



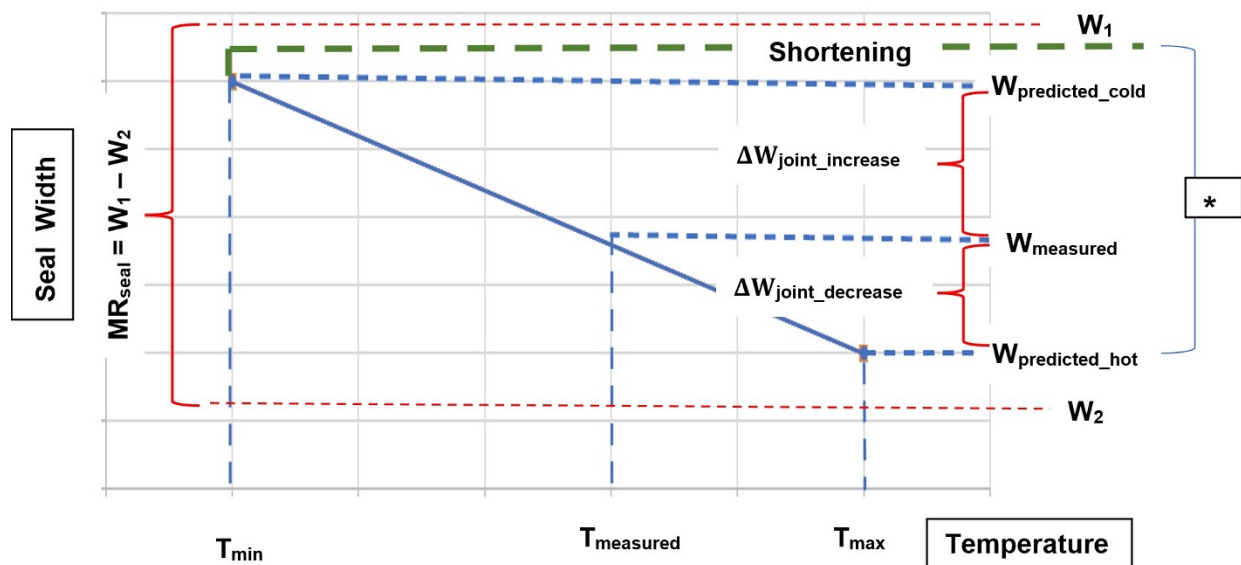
# Appendix A: Joint Seals – Additional Information & Examples

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# A-1 Additional Discussion on Joint Movement Calculations

The Joint Movement Calculation sheet contains a logical series of calculations to be filled out by the Structure Representative, as highlighted in the examples below in Section A-2, *Sample Joint Movement Calculations*. The corresponding Form BD-0307, *Joint Movement Calculations*, (formerly DSD-0129) appears in Figure A-3, with values in red; note that while the figure may display an older version of the form, the concept is unchanged. The form first provides space to input the joint seal limits  $W_1$  and  $W_2$ . The next column is for the temperature of the structure at which the joint seal will be placed, followed by a simple calculation to determine the amount of expected movement between the installation temperature and the maximum anticipated bridge temperature. In other words, “How much is this joint expected to close as the temperature rises to the maximum value?” It is a simple calculation that takes the expected rise in temperature ( $\Delta T \uparrow$ ) divided by the range in temperature, multiplied by both the thermal movement factor and the contributory length of the bridge for the joint (see Equation A-1-1). To aid in this discussion, Figure A-1 is duplicated below from Chapter 2, which illustrates the bridge joint seal width versus the superstructure temperature.



Note \*  $MR_{joint} = (W_{predicted\_cold} - W_{predicted\_hot}) + Shortening$   
 $MR_{joint} = \Delta W_{joint\_increase} + \Delta W_{joint\_decrease} + Shortening$

Figure A-1. Graph of Seal Width vs Superstructure Temperature with Shortening

$$\Delta W_{joint\_decrease} = \left( \left[ \frac{\Delta T \uparrow}{\text{temperature range}} \right] \times \text{thermal movement factor} \times \left[ \frac{\text{contributory length}}{100} \right] \right) \tag{A-1-1}$$

Where  $\Delta W_{\text{joint\_decrease}}$  is the decrease in bridge joint width due to an increase in temperature. Once  $\Delta W_{\text{joint\_decrease}}$  (i.e., the decrease in bridge joint width due to temperature rise) is calculated, this number can be subtracted from the actual groove dimension ( $W_{\text{measured}}$ ), to predict groove dimension ( $W_{\text{predicted\_hot}}$ ) after the temperature rise (see Figure A-1).

