Chapter 2: Joint Seals

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2-1 Introduction

Although thought of as static, highway structures are continually in motion. Highway structures move due to (1) expansion and contraction caused by temperature changes, (2) live loads, (3) longitudinal forces caused by vehicular traffic, and (4) prestressing forces that cause shortening and creep. Such movements are deceptively slow; however, the associated forces are tremendous.

The most common method of accommodating movement and associated forces is a joint. Joints are created in various structures, including roadway slabs, masonry walls (sound walls), barriers, retaining walls, and bridges. Figure 2-1 shows joints created in different structures.

Figure 2-1. Joints in Various Types of Structures

For bridges (and roadway slabs), joints created on the bridge deck must also provide a smooth riding surface over the gap in addition to accommodating bridge movement. In general, joints fall into two broad categories: open and sealed joints. For structures other than bridge decks, open joints are used frequently. However, for bridges, deck joints are predominantly sealed. Reasons for sealing of joints include the following:

1. Sealing prevents debris from entering the joint and clogging it. Debris/incompressible material entering the joint can become compacted and even cemented over time, preventing the joint from functioning and creating significant stress on the bridge.
2. Joint seals prevent water from entering the joint. Water entering the joint can lead to early corrosion of metallic bridge elements such as bearing pads, steel girders, and steel bent caps. It can also create unsightly watermarks and tracks on the exterior of the bridges.
3. Seals prevent water runoff (i.e., contaminated water) into traffic, rivers, or streams under the bridge.

The design and performance of a structure's deck joint seals have a significant impact on bearing pads or spherical bearings performance and future maintenance of the structure. Failed deck joint seals can affect the integrity of the whole structure. Figure 2-2 shows an example and consequence of a joint seal failing.

Figure 2-2. Consequence of Joint Seal Failing

Joint seal maintenance and rehabilitation is usually the first and most frequent rehabilitation done on structures. They have the shortest lifespan of any other element. To improve the health of structures, joint seal designs that fail to protect the structure or result in damage may be replaced. Replacing and rehabilitating joint seals provide challenges that were not likely present when the structures were first constructed; among them is minimizing the amount of time they are closed to traffic to perform the needed maintenance.

2-2 Understanding Joint Seal Types and Related Contract Requirements

The specifications for installing all types of joints are found in Section 51-2, *Concrete Structures – Joints*, in both the *Standard Specifications* and *Special Provisions* (together these comprise the *Contract Specifications*). These should be reviewed for specific details prior to the start of work. The primary considerations used in selecting a joint seal are the bridge joint movement range (MR), cost, and the service life of the seal.

All deck expansion joints and joint seals, except for special cases, will be specified by seal type and MR. 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 Bridge Construction Engineer and the appropriate Structure Construction Technical Team (Structure Rehabilitation – Team D)

The movement range for four types of joints can generally be summarized as shown in Figure 2-3 (for details, please see the Standard Plan B6-21, *Joint Seals (Maximum Movement Range = 2")*. and the information in the *Standard Specifications* Section 51-2.02D, *Strip Joint Seal Assemblies with a Movement Range of 4 inches or Less*, and Section 51-2.02E, *Modular Joint Seal Assemblies with a Movement Range Over 4 inches*). In addition to the seals shown in the table below, *Standard Specifications* Section 51-2 describes the requirement for another type of seal that is used for bridge deck joint seals. Each type of bridge deck joint seal in the preceding specifications will be described in detail later in this chapter.

Movement range	Seal type
MR ≤ 1 inch	Type A or B
1 inch < MR ≤ 2 inches	Type B
2 inches < MR ≤ 4 inches	Strip seal joint seal assembly
MR > 4 inches	Modular unit joint seal assembly or seismic joint

Figure 2-3. Movement Range (MR) for Various Seal Types

2-2.01 Type A & AL Joint Seals - Poured Seals

These items are covered in *Standard Specifications* Section 51-2.02B, *Concrete Structures – Type A and AL Joint Seals*. Type A and AL joint seals consist of field-mixed silicone sealant poured into the opening atop a polyethylene foam backer rod, which prevents material from flowing through the joint. Figure 2-4 shows the typical section of a type A & AL joint seal as provided in Standard Plan B6-21.

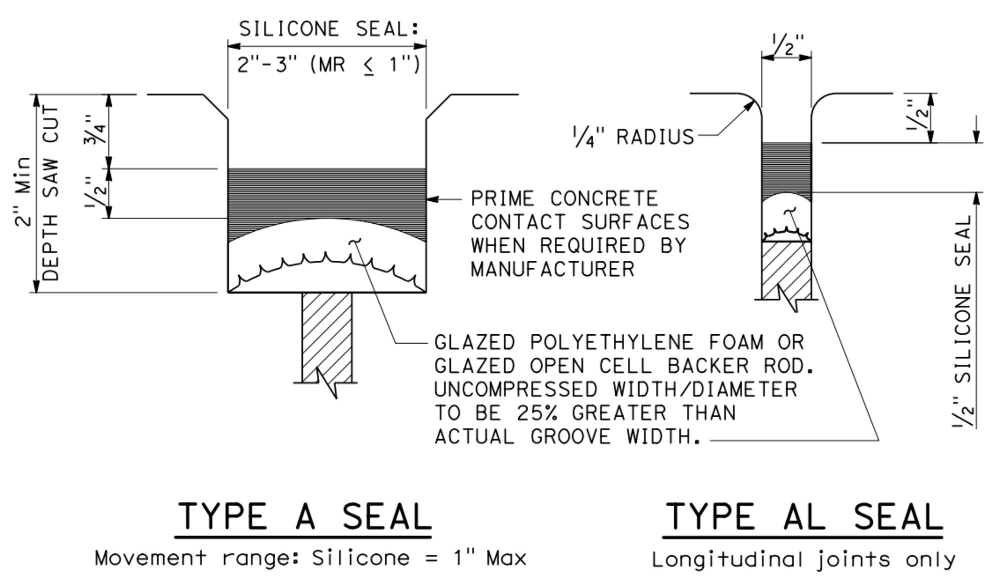


Figure 2-4. Type A and Type AL Joint Seal

These seals have the shortest life cycle of about 5+ years, depending on several factors, including how much tension they are exposed to and the weather extremes they must endure; it should be noted that per Structure Technical Policy 5.1, *Corrosion Protection for Structural Concrete Elements* Table 2, pourable seals are not allowed in freeze-thaw areas. Understanding the factors that affect performance/quality of the product will help Structure Construction (SC) staff better understand the importance of contract requirements and better evaluate the contractor's workmanship to determine compliance with the requirements. For example, temperature changes can affect the performance and quality of the joint seal installation. If the joint seal is installed when it is hot (expansion of the structure, therefore groove width will be narrow), then when it gets cold (contraction of the structure, therefore groove width becomes wider), the joint seal will be in tension.

Tension may cause the seal to pull away from bonding with the concrete and possibly compromise the seal. This type of seal also has the smallest movement range, less than or equal to 1 inch. The lifespan of Type A joint seals depends on two factors: first, the quality of the material; and second, the quality of the installation.

Type AL seals are like Type A seals with a few exceptions. Type A seals are transverse to the structure (i.e., mostly perpendicular to vehicle travel) while Type AL joints are longitudinal along the structure (i.e., parallel to vehicle travel).

Type AL seals fail more often than Type A seals, but their failure may not be as detrimental to the structure. Due to the high failure rate, these types of joints are avoided by Caltrans designers. In some cases, the longitudinal joint may be eliminated by connecting the two halves of the bridge deck.

2-2.02 Asphaltic Plug Joint Seals

This item is covered in *Standard Specifications* Section 51-2.02F, *Concrete Structures – Asphaltic Plug Joint Seals.* An asphaltic plug seal is another type of joint seal that is used when bridge movement is small, typically 1.5 inches or less. Asphaltic plugs may be placed on bridges with deck overlay and without deck overlay. Figure 2-5 provides the cross-section of an asphaltic plug placed on a bridge with asphalt concrete (AC) overlay.

