TSP2 TRANSPORTATION SYSTEM PRESERVATION TECHNICAL SERVICES PROGRAM

AASHTO BRIDGE PRESERVATION

NCHRP 20-68A "US Domestic Scan Program"

Domestic Scan 17-03

Experiences in the Performance of Bridge Bearings and Expansion Joints used for Highway Bridges

Findings, Conclusions and Recommendations

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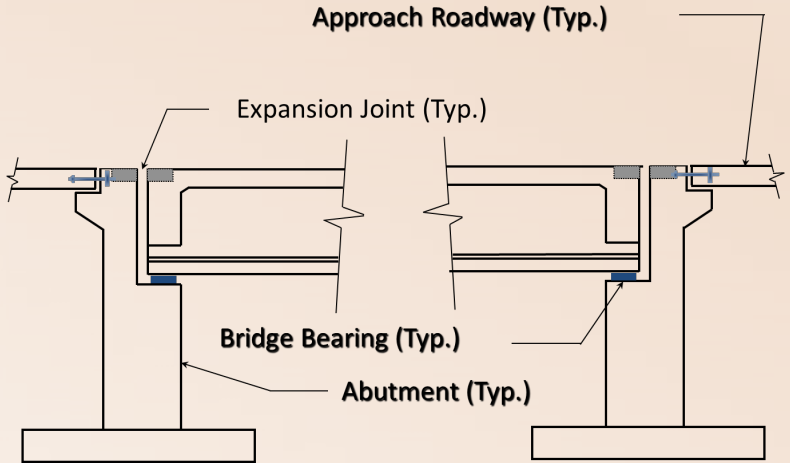

General Guidance to the Scan Team

The program was requested by the AASHTO Subcommittee on Construction (SOC), with funding provided through NCHRP.

The purpose of Project 20-68A is to accelerate innovation by:

1. Facilitating information sharing and technology exchange among states and other transportation agencies;
2. Identifying actionable items of common interest
3. Discussions will include design, construction, maintenance and operation of transportation agencies that have experienced good performance of their bridge joints and/or bearings.
4. Details for various bridge types (i.e. materials, span arrangements, geometry) and sizes will be examined

General Guidance to the Scan Team

Based on an initial review of bearing and joint performance it is suggested that the following state DOT's be studied:

1. States with severe climate challenges (cold and freezing conditions) - Illinois, New York and Massachusetts
2. States with considerable precipitation and cold climates - Washington State and Oregon.
3. States very high ADT's on bridges - California, Texas, & New York
4. Coastal states with large size bridges such as Florida, Virginia, and Louisiana
5. States with success details (Minnesota) and lessons learned to offer (Pennsylvania).

