Bridge Deck Expansion Joints and Joint Seals

Construction Policy:

A. General

All deck expansion joints and joint seals, except for special cases, will be specified by seal type and M.R. (Movement Rating). The success or failure of joint seals will depend greatly on the enforcement of the specifications. Questions concerning joint seals will be handled in normal channels through the Construction Engineers and the Structure Construction Office.

It is the Structure Representative's responsibility to:

1. Determine the proper groove width or installation width for the joint seal used, and to complete the applicable portions of the Joint Movements Calculations sheet (Form DS-D129)
2. Install movement recording scribes on all expansion joints.

B. Special Details

Check details such as water stop, formed joint openings, hinge restrainers, rollers or rockers, conduits, etc., for proper setting and movement capacity. All components in an expansion joint must be capable of withstanding more than the anticipated movement for a particular joint.

Joints to be sealed under rehabilitation contracts must first be cleaned of all existing seal material, joint filler, dirt and debris to the top of the waterstop. If the joints do not have a waterstop, or the waterstop is damaged, it is essential that the joint be cleaned down to the bearing or hinge seat. Care should be taken so that existing utilities and encroachments spanning joints are not damaged by the cleaning operations. Carefully inspect the condition of the existing joint and the face of the saw cut. It may not be necessary to resaw cut the joint. If not, a change order may be written to eliminate the saw cutting with a credit to the State.

All dimensions of the existing joint must be verified to be compatible with the new seal, including the depth. All joint damage shall be repaired as directed by the Engineer. Sawcutting or grinding may be required in addition to abrasive blast cleaning of joints. Cleaning joints below the existing damaged waterstop and repairing the existing joint damage shall be considered to be specified extra work. Cost of repair of damage caused by the contractors operations shall be borne by the contractor. Getting a satisfactory joint may require the repairs of spalls, cracks, and
expansions, dams, and this is usually classed as other work. Supplemental funds should have been provided for all above noted extra work.

C. Saw Cutting

1. Type "A" and "AL" Seals

Joints to be sealed with type "A" Seals are to be saw cut to the dimensions shown on the contract plans. If for some reason the saw cut width has to be increased slightly to maintain a uniform groove width or to expose good sound concrete, it is essential to maintain a 1 to 3 depth to width ratio of the polyurethane seal.

Joints sealed under rehabilitation contracts with type "A" (modified) seals, shall have a groove width ≥ one inch and ≤ 1.75 inches. Joint seal depth shall equal 1/3 the joint width but must be ≥ 1/2 inch, (see Attachment No. 5).

The 1 to 3 depth to width ratio does not apply to the type "AL" seal. (Saw cut not required).

2. Type "B" Seals

In new construction, type "B" seals are to be saw cut as follows:

Joint movement calculation sheets, which include saw cut information, will be furnished by Design upon the request of the Structure Representative, when they are not included in the R.E. Pending File. (Attachment #2 is an example of a completed Joint Movement Calculation Sheet.)

Saw cutting shall not be started until the Type "B" seal material has been tested and released. The Transportation Laboratory will furnish each job with a copy of the test report showing the M.R. (Movement Rating) of the Type "B" seal groove width limits, (W1 & W2) which are necessary to determine the saw cut widths. The M.R. of the Type "B" seal must be equal to or greater than that shown on the contract plans.

The minimum saw cut (groove) depth is to be checked by cutting a 1/2" to 1" section of the actual seal to be used and placing it between two flat surfaces, such as 1" x 4" x 8", e.g. Place the top of the seal to the dimensions shown on the contract standard plan and compress it to the W2 position. At this position determine the saw cut depth required per the standard plans.

At the time saw cutting is to begin, determine the groove or saw cut width as described on the joint movement calculation sheet shown in the example (Attachment No. 2). Mark and check the initial saw cut so that it can be used later to check the tolerance of the completed joint. This is very important because the joints are usually moving while the saw cutting is in operation. It is the Contractor's responsibility to adjust the cut accordingly to match the initial saw cut width and maintain the tolerances specified for the completed joint.
In new construction projects joint geometry is readily controllable, i.e., the size of the saw cut is set to accommodate the joint seal. Rehabilitation projects differ from new construction projects in that the width and condition of the joints require special consideration. The new joint seal must provide the required movement rating and also must be of sufficient size to fit the existing joint after saw cutting.

Rehabilitation projects require that both the Minimum \( W_1 \) (the maximum joint width at minimum temperature, after prestress shortening), and the M.R. be indicated on the plans. To ensure a correct fit, the \( W_1 \) of the joint seal must be greater than the minimum \( W_1 \) of the joint.

