Protecting Superstructure and Substructure Members Under Joints

Prepared By: Jeff Milton and Adam Matteo
Structure and Bridge Division
Virginia Department of Transportation
April 24, 2014
Presentation Outline

- Virginia’s Bridge Program
- Typical Joint Systems Used in Virginia
- Leaking Joints
- Preventive Maintenance Activities for Joints
- Restorative Maintenance Activities for Joints
- Joint Elimination
- When Joints Cannot be Practically Eliminated
- Other Concepts
Virginia’s Bridge Program
Virginia’s Bridge Program

The Virginia Bridge Program consists of the following four work actions:
• Preventive Maintenance
• Restorative Maintenance
• Rehabilitation
• Replacement

Preventive Maintenance and Restorative Maintenance are the components of Virginia’s Bridge Preservation Program.
Virginia’s Bridge Program

- Viewed from a high level –
  - Preventive maintenance candidates are structures in Good Condition (a low General Condition Rating of 6 or greater)
  - Restorative maintenance candidates are structures in Fair Condition (a low General Condition Rating equal to 5)
  - Rehabilitation and replacement candidates are structures in Poor Condition (a low General Condition Rating of 4 or less)
Preventive maintenance can be condition based or non-condition based. Non-condition based preventive maintenance is typically referred to as Planned Preventive Maintenance.

- Condition based Preventive Maintenance includes sealing leaking deck joints on bridges that are in overall good condition.
- Planned Preventive Maintenance includes Scheduled Replacement of Compression Seal Joints in good condition (5 year cycle) and Scheduled Replacement of Pourable Joints in good condition (5 year cycle).
Restorative Maintenance includes Reconstructing/Closing Joints on bridges that are in fair condition.

There are approximately 19,400 state maintained structures in the inventory - approximately 11,850 of the structures are bridges.
Virginia’s Bridge Program

The current overall condition for the Virginia statewide inventory is shown below:

- 70% of the structures are in Good condition
- 24% of the structure are in Fair condition
- 6% of the structures are in Poor condition
Typical Joint Systems Used in Virginia
The following types of joint systems may be found on existing bridges in Virginia:

- Armored Joints – Open or Sealed
- Hot Poured Sealer /Expansion Material
- Preformed Elastomeric Compression Seals
- Poured (Silicone) Seals
- Asphalt Plug Joints (limited number)
- Strip Seals
- Sliding Plate Joints
- Finger Joints
- Cushion Seal (previously denoted as elastomeric expansion dam – limited number remaining)
Typical Joint Systems Used in Virginia

- Performance of Selected Joint Systems in Virginia – Condition States are based on the AASHTO CORE Elements

  - **Element 300 – Strip Seal** – 85,054 LF in inventory
    - Condition State 1 – 85%
    - Condition States 2 and 3 – 15%

  - **Element 301 – Pourable Seal** – 443,104 LF in inventory
    - Condition State 1 – 68%
    - Condition States 2 and 3 – 32%

  - **Element 302 – Compression Seal** – 455,122 LF in inventory
    - Condition State 1 – 62%
    - Condition States 2 and 3 – 38%
Leaking Joints
Leaking Joints

- Leaking bridge deck expansion joints allow run-off water and deicing chemicals to pass through the joints and onto superstructure and substructure members.

- The following bridge components are adversely affected by leaking joints:
  - End Diaphragms
  - Beam/Girder Ends
  - Bearings
  - Substructure Seat Areas
  - Other Substructure Areas
Leaking Joints

- Leaking joints cause significant deterioration and damage to bridge components and are a nationwide bridge maintenance problem. Many millions of dollars are spent each year repairing the damage caused by leaking joints.
Leaking Joints
Leaking Joints
Leaking Joints - Deterioration and damage – steel End Diaphragms
Leaking Joints - Deterioration and damage – steel End Diaphragms
Leaking Joints - Deterioration and damage – concrete End Diaphragms
Leaking Joints - Deterioration and damage – steel beam ends
Leaking Joints - Deterioration and damage – steel beam ends
Leaking Joints - Deterioration and damage – concrete beam ends
Leaking Joints - Deterioration and damage – bearings
Leaking Joints - Deterioration and damage – bearings
Leaking Joints - Deterioration and damage – pier seats and cap
Leaking Joints - Deterioration and damage – pier cap

01/04/2008
Leaking Joints – Was it cold where you live this winter?
Leaking Joints - Deterioration and damage – overall
Preventive Maintenance Activities for Joints
Preventive Maintenance Activities for Joints

- Planned Preventive Maintenance - Cleaning and Flushing Troughs under open and finger joints

- Planned Preventive Maintenance - Scheduled Replacement of Compression Seal Joints in good condition (5 year cycle) and Scheduled Replacement of Pourable Joints in good condition (5 year cycle)
Preventive Maintenance Activities for Joints