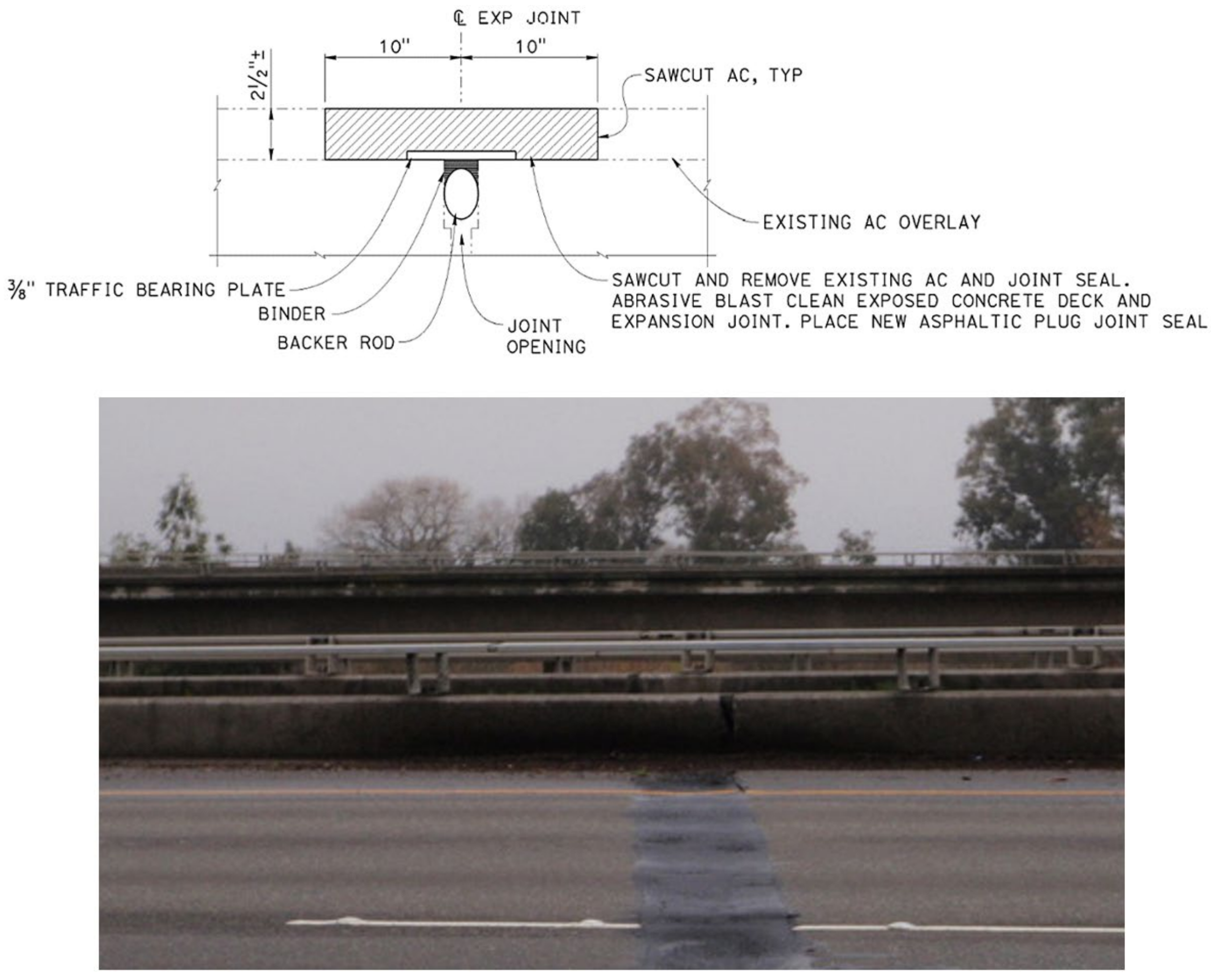


Figure 2-5. Asphaltic Plug Joint Seal

An asphaltic plug joint seal consists of a backer rod placed inside the bridge joint. A steel plate is placed on the bridge joint, and a metal pin is then inserted through the steel plate and into the backer rod to keep the steel plate in place. Then a specialty formulated asphalt cover is placed over the joint. The asphalt formulation is designed to prevent cracking at low temperatures and tracking/softening at high temperatures. As shown in Figure 2-5, an asphaltic plug may be used on structures with or without an asphalt overlay; however, it is commonly used on structures with an asphalt overlay. It is important to note that an asphaltic plug is placed on a recessed bridge surface so that the top of the asphaltic plug will be flush with the bridge deck surface.

2-2.03 Type B-Compression Seals

This item is covered in *Standard Specifications* Section 51-2.02C, *Concrete Structures –Type B Joint Seals.* Type B seals consist of preformed elastomeric joint seals placed in grooves in the concrete; see Figure 2-6 for examples of Type B seals.

Figure 2-6. Type B Seals

Type B seals are often preferred over Type A seals. They have a longer life span (10-15 years) and are always in compression. If sized and installed correctly, they should never get pulled away from the surfaces they are bonded to. Because of this, it is not uncommon to see Type A seals being replaced by Type B seals. There are limitations to doing this because the joint must be saw cut, and reinforcing bar (rebar) coverage still needs to be maintained. Also, Type B joints don't perform well on high skew bridges and they tend to tear due to excessive shear strain. In a subsequent section, the effect of the bridge skew on joint seals will be discussed in detail.

2-2.04 Assemblies

These items are covered in *Standard Specifications* Section 51-2.02D, *Concrete Structures – Strip Joint Assemblies with a MR of 4 inches or Less*, and Section 51-2.02E, *Modular Joint Seal Assemblies with a MR Over 4 Inches*. When a bridge joint movement range exceeds 2 inches, a Type B seal cannot safely handle the movement and a joint seal assembly is typically specified. Joint seal assemblies vary in design but can handle much larger movements than a single compression seal, often utilizing multiple rubber glands to accommodate large displacements. Figure 2-7 illustrates a typical cross-section of a joint seal assembly.

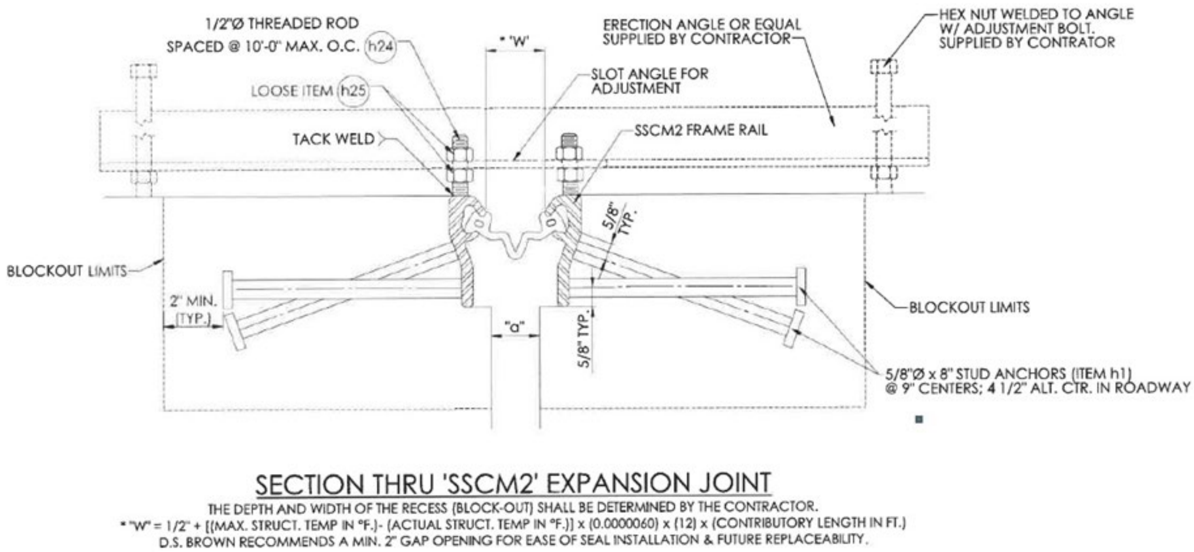


Figure 2-7. Diagram from DS Brown Joint Seal Assembly Shop Drawings

2-3 Joint Seal Replacement Project Administration and Field Inspection

In this section, SC staff duties in administering and inspecting joint seal replacement work will be explained. Bridge Construction Memo (BCM) 51-2, *Concrete Structures – Joints*, related to the type of rehabilitation work will be introduced and a detailed explanation of the BCM will be provided. Prior to discussing each specific joint seal type, it is essential to address general practices and considerations common for all joint seal work.