The Special Provisions require that the joint size be verified prior to ordering the seals. A joint should be re-measured only after that joint and its adjacent joints have been cleaned. Record the concrete temperature at the time of measurement.

Calculate the minimum \( W \), required for the joints using the actual measurements.

\[
\text{Min } W_1 = W_e 1/2 \frac{(T_{str}) - T_{\text{min}}}{1} \left(\frac{2}{100}\right)
\]

Where:

- \( \text{Min } W_1 \) = Maximum joint width in inches
- \( W_e \) = Existing joint width in inches (measured at the widest point)
- \( 1/2 \) = Minimum practical concrete removal (1/4 inch each side of the joint)
- \( T_{str} \) = Structure temperature, deg F (measured at the time the existing joint width was measured, \( W_e \))
- \( T_{\text{min}} \) = Minimum temperature at structure site – from form DS-D129
- \( 1 \) = Temperature range at structure site - from form DS-D129
- \( 2 \) = Thermal movement in inches/100 feet - from form DS-D129
- \( 4 \) = Contributory length in feet - from form DS-D129

Compare these recalculated \( W_1 \)’s with the minimum \( W_1 \)’s shown on the plans. If they agree within 0.1 inch, the data shown on the plans does not need to be revised. If the new \( W_1 \)’s do not agree with the values shown on the plans, prepare a contract change order to revise the \( W_1 \)’s and state whether or not the movement ratings have changed.

If a calculated \( W_1 \) exceeds 4.25 inches, a compression seal should not be used. Contact the chairman of the Joint Seal Committee for a recommended course of action to follow.

Again, saw cutting should not start until test data for the seal to be used is available. Saw cut widths should be set to provide the minimum joint width possible. Due to the variables involved, saw cut widths should be calculated using the formulas given below and the narrower width chosen, provided it will work.

\[
S_1 = W_1 - \frac{(T_{str} - T_{\text{min}})}{1} \left(\frac{2}{100}\right)
\]
\[
S_2 = W_2 + \frac{1}{1} \left( \frac{T_{\text{max}} - T_{\text{str}}}{100} \right) \quad \text{(4)}
\]

\[
S_3 = W_e + \frac{1}{2} = \text{Minimum practical saw cut width}
\]

Where:

- \( S_1, S_2, S_3 \) = possible saw cut widths
- \( W_1 \) = \( W_1 \) taken from test report (R-29)
- \( W_2 \) = \( W_2 \) taken from test report (R-29)
- \( W_e \) = Existing joint width in inches (measured at widest point)
- \( 1/2 \) = minimum practical concrete removal (1/4 inch each side of joint)
- \( T_{\text{str}} \) = Structure temperature, deg F (taken at the time of measurement of \( W_e \))
- \( T_{\text{min}} \) = Minimum temperature at structure site - from form DS-D129
- \( 1 \) = Temperature range at structure site - from form DS-D129
- \( 2 \) = Thermal movement in inches/100 feet - from form DS-D129
- \( 4 \) = Contributary length in feet - from form DS-D129.

### D. Installation

1. **Type "A" and "AL" Seals:**

   Be thoroughly familiar with the contract specifications and details and enforce them.

   It is essential that the polyethylene foam be placed at a uniform depth to preclude excessively thin or thick sections. There is a successful relationship between the cohesion and the adhesion of the polyurethane seal if the proper shape and dimensions shown on the Standard Plan are maintained. Cut templates out of plywood to check the surface depths of the polyethylene foam and the polyurethane.

   Type A (modified) seals require placing the joint seal and rod stock 3 inches up into the curb or rail on the low side of the deck at the curb or rail joint that lines up with the deck joint.

2. **Type "B" Seals:** (Attachment #1 gives the properties for some brands of Type "B" seals.)

   Again be thoroughly familiar with the contract plans and specifications and enforce them.

   Repair all spalls and grind chamfer in advance of installing the seal.

   As a final check, prior to installation, it is recommended to use a thin section of joint seal material and use it to check the saw cut depth throughout the length of joint. Place the seal section in the planned position and check to see that the dimensions shown on the Standard Plan are maintained. Most joint seal failures result from improper saw cuts or from the seal being placed too near the deck surface.
Bend type "B" seals 6 inches up into the curb or barrier rail on the low side of the deck. If the curb or rail joints don't line up with the deck joint, an attempt must be made to abut the joint seal to the face of the curb or rail so that it will provide a water tight seal.