$$W_{\text{predicted\_hot}} = W_{\text{measured}} - \Delta W_{\text{joint\_decrease}} \quad (\text{A-1-2})$$

As depicted in Figure A-1, at maximum expected bridge temperature ( $T_{\text{max}}$ ),  $W_{\text{predicted\_hot}}$  must meet the following criteria:

$$W_{\text{predicted\_hot}} \geq W_2 \quad (\text{A-1-3})$$

Substituting Equation A-1-2 into Equation A-1-3, the following can be obtained:

$$(W_{\text{measured}} - \Delta W_{\text{joint\_decrease}}) \geq W_2 \quad (\text{A-1-4})$$

Or,

$$W_{\text{measured}} \geq W_2 + \Delta W_{\text{joint\_decrease}}$$

Where:

$$\Delta W_{\text{joint\_decrease}} = \left( \left[ \frac{\Delta T \uparrow}{\text{temperature range}} \right] \times \text{thermal movement factor} \times \left[ \frac{\text{contributory length}}{100} \right] \right) \quad (\text{A-1-5})$$

In equation A-1-5,  $W_2 + \Delta W_{\text{joint\_decrease}}$  represents the lower limit of  $W_{\text{measured}}$  that is conveniently calculated using Form BD-0307, *Joint Movement Calculations*. To continue with our discussion, let's refer to  $W_2 + \Delta W_{\text{joint\_decrease}}$  as  $W_{\text{measured\_lowerlimit}}$ .

$$W_{\text{measured\_lowerlimit}} = W_2 + \Delta W_{\text{joint\_decrease}} \quad (\text{A-1-6})$$

Note:  $W_{\text{measured\_lowerlimit}}$  has previously been defined as  $S_2$  in Attachment 1, *Guidance for Verifying Contract Compliance for Sealed Joints*, of BCM 51-2.

At this time, the reader might naturally ask:

- A. If there is a lower limit for  $W_{\text{measured}}$ , shouldn't there be an upper limit as well?
- B. And if there is an upper limit, what is the upper limit?
- C. Lastly, why is the upper limit not calculated on Form BD-0307, *Joint Movement Calculations*?

So, let's look at each question one by one.

The answer to question A is that there is, in fact, an upper limit for  $W_{\text{measured}}$ . To answer question B, the maximum groove width needs to be determined. It should be easy to realize that the maximum groove width will occur when the bridge is at its lowest temperature (i.e., at  $T_{\text{min}}$ ). However, another factor needs to be considered when determining the maximum groove width: the shortening of the new bridge with time if it is prestressed (for additional information, refer to Attachment 1, *Prestress Shortening*, of [Memo to Designers](#) 7-1, *Bridge Bearings*). Now, the maximum groove width (which will be at the coldest temperature and after any prestress shortening) must meet the following criteria:

$$W_{\text{predicted\_cold \& shortening}} \leq W_1 \quad (\text{A-1-7})$$

And by looking at Figure A-1, it can be seen:

$$W_{\text{predicted\_cold \& shortening}} = W_{\text{measured}} + \Delta W_{\text{joint\_increase}} + \text{shortening} \quad (\text{A-1-8})$$

Using equations A-1-7 and A-1-8, the following can be obtained:

$$W_{\text{measured}} \leq W_1 - \Delta W_{\text{joint\_increase}} - \text{shortening} \quad (\text{A-1-9})$$

In Equation A-1-9,  $W_1 - \Delta W_{\text{joint\_decrease}} - \text{shortening}$  represents the upper limit of  $W_{\text{measured}}$ . Let's refer to  $W_1 - \Delta W_{\text{joint\_increase}} - \text{shortening}$  as  $W_{\text{measured\_upperlimit}}$ . It becomes apparent that to determine  $W_{\text{measured\_upperlimit}}$ , calculating  $\Delta W_{\text{joint\_increase}}$  directly using an equation similar to A-1-1 is relatively cumbersome. It can be shown that the  $W_{\text{measured\_upperlimit}}$  can be calculated more easily using  $W_{\text{measured\_lowerlimit}}$  that was already obtained in A-1-6 as follows:

$$W_{\text{measured\_upperlimit}} = W_{\text{measured\_lowerlimit}} + (\text{MR}_{\text{seal}} - \text{MR}_{\text{joint}}) \quad (\text{A-1-10})$$

Note:  $W_{\text{measured\_upperlimit}}$  has previously been defined as  $S_1$  in Attachment 1, *Guidance for Verifying Contract Compliance for Sealed Joints*, of BCM 51-2.