Scan Team Members

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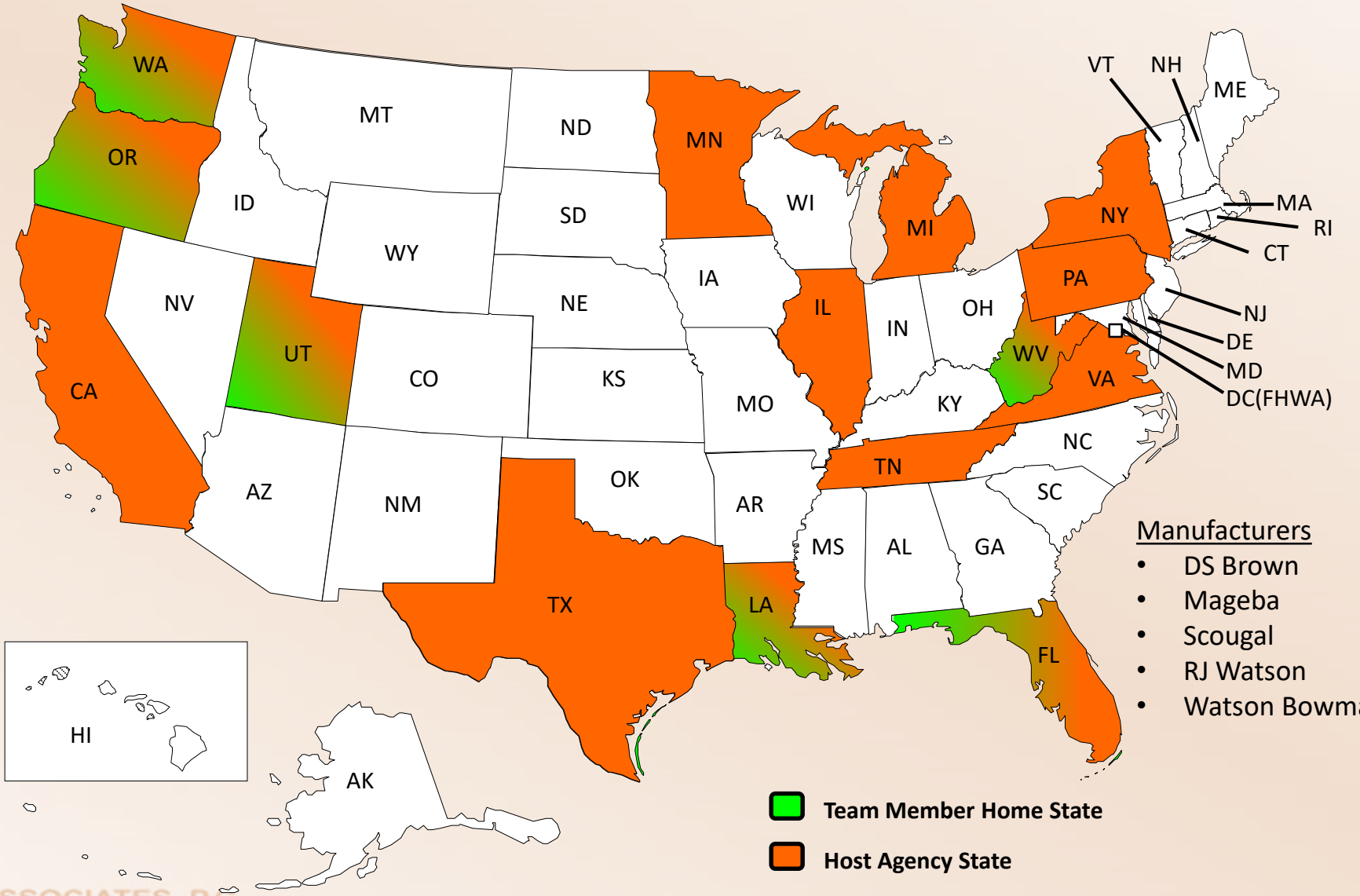
Scan Team Members and Host States



Manufacturers

- DS Brown
- Mageba
- Scougal
- RJ Watson
- Watson Bowman

Topics considered by the scan team

- Design, details, construction specifications and maintenance procedures for durable bearings and expansion joints with good performance history.
- Visual inspection and testing of joint and bearing details;
- Specialized technology used in monitoring, inspecting, and repair of joint and bearings.
- Relative costs for design, construction, maintenance, and inspection of various joint and bearings.
- Lessons learned and suggestions for improvement.

Anticipated Scan Outcomes

- **This scan would be of specific interest to:**
  - AASHTO COB Committee T-2 "Bearings and Expansion Devices",
  - AASHTO Committees on Materials and on Maintenance.
- The scan report will provide current information on successful expansion joints and bearings to bridge owners and to AASHTO for developing **work plans and research needs**.
- A synthesis of this scan would also be of interest to:
  - State DOTs and Local transportation agencies,
  - FHWA and other Federal offices,
  - Bearing and joint manufacturers,
  - University researchers, Bridge Consultants and Contractors

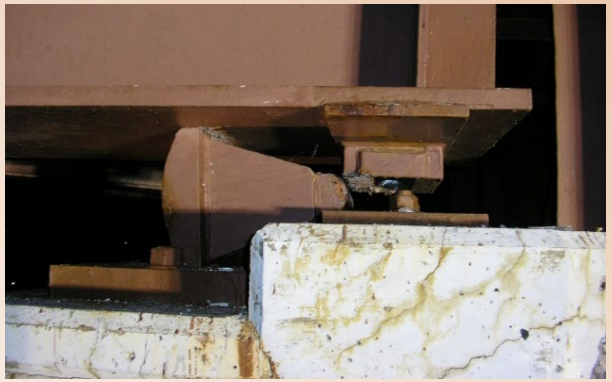
Suggestions for Amplifying Questions (Sent to DOTs)