3. Joint Seal Assemblies:

Details of a joint seal assembly are shown on the contract plans. The Structure Representative is to calculate the installation width of the joint seal assembly. Calculations are to be shown on the Joint Movements Calculations (DS-D129) sheet using a W2 equal to 1/2 inch minimum at maximum temperature.

The Special Provisions permit alternate joint seal assemblies which the Contractor may use in lieu of the joint seal assembly detailed on the Contract Plans.

If the Contractor proposes to use an alternate joint seal assembly, the Structure Representative shall send two copies of the initially submitted working drawings to Structures Design for a determination as to the adequacy of the proposed alternate joint seal assembly. When submitting the working drawings, point out that they detail a contractor proposed alternate joint seal assembly, and that they are submitted for an informal review by the Joint Seal Committee and by Structures Design.

If an alternate joint seal assembly is incorporated in the contract work, the Structure Representative should make the necessary changes on the "As Built" plans to indicate the details of the alternate joint seal assembly. An additional sheet may be necessary to show the "As Built" details. Do not submit the shop plans as "As Built" plans.

Note that prestressed concrete structures are expected to initially shorten about 0.50 in./100 ft. due to stressing. The total long-term shortening is anticipated to be 1.00 in./100 ft. for post-tensioned bridges and somewhat less for pretensioned bridges. The difference between the long-term shortening (1.00 in.) and the initial shortening is equal to 0.5 in./100 ft. This is the value shown on the Joint Movements Calculations" form (DS-D129) as "Anticipated Shortening for Post Tensioned Concrete Structures". For unusual situations when a substantial amount of time has elapsed between stressing and the placement of joint seals, an estimate may be made of the amount of prestress shortening that has occurred. Refer to Attachment No. 10 for an example.

4. Modular Joint Seal Assemblies (MR over 4")

Refer to the Special Provisions for details concerning the installation of modular joint seal assemblies. Any questions can be directed to your area Senior or the Joint Seal Committee.

5. Open Joint and Experimental Test Seals

Obtain the necessary brochures on installation procedures from your Construction Senior or the Chairman of the Joint Seal Committee if they are not included in the R.E. Pending File.
The proper installation width of open joints or experimental joint seals will be calculated from the **Joint Movement Calculation Sheet**. Determine the minimum width at maximum temperature \((W_2)\) and insert this in Column 5. The adjustment of the width for temperature at time of installation will be the same as for the Type B Seal.

### E. Expansion Joint Scribes

Scribes are to be placed at all expansion joints as shown on the attached instruction sheet (Attachment No. 3). Placement of the scribes at a location other than that shown may be required when special barrier rails are used. Use the 8" steel railing scribe, 3/4" x 8" 24 gauge (Item No. 6635 1760 5) and 4" aluminum scribe plate, 1 1/2" x 4" 16 gauge (Item No. 6635 1790 8) for joints having a movement rating of 2" or less. Use the 10" steel railing scribe, 3/4" x 10" 24 gauge (Item No. 6635 1780 7) and 6" aluminum scribe plate, 1 1/2" x 6" 16 gauge (Item No. 6635 1770 6) for joints having a movement rating greater than 2". Use 681-80-44 Rapid Set Epoxy (Item No. 8040 0100 4) to attach the scribes and plates to the rail. Scribes, plates and epoxy should be obtained from the District through the Resident Engineer. Order one scribe per expansion joint and epoxy at the rate of 1 unit (1/4 pint can of "A" and 1/4 pint can of "B") per 20 scribe units. Skewed, or extra wide structures may require a scribe unit on the joint on both sides of the structure.
APPROXIMATE PROPERTIES
FOR
PREFORMED ELASTOMERIC JOINT SEALS
TYPE B₁

Manufacturer's Nominal Properties for Design Data Only
(See Note 4)