- Condition based Preventive Maintenance includes sealing leaking deck joints on bridges that are in overall good condition. Replacing existing leaking joint material with new material – where the surfaces adjacent to the joint are in good condition – this activity may require saw cutting when the new material is a preformed elastomeric compression sealer.
Preventive Maintenance Activities for Joints - Cleaning and Flushing Troughs under open and finger joints
Preventive Maintenance Activities for Joints - Replacing existing joint material with new silicone material
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Preventive Maintenance Activities for Joints

• Replacing existing joint material with Preformed Elastomeric Compression Seal – Traditional Method – This type of seal will be phased out in Virginia
Preventive Maintenance Activities for Joints

- Replacing existing joint material with Preformed Elastomeric Compression Seal Modified – Inflatable/Adhesive Based Seal – Preferred Method
Restorative Maintenance Activities for Joints
Restorative Maintenance Activities for Joints

- Traditional Restorative Maintenance activities for Joints:
  - Reconstructing concrete slabs and/or back-walls adjacent to joints and installing new joint material

- Preferred Restorative Joint Maintenance Activities for Joints:
  - Eliminating joints by constructing joint closures at piers and slab extensions at abutments
The hierarchy of decisions for restorative maintenance activities for joints follows:

• Eliminate Joints
• Reconstruct concrete adjacent to joint and install strip seals
• Install Asphalt Plug Joints on decks having asphalt overlays
• Reconstruct concrete adjacent to joint (if required) and install silicone (pourable) seals
• Reconstruct concrete adjacent to joint (if required) and install adhesive based compression seal
Restorative Maintenance Activities for Joints

- When joints cannot be practically eliminated, the following activities should also be performed:
  - Perform concrete substructure surface repair as necessary
  - Apply waterproofing coating to pier and abutment seats and ends of beams/girders
Traditional Restorative Maintenance Activities for Joints - Reconstructing concrete slabs and back-walls adjacent to joints and installing new joint material
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![Diagram of Tooth Joint](image-url)
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Traditional Restorative Maintenance Activities for Joints

- Check Points for reconstructing concrete slabs and back-walls adjacent to joints:
  - Mark area of concrete to be removed as shown on plan details
  - Outline area with saw cut to a depth of 1”
  - Remove concrete as shown on the plan details using hand tools and pneumatic hammers. Pneumatic hammers should have maximum weight of 30 pounds and should be worked at an angle of 45 to 60 degrees to the plane of the surface being removed
  - Set and secure forms for joint – adjusting joint opening as necessary for temperature
  - Clean area by abrasive blast cleaning
Check Points for reconstructing concrete slabs and back-walls adjacent to joints (Continued):

- Place new reinforcing steel as shown on plan details and check reinforcing steel for section loss – bars that has lost \(\frac{1}{4}\) or more of their original cross sectional area shall be lapped with new bars of the same size – lap shall be 30 diameters on each side
- Remove dust and debris from area and ensure that existing concrete is in a saturated-surface dry condition before placing new concrete
- Measure and record dimensions of area before placing new concrete
- Place, consolidate, and cure new concrete
Joint Elimination
Joint Elimination

- The best joint maintenance is to eliminate the joint
- VDOT policy requires the designer to investigate the feasibility of eliminating all deck expansion joints
- When the elimination of all pier joints is not possible, provide deck continuity over substructure units with potentially higher relative repair costs such as tall column piers in the water as opposed to short piers on land
Joint Elimination

• Elimination of the existing abutment joints by using deck extensions is also expected; however, the issues relating to the nature of the bridge and the presence of existing approach slabs to remain in place may inhibit feasibility.

• Justification for any remaining joints shall be provided via email to the Assistant State Structure and Bridge Engineer for Maintenance.
Joint Elimination - Constructing joint closures at piers

Limits of payment for expansion joint reconstruction

4'-0"

Pier

2'-0"

2'-0"

Top of existing deck

Top of deck overlay 1/2" min.

Bottom of Type A Milling, 1/2"

Bottom of existing deck

New #5 bars to be lapped with existing #5 bars

Beam

Beam

8 1/2"

Remove existing concrete to these lines typ. each side of joint

Existing transverse and longitudinal reinforcing steel shall be cleaned and shall remain in place.

- Limit of payment for Type A Milling, 1/2"

- 1/2" expanded polystyrene
Joint Elimination - Constructing joint closures at piers
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Joint Elimination - Constructing joint closures (slab extensions) at abutments
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Joint elimination over piers often requires bearing modification.

Bearings may need to be released or fixed depending on span arrangement and bridge geometry.

