Small Movement Expansion Joints: Performance and State of Practice in the North East

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Professor and Chair
Objective

- Determine the current state of practice of joint design and maintenance of the states in the NEBPP
- Determine commonly used expansion joints in the North East
- Collect information on the historical performance of joints in the North East
Background

- Varied design and maintenance practices among NEBPP agencies
- Varied experiences with joints among NEBPP agencies
- Concerns about long term bridge maintenance related to small movement expansion joints
- Failure of bridge joints leads to deterioration of structural members
- Failure of bridge joints affects ride quality and life of decking surface
Research Method

• Literature Search
  – DOT manuals and design specifications
  – Prior studies
  – Manufacturer specifications
• Web survey of NEBPP DOT Engineers
  – Quality of performance
  – Causes of failure
  – Maintenance practices
• Follow-up interviews/emails
• Synthesis of data/information
• Final Report
Prior Research

• Simplifying Bridge Expansion Joint Design and Maintenance
  – University of South Carolina

• Sealing of Small Movement Bridge Expansion Joints
  – The New England Transportation Consortium

• Evaluation and Policy for Bridge Deck Expansion Joints
  – Purdue University
Common Joint Types in Use*

- Asphaltic Plug (APJ)
- Poured Silicone (PS)
- Preformed Silicone (PFS)
- Compression Seal (CS)
- Closed Cell Foam (CCF)
- Open Cell Foam (OCF)
- Strip Seal (SS)

*Determined by DOT Bridge Manuals and Surveys
Online Survey

- Types of Joints Used
- Expected Lifespan of a Joint
- Common Failure Modes
- Causes of Common Failures
- Avoided Joint Types
- Routine Maintenance
- Sizing Method
- Inspection Reports
- Repair Methods
- Unique Procedures
Online Survey (continued)

• Surveys Issued – 27
  – Sent to Design and Maintenance personnel if available
  – Differing numbers provided per state

• Responses Received – 22
  – All 12 member agencies with at least one response
Follow-up Interview

• Follow Up Questions Answered – 13
  – Represents 5 states

• States with Sufficient Level of Response – 5

• Work still to be done – in progress

• Will be in contact today, if not already at the meeting!
# Joint Type vs. State

<table>
<thead>
<tr>
<th>State</th>
<th>Joints Used for New Construction</th>
<th>Joints Used for Maintenance</th>
<th>General Movement Range</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>APJ</td>
<td>CS</td>
<td>PS</td>
</tr>
<tr>
<td>CT</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>DC</td>
<td></td>
<td>●</td>
<td></td>
</tr>
<tr>
<td>DE</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>MA</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>MD</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>ME</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>NH</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>NJ</td>
<td></td>
<td>●</td>
<td></td>
</tr>
<tr>
<td>NY</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>PA</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>RI</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>VT</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
</tbody>
</table>

**General Movement Range**
- APJ <1.5”, PS <1.5”, PFS <3”
- CS fixed, PS fixed, SS < 4”
- PS <.5”, APJ <2”, SS <2” if skew>30°
- PS <1”, PFS <3”
- CS <3", PFS <3", APJ < 1.5", PS < 1.5"
- APJ <.75”, CS <2”, SS <4”
- PFS <3”
- SS <5”
- APJ <1”, SS <5”
- APJ <1”
Frequency of Joint Type

Number of Agencies Using Joint

New Construction

Maintenance

- APJ
- CS
- PS
- PFS
- CCF
- OCF
- SS
## Joint Types Avoided

<table>
<thead>
<tr>
<th>State</th>
<th>Joints Avoided</th>
<th>Reason</th>
</tr>
</thead>
<tbody>
<tr>
<td>CT</td>
<td>Compression Seals</td>
<td>Frequent failures</td>
</tr>
<tr>
<td></td>
<td>Elastomeric Concrete with Armoring</td>
<td>Rutting</td>
</tr>
<tr>
<td>DC</td>
<td>Compression Seals</td>
<td>Frequent pushing out of seal</td>
</tr>
<tr>
<td>DE</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td>MA</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td>MD</td>
<td>Compression Seals</td>
<td>Difficult maintenance</td>
</tr>
<tr>
<td></td>
<td>Closed Cell Foam</td>
<td>Compression set</td>
</tr>
<tr>
<td>ME</td>
<td>Compression Seals</td>
<td>Poor performance on larger movements</td>
</tr>
<tr>
<td>NH</td>
<td>Compression Seals</td>
<td>Tension failures</td>
</tr>
<tr>
<td>NJ</td>
<td>Preformed Silicone</td>
<td>Pushing out of seal</td>
</tr>
<tr>
<td></td>
<td>Asphalitic Plug</td>
<td>Failure under heavy traffic</td>
</tr>
<tr>
<td>NY</td>
<td>Any armored joints</td>
<td>Plow damage</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Difficult to install</td>
</tr>
<tr>
<td>PA</td>
<td>Poured Silicone Compression Seals</td>
<td>Inconsistent installation</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Frequent failures</td>
</tr>
<tr>
<td>RI</td>
<td>Compression Seals</td>
<td>Frequent pushing out of seal</td>
</tr>
<tr>
<td>VT</td>
<td>N/A</td>
<td></td>
</tr>
</tbody>
</table>