2-3.01 General Practice and Considerations

The impact of bridge skew angle on joint movement has a significant effect on the stresses developed in a joint seal. Figure 2-8 shows a plan view of a single-span bridge. The bridge may contract or expand due to temperature changes, which will result in joint movement B as shown in the figure. The joint movement B can be broken into component A and component C. Component A is the bridge movement perpendicular to the joint and will result in tension or compression of the joint material. Component C is the bridge movement parallel to the joint and will result in the shear of the joint material. Depending on the skew angle, the shear movement of the joint can be significant and is a consideration in proper selection of the joint seal Type by Design and in the determination of the joint seal dimensions. However, per Memo To Designers 7-10, *Bridge Deck Joints and Deck Joint Seals,* "there is no practical way to reduce this shear stress other than to limit the skew." While we cannot reduce the shear stress, with the introduction of bonded joint seals into the Caltrans joint seal inventory, we have a tool to deal with these higher skews (greater than 20 degrees) and a range of MR. Type A can be used for MR of 1" or less with any skew, and for larger MR, a bonded joint seal can be used for skews of 20 degrees or more.

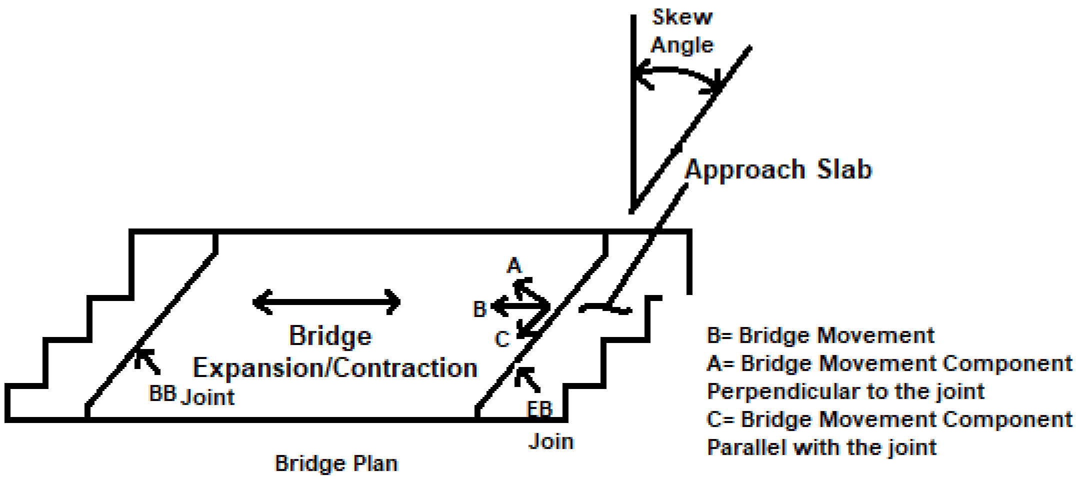


Figure 2-8. Effect of Bridge Skew on Joint Seal

Another important consideration when working on joint seal construction is to check details such as the waterstop, formed joint openings, hinge restrainers, rollers or rockers, conduits, etc., for proper installation to accommodate joint movement. The expansion joint must be capable of withstanding more than the anticipated movement for that particular joint. Additionally, careful consideration should be taken to protect existing utilities and any encroachments from potential damage during cleaning and saw-cutting operations. 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. Per *Standard Specifications* Section 51-2.02A(1)(c), *Submittals,* the Contractor is required to submit a work plan for cleaning the expansion joint, which includes details for preventing material, equipment, or debris from falling onto traffic or railroad property. It needs to be verified that work is done per the authorized work plan. Successful steps for preparing joints for sealant installation will include removing the old sealant, abrasive blast cleaning, and air blasting. Carefully inspect the condition of the existing joint and the face of the joint. It may not be necessary to recut the joint. For Type B seals, if the joint does not need to be recut, a change order may be written to eliminate the saw cutting with a credit to the State. If there are spalls, they will need to be repaired before joint placement; see Chapter 5, *Concrete Structure Repair and Rehabilitation*, for guidance on spall repairs. If new expansion dams are installed, the joint will be saw-cut to the proper dimension; see Figure 2-9 for an illustration. Expansion dams may be required in case of a hot mix asphalt (HMA) overlay to reconstruct the joint limits.

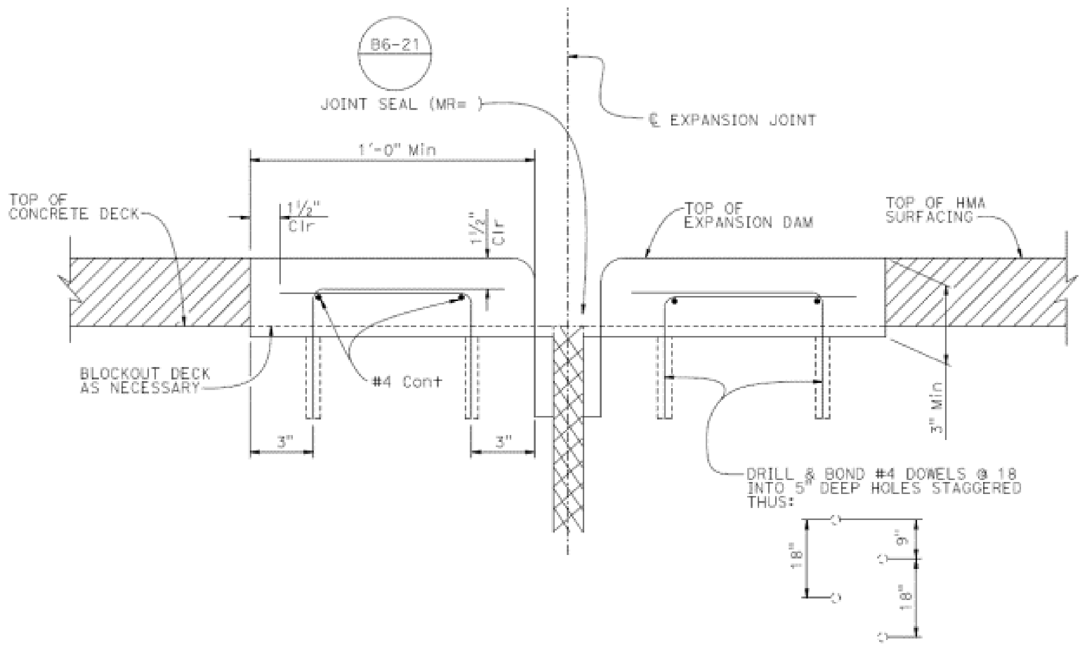


Figure 2-9. Expansion Dam

Prior to construction, a thorough inspection of the joint is required to accurately determine the extent of spall repair needed. During the design phase, the spall repair amount is assumed. However, at the construction phase, it is possible that there are more spalls encountered than were assumed in the design phase. Therefore, the spall repair quantity needs to be verified as soon as possible to determine whether additional funds are required to complete this work. When working on joints, it is critical to verify that construction debris or foreign material is not allowed to enter the joint; as stated in the *Standard Specifications* Section 51-2.02A(3), *Construction*, “Cover or otherwise protect joints at all times before joint seals are installed. Do not allow debris or foreign material to enter joints.”

