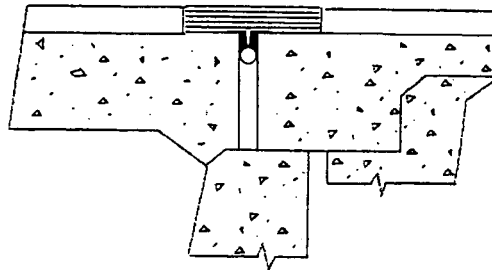


An Evaluation of Thorma Joint
A Flexible Bridge Expansion Joint System

Final Report

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16. Abstract The objective of this study is to develop construction specifications for the Thorma Joint flexible bridge expansion joint system for bituminous concrete overlays of bridges. Using an experimental construction project and field testing, the performance evaluation monitors the joint for deformation and deterioration under traffic loads and for its resistance to cracking while effectively sealing the existing bridge joint. In July 1988, the Thorma Joint system was constructed over the joints of six bridges of a resurfacing project on Route 3, Section 2J in the City of Clifton, Passaic County. Initial field inspections indicated an unaesthetic joint appearance from poor workmanship in spreading the top layer and an overabundance of binder being screeded onto the compacted surface during the hot weather installation. The manufacturer has corrected the installation methods and stiffened the binder to alleviate this aesthetic problem. From recent field inspections, the Thorma Joints have resisted substantial deformation and deterioration under traffic loads and do not show significant cracking. The joints appear to seal and waterproof the bridge joints. The draft of the proposed Thorma Joint specification was completed to describe the joint system construction. The specification should be adopted into the Standard Specification for Road and Bridge Construction pending continued inspection of projects.			
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AN EVALUATION OF THORMA JOINT

A FLEXIBLE BRIDGE EXPANSION JOINT SYSTEM

PART ONE: INTRODUCTION

1.1 Objective

The objective of this study is to develop construction specifications for the Thorma Joint¹ flexible bridge expansion joint system for bituminous concrete overlays of bridges. Using an experimental construction project and field testing, the performance evaluation monitors the joint for deformation and deterioration under traffic loads and for its resistance to cracking from lateral, vertical and vibrational stresses while effectively sealing the existing bridge joint.

1.2 Background

Deteriorating concrete bridge decks are frequently rehabilitated by resurfacing with a bituminous concrete overlay. This resurfacing covers the expansion joints. The relatively inflexible asphalt overlay is prone to cracking and deterioration at the expansion joints during normal contraction and expansion of the bridge deck. Consequently, surface water enters the joint and causes corrosion and damage to the steel in the concrete superstructure and bearing assemblies.

The Thorma Joint is one of several proprietary systems developed to deal with this problem. The joint is composed of a rubber asphalt binder and aggregate mixture placed over a steel plate in an 18 inch wide trench which is saw cut in the bituminous resurfacing over the existing bridge joint. The Thorma Joint asphalt binder and aggregate mixture

¹ The Thorma Joint is a proprietary product manufactured by Linear Dynamics Inc., Muncy, Pennsylvania

function as a riding surface and a waterproof flexible joint system. A cross - section of a typical application is shown in Figure 1.

1.3 Research Approach

In this study, an analysis of the constructability, field performance and costs of the Thorma Joint on an experimental construction project was developed to prepare construction specifications. A preconstruction pavement condition survey documented the distress of the existing joints using photographs. The installation of the joints was monitored during construction for project description and visual observations. Several post construction joint condition surveys were conducted immediately and periodically after construction.

PART TWO: CONSTRUCTION

2.1 Location and Project Description

In July 1988, the Thorma Joint system was constructed over the joints of six bridges of a resurfacing project on Route 3, Section 2J in the city of Clifton, Passaic County. The Thorma Joint contractor was Linear Dynamics, Inc. The construction and preliminary investigation to develop plans and preliminary specifications were documented in the Construction Report². As a main east-west arterial highway, Route 3 carries traffic from highly urbanized northern New Jersey to the Lincoln Tunnel and New York City. The highway is a six lane divided pavement with limited access. The 1985 2-way AADT was 125,000 vehicles with 4% heavy trucks. The resurfacing project consisted of a 2-inch

² Gerald Kauffman and Victor Mottola, "An Evaluation of Thorma Joint: A Flexible Bridge Expansion Joint System," Construction Report. FHWA/NJ-90-009 New Jersey Department of Transportation, Trenton, NJ. March 1990.

bituminous concrete overlay of the existing jointed reinforced concrete pavement. Within the project, six bridges were also resurfaced with the overlay.