In summary,  $W_{\text{measured}}$  is determined as follows:

$$W_{\text{measured\_upperlimit}} \geq W_{\text{measured}} \geq W_{\text{measured\_lowerlimit}}$$

Where:

$$W_{\text{measured\_lowerlimit}} = W_2 + \Delta W_{\text{joint\_decrease}}$$

$$\Delta W_{\text{joint\_decrease}} = \left( \left[ \frac{\Delta T \uparrow}{\text{temperature range}} \right] \times \text{thermal movement factor} \times \left[ \frac{\text{contributory length}}{100} \right] \right)$$

(Obtained using Form BD-0307 *Joint Movement Calculations* (Adjust from Max.Temp = Col 6))

And,

$$W_{\text{measured\_upperlimit}} = W_{\text{measured\_lowerlimit}} + (MR_{\text{seal}} - MR_{\text{joint}}) \quad (\text{A-1-11})$$

By looking at Equation A-1-11, it can be seen that if  $MR_{\text{seal}} = MR_{\text{joint}}$  then:

$$(MR_{\text{seal}} - MR_{\text{joint}}) = 0 \quad \text{and} \quad W_{\text{measured\_upperlimit}} = W_{\text{measured\_lowerlimit}}$$

This means that for the joint seal to be installed properly,  $W_{\text{measured}}$  must be exactly equal to  $W_2 + \Delta W_{\text{joint\_decrease}}$  (as calculated on Form BD-0307, *Joint Movement Calculations*). On the other hand, if  $MR_{\text{seal}}$  is greater than  $MR_{\text{joint}}$ , then as long as  $W_{\text{measured}}$  is selected as any number between the upper and lower limit, the joint seal will function properly. However, it's generally preferred to select  $W_{\text{measured}}$  very close to the lower limit because it is easier to make a groove wider later on (if needed for any reason) than to make it narrower. In plain language, it is desired to have the sawcuts for a groove width to be as narrow as possible.

Now, question C can be answered as follows:

$W_{\text{measured\_lowerlimit}}$  (i.e., calculated on Form BD-0307, *Joint Movement Calculations*) is always needed to determine the  $W_{\text{measured}}$ . On the other hand,  $W_{\text{measured\_upperlimit}}$  is needed only sometimes (i.e., when the  $MR_{\text{seal}} \neq MR_{\text{joint}}$  and  $W_{\text{measured}}$  slightly bigger than  $W_{\text{measured\_lowerlimit}}$  is desired) to verify that  $W_1$  limit of our seal is not exceeded. Additionally, once  $W_{\text{measured\_lowerlimit}}$  is calculated,  $W_{\text{measured\_upperlimit}}$  can be quickly determined by simple arithmetic without the need for any calculation sheet.

Technical Team D, Structure Rehabilitation Team, has created an SC Joint Seal Calculations spreadsheet to assist with joint movement calculations. This spreadsheet can be found on the SC Intranet under the [Downloads tab](#)<sup>1</sup>, grouped with other Software Tools; see Figure A-2 for an illustration.

<sup>1</sup> Caltrans internal use only

## A-2 Sample Joint Movement Calculations

### Example 1: Joint Seal Assembly (Numbers Shown in Red in Figure A-3)

#### Given:

Bridge Joint data provided by Design	= See Figure A-3; Hinge 15
$MR_{\text{joint}}$ = Bridge joint movement range	= 3 in
$W_1$ = Maximum seal opening limit	= 4 ½ in
$W_2$ = Minimum seal opening limit	= ½ in
Installation Temperature	= 65° F

#### Find:

1. What is the joint seal movement range ( $MR_{\text{seal}}$ )? Is this acceptable?
2. At the time/temperature of installation, what is the joint seal assembly minimum acceptable opening width?
3. At the time/temperature of installation, what is the joint seal assembly's maximum acceptable opening width?

#### Solution:

1.  $MR_{\text{seal}}$  = Seal movement range  
 $= W_1 - W_2 = 4 \frac{1}{2} \text{ in} - \frac{1}{2} \text{ in} = 4 \text{ in}$ . <= This is acceptable since this number is equal to or greater than the bridge joint movement range ( $MR_{\text{joint}}$ ) of 3 inches

2. Minimum Opening at 65° F per Equation A-1-6

$$\begin{aligned} W_{\text{measured\_lowerlimit}} &= W_2 + \Delta W_{\text{joint\_decrease}} \\ &= 0.5 \text{ in.} + \{[(105^\circ - 65^\circ)/85^\circ] \times (0.734 \text{ in}) \times (407.9/100)\} \\ &= 0.5 \text{ in.} + 1.410 \text{ in.} \\ &= 1.910 \text{ in} \end{aligned}$$