If the joint seal is not placed in the same shift as the joint is cleaned (i.e., abrasive blasted), it will be necessary to abrasive blast clean the joint again and remove foreign material with high-pressure air immediately before installing the seal. Even if there is only one shift between these operations, debris can get into the joint and hinder the seal's ability to function as designed.

2-3.02 Type A & AL Poured Seals

After removal of the old joint seal, repair of spalls and cleaning of the joint, a polyethylene rod (or backer rod as it is sometimes called) needs to be installed. As discussed earlier, the backer rod is placed to prevent the seal material from running through the joint. This material is installed into the joint by simply pushing it into the groove at the top of the joint using a tool such as a roller that can help place the backer rod to the correct depth; see Figure 2-10. 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 in the standard plans are maintained. A template cut out of plywood can be used to check the surface depths of the polyethylene foam and the polyurethane.

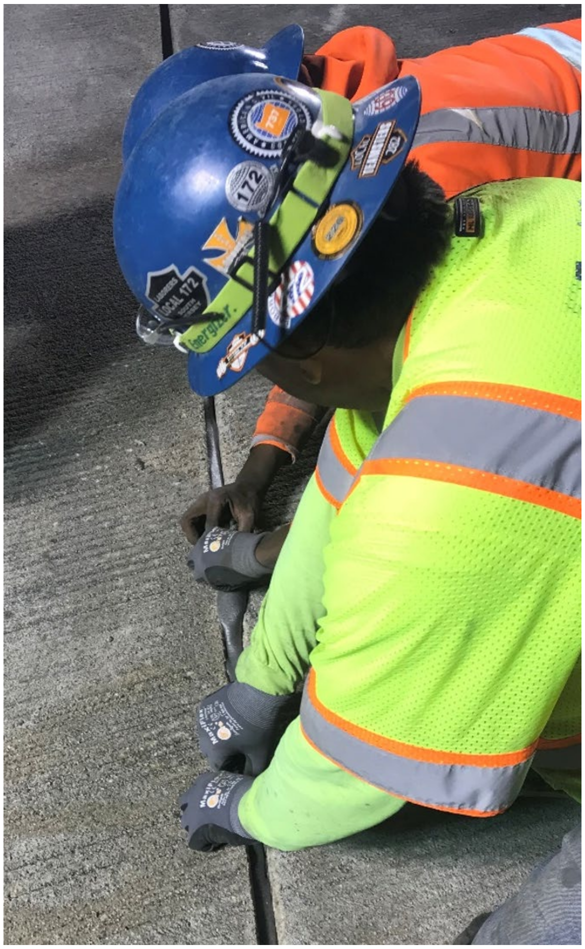


Figure 2-10. Backer Rod Installation

The backer rod stock needs to be closed-cell with a glazed surface. This prevents the joint seal material from adhering to the backer rod. The joint seal material should freely expand and contract in the joint and remain adhered to the concrete. Backer rods must be compressible so they will not expel the sealant when the deck expands. The backer rod should be at least 25 percent greater in width than the maximum joint opening to ensure that it is in a constant state of compression. When placing the backer rod, it should be noted that Type A seals require placing the backer rod and joint seal 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, as noted on Standard Plan B6-21.

Type A & AL joint seals are often referred to as "pourable seals" since the seal material is in a liquid form when first applied/placed (i.e., "poured") into the joint; the material then sets after some time and begins to function as a seal to prevent foreign materials from entering the joint. See Figure 2-11 for an illustration of the actual pouring of the Type A seal into the joint.

Figure 2-11. Type A Seal Being Poured into the Joint

After the seal material sets in the joint and becomes a rubber-like solid, changes in the bridge joint width due to expansion or contraction of the bridge will result in tensile or compressive stresses in the seal material. Stresses that can develop in the bridge joint seal are an important consideration in verifying that the seal will perform well during its intended service life.

When examining the typical section of a Type A joint seal, notice that the width of the joint increases at the top of the bridge joint, as shown in Figure 2-12.

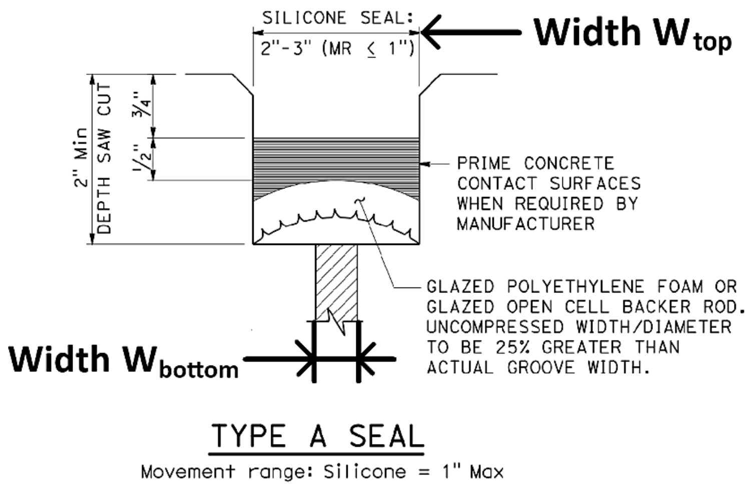


Figure 2-12. Type A Joint Seal Widths

It is important to note why the bridge joint is not constant and how the widths of the joint are determined in the two sections identified as $\mathbf{W_{top}}$ and $\mathbf{W_{bottom}}$ in Figure 2-12. $\mathbf{W_{bottom}}$ is simply the width of the gap provided to allow for movement of the bridge. $\mathbf{W_{bottom}}$ is determined at the time of the bridge construction based on the bridge movement range, type of structure, and the general temperature of the structure based on the season when the concrete deck placement is anticipated (it should be noted that what is referred to as $\mathbf{W_{bottom}}$ in this paragraph, Standard Plan B6-21 refers to as the "a" dimension). The $\mathbf{W_{bottom}}$ is a consideration during the superstructure construction, but not for joint seal placement. On the other hand, $\mathbf{W_{top}}$, which is sometimes referred to as the groove width, is the width of the gap based on the allowable strain capacity of the joint seal material (after it has set/solidified). This is an important dimension that must be looked at for joint seal placement. In other words, as the bridge expands and contracts, the joint seal placed at the top of the joint will be compressed or stretched accordingly. The width of $\mathbf{W_{top}}$ (i.e., the groove width) needs to be determined to allow for the joint seal to be wide enough so that the strain capacity of the joint seal is not exceeded due to bridge movement. If the $\mathbf{W_{top}}$/groove width is too narrow for a given bridge MR, the joint seal could snap, crush, or shear when the strain capacity of the joint seal is exceeded.

It should be realized that since Type A sets/solidifies after being poured into the groove, the bridge deck temperature at the time of pouring of the seal can significantly affect the stress/strain experienced by the seal throughout its life. For example, if the seal is poured into the groove in winter when the bridge deck temperature is low, the groove width will be near its widest; and after the seal solidifies, increases in the temperature during the rest of the year will result in a narrower groove width, thus creating compressive strain/stress on the seal for the remaining part of the year. Similarly, a seal poured in summer (when bridge deck temperature is high) will result in the seal experiencing tensile strain/stresses for the remaining parts of the year. As a result, the

$\mathbf{W_{top}}$/groove width must be determined based on the MR, the manufacturer data sheet of the joint seal, and the bridge deck temperature at the time of the seal installation.

It should also be noted that the joint seal should not be unnecessarily made too wide since that would result in increased material costs for the construction of the joint. As mentioned earlier, when the skew angle of the bridge is large, the bridge movement will result in the shear strain of the joint seal, and the width $\mathbf{W_{top}}$ should also be checked for the shear strain capacity of the joint seal material. By the same token, Type AL joint seals often experience significant shear movement since the movement of the bridge is typically in parallel with the joint; combined with a small width for Type AL, significant shear strain can develop in Type AL joint seal and can explain why Type AL joint seals don't last too long. (The failure of a Type AL might not be a significant problem, however, since the Type AL joint seal is frequently placed only to prevent water from going through the joint and onto traffic or a stream below. In other words, debris and incompressible material entering a Type AL joint is typically not of primary concern since the joint commonly acts in shear movement rather than compression/tension.) From the above discussion, it should be clear that the $\mathbf{W_{bottom}}$ has no relation to the type of joint seal used; only the $\mathbf{W_{top}}$/groove width is dependent on the type of joint seal used.