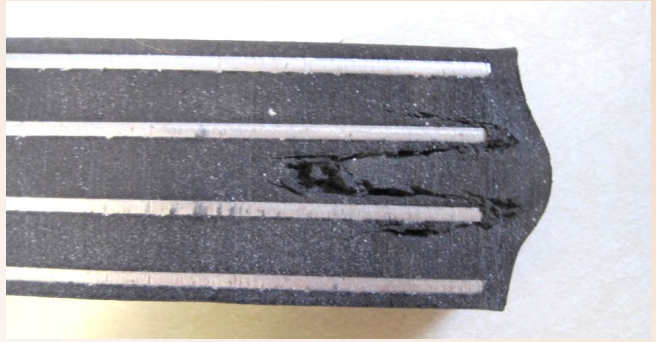
1) **Questions focusing on the Performance**
   a. Successful Strategies
   b. Advances in Practice & Emerging Technologies
2) **QA/QC**
   a. Training and retraining
   b. Quality Control/Assurance Plan
   c. Certifications
3) **Performance Measures**
   a. Metrics, Evaluations of performance
   b. Corrective Action Procedures
4) **Sustainability**
   a. Succession planning and training
   b. Modernization and upgrading of equipment

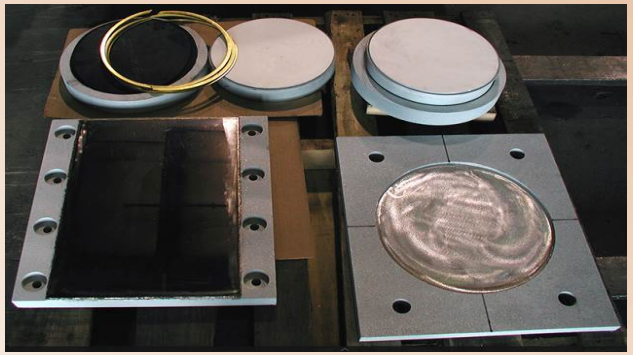
Major Findings & Recommendations

- Over-arching Issues
  - Bearing Design
  - Bearing Construction
  - Bearing Inspection and Maintenance
  - Expansion Joint Design
  - Expansion Joint Construction
  - Expansion Joint Inspection/Maintenance
- Overall Conclusions
- Recommendations

Bearings: Design, Construction, Inspection and Maintenance

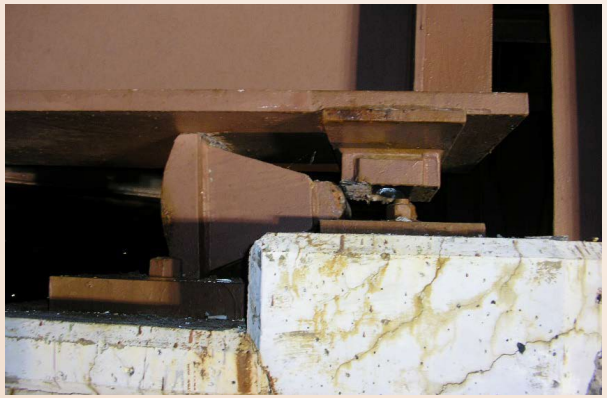


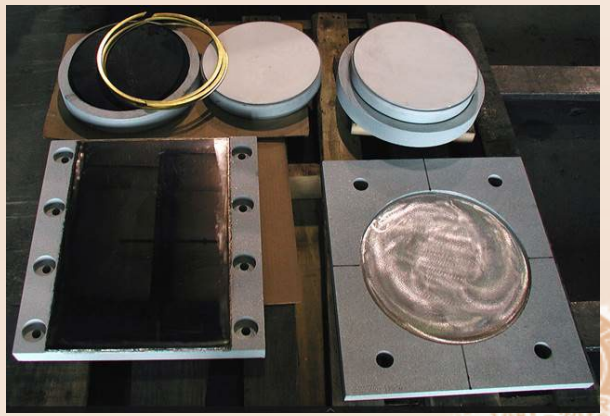




Bearings – Design - 1

- ***Uplift and horizontal forces.***
  - Design system to avoid uplift forces.
  - If possible, use some element to resist horizontal forces.
- ***Provision for replacement.***
  - Make provision at design time, e.g. jacking points.
- ***Type selection.***
  - Steel-reinforced elastomeric for short-medium span.
  - HLMR (pot, disk, spherical) for high loads.
  - No new rocker steel bearings.
- ***HLMR type selection – no consensus.***
  - Some states ban pots (elastomer leakage).
  - CA uses mostly spherical bearings
  - States moving from pots to disks bearings