<table>
<thead>
<tr>
<th>Catalog Number Depth (See Note 1)</th>
<th>Uncompressed W₀ (See Note 3)</th>
<th>Uncompressed D₀ (See Note 3)</th>
<th>Approx. M.R. (See Note 2)</th>
<th>W₁ Max. Groove Width</th>
<th>W₂ Min. Groove Width</th>
<th>Recommended Saw Cut</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brown H-2503</td>
<td>2.5&quot;</td>
<td>2.625&quot;</td>
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<td>2.55&quot;</td>
<td>1.55&quot;</td>
<td>5.0&quot;</td>
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<td>Brown H-3500</td>
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<td>3.75&quot;</td>
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<td>2.98&quot;</td>
<td>1.48&quot;</td>
<td>5.85&quot;</td>
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<td>1.90&quot;</td>
<td>6.0&quot;</td>
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<td>2&quot;</td>
<td>4.25&quot;</td>
<td>2.25&quot;</td>
<td>7.75&quot;</td>
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<td>5.10&quot;</td>
<td>2.60&quot;</td>
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<td>1.13&quot;</td>
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<td>1.55&quot;</td>
<td>4.31&quot;</td>
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<td>1.98&quot;</td>
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<tr>
<td>W.B. WA-600</td>
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<td>6.0&quot;</td>
<td>2.5&quot;</td>
<td>5.10&quot;</td>
<td>2.60&quot;</td>
<td>7.75&quot;</td>
</tr>
</tbody>
</table>

*W.B. - Watson Bowman

Notes:
(1) Brand Names other than those listed may be available.
(2) The actual Movement Rating equals (W₁ - W₂). W₁ shall be the smaller of the values determined as follows:
   a. 0.85 times the manufacturer's designated minimum uncompressed width of the seal (W₀).
   b. The width of seal on the third successive test cycle of the pressure-deflection test, when compressed to an average pressure of 3.0 pounds per square inch.

W₂ shall be the width of seal determined on the third successive test cycle of the pressure-deflection test, when compressed to an average pressure of 4 times the pressure measured at the seal width W₁.

(3) Data shown may change significantly due to variations in extrusions. Dimensions must be verified in the field.
(4) Do not use these properties in lieu of actual test results. This is for additional information only. Actual values for W₁, W₂, and M.R. are obtained from test results performed by the Transportation Laboratory on the Report of Inspection of Material (Form TL-29).
### Bridge Construction Records & Procedures Manual

**Attachment No. 2**

#### Bridge Movement Calculations

<table>
<thead>
<tr>
<th>Location</th>
<th>Seal Width Limits</th>
<th>Groove Saw Cut Width</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abut. 1 (Conv.)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Span 3 Hinge (Conv.)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Span 3 Hinge (CIP/S)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Span 3 Hinge Total</td>
<td></td>
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</tr>
<tr>
<td>Span 5 Hinge (CIP/S)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Span 5 Hinge (Conv.)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Span 5 Hinge Total</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Abut. 7 (Conv.)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Details:**
- **Temperature Extremes:**
  - MAX: 110 °F
  - MIN: 23 °F
  - RANGE: 87 °F

- **Thermal Movement:**
  - 0.00

- **Anticipated Shortening:**
  - 0.55

- **Movement Factor:**
  - 0.61

**Catalog Numbers:**
- FRC 3105
- Brown B-5000

**Seal Widths:**
- 4.50
- 4.25

**Joint Assembly:**
- Arm, Neoprene

**Notes:**
- Use sketch or drawing to show location of structures and joint assemblies.
- For joint space between abutments, select correct width from sketches shown on Attachment No. 6.

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**Information from Transportation Laboratory Reports:**
- Groove width is based on superstructure temperature, max. temperature minus temperature at joint end.

**Measure:**
- Superstructure temperature by placing red of concrete thermometer for 5 min into expansion joint.

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**Design and Specifiers:**
- P. C. Boyd
- A. J. Pugh
- C. W. Jones
- W. T. Trustworthy

**Date:**
- 5-1-76
- 7-2-76
### Calculation of Points of No Movement

#### Diagram:

![Diagram of bridge construction with dimensions and labels].

#### Table:

<table>
<thead>
<tr>
<th>I (ft)^4</th>
<th>L (ft)</th>
<th>P (kips)</th>
<th>D (dist. from 1st. member of frame)</th>
<th>X</th>
<th>Notes</th>
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<tbody>
<tr>
<td>1.38</td>
<td>5.50</td>
<td>1200</td>
<td>0</td>
<td></td>
<td>Width Str. = 78°</td>
</tr>
<tr>
<td>61.36</td>
<td>35.0</td>
<td>618</td>
<td>90</td>
<td></td>
<td>Dia. Col. = 9°0'</td>
</tr>
<tr>
<td>61.36</td>
<td>61.36</td>
<td>415</td>
<td>210</td>
<td></td>
<td>K / Pile @ 1' defl. = 100</td>
</tr>
<tr>
<td>61.36</td>
<td>40.0</td>
<td>2,233</td>
<td>870</td>
<td></td>
<td>X = Point of No Movement</td>
</tr>
<tr>
<td>61.36</td>
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<tr>
<td>61.36</td>
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<tr>
<td>102</td>
<td>7.0</td>
<td>600</td>
<td>0</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Assumptions:

1. Super str. Inf. rigid
2. Col's fixed top & bottom
3. Abut. diahp. will slide @ a force equal to D.W.
4. E (plies) = 4 x 10^6
5. E (columns) = 3 x 10^6

#### Formulas:

- \( P (Col) = \frac{12 EI}{L^5} \)
- \( \Delta = \frac{432 I}{L^3} \)
- \( I (obut) \approx \frac{12}{3} (2.5)^3 \)
- \( I (obut) \approx 102 \)
- D.W. Abut 5 x 600K (assume linear up to 1' defl.)
NOTES:
1. Install one scribe at each deck joint on the most convenient side of the roadway i.e., widest shoulder. Use 8" scribe and 4" plate for joints having movement rating of 2" or less. Use 10" scribe and 6" plate for joints having movement rating greater than 2".
2. Place scribe on top of the concrete portion of the barrier railing.
3. Sand or wire brush surfaces of scribe and concrete to insure good adhesion.
4. Mix only enough epoxy for one scribe and plate when using the 681-80-44 Rapid Setting Epoxy. (5 min, pot life @ 70°)
5. Use weight on a piece of paper to hold the scribe down on the concrete surface while the epoxy is setting.
6. Mark the Initial Position of the scribe, date, and concrete temperature on the plate as shown with a scriber. Measure the concrete temperature by placing the bulb of a concrete thermometer 6" + into the deck section, if possible, or at any convenient location to obtain the approximate superstructure temperature.
SAMPLING AND TESTING OF TYPE "B" JOINT SEALS

The following revised instructions for sampling and testing Type "B" joint seals have been issued by the Transportation Laboratory. The procedures are currently in use. If there are any questions call Richard Spring at (916)739-2314.

1. Following the manufacturing of a given quantity of various sizes (Movement Ratings) of joint seal materials for use on Caltrans contracts, such as:
   MR=1"  (1500 LF)
   MR=1 1/2" (1000 LF)
   MR=2"  (1000 LF)

   The manufacturer will notify our Caltrans Laboratory (Richard Spring (916)739-2314).

2. Mr. Spring will arrange for an independent inspection agency to contact the manufacturer for the purpose of sampling the various lots of materials at the source.

3. The sampling agency will obtain one 3’ long sample of each size and lot of material for every 500 LF 2 and send to our laboratory for testing along with the manufacturer's test report. The manufacturer’s lot number will appear along the length of the seal.

4. Following satisfactory testing, the manufacturer will be notified and the material will be set aside for stock to be used on Caltrans contracts only.

5. As the manufacturer receives orders and makes shipments to the individual contracts, form letters will be sent to our Caltrans Laboratory and with the shipment to the jobsite. This letter will contain the following information:

   a. Name and address where the seal is being sent.
   b. State Contract Number.
   c. Size, quantity and movement rating of the seal.
   d. The Lot Number identifications.
   e. The Trans Lab's test number (SM number).

Upon receiving the letter from the supplier as to where the seal is being sent, the TransLab will send to the RE or Structure Rep a copy of the test report for the particular lot of material. Included on the test report will be the \( W_1 \) and \( W_2 \) values for the seal. The RE or Structure Rep should verify the lot number on the seal with the test report lot number.
JOINT SEAL TYPE A MODIFIED (MR 1/2")

1. If required, sawcut or grind transverse joints to the minimum (W) shown. Clean and abrave blast joint.
2. Install commercial quality closed cell polyethylene rod stock with glazed surface. Diameter = joint width + 1/4".
3. Install joint seal. Place joint seal 3" up into curb or rail on low side of deck.

Notes:

Depth = W/3, (1/2" min.)

Original deck surface

1/4" Bevel

1/4" Ctl.

Varies 1" min.
Prestress Shortening

Assume long term total shortening is 0.10/100 ft.

If saw cut made at following weeks:
- 6 weeks: 0.10"/100 ft
- 15 weeks: 0.10"/100 ft
- 30 weeks: 0.10"/100 ft
- 52 weeks: 0.10"/100 ft

Additional opening of expansion joint after point placement per 100 ft of contributory length:
- 0.057"/100 ft
- 0.057"/100 ft
- 0.057"/100 ft

Projected Rate

Elastic due to Stressing

Shorening: h per 100 ft