When making the bridge width $\mathbf{W_{top}}$, as specified in *Standard Specifications* Section 51-2.02B(3)(b), *Type A Seal Preparation,* the saw cuts must be made with a double saw blade; see Figure 2-13 for an example. For the joint seal to function optimally, the two sides need to be parallel. Saw cuts not parallel will create undesired skew stresses and limit the bearing area of the seal. This condition will ultimately cause premature failure of the joint. It is impossible to achieve this with a single blade, no matter how good the saw operator is. For Type AL joint seals, the foreign material is only removed to the depth of the joint seal; no saw cutting of the joint is required.

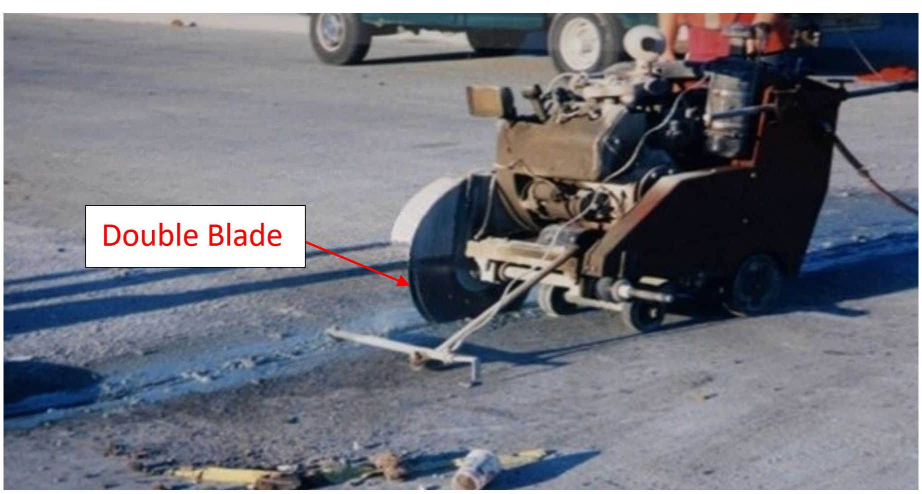


Figure 2-13. Double Blade Saw Cutting to Create Joint Groove

Note on the details of Standard Plan B6-21, that the concrete edges of the joint are either rounded or have chamfers. This reduces the spalling of the concrete along the edge. So, whenever the joint is saw cut, the edges of the concrete should be smoothed out before placement of the new joint. In practice, this is typically accomplished by the use of a handheld grinder. A word of caution: if there is a utility in the deck or sidewalk, the height of the saw cutting needs to be adjusted to accommodate and prevent damage to the utility.

2-3.03 Type B-Compression Seals

As outlined in *Standard Specifications* Section 51-2.02C(1)(d)(ii), *Quality Control*, the Contractor must demonstrate the adequacy of installation procedures for Type B joint seals before starting installation activities. In this section, factors that affect the adequacy of Type B joint seal will be discussed. Per earlier discussion, with “pourable seals” (i.e., Type A and Type AL), after the material sets and solidifies, changes in the bridge joint width can result in tensile or compressive stresses. Type B joint seal material, on the other hand, is never in liquid form and is not intended to experience tension due to the way it is designed to fill the gap at the top of the bridge joint. Type B seals are a solid elastomeric material that are initially squeezed/compressed and forced into the gap at the top of the joint using machines or manual tools. See Figure 2-14 for placement of a Type B seal.

Figure 2-14. Placement of Type B Seal - Machine vs Manual Tools

To understand how a Type B seal is intended to function, two measurements commonly referred to as $\mathbf{W_1}$ and $\mathbf{W_2}$ that are used to describe a Type B seal need to be discussed.

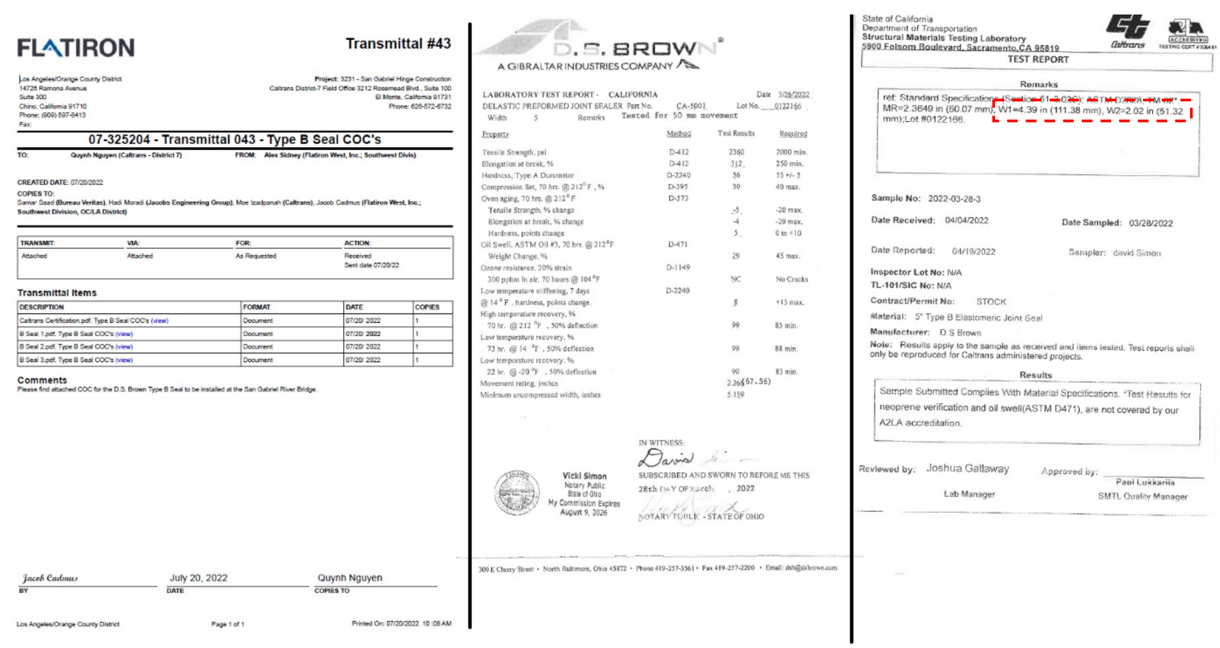
1. The measurement $\mathbf{W_1}$ of a Type B joint seal is defined as the smaller of the following values:
    a. 0.85 times the manufacturer's designated minimum uncompressed width of the seal ($\mathbf{W_0}$).

b. The width of the 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.

2. The measurement W_2 of a Type B joint seal is defined as:

   a. 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.

In other words, in simple language, the W_1 measurement pertains to the seal width dimension obtained with minimal/no compression on the seal, and the W_2 measurement pertains to the seal width dimension obtained with maximum compression on the seal (i.e., without damaging the seal). W_1 and W_2 are also referred to as **maximum and minimum seal width limits**, respectively. According to *Standard Specifications* Section 51-2.02C(1)(c), *Submittals*, a certificate of compliance (COC), with a certified test report for each lot of joint seal and lubricant-adhesive, as well as joint seal test samples, must be provided by the Contractor to Caltrans. The test reports must include the seal MR, the manufacturer's minimum uncompressed width, and test results. After reviewing the test reports and performing applicable IQA testing, Materials Engineering and Testing Services (METS) will provide a report to SC Structure Representative (SR) stating both the W_1 and W_2 of the Type B submitted by the Contractor. See Figure 2-15 for an example of a contractor's COC and test reports.