2.2 Thorma Joint Construction

A pre-construction survey of the six bridges indicated that the non-armored expansion joints exhibited spalling of the edges and generally poor condition of the sealer. The armored expansion joints exhibited no spalling and good condition of the sealer. Joint openings ranged from 1 to 2 inches wide. The concrete bridge decks exhibited severe spalls and potholes.

After removal of an 18 inch wide trench of the bituminous resurfacing over the bridge joint, the remaining concrete and the bituminous surface are cleaned with compressed air. The expansion joint is sealed with hot rubber asphalt sealer. For non-armored joints, an aluminum plate is placed over the joint with a nail through the plate into the sealer. For armored joints, a 1/16 inch steel plate is placed over the joint with a nail through the plate into the sealer.

The aggregate (3/8 inch stone) is heated to the working range of 230 to 350 degree F and placed to a depth of 1 inch in the trench. Hot rubber asphalt binder is poured over the layer of aggregate to fill the voids. The stone and binder are mixed in the trench by raking. The remaining depth of 1 inch in the trench is filled with a heated mix consisting of a ratio of 6:1 by weight of aggregate to binder. This final layer is compacted with a vibratory drum roller and an asphalt rubber binder is screeded over the finished joint to seal remaining surface voids.

The cost of the joint was \$110 per linear foot: the total project was 1480 linear feet. The high cost of the joint is attributed to the saw cutting of the trench and the labor intensive placement of the asphalt mixture.

PART THREE: RESULTS AND DISCUSSION

A visual inspection of the joints was made shortly after installation in September 1988. Although the overall appearance of the completed joints was rough and uneven on either side of the trench, the surface of the joints was not cracked and the underside of the bridge decks showed no indication of water leakage. Some joints were not compacted flush to the surrounding overlay and the resulting hump caused noticeable traffic noises as vehicles passed over it. At some joints rutting, shoving and slight delamination were noted. The initial irregular appearance was attributed to high ambient temperatures during construction, heavy traffic and some poor workmanship which was caused by an excess of asphalt binder being screeded onto the compacted surface to fill voids. It is noted that this problem is aesthetic; not effecting the ability of the Thorma Joint to seal the expansion joint.

A second visual inspection was made approximately one year later in August 1989. The overall appearance was improved by compaction under traffic. The rutting stabilized and had not increased from the initial survey. Inspection of the underside of the bridge decks continued to show no leakage through the expansion joints.

The most recent visual inspection was conducted in December 1994 after six years of service. From a total of 36 joints in both directions, 3 joints in the eastbound and 4 joints in the westbound lanes showed some center cracking. The remainder showed no significant

cracking. Most joints had an unaesthetic appearance as noted earlier and some aggregate was exposed at the surface. Some rutting and surface deformation was noted on all joints but this did not appear to significantly effect traffic. Most joints appeared to successfully water proof the bridge.

A second non-experimental installation of the Thorma Joint was constructed on Route 21, Viaduct in 1993. A visual inspection from a moving vehicle indicated that some joints showed minor cracking. The unaesthetic appearance which was noted on the Route 3 project was not noted on this project. Rutting and surface deformation appeared to be minimal on all joints.

The Thorma Joint system was constructed on numerous bituminous overlaid bridges along the Garden State Parkway in the past several years and has performed well under traffic. The hot poured rubber asphalt surface has remained resilient and provided adequate waterproofing protection. Informal field tests by the Parkway engineers indicate that the rubber asphalt Thorma Joint will stretch about 1 1/2" to 2" before cracking. Essentially, the joint is expected to be effective up to 2" of joint movement.

