting documentation for the proposed railing's MASH crashworthiness or its evaluated equivalency.
 - iv. MASH crash tested bridge railing systems without a full set of MASH tests are not acceptable unless an evaluation is performed and approved by NJDOT Structural Engineering Services.
 - v. Designer shall provide MASH, or NCHRP 350 when applicable, Test Level designation in design notes on the contract plans.

5. NJDOT Authorized MASH Crashworthy Bridge Railing Systems

- a. The NJDOT authorized bridge railing systems listed in TABLE 1 are considered MASH crashworthy for NJDOT projects at the designated Test Level (TL).
- b. Due to the time required for MASH crash testing and the capacity of MASH crash testing facilities, available MASH compliant bridge railing systems are still limited. NJDOT Standard Construction Details for bridge railings, barriers, and transitions have not yet been updated to reflect MASH testing and/or MASH TL level designations. FHWA allows State DOTs to self-certify bridge railing, barrier, and transition systems that the State DOT deems acceptable for use on NHS and non-NHS roadways. NJDOT has determined that the steel railing, concrete barrier, and combination railing systems, identified in TABLE 1, are satisfactory in strength and safety configuration to meet the AASHTO MASH requirements for crashworthiness.

6. Approach Guide Rail Transition (AGT) Attachments to Existing and New Bridge Pylons and Abutments

AGT attachments to Bridge Railing Details shall follow the *NJDOT Standard Roadway and Bridge Construction Details* with modification below. AGT attachments shall be MASH compliant following CD-609 series. AGT attachment to bridge abutment walls or attachment directly to new/existing bridge railing front surface is not permitted without prior written approval from NJDOT Manager of Bureau of Structural Engineering Services.

For projects where bridge deck replacement is included in the scope of work, the bridge railing system and pylon shall be reconstructed to meet MASH standards. For projects where bridge deck replacement is not included in the scope of work, upgrading the bridge railing system is not required and pylon modifications to receive the AGT attachments shall be limited to only what is necessary to accommodate the attachment. Pylons should be modified to meet the geometric requirements for an AGT attachment. When the AGT attachment can be made without reconstructing the entire pylon, then strengthening the pylon to MASH standards is not required. When extensive pylon modifications are required to accommodate the AGT attachment then the pylon shall be reconstructed to meet MASH standards to the extent practicable. Moment slab and retaining wall strengthening are not required unless the bridge is being rehabilitated and the entire bridge railing system is upgraded to MASH standards.

Bridge pylon details within standard construction details (BCD 609 and CD 609 series) are currently not MASH compliant and will be updated to MASH with future BDCs. Until MASH compliant standard pylon details are issued, the current pylon details along with MASH AGT details in Standard Roadway Construction details may be used with updated pylon requirements listed below.

- a. For new construction, reconstruction, and limited scope projects, vertical transition slope (taper) for concrete pylons with AGT attachments shall be 6:1 (Horizontal: Vertical) or flatter. Additionally, horizontal safety shape transitions for bridge railings to concrete pylons shall be 10:1 (Horizontal: Thickness) or flatter. In the case where existing bridge structures cannot satisfy this requirement, the Designer shall contact NJDOT Structural Engineering Services, and Roadway Standards if necessary.
- b. For new AGT attachments to existing bridge pylons, use details within BCD 609 series to complete pylon retrofits and match roadway construction details (CD-609 series) with update requirement in Section 6.a.
- c. For new construction proposed bridge railings and pylons shall be constructed on bridge decks, wingwalls, approach slabs or moment slabs with adequate capacity to resist vehicle impact loads.
- d. Depending on existing condition of safety walk or sidewalk, new guide rail may be attached to the curb line of safety walk or sidewalk for rehabilitation projects using NJDOT Standard Construction Detail CD-609-11. This will not require AGT attachment to a bridge pylon, bridge railing front surface, or bridge abutment wall.
- e. Each project is unique, and details may be designed on a project-by-project basis. Based on the site conditions (such as roadway feature, speed limit, traffic and truck traffic volumes, safety walk/sidewalk condition, utility conduit location/status, etc.) and project scope of work (guide rail upgrade, resurfacing, deck repair, etc.), the Designer should review existing as-built documents and inspection reports (SI&A report) for concept development and final design.
- f. If a bridge is planned to have a deck replacement, superstructure replacement, or total replacement in the near future, the bridge railing and/or AGT attachment work may be deferred such that it is included as part of the replacement

project. To discuss the feasibility of deferring work, the Designer should contact the NJDOT Project Manager and NJDOT Structural Engineering Services.