FLATIRON Transmittal #43

Los Angeles/Orange County District
14726 Ramona Avenue
Suite 300
Chino, California 91710
Phone: (909) 597-8413
Fax:

Project: 3231 - San Gabriel Hinge Construction
Caltrans District-7 Field Office 3212 Rosemead Blvd., Suite 100
El Monte, California 91731
Phone: 626-572-6732

07-325204 - Transmittal 043 - Type B Seal COC's

TO: Quynh Nguyen (Caltrans - District 7) FROM: Alex Sidney (Flatiron West, Inc.; Southwest Divis)

CREATED DATE: 07/20/2022
COPIES TO:
Samar Saad (Bureau Veritas), Hadi Moradi (Jacobs Engineering Group), Moe Izadpanah (Caltrans), Jacob Cadmus (Flatiron West, Inc.; Southwest Division, OC/LA District)

TRANSMIT:	VIA:	FOR:	ACTION:
Attached	Attached	As Requested	Received Sent date 07/20/22

Transmittal Items

DESCRIPTION	FORMAT	DATE	COPIES
Caltrans Certification.pdf. Type B Seal COC's (view)	Document	07/20/ 2022	1
B Seal 1.pdf. Type B Seal COC's (view)	Document	07/20/ 2022	1
B Seal 2.pdf. Type B Seal COC's (view)	Document	07/20/ 2022	1
B Seal 3.pdf. Type B Seal COC's (view)	Document	07/20/ 2022	1

Comments
Please find attached COC for the D.S. Brown Type B Seal to be installed at the San Gabriel River Bridge.

Jacob Cadmus — BY; July 20, 2022 — DATE; Quynh Nguyen — COPIES TO

Los Angeles/Orange County District Page 1 of 1 Printed On: 07/20/2022 10:08 AM

D.S. BROWN
A GIBRALTAR INDUSTRIES COMPANY

LABORATORY TEST REPORT - CALIFORNIA Date 3/26/2022
DELASTIC PREFORMED JOINT SEALER Part No. CA-5001 Lot No. 0122166
Width 5 Remarks Tested for 50 mm movement

Property	Method	Test Results	Required
Tensile Strength, psi	D-412	2360	2000 min.
Elongation at break, %	D-412	312	250 min.
Hardness, Type A Durometer	D-2240	56	55 +/- 5
Compression Set, 70 hrs. @ 212°F, %	D-395	30	40 max.
Oven aging, 70 hrs. @ 212°F	D-573		
Tensile Strength, % change		-5	-20 max.
Elongation at break, % change		-4	-20 max.
Hardness, points change		5	0 to +10
Oil Swell, ASTM Oil #3, 70 hrs. @ 212°F	D-471		
Weight Change, %		29	45 max.
Ozone resistance, 20% strain	D-1149		
300 pphm in air, 70 hours @ 104°F		NC	No Cracks
Low temperature stiffening, 7 days	D-2240		
@ 14°F, hardness, points change.		8	+15 max.
High temperature recovery, %			
70 hr. @ 212 °F, 50% deflection		99	85 min.
Low temperature recovery, %			
72 hr. @ 14 °F, 50% deflection		99	88 min.
Low temperature recovery, %			
22 hr. @ -20 °F, 50% deflection		90	83 min.
Movement rating, inches		2.266 (67.56)	
Minimum uncompressed width, inches		5.159	

IN WITNESS:
Vicki Simon
Notary Public
State of Ohio
My Commission Expires
August 9, 2026
SUBSCRIBED AND SWORN TO BEFORE ME THIS 28th DAY OF March, 2022
NOTARY PUBLIC - STATE OF OHIO

300 E Cherry Street • North Baltimore, Ohio 45872 • Phone 419-257-3561 • Fax 419-257-2200 • Email: dsb@dsbrown.com

State of California
Department of Transportation
Structural Materials Testing Laboratory
5900 Folsom Boulevard, Sacramento, CA 95819

TEST REPORT

Remarks
ref: Standard Specifications (Section 51-2.02C); ASTM D2628; TM 68*; MR=2.3649 in (60.07 mm); W1=4.39 in (111.38 mm), W2=2.02 in (51.32 mm);Lot #0122166.

Sample No: 2022-03-28-3
Date Received: 04/04/2022 Date Sampled: 03/28/2022
Date Reported: 04/19/2022 Sampler: david Simon
Inspector Lot No: N/A
TL-101/SIC No: N/A
Contract/Permit No: STOCK
Material: 5" Type B Elastomeric Joint Seal
Manufacturer: D.S Brown
Note: Results apply to the sample as received and items tested. Test reports shall only be reproduced for Caltrans administered projects.

Results
Sample Submitted Complies With Material Specifications. *Test Results for neoprene verification and oil swell(ASTM D471), are not covered by our A2LA accreditation.

Reviewed by: Joshua Gallaway, Lab Manager
Approved by: Paul Lukkariia, SMTL Quality Manager

Figure 2-15. Example of Contractor's COC and the Test Reports (Manufacturers and Caltrans)

The Caltrans report can also be found on METS DIME website (choose "SMTL TM2-Type B Elastomeric Joint Seal" for the Material Type field box in the DIME search web page). See Figure 2-16 for DIME website search and report example.

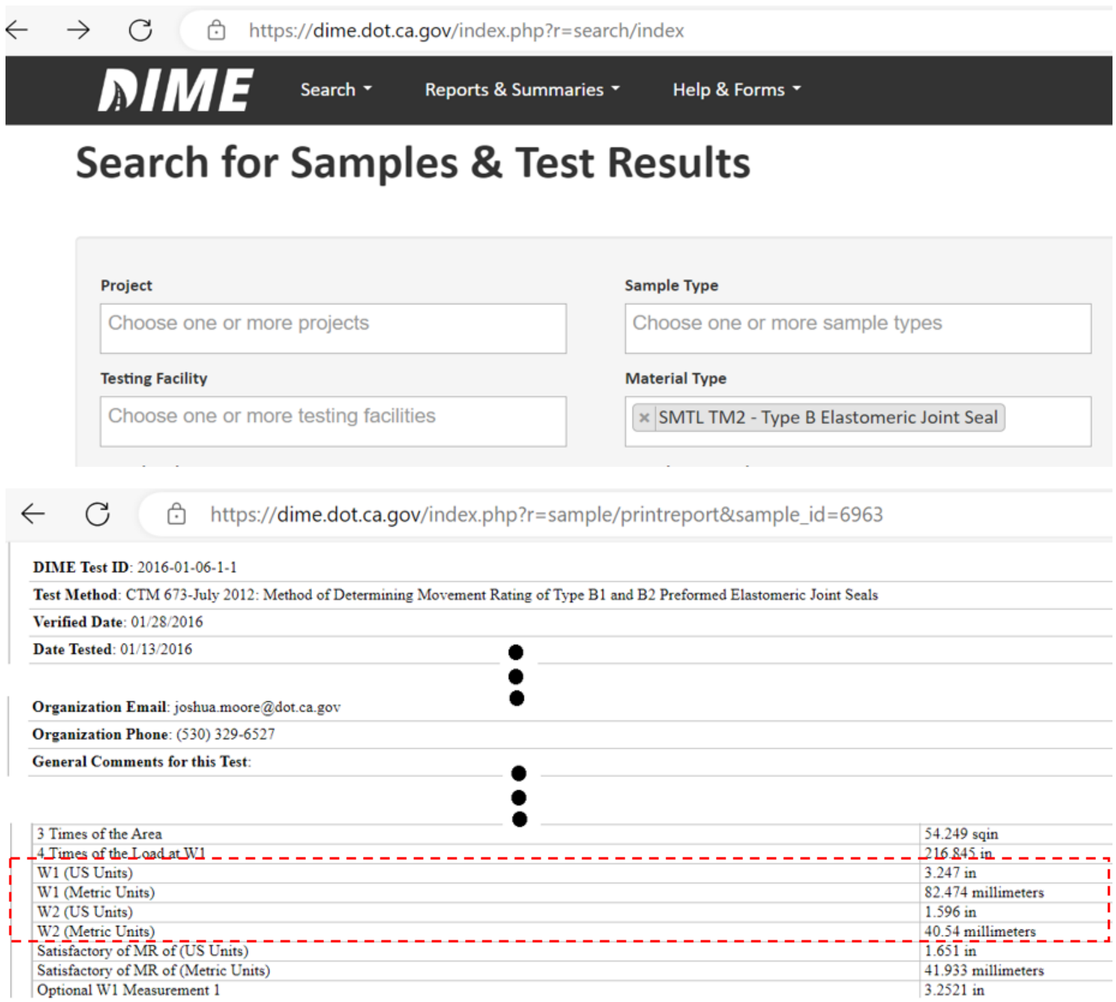


Figure 2-16. DIME Search Web Page and Sample METS Test Report for Type B Joint Seal