The proposed draft specification of the Thorma Joint system is presented in the Appendix. The specification describes the sawcutting and removing of the section of bituminous resurfacing and construction of a flexible expansion joint over the existing bridge joint.

PART FOUR: CONCLUSIONS

This report documents the experimental construction of the Thorma Joint flexible bridge expansion joint system on the Route 3 bituminous concrete bridge overlay project. The experimental joint was constructed over 34 joints on 6 bridges in July 1988. Initial field inspections indicated a somewhat unaesthetic joint appearance from poor workmanship in spreading the top layer and an overabundance of binder being screeded onto the compacted surface during the hot weather installation. The manufacturer has corrected the installation methods and stiffened the binder to alleviate this problem.

From recent field inspections, the Thorma Joints have resisted substantial deformation and deterioration under traffic loads and do not show significant cracking. The joints appear to successfully seal and waterproof the bridge joints.

The draft of the proposed Thorma Joint specification describes the joint system construction and materials.

PART FIVE: RECOMMENDATIONS

1. The draft Thorma Joint specification should be adopted into the Standard Specification for Road and Bridge Construction pending continued inspection of the Route 3 and the Route 21 Thorma Joint projects.
2. Field inspections of the Route 3 and Route 21 projects should continue to monitor the appearance, rutting, deterioration and cracking of the Thorma Joint systems.

3. Because of the high cost and proprietary nature of the Thorma Joint system, other available systems should be reviewed for possible use on experimental projects. It may then be possible to develop two or more candidate systems suitable for routine installations which would help to keep market prices competitive.

APPENDIX

PROPOSED DRAFT SPECIFICATION

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FLEXIBLE BRIDGE EXPANSION JOINT FOR BITUMINOUS OVERLAYS

A. DESCRIPTION.

THIS WORK SHALL CONSIST OF SAWCUTTING AND REMOVING A SECTION OF BITUMINOUS RESURFACING AND CONSTRUCTING A FLEXIBLE EXPANSION JOINT OVER THE EXISTING BRIDGE JOINT AS SHOWN ON THE CONSTRUCTION PLANS.

B. MATERIALS.

AGGREGATE - THE AGGREGATE SHALL BE FROM THE BASALT, GABBRO OR GRANITE GROUPS AS SUPPLIED BY THE MANUFACTURER: LINEAR DYNAMICS INC., MUNCY, PENNSYLVANIA 17756, OR EQUAL.

BINDER -- THE BITUMEN BINDER AND SEALER SHALL BE AS SPECIFIED BY THE MANUFACTURER, OR EQUAL.

C. CONSTRUCTION REQUIREMENTS.

THE SAW CUT SHALL BE MADE 230 MM (9 INCHES) ON EITHER SIDE OF THE JOINT TO THE FULL DEPTH OF THE RESURFACING, AND DECK WATER-PROOFING LAYER. THE SAW CUT SHALL NOT EXTEND INTO THE CONCRETE DECK. THE ASPHALT AND WATER-PROOFING LAYER BETWEEN SAW CUTS SHALL BE REMOVED TO CONCRETE DECK TO FORM A TRENCH.

ALL CONCRETE SURFACES SHALL THEN BE CLEANED BY THE USE OF A HOT COMPRESSED AIR (HCA) LANCE UNTIL A CLEAN DRY SURFACE IS PRODUCED. THE SAW CUT ASPHALT SIDES OF THE TRENCH SHALL BE CLEANED IN A SIMILAR MANNER. IF THERE IS AN INTERRUPTION DUE TO WEATHER OR OTHER CAUSES, THE CLEANING OPERATION SHALL BE REPEATED WITH THE HCA LANCE IMMEDIATELY BEFORE THE TANKING OPERATION.

THE EXISTING BRIDGE JOINT SHALL BE CAULKED, SEALED AND COVERED WITH A METAL PLATE AND SECURED WITH A NAIL AS FOLLOWS:

A. CAULKING - BACKER ROD CAULKING SHALL BE INSTALLED IN THE EXISTING JOINT NO LESS THAN 20 MM AND NO GREATER THAN 30 MM BELOW THE TOP OF THE DECK.