Department of Civil and Environmental Engineering
Design Methods for Sizing

- AASHTO LRFD Bridge Design Manual: Thermal Expansion
- Standardized Expansion per Length of Bridge
  - Based on material types
- Previous Experience
- Excel Calculator

<table>
<thead>
<tr>
<th>State</th>
<th>Sizing Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>CT</td>
<td>AASHTO</td>
</tr>
<tr>
<td>DC</td>
<td>AASHTO</td>
</tr>
<tr>
<td>DE</td>
<td>AASHTO</td>
</tr>
<tr>
<td>MA</td>
<td>AASHTO</td>
</tr>
<tr>
<td>MD</td>
<td>AASHTO</td>
</tr>
<tr>
<td>ME</td>
<td>Movement / Length</td>
</tr>
<tr>
<td>NH</td>
<td>AASHTO / started using Calculator</td>
</tr>
<tr>
<td>NJ</td>
<td>AASHTO</td>
</tr>
<tr>
<td>NY</td>
<td>AASHTO / moving towards Calculator</td>
</tr>
<tr>
<td>PA</td>
<td>AASHTO</td>
</tr>
<tr>
<td>RI</td>
<td>AASHTO</td>
</tr>
<tr>
<td>VT</td>
<td>AASHTO</td>
</tr>
</tbody>
</table>
General Failure Modes

• Debonding from deck or header material
  – APJ, PS, PFS, CS, CCF

• Rupture of seal
  – PS, PFS, SS

• Pushing out of seal
  – CS, CCF, OCF

• Material failure

• Snow plow damage
  – Armored joints
## Average Expected Lifespan

<table>
<thead>
<tr>
<th>Joint</th>
<th>New Construction</th>
<th>Replacement / Rehabilitation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asphalitic Plug Joint</td>
<td>10 yrs</td>
<td>4 yrs</td>
</tr>
<tr>
<td>Compression Seals</td>
<td>15 yrs</td>
<td>6 yrs</td>
</tr>
<tr>
<td>Poured Silicone</td>
<td>7 yrs</td>
<td>3 yrs</td>
</tr>
<tr>
<td>Preformed Silicone</td>
<td>7 yrs</td>
<td>3 yrs</td>
</tr>
<tr>
<td>Closed Cell Foam</td>
<td>5 yrs</td>
<td>2 yrs</td>
</tr>
<tr>
<td>Open Cell Foam</td>
<td>Test joints in place, performing well after 1 yr</td>
<td>unknown</td>
</tr>
<tr>
<td>Strip Seals</td>
<td>15 yrs</td>
<td>10 yrs</td>
</tr>
</tbody>
</table>

- Shown lifespans assume no installation problems and some maintenance
- Lifespans varied considerably between states
- Armored joints may fail prematurely due to snow plows
Common Maintenance Issues

- Inconsistent material properties
  - APJ, PS, and CCF

- Lack of preventative maintenance or washing

- Improper installation

- General lack of funding and manpower for proper maintenance
Maintenance and Repair

• Installation Crews
  – State bridge maintenance
  – Private contractor

• Installation Procedure
  – Ideal Conditions vs. Reality

• Material Quality
  – Inconsistent from manufacturer
  – On-site issues

➢ Is the crew experienced?
➢ Do they follow manufacturer procedures?

➢ Is it realistic to expect a perfect installation?

➢ Are preformed materials consistent?
➢ Do materials mixed on site meet requirements?
Evaluation of New Products

Typical procedure as described in follow-up interviews by 5 states:

1. Materials Testing Department

2. Presentation/Data from Manufacturer

3. Testing
   a. Laboratory
   b. Field Installation

4. Evaluation and Approval
New Developments

• Open Cell Foam – EMSEAL BEJS System
  – Similar to compression seal
  – Lighter and more flexible

• Slab over back wall
  – May require joint
  – Runoff does not affect structural members

• Joint Calculator
  – Avoids all tension
Schedule Moving Forward

- Finish Gathering Information – October
- Summarize Data – November
- Draft Report – December
- Submit Final Report – December/January
Acknowledgments

• North East Bridge Preservation Partnership

• Survey Participants and DOT contacts

• University of Delaware
Thank You!

Questions?