3. Maximum Opening at 65° F per Equation A-1-10

$$\begin{aligned} W_{\text{measured\_upperlimit}} &= W_{\text{measured\_lowerlimit}} + (MR_{\text{seal}} - MR_{\text{joint}}) \\ &= 1.910 \text{ in} + (4 \text{ in} - 3 \text{ in}) \\ &= 2.910 \text{ in} \end{aligned}$$

Example 2: Type B-Compression SealGiven:

Bridge Joint data provided by Design = See Figure A-3; Hinge 6

$MR_{\text{joint}}$  = Bridge joint movement range = 2 in

Joint seal product test data from METS:

- $W_1$  = max. joint seal width at min. temperature = 4.25 in
- $W_2$  = min. joint seal width at max. temperature = 1.69 in

Rehabilitation project (assume shortening = 0)

Existing joint Groove Width Field Measurement Before Removal of existing

Joint Seal = 2 ½ in

Bridge superstructure temperature = 65° F

Find:

To select a suitable Type B joint seal for Hinge 6, with minimal change to the existing joint seal groove width, determine the following:

1. What is the predicted value for existing joint groove width at the maximum expected bridge temperature ( $W_{\text{predicted\_hot}}$ )? Is the  $W_2$  test value OK?
2. What is the predicted value for existing joint groove width at the minimum expected bridge temperature ( $W_{\text{predicted\_cold}}$ )? Is the  $W_1$  test value OK?

Solution:

Before proceeding with the calculation, the anticipated widening of the groove due to the removal operation of the old joint seal needs to be taken into account. After obtaining the groove width field measurement (before removal at the widest location), ½ inches needs to be added to account for the minimum possible saw cutting width.

Thus:

$W_{\text{measured}} = 2 \frac{1}{2} \text{ in} + \frac{1}{2} \text{ in} = 3.0 \text{ in}$  ← Measured dimension modified to account for widening of groove due to saw-cutting for the removal of old joint

1. Calculating the maximum  $W_2$  value:

- a. The first step is to predict the existing joint groove width at the maximum expected bridge temperature using Equation A-1-1 and Equation A-1-2.

$$\Delta W_{\text{joint\_decrease}} = ([\Delta T \uparrow / \text{temperature range}] \times \text{thermal movement factor} \times [\text{contributory length} / 100])$$

$$\Delta W_{\text{joint\_decrease}} = \{[(105^\circ - 65^\circ) / 85^\circ] \times (0.734 \text{ in}) \times (257.9 / 100)\}$$

$$\Delta W_{\text{joint\_decrease}} = 0.891 \text{ in}$$

$$W_{\text{predicted\_hot}} = W_{\text{measured}} - \Delta W_{\text{joint\_decrease}}$$

$$W_{\text{predicted\_hot}} = 3.0 \text{ in} - 0.891 \text{ in} = 2.109 \text{ in}$$

$$W_{\text{predicted\_hot}} = 2.109 \text{ in}$$

b. Per Equation A-1-3, value of  $W_2$  must be

$$W_2 \leq W_{\text{predicted\_hot}}$$

$$W_2 \leq 2.109 \text{ in}$$

2. Calculating the minimum  $W_1$  value:

Recall: shortening is ignored for this example, thus:

Per Equation A-1-7,

$$W_1 \geq W_{\text{predicted\_cold \& shortening}} \longrightarrow W_1 \geq W_{\text{predicted\_cold}}$$

By referring to Figure A-1, it can be seen

$$MR_{\text{joint}} = (W_{\text{predicted\_cold}} - W_{\text{predicted\_hot}})$$

Note: In this equation,  $MR_{\text{joint}}$  is **not** the rounded figure specified in the contract plans: given as 2 inches in this example.

$MR_{\text{joint}}$  here is the calculated joint movement, which is a slightly more exact figure. This is a Structure Designer input on the BD-0307 form, and it is equal to:

$$(\text{Joint Movement Factor}) \times (\text{Contributory Length} / 100)$$

Therefore,

$$W_{\text{predicted\_cold}} = W_{\text{predicted\_hot}} + MR_{\text{joint}}$$

$$W_{\text{predicted\_cold}} = 2.109 \text{ in} + 1.894 \text{ in} = 4.003 \text{ in}$$

$$W_{\text{predicted\_cold}} = 4.003 \text{ in}$$

Therefore,

$$W_1 = 4.25 \text{ in} \geq 4.003 \text{ in} \quad \text{OK}$$

The SC Joint Seal Calculations spreadsheet (mentioned above at the end of Section A-1) can be used to check the solution to these types of problems. A snapshot of the worksheet used to solve this example is provided below, in Figure A-2.