It is important to note that saw cutting must not be started until the Type B seal material has been verified as having successfully been tested by METS. It is worth mentioning a little about the testing at the time of manufacturing; Type B seals are normally supplied by one of two sources from producers in the Midwest. As part of the manufacturing process, the various sizes of Type B seals are identified on the side of the seals with a lot number which represents a certain quantity. A sample of each lot of material is sent to METS in Sacramento for testing. Following the successful testing, the manufacturer is notified that the lot or lots of Type B seals are acceptable. At the time testing is performed, the lab does not know on which state contracts the Type B seals will be used, therefore no information can be sent to the SR. To obtain the METS report, the SR can contact the METS Representative (METS Rep) and obtain the **W_1** and **W_2**

values for the lot of seals that will be used by the Contractor. The movement range ($\mathbf{W_1}$ – $\mathbf{W_2}$) of the Type B seal must be equal to or greater than that shown on the contract plans.

When contacting METS for $\mathbf{W_1}$ and $\mathbf{W_2}$ information, the SR should have the following information readily available:

1. Manufacturer of the Type B seal
2. Lot number shown on the side of the Type B seal
3. Date of manufacture
4. Movement range for the seal

If requested, a copy of the METS test report for the Type B seal can be sent to the Structure Representative. It is important to note that the Type B joint seal will arrive at the job site without any state inspection release tags or an inspection document such as Form TL-0029, *Report of Inspection of Material*.

Now that the $\mathbf{W_1}$ and $\mathbf{W_2}$ measurements of the Type B seals have been explained, how these measurements relate to bridge movement and bridge joint width (dimensions shown in Figure 2-17) will be discussed.

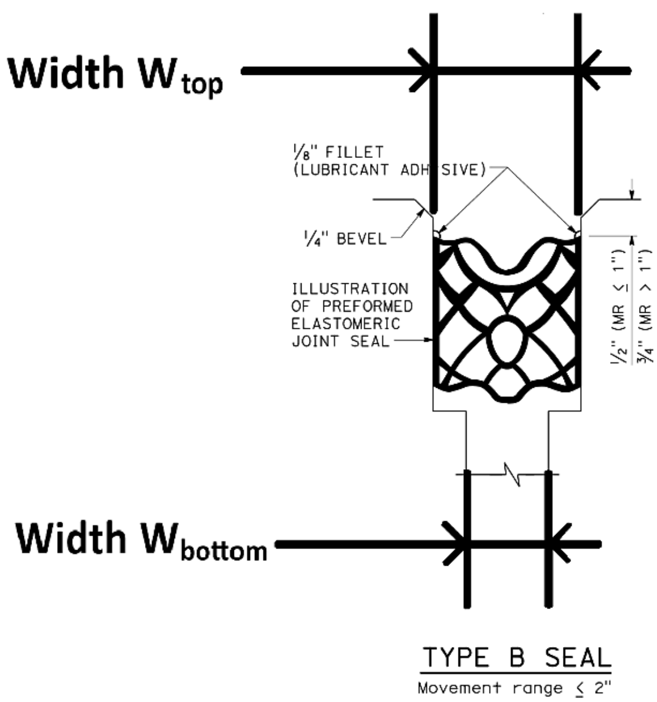


Figure 2-17. Type B Joint Seal Width

As discussed for joint seal Type A, the width of the bridge joint $\mathbf{W_{bottom}}$ is the gap provided to allow for movement of the bridge. This width is determined simply based on the bridge movement range for that joint, the type of structure, and the season that the deck concrete placement is anticipated (refer to Standard Plan B6-21; “a” dimension shown on the Standard Plan is the same as $\mathbf{W_{bottom}}$ discussed in this chapter). The $\mathbf{W_{bottom}}$ has no relation to the type of joint seal used; only $\mathbf{W_{top}}$ is dependent on the joint seal type. As stated before, $\mathbf{W_{top}}$ is sometimes referred to as the groove width, including on Standard Plan B6-21. For Type B joint seal, $\mathbf{W_1}$, $\mathbf{W_2}$, and groove width must meet the following three criteria to be suitable for a bridge joint:

1. ($\mathbf{W_1} - \mathbf{W_2}$) ≥ MR of the bridge joint shown in the contract plans. It should be noted, in simple language, that $\mathbf{W_1}$- $\mathbf{W_2}$ represents the maximum amount that the joint seal can be compressed since $\mathbf{W_2}$ is the width of the seal at maximum compression and $\mathbf{W_1}$ is the width of the seal at minimum/zero compression. In other words, the equation above states that the MR of a bridge joint must be equal or less than the amount that the seal can be squeezed (without damaging it); it should be noted that for Type B seal, ($\mathbf{W_1}$- $\mathbf{W_2}$) is sometimes referred to as the movement range (MR) of the seal; so the equation above simply states MR of the seal must be greater or equal to the MR of the bridge joint.
2. $\mathbf{W_1}$ limit of Type B ≥ ($\mathbf{W_{top}}$/groove when widest). This equation states that the max seal width limit (corresponding to no/minimum compression on the seal) must be greater than or equal to the maximum expected $\mathbf{W_{top}}$/groove width. Based on our discussion so far, it should be evident that lowering of bridge superstructure temperature makes the groove wider due to thermal contraction. But another factor that has not been talked about is the prestress shortening of bridges with time (this subject will be covered in more detail later on). This equation is used to verify that even when the bridge deck temperature reaches the minimum expected temperature and as the bridge shortens with age, resulting in the $\mathbf{W_{top}}$ /groove width becoming its widest, the joint seal would still be able to fill the groove and not separate from the walls of the groove.
3. $\mathbf{W_2}$ limit of Type B ≤ ($\mathbf{W_{top}}$/groove when narrowest). This equation states that the smallest $\mathbf{W_{top}}$/groove width (i.e., when the structure temperature is highest, resulting in expansion of the bridge deck) is never less than the minimum seal width limit (corresponding to maximum compression on seal). This equation is used to verify that when the bridge deck temperature reaches the maximum expected temperature and the groove width becomes its narrowest, the joint seal can function as intended and does not get damaged (i.e., get crushed).

As stated in criteria 2 and 3, the narrowest and the widest expected groove widths need to be determined. It should be evident that direct field measurement of the narrowest and widest groove width is not practical since it requires that the superstructure reach the highest and lowest expected temperatures. Later in the chapter, the methods and calculations used to estimate the narrowest and widest anticipated groove width based on width and temperature measurements taken at any other time will be covered. This topic will be discussed in Section 2-3.06, *Overview of Joint Movement Calculations and Movement Recording*.

A key takeaway point from the above criteria is that the proper selection and installation of a Type B seal not only depends on the bridge movement range but is also dependent on the groove width. As an example, let's briefly look at a typical manufacturer's catalog for a Type B such as DS Brown manufacturer shown below in Figure 2-18.