7. Bridge Railing Aesthetic Treatments

When aesthetic treatments are required for a project, the Designer shall first consider the use of MASH crash tested bridge railing systems with aesthetic treatment. When such a system is not available, use the following guidance:

- a. For aesthetic treatments on the traffic exposed face of bridge railings, designers may refer to NCHRP Report 554 for design guidance which was based on NCHRP 350 TL-3 crash testing and analysis.
 - i. For low-speed roadways (design speed ≤ 45 mph) when a TL-4 or lower test level railing is used, these aesthetic guidelines may be used.
 - ii. For high-speed roadways (design speed > 45 mph) TL-4 and higher test level bridge railing, Aesthetic treatments should follow the guidance in *NJDOT Design Manual for Bridges and Structures* with maximum recess depth of 1/2". Aesthetic treatments not meeting these guidelines shall be submitted for approval by NJDOT Structural Engineering Services on a project-by-project basis.
 - iii. Aesthetic treatments listed in FHWA Letter HAS-10/B110 as "not acceptable" shall not be used for projects in New Jersey. Designers may request the FHWA Letter from NJDOT if it is not available from the FHWA website.
 - iv. Aesthetic treatments using form liners that meet the above requirements are acceptable.
- b. Pilaster and pylon of bridge railings may follow the following guidance:
 - i. Snag points should be eliminated from pilaster and pylon design. Aesthetic pilasters facing traffic are considered a snagging concern and should be limited in design. If a special aesthetic design is required for a project, the Designer shall contact NJDOT for approval on a project-by-project basis.
 - ii. Aesthetic treatment for pilaster and pylon surface shall follow the guidance in Section 7.a above.

8. Temporary Construction Barrier Systems for Bridge Construction:

NJDOT issued standard construction details for MASH TL-3 compliant construction barrier curbs (Type A through Type D) via BDC21D-06 in March 2022. These construction details may be used for bridge construction or staged bridge construction projects with the following requirements:

- a. Designer should contact NJDOT Work Zone Traffic Control Unit for the type of construction barrier systems, speed limit and work zone safety control plans to be used in a specific construction project.
- b. A clear area behind a construction barrier curb is given in the standard Traffic Control Details (TCD-2) for each construction portable barrier curb (PBC) attachment type. However, the following additional requirements are to be met for a construction barrier curb with Attachment Type D when anchored into an existing concrete bridge deck:
 - i. The adhesive anchor bolt system shall use one of the following products selected from the NJDOT Qualified Products List (QPL) database:
 - DeWALT Pure220+
 - Hilti HIT-RE 500 V3
 - Simpson Strong-Tie SET-3G
 - ITW Red Head C6+

Contractors shall ensure the adhesive anchor bolt system will obtain a minimum pull-out capacity of 20,500 lbs specified in Standard Construction Details CD-159-3.2 and the project specific conditions, such as concrete strength (3,000psi min.), concrete deck thickness (8-1/4" min.) and anchor embedment length (7" min.). Installation of the adhesive anchor bolt system shall follow the Manufacturer's specifications, including minimum anchor bolt edge distance requirements.

- ii. To ensure the structural stability and integrity of the Attachment Type D construction barrier curbs on bridge decks during construction staging, a min. 6-inch Clear Area is required behind the construction barrier curb, measured from the rear face of the barrier curb to the edge of the bridge deck. When developing bridge staging plans and details, Designers or Contractors shall account for the Clear Area by positioning the construction barrier curbs on the bridge deck slab to meet this requirement.
- iii. To ensure the structural integrity and service life of bridge decks, NJDOT does not permit the drilling of holes in new bridge decks or in existing bridge decks that are to remain in service after construction. Therefore, construction barrier curbs using Attachment Types C and D are not permitted under these

conditions. In addition, construction barrier curbs of any attachment type are not permitted to be used in a permanent condition after construction.

- iv. There are cases where the existing project specific conditions are not suitable for the installation of a NJDOT Type D construction barrier curb on a bridge deck, and the requirements stated in items 9.b.i and/or 9.b.ii above cannot be met. For these cases the Designer or Contractor shall contact NJDOT Structural Engineering Services, and NJDOT Work Zone Traffic Control Unit if necessary, to discuss alternative methods.