**SC JOINT SEAL CALCULATIONS FOR NEW OR EXISTING STRUCTURES**  
**\*\* Attach spreadsheet to BD-0307 form after completion \*\***  
 {Refer to BCM 51-2 & Structure Rehab. Manual Ch. 2 & App. 1 for further info}

**SPREADSHEET USAGE INSTRUCTION & LIMITATIONS**

Read all notes where present (spreadsheet cells w red triangles at upper right corner, hover mouse on these triangles to show notes)

Contract No.	07-012344	
Bridge Number	Br. No. 10-0111	
Location	Hinge 6	
Joint Seal Type	Type B (Compression Seal) <span style="float: right;">** select from drop-down menu **</span>	
Vendor / Product	Watson Bowman	WA-500
Lot Number		

**Legend for Input Section Below:**

	data input	--->	all fields must be complete for equations to properly calculate
	locked equation, automatically calculated		

Groove Type	Replace Existing	** select from drop-down menu **
Structure Type	Concrete (Post Tensioned)	** select from drop-down menu **
Ignore Shortening?	Yes	** select from drop-down menu **

$MR_{joint}$	<input type="text" value="2.00"/>	inches	specified movement rating for joint - from contract documents
$W_1$	<input type="text" value="4.250"/>	inches	max. joint seal width at min. temperature - from CT test data for product / lot above
$W_2$	<input type="text" value="1.690"/>	inches	min. joint seal width at max. temperature - from CT test data for product / lot above
$W_{groove}$	<input type="text" value="2.50"/>	inches	joint groove width (existing or new)
$T_{str}$	<input type="text" value="65"/>	degrees F	superstructure temperature taken at the time of measurement of $W_{groove}$
$T_{min}$	<input type="text" value="20"/>	degrees F	min. superstructure temperature at project location
$T_{max}$	<input type="text" value="105"/>	degrees F	max. superstructure temperature at project location
	<input type="text" value="257.90"/>	ft	contributory length
$MR_{seal}$	<input type="text" value="2.56"/>	inches	movement rating of joint seal product = $W_1 - W_2$
$T_{range}$	<input type="text" value="85"/>	degrees F	ambient temperature range at project location
	<input type="text" value="0.0000060"/>	--	thermal joint movement factor
	<input type="text" value="0.734"/>	in/100ft	joint movement factor
	<input type="text" value="1.894"/>	inches	calculated joint movement
$W_{measured}$	<input type="text" value="3.000"/>	inches	existing structures: narrowest practical groove width (0.25in on each side of existing joint)
$\Delta W_{joint\_decrease}$	<input type="text" value="0.891"/>	inches	diff. between width of existing joint and min. joint width at max. temp.
$\Delta W_{joint\_increase}$	<input type="text" value="1.003"/>	inches	diff. between max. joint width at min. temp. and width of existing joint
$W_{predicted\_hot}$	<input type="text" value="2.109"/>	inches	joint width after temperature rise
$W_{predicted\_cold}$	<input type="text" value="4.003"/>	inches	joint width after temperature decrease
$W_{measured\_upperlimit (exact)}$	<input type="text" value="3.247"/>	inches	exact value for max. joint width at measured temp. after shortening
$W_{measured\_upperlimit (approx)}$	<input type="text" value="3.141"/>	inches	approximate value for max. joint width at measured temp.
$W_{measured\_lowerlimit}$	<input type="text" value="2.581"/>	inches	min. joint width at measured temp.

**Results:**

       --->   

Proposed groove width of **3.00** inches at structure temp. = **65** degrees F  
 (acceptable groove range of min. **2.58** inches and max. **3.25** inches)

Outputs for SC Portion of BD-0307 Form	Seal Width Limits	Product	WA-500
		$W_1$ (inches) Maximum	4.25
		[5] $W_2$ (inches) Min. @ Max. Temp.	1.69
		Structure Temperature (deg. F)	65
		[6] Adjust from Max. Temp. (inches) -- $\Delta eIT/1x2x4/100$	0.89
	Min. Width at Temp. Listed (inches) -- $w = [5] + [6]$	2.58	
	Final Groove Width (inches)	3.00	

Figure A-2. Illustration of SC Joint Seal Calculations Spreadsheet for Example 2

**Example 3: Type A Pourable Seal****Given:**

Bridge joint data provided by Design	= See Figure A-3; Abut 1
$MR_{\text{joint}}$ = Bridge joint movement range	= 1 in
New construction project	
Contractor proposed type A sealant	BASF Wabo®SiliconeSeal
Sealant maximum movement range	+100% /-50% of the joint opening
(i.e., max tensile and compression strain)	Per manufacturer website datasheet

**Find:**

- 1<sup>st</sup> Scenario: It's a hot summer. The bridge superstructure temperature is 100 degrees F. Per the standard plan for silicone seal, the groove width should be between 2 to 3 inches. Determine if the proposed sealant is suitable if saw cut width is chosen as 2 inches.
- 2<sup>nd</sup> Scenario: It's a cold winter. The bridge superstructure temperature is 24 degrees F. Determine if the proposed sealant is suitable if saw cut width is chosen as 2 inches.