B. JOINTSEALING - AFTER CAULKING, THE JOINT SHALL BE FILLED WITH HOT SEALER WHICH SHALL BE HEATED BETWEEN 182 DEGREES TO 193 DEGREES CENTIGRADE (360 DEGREES TO 380 DEGREES FAHRENHEIT).

C. METAL PLATE - THE PLATE SHALL COVER AND EXTEND A MINIMUM OF 50 MM (2 INCHES) BEYOND THE SPALLED AREAS. WHERE THERE IS A HEIGHT DIFFERENCE BETWEEN THE CONCRETE MEMBERS ACROSS THE JOINT, THE STEEL PLATE SHALL BE PREFORMED TO LIE FLAT ACROSS THE JOINT.

TANKING - HOT BINDER SHALL BE SPREAD OVER THE SURFACE AREA OF THE TRENCH AND THE PLATE COATING EVENLY ALL EXPOSED SURFACES BOTH VERTICAL AND HORIZONTAL. THE CLEANING AND TANKING SHALL BE CONTINUOUS AND ADHERE TO VERTICAL SURFACES.

THE MATERIAL SHALL BE PREPARED AND INSTALLED IN THE TRENCH AS FOLLOWS:

BOTTOM LAYER - AGGREGATE SHALL BE ROTATED IN A PERFORATED HEATED DRUM TO REMOVE DUST AND MOISTURE. THE AGGREGATE SHALL BE HEATED TO 191 DEGREES CENTIGRADE (375 DEGREES F).

THE HEATED AGGREGATE SHALL BE PLACED IN THE JOINT TRENCH IN LAYERS NOT LESS THAN 25 MM (1 INCH) AND NOT MORE THAN 60 MM (2.5 INCHES) THICK. WHERE THE JOINT DEPTH VARIES ACROSS THE DECK, SUCCESSIVELY THINNER LAYERS SHALL BE PLACED IN THE TRENCH. THE AGGREGATE SHALL BE RAKED LEVEL IN THE TRENCH BEFORE APPLICATION OF BINDER.

THE HOT BINDER SHALL BE POURED AND SPREAD OVER THE AGGREGATE LAYER. THE BINDER SHALL COAT THE AGGREGATE EVENLY AND FILL VOIDS. EXCESS BINDER SHALL BE REMOVED. THE BINDER SHALL BE HEATED BETWEEN 182 DEGREES TO 193 DEGREES CENTIGRADE (360 DEGREES TO 380 DEGREES FAHRENHEIT).

TOP LAYER - THE TOP LAYER OF AGGREGATE AND BINDER SHALL HAVE A RATIO OF 6:1 BY WEIGHT. THE HEATED AGGREGATE AND BINDER SHALL BE MIXED IN A ROTATING DRUM MIXER.

THE TOP LAYER SHALL SLIGHTLY OVERFILL THE TRECH WITH THE MIXTURE AND COMPACTED TO THE TOP OF PAVEMENT SURFACE. THE TOP LAYER SHALL BE COMPACTED WHEN THE SURFACE TEMPERATURE IS 107 DEGREES CENTIGRADE (225 DEGREES F.).

IMMEDIATELY AFTER COMPACTION, SUFFICIENT BINDER SHALL BE SCREEDED OVER THE FLEXIBLE BRIDGE EXPANSION JOINT AND AT LEAST 25 MM (1 INCH) OF THE PAVEMENT TO FILL THE SURACE VOIDS AND COAT THE SURFACE.

D. METHOD OF MEASUREMENT.

FLEXIBLE BRIDGE EXPANION JOINT SHALL BE MEASURED BY THE LINEAR FOOT.

E. BASIS OF PAYMENT.

PAYMENT SHALL BE MADE UNDER :

PAY ITEM

FLEXIBLE BRIDGE EXPANSION JOINT

PAY UNIT

LINEAR FOOT