Bearings – Design - 2

- ***Steel-reinforced elastomeric bearings***
  - Most states use Method B. (More logical).
  - Walking out of place: TX bans Natural Rubber. CA uses minimum compressive stress. Some states use a recess. Others recommend bonded external plates.
- ***Sliding surfaces***
  - AASHTO specifies only PTFE. More durable materials are now available.
- ***Disk bearing design specifications***
  - AASHTO requirements lack detail. Need more complete provisions.
- ***Performance-based specifications***
  - Manufacturers would prefer them (incentive for innovation).
  - European specs use them.
  - How to implement transition?

Bearings – Inspection and Maintenance

- ***Instantaneous movements (e.g. creep and shrinkage)***
  - How to accommodate? Design for full horizontal capacity/lift and re-set.
- ***Storage and Handling***
  - Do not open (HLMR) bearings on site (contamination).
  - Treat them as a mechanical device. i.e. carefully.
- ***Steel prices***
  - Steel prices fluctuate.
- ***Steel-reinforced elastomeric bearings (SREB)***
  - Checking that they have not walked out of place.
- ***Steel rocker and roller bearings***
  - Need to clean to prevent freezing. or replace.
- ***Bearing replacement***
  - Adjust the height if old bearing is replaced by an SREB.

Expansion Joints: Design, Construction, Inspection and Maintenance

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Consulting Engineers

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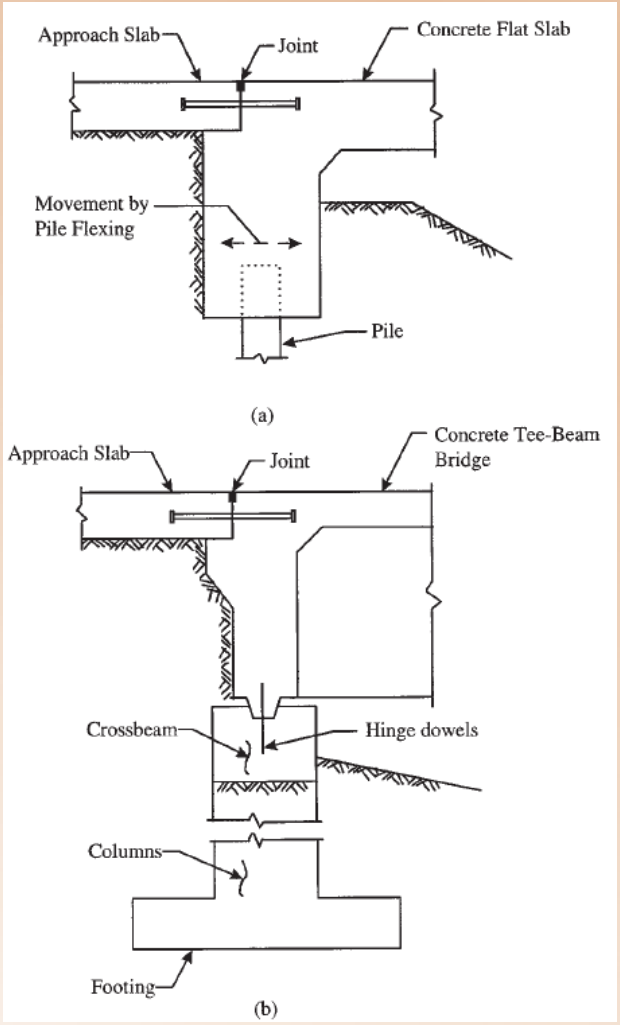
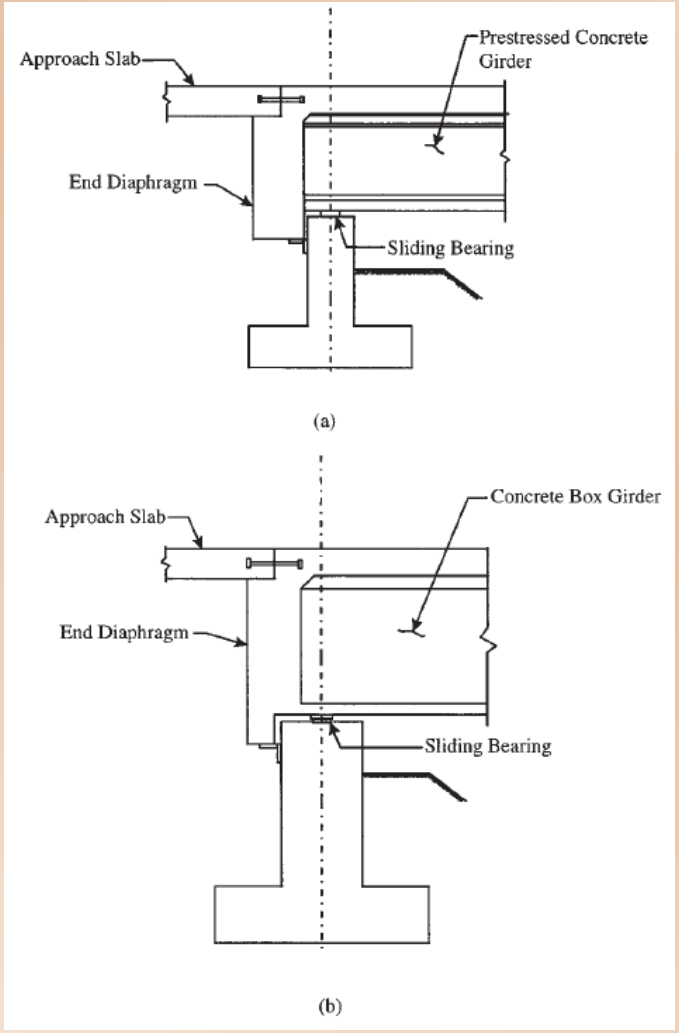
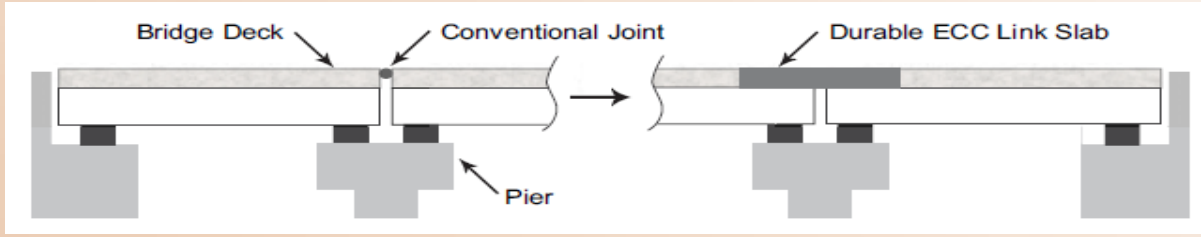
Joints – Design - 1

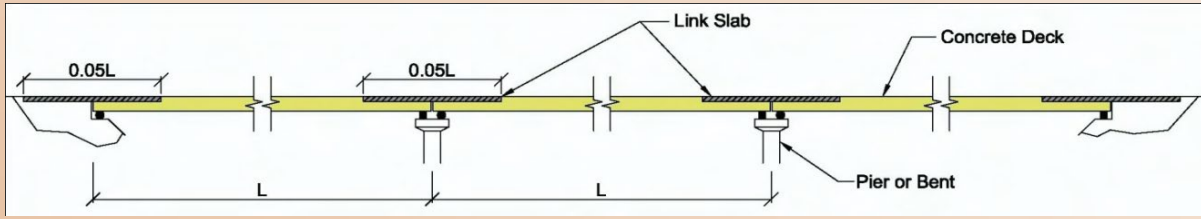
- ***Major problems.***
  - **Indirect damage:** Leaking onto bearings and girder ends.
  - **Direct damage:** Snowplow hits, raised fingers in finger joints.
- ***Joint type selection – guidelines:***
  - $0" < \Delta < 2"$: plug or filler type.
  - $2" < \Delta < 4"$: gland type (e.g. strip seal). <5" (WA)
  - $4" < \Delta$: finger joint, modular joint, etc.
- ***Skew bridges.***
  - Extra stress in gland types.
  - Finger joints bind up.
  - More taxing for modular joints.