**Solution:**

1. Answer to 1<sup>st</sup> scenario

$$W_{\text{measured}} = 2 \text{ in}$$

$$\Delta W_{\text{joint\_decrease}} = ([\Delta T \uparrow / \text{temperature range}] \times \text{thermal movement factor} \times [\text{contributory length}/100])$$

$$\Delta W_{\text{joint\_decrease}} = \{[(105^\circ - 100^\circ) / 85^\circ] \times (0.7344 \text{ in}) \times ((119.2) / 100)\}$$

$$\Delta W_{\text{joint\_decrease}} = 0.052 \text{ in}$$

$$\Delta W_{\text{joint\_increase}} = MR_{\text{joint}} - \Delta W_{\text{joint\_decrease}}$$

$$\Delta W_{\text{joint\_increase}} = 1 \text{ in} - 0.052 \text{ in} = 0.948 \text{ in}$$

Compression Strain =

$$\Delta W_{\text{joint\_decrease}} / W_{\text{measure}} = 0.052 \text{ in} / 2 \text{ in} = 0.026 = 2.6\% < 50\% \leftarrow \text{Good}$$

Tensile Strain =

$$\Delta W_{\text{joint\_increase}} / W_{\text{measure}} = 0.948 \text{ in} / 2 \text{ in} = 0.474 = 47.4\% < 100\% \leftarrow \text{Good}$$

Proposed sealant is suitable

2. Answer to 2<sup>nd</sup> scenario:

$$W_{\text{measured}} = 2 \text{ in}$$

$$\Delta W_{\text{joint\_decrease}} = ([\Delta T \uparrow / \text{temperature range}] \times \text{thermal movement factor} \times [\text{contributory length}/100])$$

$$\Delta W_{\text{joint\_decrease}} = \{[(105^\circ - 24^\circ)/85^\circ] \times (0.7344 \text{ in}) \times ((119.2)/100)\}$$

$$\Delta W_{\text{joint\_decrease}} = 0.834 \text{ in}$$

$$\Delta W_{\text{joint\_increase}} = MR_{\text{joint}} - \Delta W_{\text{joint\_decrease}}$$

$$\Delta W_{\text{joint\_increase}} = 1 \text{ in} - 0.834 \text{ in} = 0.166 \text{ in}$$

Compression Strain =

$$\Delta W_{\text{joint\_decrease}} / W_{\text{measured}} = 0.834 \text{ in} / 2 \text{ in} = 0.417 = 41.7\% < 50\% \leftarrow \text{Good}$$

Tensile Strain =


$$\Delta W_{\text{joint\_increase}} / W_{\text{measured}} = 0.166 \text{ in} / 2 \text{ in} = 0.083 = 8.3\% < 100\% \leftarrow \text{Good}$$

The proposed sealant is suitable

Remarks:

1. Regarding question 2, it should be noted that per the current standard plan for Type A seal, the groove width should be between 2 inches and 3 inches for MR of 1 inch or less. However, the standard plans do not specify at what bridge temperature the measurement is to be taken. Thus, it is possible that a groove width measured in the summer can be as low as 1 inch if the groove was constructed in winter at 2 inches. The purpose of question 2 was to show that if the sealant was deposited in 2-inch groove during winter, the seal material should still perform well in summer when the joint gets even smaller (i.e., as small as 1 inch). It should be noted that standard plan drawings are periodically revised and updated. The standard plan drawing used initially to build the joint might have had different requirements (for seal material and geometry) than the most current standard plan drawings. Therefore, it is necessary to verify that the existing bridge groove width is compatible with the proposed joint seal material.

