Survey of Past Experience and State-of-the-Practice in the Design and Maintenance of Small Movement Expansion Joints in the Northeast

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Background

- Varied design and maintenance practices among NEBPP agencies
- Varied experiences
- Concerns about long term bridge maintenance related to small movement expansion joints (<2”)
- Failure of bridge joints leads to
  - deterioration of structural members
  - ride quality and life of decking surface

NEBPP proceeds with plan to undertake funded research project
Mechanism for Conducting the Research

- Fixed-fee contract between UD and NEBPP (MSU) ($7500)
- Graduate student hired to work during the summer and part time during the fall ‘13 semester
- Paid $15.00/hr
- Start date - June 2013, projected end date Dec, 31, 2013
- Final deliverable – Final report
Objectives of the Research

• Determine the current state of practice of design and maintenance of small movement expansion joints (<2”) of the states in the NEBPP

• Determine commonly used small movement expansion joints (<2”) for new construction and maintenance in the northeast

• Examine the historical performance of joints in the northeast

Keys to success – clear objectives, expectations, deliverables, and schedule
Methodology

1. Literature Search
   a) Prior research
   b) DOT manuals and design specifications
   c) Manufacturer specifications
2. Online survey of NEBPP DOT Engineers
   a) Past performance
   b) Causes of failure
   c) Maintenance practices
3. Follow-up interviews/emails
4. Synthesis of data/information
5. Final Report
Summary of Prior Research

  – some limited information on performance of joints
• 2003 - NCHRP Synthesis of Highway Practice 319 - “Bridge Deck Joint Performance”
  – follow-up to ’89 study, more relevant
• AASHTO Maintenance Manual for Roadways and Bridges – references NCHRP 319
Summary of Prior Research

• “Simplifying Bridge Expansion Joint Design and Maintenance”
  – University of South Carolina study of SCDOT joints
• “Sealing of Small Movement Bridge Expansion Joints”
  – The New England Transportation Consortium
• “Evaluation and Policy for Bridge Deck Expansion Joints”
  – Purdue University
Online Survey

- Email request with web link invitation to complete the survey sent to NEBPP contacts
- 14 question survey
  - 3 contact and job information
  - 11 survey questions
- Most survey questions were of a textual input format
- Mean response time was 37 minutes
Online Survey Question Topics

- Types of joints used
- Expected lifespan
- Common modes of failure
- Causes of failures
- Joints that are, or have been avoided
- Routine maintenance procedures
- Sizing method
- Inspection reports
- Repair methods
- Unique procedures
Online Survey

• Surveys Issued – 28
  – Sent to Design and Maintenance personnel if available
  – Contacts provided by NEBPP board members
  – Number of contacts varied per state
• Responses Received – 24 (86% response rate)
  – All 12 member agencies with at least one response
Follow-up Interview

- Follow Up Questions Answered – 19 (68%)
  - Responses received from all but one DOT/agency
- Follow-up interviews completed from both the design side and the maintenance side from five DOT/agencies
Common Small Movement Joints 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)
## Joint Type by State

<table>
<thead>
<tr>
<th>State</th>
<th>APJ</th>
<th>CS</th>
<th>PS</th>
<th>PFS</th>
<th>CCF</th>
<th>OCF</th>
<th>SS</th>
<th>APJ</th>
<th>CS</th>
<th>PS</th>
<th>PFS</th>
<th>CCF</th>
<th>OCF</th>
<th>SS</th>
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</tbody>
</table>

Legend: ● - used by the agency, ✖ - limited use or is being phased out, ✖ - not used/discontinued, empty cell indicates no reference to the use of that joint type.
Frequency of Joint Type – New Construction

![Bar Chart: Number of Agencies Using Joint for New Construction]

- APJ
- CS
- PS
- PFS
- CCF
- OCF
- SS

Number of Agencies Using Joint for New Construction

- Joint/Seal: APJ
- Joint/Seal: CS
- Joint/Seal: PS
- Joint/Seal: PFS
- Joint/Seal: CCF
- Joint/Seal: OCF
- Joint/Seal: SS
Frequency of Joint Type - Maintenance