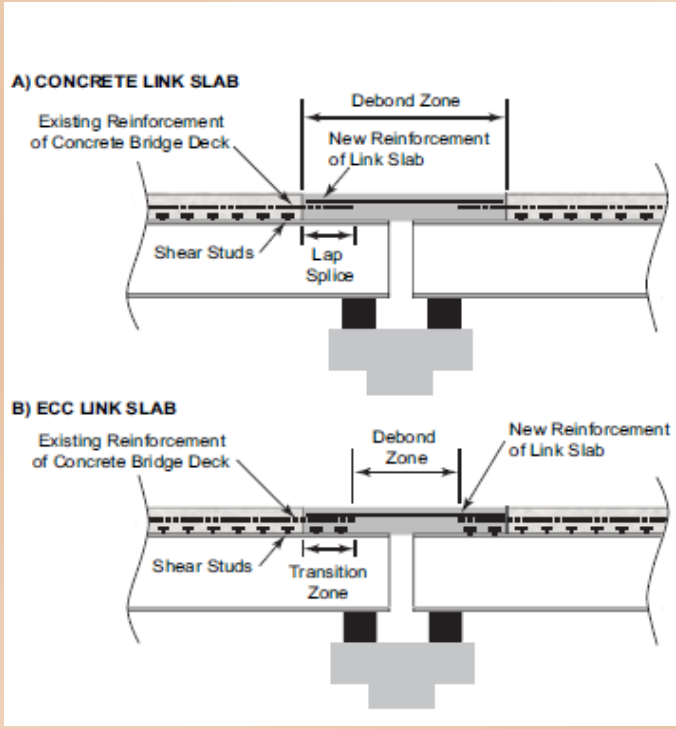
Integral or semi-integral Jointless Bridges
Link Slab Jointless Bridges