STATE OF CALIFORNIA • DEPARTMENT OF TRANSPORTATION  
**JOINT MOVEMENT CALCULATIONS**  
 BD-0307

Note: Specific instructions are included as footnotes 

EA 07-012344	DISTRICT 7	COUNT LA	ROUT 101	KP 50.00	BRIDGE NAME AND NUMBER Example Bridge 10-0111						
TYPE 19-Span RC Box-Girder		TYPE ABUTMENT RC Diaphragm		TYPE BEARING Elastomeric pads							
1 TEMPERATURE EXTREMES (from Preliminary Report)				2 THERMAL MOVEMENT (inches/100 feet)	3 MOVEMENT (inches/100)						
Type of Structure Maximum <u>105</u> °F Steel Minimum <u>20</u> °F Concrete (Conventional) Range <u>85</u> °F Concrete (Post tensioned)		Design Range _____ °F _____ °F _____ °F _____ °F		= = + = = + = = + = 0.7344 = +							
ITEM 1 DESIGNER Best Designer		DATE 9/30/2010		ITEM 2 Best Checker							
				DATE 9/30/10							
To be filled in by Division of Structures Design <sup>b</sup>			To be filled in by SR: <sup>c</sup> <b>Best SR</b> DATE: <b>2024</b>								
LOCATION	Skew (degrees) Do not use in calcs.	4 Contributing Length (feet)	Calculated Move- ment (inches) 3*4/100	M.R. (in) (Round up to 1/2")	Seal Type A.B. (Others) or Open Joint	Seal Width Limits <sup>d</sup>		Groove (saw cut) Width or Installation Width <sup>e</sup>			
						5 W <sub>2</sub> (inches) Min. @ Temp.	Structure Temperature	6 Adjust from Max. Temp. (inches) DelT/1x2x4/100	Width at Temp. Listed. w = 5 + 6		
Hinge 6		257.9	1.89	2.0	B						
Hinge 15		407.9	3.00	3.0	JSA	JSA-Awesome	4 1/2 in	1/2	65	1.410	1.910
Abut 1		119.2	0.875	1.0	A						

a Project Designer: Send to RE or SR with preliminary report.  
 b Show line drawing of Structure on reverse side: show points of no movement and contributory lengths. Retain copy for design calculations file.  
 c RE or SR: Complete and return to structure construction with final report.  
 d Type B information from Translab reports.  
 e Groove width adjustment based on DelT = (maximum temperature extreme) (superstructure temperature).  
 f Measure superstructure temperature by placing bulb of concrete thermometer + 6 into expansion  
 g When MR is greater than 4 inches, increase anticipated shortening 25%

Figure A-3. Example of Joint Movement Calculations Form Provided by Bridge Design

## A-3 Supplemental Information

### Supplemental 1: Instructions and Parts for Joint Scribes

Chapter 2, *Joint Seals*, Section 2-3.06A, *Joint Movement Recording*, provided an introduction to joint scribes, which are discussed here in additional detail. A schematic illustration of an installed joint scribe is provided in Figure A-4.

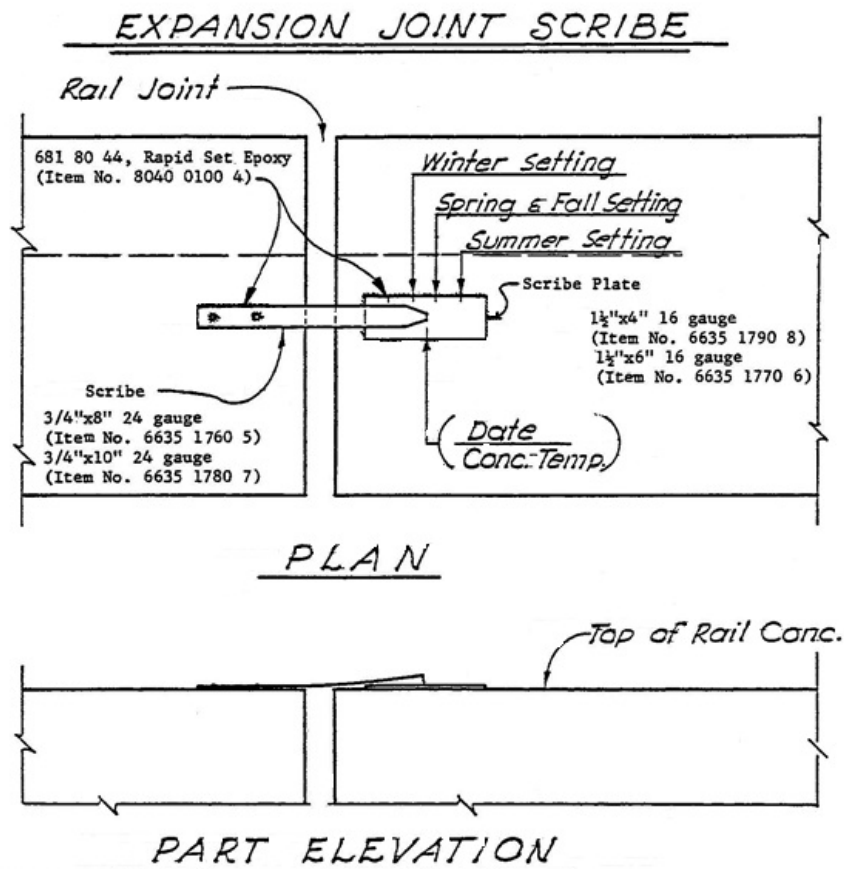


Figure A-4. Expansion Joint Scribe

#### Installation 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 MR of 2" or less. Use 10" scribe and 6" plate for joints having movement 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 ensure good adhesion.
4. Mix only enough epoxy for one scribe and plate when using 681-80-44 Rapid Setting Epoxy. (5 min, pot life @ 70°F)
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.