Number of Agencies Using Joint for Maintenance

- APJ
- CS
- PS
- PFS
- CCF
- OCF
- SS

Number of Agencies Using Joint

Joint/Seal
## Joints Discontinued Use by States

<table>
<thead>
<tr>
<th>State</th>
<th>Joints/System Discontinued</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>Phasing out Compression Seals</td>
<td>Frequent pushing out of seal</td>
</tr>
<tr>
<td>DE</td>
<td>None Indicated</td>
<td>None Indicated</td>
</tr>
<tr>
<td>MA</td>
<td>None Indicated</td>
<td>None Indicated</td>
</tr>
<tr>
<td>MD</td>
<td>Phasing out 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>None Indicated</td>
<td>None Indicated</td>
</tr>
<tr>
<td>NH</td>
<td>Limit Compression Seals</td>
<td>Tension failures</td>
</tr>
<tr>
<td></td>
<td>Maintenance Phasing Poured Silicone</td>
<td>Difficult installations</td>
</tr>
<tr>
<td>NJ</td>
<td>Asphaltic Plug</td>
<td>Failure under heavy traffic</td>
</tr>
<tr>
<td></td>
<td>Compression Seal for new designs</td>
<td>Pushing out of seal</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>Phasing out Poured Silicone</td>
<td>Inconsistent installation</td>
</tr>
<tr>
<td></td>
<td>Closed Cell Foams</td>
<td>Tested poorly</td>
</tr>
<tr>
<td></td>
<td>Compression Seals</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>None Indicated</td>
<td>None Indicated</td>
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</table>
## Methods for Sizing Joints

<table>
<thead>
<tr>
<th>State</th>
<th>Determining Movement</th>
<th>Sizing Joint</th>
</tr>
</thead>
<tbody>
<tr>
<td>CT</td>
<td>AASHTO specifications</td>
<td>Manufacturer</td>
</tr>
<tr>
<td>DC</td>
<td>Movement per length of span</td>
<td>Manufacturer with lower limits</td>
</tr>
<tr>
<td>DE</td>
<td>AASHTO specifications</td>
<td>Manufacturer</td>
</tr>
<tr>
<td>MA</td>
<td>AASHTO specifications</td>
<td>Manufacturer</td>
</tr>
<tr>
<td>MD</td>
<td>AASHTO specifications</td>
<td>Manufacturer / spreadsheet</td>
</tr>
<tr>
<td>ME</td>
<td>Movement per length of span</td>
<td>Manufacturer / Experience</td>
</tr>
<tr>
<td>NH</td>
<td>AASHTO specifications</td>
<td>Manufacturer with lower limits / started using spreadsheet</td>
</tr>
<tr>
<td>NJ</td>
<td>AASHTO specifications</td>
<td>Manufacturer</td>
</tr>
<tr>
<td>NY</td>
<td>AASHTO specifications</td>
<td>Manufacturer / moving towards spreadsheet</td>
</tr>
<tr>
<td>PA</td>
<td>AASHTO specifications</td>
<td>Experience</td>
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<tr>
<td>RI</td>
<td>AASHTO specifications</td>
<td>Manufacturer</td>
</tr>
<tr>
<td>VT</td>
<td>AASHTO specifications</td>
<td>Manufacturer</td>
</tr>
</tbody>
</table>
Typical Lifespan Experienced by DOT’s

<table>
<thead>
<tr>
<th>Joint</th>
<th>New Construction (yrs)</th>
<th>Replacement/Rehabilitation (yrs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asphaltic Plug Joint</td>
<td>10</td>
<td>5</td>
</tr>
<tr>
<td>Compression Seals</td>
<td>15</td>
<td>6</td>
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<tr>
<td>Poured Silicone</td>
<td>7</td>
<td>3</td>
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<tr>
<td>Preformed Silicone</td>
<td>7</td>
<td>3</td>
</tr>
<tr>
<td>Closed Cell Foam</td>
<td>5</td>
<td>2</td>
</tr>
<tr>
<td>Open Cell Foam</td>
<td>Unknown</td>
<td>Test joints in place, performing well after 3 yrs</td>
</tr>
<tr>
<td>Strip Seals</td>
<td>15</td>
<td>10</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
Factors Leading to Poor Performance

- Inconsistent material properties
  - APJ, PS, and CCF
- Lack of preventative maintenance, clearing joints of debris
- Improper installation
- General lack of funding and manpower for proper maintenance
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
- New Jersey joint database
Key Conclusions

• Widely varying practices and experiences among the NEBPP agencies
• Most common joint used for new construction in the northeast –
  – Strip Seal
• Most common joints used for maintenance in the northeast
  – asphaltic plug, strip seal, poured silicone
• Average lifespan for new construction – 5 to 15 years
• Average lifespan for maintenance – 2 to 10 years
• Two leading causes of failure are improper installation and lack of preventative maintenance (clearing of joint debris)
Acknowledgments

- Northeast Bridge Preservation Partnership
- Survey Participants and DOT contacts
- University of Delaware
Where can you get the report?

Thank You!

Questions?