TABLE 1 - List of MASH Crashworthy Bridge Railing Systems Authorized for Use by NJDOT

BRIDGE RAILING NEED	NJDOT Standard Construction Details # or FHWA Eligibility Letter #	Bridge Railing, Barrier, or Transition	MASH Test Level (See Note 2)
<p>Concrete and Combination Traffic Railing Systems</p> <p>(Other such types of bridge railing systems are shown in below categories and not repeated herein)</p>	BCD-507-3.4	2'-10" high parapet with barrier curb (NJ Shape)	3 *
	BCD-507-9	42" F-shape parapet (without sidewalk)	5 *
	BCD-507-8	50" Heavy Truck Parapet (without sidewalk) with modifications of curb height from 3"+10" (NJ Shape) to 3"+7" (F-Shape), and barrier bottom width remains 1'-8". The reinforcement location should be modified as appropriate to satisfy concrete cover requirements (2" min. cover). Details of reinforcement size and spacing, steel rail and post, steel railing setback from curb-line (3 5/8 inch), and anchor bolt details remain unchanged.	5 *
	B-318	50" PennDOT Two Steel Rail Combination Railing (without sidewalk)	5
	B-345	34" HIDOT Vertical Shape. Smooth surface and form liner treatments are acceptable. (See Section 7.a; Good for aesthetics but not for pedestrian/bicycle use requiring 42" min)	3
	CD-159-3 to CD-159-5	NJ Shape Portable Construction Barriers (Type A, B, C, and D)	3

	<p>Pedestrian/Bicycle</p> <p>(Curb height for sidewalk is 6 inches)</p> <p>When bridge railings are installed with sidewalk, crash tested bridge railing height shall be measured from the sidewalk surface at the bottom of the bridge railing to the top of bridge railing.</p>		Two-steel-bar combination railing details (MIDOT B-25-K). With or without sidewalk. (NCHRP 20-07 Task 395 Report)	4 *
		BCD-507-3.2	Traffic railing in front of sidewalk can be replaced with an alternative MASH compliant system which meets the bridge railing test level (TL) requirement. Pedestrian railing or chain link fence serves as ornamental railing. (On expressways for design speeds over 45 mph)	3, 4, 5
		B-346	42" HIDOT Vertical Shape (Also good for aesthetic treatment needs) with and without sidewalk. Smooth surface and form liner treatments are acceptable. See Section 7.a	3
		B-341	42" Oregon 3-Tube Curb Mount Bridge Rail (with or without sidewalk)	4
		B-317	45" Three-Rail Steel Bridge Rail with Curb (with or without sidewalk)	5
		B-285	44" NJDOT Open Balustrade (with or without sidewalk).	4
	<p>TL-4 and TL-5 Open Railing for Hydraulic/Aesthetic use</p>	B-317	45" Three-Rail Steel Bridge Rail with Curb (with or without sidewalk)	5
		B-341	42" Oregon 3-Tube Curb Mount Bridge Rail (with or without sidewalk)	4
		B-327	38" Alaska 2-Tube (Not for pedestrian/bicycle use)	4
		B-285	44" NJDOT Open Balustrade (with or without sidewalk)	4

Over Railroad	BCD-507-4.1	6'-6" High Parapet with Sidewalk over Electrified Railroad (Designers are required to design for the impact loads of TL required)	NA
	BCD-507-4.2	Traffic railing in front of sidewalk can be replaced with an alternative MASH compliant system which meets the bridge railing test level (TL) requirement. (For speed in excess of 45 MPH). 6'-6" High Parapet with sidewalk over Electrified Railroad on NHS is not exposed to impact loads.	3, 4, 5
Concrete Bridge Pylon and AGT Attachment		Midwest Standardized Buttress (Pylon) and AGT attachment. Refer to MwRSF Report # TRP-03-369-20 for details.	3
	B-350	2-Tube Bridge Rail Transition used with the corresponding 38" Alaska 2-Tube Open Railing (See B-327 shown above).	3

- NOTES: 1. Please contact NJDOT Structural Engineering Services for any questions.
2. The TL level shown in Table 1 is either MASH crash tested or equivalent crashworthiness. Symbol * indicates MASH equivalent.
3. This table is not all inclusive. Some MASH crashworthy bridge railing systems are not included in TABLE 1. Designer can explore FHWA website for MASH bridge railings with Eligibility Letter for NJDOT consideration and approval. See Section 4 of this CAN document.
4. Some bridge railing systems analyzed to be equivalent to MASH criteria are not included in this Table. Designer may refer to NCHRP 20-07 Task 395 Report "*MASH Equivalency of NCHRP Report 350-Approved Bridge Railings*". They may be used on a project-by-project basis upon approval of NJDOT.
5. In general, designer does not need pre-approval for use of a sidewalk (6" curb height) for the bridge railing systems listed in Table 1 under "Pedestrian/Bicycle" category, unless special or non-standard situations occur.

CAN No. 086 - NJDOT GUIDANCE ON TRANSITION OF MASH IMPLEMENTATION FOR BRIDGE RAILINGS, dated October 5, 2018, is hereby superseded with CAN086R.

Implementation: Changes must be implemented in all projects that final design has not been initiated as of the date of the CAN announcement.