The scribes require the following scribes and plates:

For  $MR \leq 2''$ :

- 8" steel railing scribe,  $\frac{3}{4}'' \times 8''$  24 gauge (Item No 6635 1760 5), with
- 4" aluminum scribe plate,  $1\text{-}1/2'' \times 4''$  16 gauge (Item No. 6635 1790 8)

For  $MR > 2''$ :

- 10" steel railing scribe plate,  $\frac{3}{4}'' \times 10''$  24 gauge (Item No. 6635 1780 7), with
- 6" aluminum scribe plate,  $1\text{-}1/2'' \times 6''$  16 gauge (Item No. 6635 1770 6)

Additionally, the following item is required for attachment:

- 681-80-44 Rapid Set Epoxy (Item No. 8040 0100 4) to attach scribes and plates to rail.

Scribes, plates, and epoxy should be obtained from the District through the Resident Engineer (RE). 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.

## Supplemental 2: Nominal Dimensions of Type B Elastomeric Joint Seals

Additional samples of Type B seals are provided in Table A-1, followed by notes pertaining to the table.

**Table A-1. Approximate Properties for Preformed Elastomeric Type B Joint Seals (See Note 1)**

Catalog Number Depth (See Note 2)	Uncompressed $W_0$ (See Note 4)	Uncompressed $D_0$ (See Note 4)	Approx. MR (See Note 3)	$W_1$ Max. Groove Width	$W_2$ Min. Groove Width	Recommend. Saw Cut Depth
Brown H-2503	2.5"	2.625"	1"	2.13"	1.13"	4.0"
Brown H-3000	3.0"	3.25"	1"	2.55"	1.55"	5.0"
Brown H-3500	3.5"	3.75"	1.5"	2.98"	1.48"	5.85"
Brown H-4000	4.0"	4.25"	1.5"	3.40"	1.90"	6.0"
Brown H-5000	5.0"	5.00"	2"	4.25"	2.25"	7.75"
Brown H-6000	6.0"	5.5"	2.5"	5.10"	2.60"	9.25"
Watson Bowman WA-250	2.5"	2.75"	1"	2.13"	1.13"	3.56"
Watson Bowman WA-300	3.0"	3.38"	1"	2.55"	1.55"	4.31"
Watson Bowman WA-350	3.5"	3.5"	1"	2.98"	1.98"	4.44"
Watson Bowman WA-400	4.0"	4.38"	1.5"	3.40"	1.90"	5.00"
Watson Bowman WA-500	5.0"	5.0"	2"	4.25"	2.25"	5.94"
Watson Bowman WA-600	6.0"	6.0"	2.5"	5.10"	2.60"	7.75"

### Notes:

- The manufacturer's nominal properties in Table A-1 are for design data only. These properties cannot be used in lieu of actual test results. Table A-1 is included for additional information only. Actual values for  $W_1$ ,  $W_2$ , and the MR are obtained from test results performed by the METS Laboratory on the Structural Materials Testing Laboratory Test Report.
- Brand names other than those listed may be available.
- The actual MR equals  $(W_1 - W_2)$ .  $W_1$  shall be the smaller of the values determined as follows:
  - 0.85 times the manufacturer's designated minimum uncompressed width of the seal ( $W_0$ ).
  - 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. $W_2$  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  $W_1$ .
- Data shown may change significantly due to variations in extrusions. Dimensions must be verified in the field.

### Supplemental 3: Open Joint and Experimental Test Seals

Obtain the necessary brochures on installation procedures from the area Structure Construction Bridge Construction Engineer or the Division of Engineering Services (DES) Joint and Bearings Technical Specialist, if they are not included in the RE Pending File. The DES [Bridge Design](#)<sup>1</sup> Technical Team focusing on bearings and expansion joints may be another resource. The proper installation width of open joints or experimental joint seals will be calculated on Form BD-0307, *Joint Movement Calculations* (formerly DSD-D-0129). Determine the minimum width at maximum temperature ( $W_2$ ) and insert this in the appropriate column on Form BD-0307 (Column 5, on Figure A-3). The adjustment of the width for temperature at time of installation will be the same as for the Type B seal.

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<sup>1</sup> Caltrans internal use only