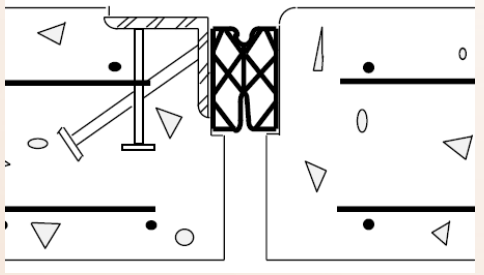






Joints – Design 2

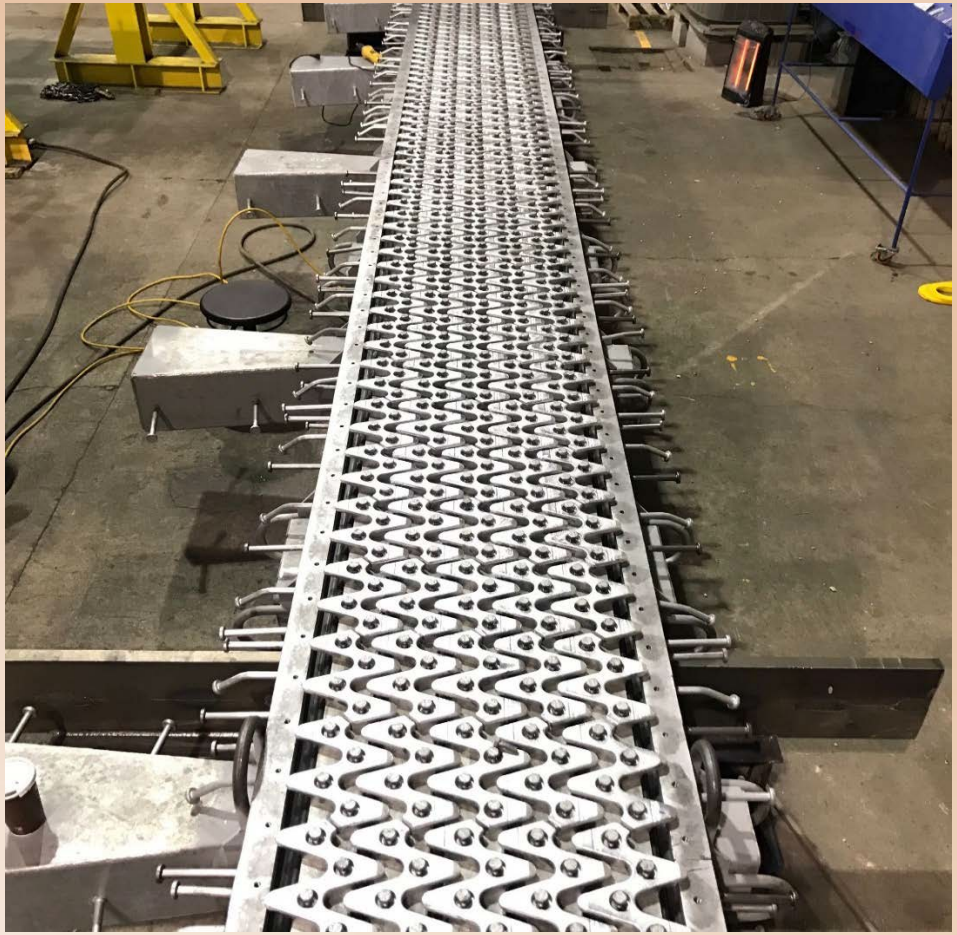
- ***Compression seals.***
  - Less widely used today.
- ***Strip seals vs pre-formed silicone.***
  - Strip seal gland secured by a groove formed in steel end dam. Sometimes use adhesive in groove.
  - Pre-formed silicone, secured by adhesive.
  - Need test program to determine best approach. (Durability and ease of replacement).
- ***Modular joints.***
  - Early versions showed fatigue problems.
  - Now mostly resolved – Requiring fatigue test
  - Large opening needed in deck to accommodate support beams and boxes.
  - Not used in large skews



Joints – Construction - 1

- ***Construction/installation is where most problems occur***.
  - Pre-submit installation procedures.
  - Pre-construction meeting.
  - Manufacturer's rep on site (especially for large joints).
- ***Installation temperature***.
  - Opening must be consistent with plans for that temperature.
- ***Lane closures***.
  - Some lane closures are unavoidable.
  - Need to connect sections. Welds are best. Bolts eventually corrode.
- ***Modular joints***.
  - Large ones will be heavy. May need a large crane.
  - Concrete must be consolidated around support beams.
  - Allow for (thermal) change of opening during installation.

Modular Joints



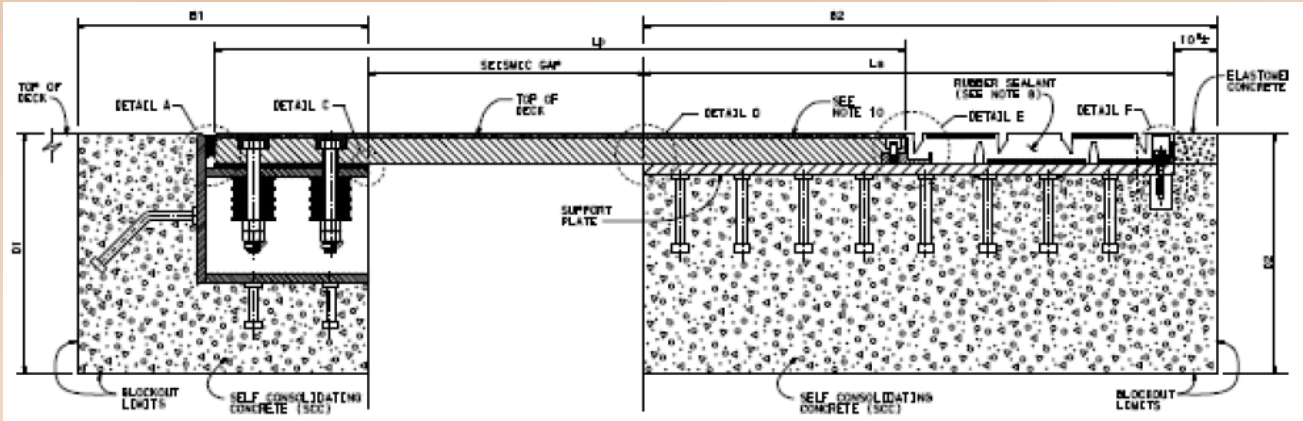


Figure 2.4-36. California Plate Joint Seal Assembly (Type II). Isometric and Section