Deck extensions generally will not require bearing modification.
When Joints Cannot be Practically Eliminated
When Joints Cannot be Practically Eliminated - Reconstruct Ends of Deck Slab and Install Strip Seal – *Traditional Detail for Strip Seal Anchorage – This Anchorage Detail will be phased out in Virginia*

One piece steel extruded or hot rolled cross section, $\frac{3}{8}$" min. thickness

Preformed non-reinforced, polychloroprene strip seal gland mechanically locked into steel retainers.

$2\frac{1}{4}$" min.

$3\frac{1}{4}$" min.

$\frac{5}{8}$" $\times$ 6" stud anchor @ 9" centers each line and staggered between lines.

**TYPE F2**

**Dam Proprietary Nomenclature:**

Type F2 = Wabo Strip Seal, Steelflex SSCM-2 and SSPA (D.S. Brown)
When Joints Cannot be Practically Eliminated - Reconstruct Ends of Deck Slab and Install Strip Seal

Limits of Expansion Joint Reconstruction

1'-8” ***
2 spa. @ 6” = 12”
ES0501 (spa. 12” c-c)
ST0501 & ST0503

Joint

2 spa. @ 6” = 12”
ST0501 & ST0503
ES0501 (spa. 12” c-c)

* * * - Longitudinal bars to remain.
Top of existing beam

Take care to keep this area clean and free of incompressible material.
When Joints Cannot be Practically Eliminated - Reconstruct Ends of Deck Slab and Install Strip Seal - **New Detail for Strip Seal Anchorage – Preferred Anchorage**
When Joints Cannot be Practically Eliminated - Reconstruct Ends of Deck Slab and Install Strip Seal
When Joints Cannot be Practically Eliminated

- Planned Preventive Maintenance Activities – Perform Seats and Beam End Washing on a two year cycle

- Coat concrete pier and abutment seat areas that are located under deck expansion joints
  - Epoxy
    - Coat Top and Both Sides of Pier Caps – Bottom of Pier Caps should remain uncoated to allow the concrete to breathe

  - Coatings from VDOT Approved Products (Hydraulic Cement Concrete Sealants, Stains, and Coatings)

  - Other Coating Materials
When Joints Cannot be Practically Eliminated

- Coat Ends of Steel Beams/Girders for Five Feet - Including End Diaphragms and Bearings
  - Three Coat Zinc Based Paint System
  - Metalizing
  - Other Coatings

- Coat Ends of Concrete Beams/Girders for Five Feet Using Epoxy - Including End Diaphragms
  - Epoxy
  - Coatings from VDOT Approved Products (Hydraulic Cement Concrete Sealants, Stains, and Coatings)
  - Other Coating Materials
When Joints Cannot be Practically Eliminated – Beam End Coating
When Joints Cannot be Practically Eliminated
Pier Cap Coating
When Joints Cannot be Practically Eliminated
Pier Cap and Beam Coating
When Joints Cannot be Practically Eliminated

- Perform Concrete Substructure Surface Repair as Necessary
  - Conviental Concrete
  - Self Consolidating Concrete
  - Shotcrete
  - Install galvanic anodes for individual patches
Other Concepts
Asphalt Plug Joints
Asphalt Plug Joints
Asphalt Plug Joints

- Preferred joint for decks with asphalt overlays
- Has value for locations where integral abutments or approach slabs meet with asphalt paving
- Can be used with concrete or asphalt support
- Good to 45° skew with normal specification
- Good for 45° to 60° with manufacturer’s representative
- [http://www.youtube.com/watch?v=dhi3ET0L22s](http://www.youtube.com/watch?v=dhi3ET0L22s)
Elastomeric Concrete Plug Joint - Candidate Materials:
Fiber-reinforced concrete
RJ Watson “Liquid Polytron” (high elongation properties)
Elastomeric Concrete Plug Joint -
Candidate Materials:
 Fiber-reinforced concrete
 RJ Watson “Liquid Polytron” (high elongation properties)
Joint Elimination using UHPC

Existing Deck | 1”-0” UHPC | Existing Deck

Closure Pour

Remove concrete to this line (typ)

Top of new thin overlay

Existing long bars to remain

End cross-frames
Deck Extension with “Turned Down” Approach

Typical Existing Condition

Possible Deck Extension Detail

- Existing Approach Slab
- New Deck Extension
- Face of backwall
- Existing long. bars
- End cross-frame
- Back of backwall
- Sealer Silicone?
- Top of new thin overlay
- Existing long. bars to remain
- End cross-frame
- 1/2" expanded rubber joint sealer
- End of slab
- Remove concrete to this line
- Top of new thin overlay
- Existing long. bars to remain
- End cross-frame
- Back of backwall
Protecting Superstructure and Substructure Members Under Joints

Thank you for your time and attention

Questions??