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Joints – Construction - 2

- *Concrete for pour-backs*.
  - May need high early strength concrete (Closure time).
  - Consolidation important. Use SCC?
  - UHPC isproposed. Very hard in case of replacement.
  - Preformed silicone seals: Make sure that chemical admixtures for the concrete are compatible with adhesive.
- *Plug type joints*.
  - Need good bond between plug material and concrete.
  - Polymeric concrete may be slippery. Add grit to surface
- *Continuation of joint into barrier*.
  - Set joint back from face of barrier.
  - Wide joints need plate to protect from snowplow.

Joints – Inspection and Maintenance

- ***Active maintenance program***.
  - Prolongs joint life.
  - Protects bearings by preventing leaks.
  - Some states use State personnel, others contract out.
  - Documentation important and accurate as-builts
  - Document hardware types for replacement parts.
  - Keep as-built drawings up to date for all repairs.

Levels of Maintenance Work

Level I: clean joints. Frequency varies by state.

Level II: Minor repairs when cleaning. e.g. gland patching.

Level III: Partial replacement (e.g. gland in strip seal or preformed silicone).

Level IV: Total replacement, including steel end dam.

Over-arching Issues (Joints and Bearings)

- ***Funding Challenges.***
  - Gas taxes have not risen with bridge costs.
  - New bridges attract funding more than preservation and maintenance.
- ***Attraction and retention of staff.***
  - Design-build reduces interesting work for DOTs.
  - Staff retiring/transferring to private sector.
- ***Training and knowledge transfer.***
  - Need: experienced engineering staff and training
- ***Design responsibility and incentives for innovation.***
  - AASHTO requirements are prescriptive.
  - Consider performance based design
  - Difficult for manufacturers to understand states pre-approved requirement.

OVERALL CONCLUSIONS -1

- ***Wide variation in practices among states.***
  - Variations depend partly on climate, traffic.
  - Sharing of best practices likely to prove real benefits.
- ***Life-cycle costs***.
  - Cost of failed joints and bearings high in proportion to initial cost (e.g. closing and lifting bridge to replace bearings).
  - Maintenance is essential to prevent major problems to other bridge components.
- ***Funding***.
  - Almost all states reported limited funding, need to allocate funds strategically (e.g. policy for maintenance vs. replacement.)
- ***Continuity of operations.***
  - Staff retention and training.
  - Transfer of knowledge to less experienced staff.

OVERALL CONCLUSIONS - 2

- ***Bearings – Common types for new construction***
  - Large loads: HLMR bearings (Pot, Disk, Spherical). Vary among states.
  - Small to moderate loads: Elastomeric bearings are very widely used.
- ***Older bearing types (steel rocker, roller)***
  - Replace as the opportunity arises.
- ***Jointless bridges***. The best joint is no joint".
  - Elimination of joints provides benefits and protects bearings.
  - Link slabs at interior piers.
  - Integral or semi-integral abutments at bridge ends.
  - Full depth continuity diaphragm makes system continuous for live load. Also beneficial for seismic
- ***Length between joints:***
  - Limited by longitudinal movement required for CR, SH, and T ranges.

RECOMMENDATIONS

- ***Training tools***. Develop training tools to help transfer knowledge from experienced to newer employees.
- ***Selection guides***. Develop guides for selecting joints and bearings, based on the information assembled in this scan and elsewhere.
- ***Gathering field information.*** Develop web-based methods for gathering and organizing field information on joints and bearings.
- ***Elastomeric Bearings*** – Resolve the inconsistencies between the LRFD design spec and M251 Materials specifications.
- ***Disk Bearings*** – Develop NCHRP topic for writing a design specification for disk bearings.


Questions