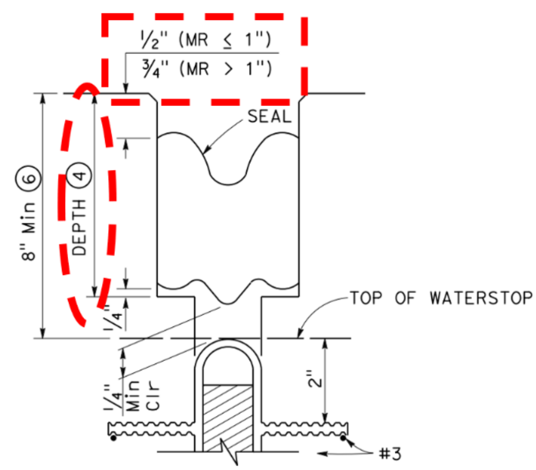
Catalog Number Depth	Uncompressed W_0	Uncompressed D_0	Approx. MR	W_1 Max. Groove Width	W_2 Min. Groove Width	Recommended Saw Cut **Depth**
Brown H-2503	2.5″	2.625″	1″	2.13″	1.13″	4.0″
Brown H-3000	3.0″	3.25″	1″	2.55″	1.55″	5.0″
Brown H-3500	3.5″	3.75″	1.5″	2.98″	1.48″	5.85″
Brown H-4000	4.0″	4.25″	1.5″	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″

Figure 2-18. Type B Seals from a Typical Manufacturer Catalog

To continue with our example, suppose a specific Type B seal is being examined for suitability for a bridge joint that has an MR of 1.5 inch. From the above table it can be seen that there are four joint seals from DS Brown manufacturer that have MR of 1.5 inch or greater (H-3500, H-4000, H-5000, and H-6000); any of these seals can potentially be used. Other determining factors in selecting the proper seal include the $\mathbf{W_1}$ and $\mathbf{W_2}$ of the seal and the actual bridge groove width dimensions. At this time, a clear distinction must be made between constructing a new Type B joint vs rehabilitating an existing joint. In new construction projects, joint geometry is readily controllable; therefore, the size of the groove width is set to accommodate the joint seal size (i.e., $\mathbf{W_1}$ & $\mathbf{W_2}$). Rehabilitation projects differ from new construction projects in that the joint already exists, and as a practical approach, a new joint seal is selected with a size (i.e., $\mathbf{W_1}$ & $\mathbf{W_2}$) that can fit the existing joint after minimum saw cutting. As a result, rehabilitation projects require that both the Minimum $\mathbf{W_1}$ (minimum seal width that will fill the maximum joint width at minimum temperature, after prestress shortening) and the MR be indicated on the plans. To ensure a correct fit, the $\mathbf{W_1}$ of the joint seal must be greater than the minimum $\mathbf{W_1}$ of the joint. See Supplemental 2, *Nominal Dimensions of Type B Elastomeric Joint Seals*, of Appendix A, for additional information and tabulated data for Type B seals.

Going back to our example, in a new bridge construction, any of the above four joint seals can be selected since the groove width can be constructed to match the seals $\mathbf{W_1}$ and $\mathbf{W_2}$ (i.e., to properly construct the groove for the desired width, joint rebar has to be placed to provide for sufficient rebar clearance at the groove). For rehabilitation projects, however, since the groove is already constructed, typically a joint seal with the proper $\mathbf{W_1}$ and $\mathbf{W_2}$ needs to be selected to <u>closely</u> (instead of exactly, since the groove width can be modified by saw-cutting) match the existing groove width as described in criteria 2 and 3 earlier. For this reason, the *Special Provisions* require that the joint size be verified before 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.

Another joint geometry that needs to be checked is the depth of the groove and the height of the joint seal when it is compressed to the width $\mathbf{W_2}$. As shown in Standard Plan B6-21, per note (3), the depth of the groove must be equal to or greater than the depth of the seal measured along the contact surface, when compressed to width position $\mathbf{W_2}$ plus the dimensions shown in the drawing below:



TYPE B JOINT SEAL IN MINIMUM WIDTH POSITION (W_2)

Figure 2-19. Groove Depth

The depth of the seal is measured by cutting a 1/2 to 1-inch section of the actual seal to be used and placing it between two flat surfaces, such as 1-by 4-by 8 inches and then compressing the seal to width $\mathbf{W_2}$. Again, a comparison between new construction vs rehabilitation of the joint needs to be made. In new construction, the joint seal height is accommodated by a saw cutting the groove to the depth ④ shown in Figure 2-19. A word of caution: if there is a utility in the deck or sidewalk, the height of the saw cutting needs to be adjusted to accommodate and prevent damage to the utility. In rehabilitation work, the joint seal height is verified to fit in the groove depth as shown in the above figure. Speaking of groove depth, it is worth describing how saw cutting is done for a new construction. At the time saw cutting is to begin, the groove or saw cut width is to be determined as described on the joint movement calculation sheet which will be described later in Section 2-3.06. The initial saw cut is marked and checked 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 (due to thermal expansion/contraction) while the saw cutting is in operation. It is recommended that SC personnel discuss with the Contractor at the preconstruction meeting and encourage using powerful concrete saw that can cut the entire length of the joint quickly. 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.

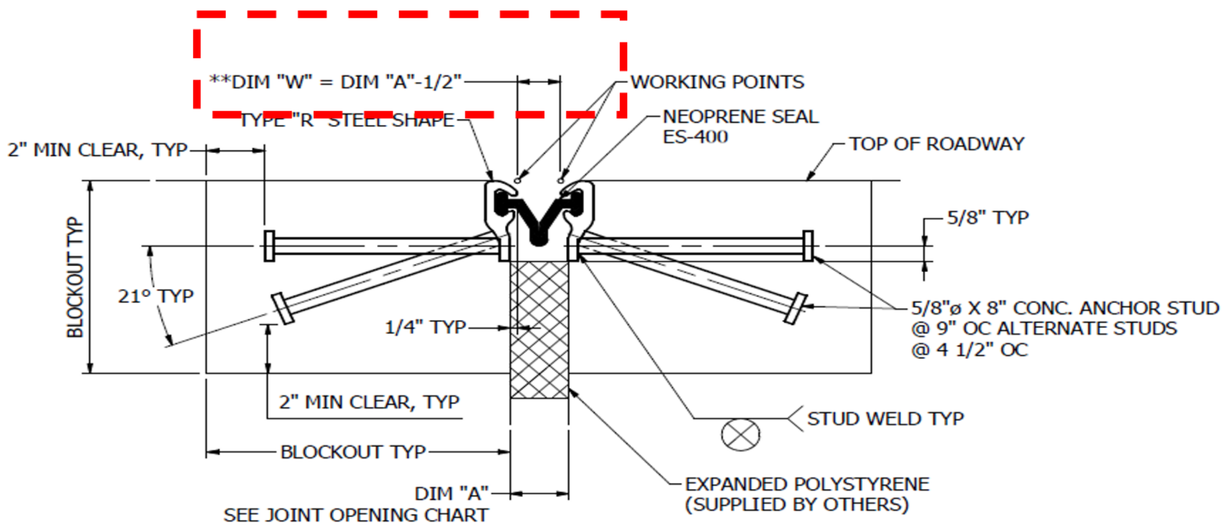
Before installing the seal, all spalls of the existing joint need to be repaired. The top of the joint must have a chamfer (that is created by grinding) all along the length of the joint. As a final check, before installation, it is recommended to use a thin section of joint seal material and use it to check the saw cut depth throughout the length of the joint. Place the seal section in the planned position and check to see that the dimensions shown on the standard plans are maintained. Most joint seal failures result from improper saw cuts or from the seal being placed too near the deck surface.

It is preferred not to splice Type B seals. However, in doing replacement work it might become necessary. The specifications allow for one splice to be authorized per *Standard Specifications* Section 51-2.02C(3), *Construction*, and states that the location and method must be authorized. For doing the splice, the manufacturer's procedures must be followed. The location of the splice is left to the judgment of the Structure Representative. The traffic closure tables for the freeway will influence where this splice can occur. Standard practice in the past has been to place the splice at the lane line. Roadway drainage might also be another consideration affecting the splice location; a joint seal splice at any type of surface valley that might accumulate water is typically avoided. Per Standard Plan B6-21, Type B seals need to be installed a minimum of 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 watertight seal.

2-3.04 Assemblies

Installing joint seal assemblies (referred to as JSA or assembly for short) follows the same logic as installing Type B compression seals. The assembly must be installed with room to expand and contract to the limits expected during the life of the structure. It does not make sense to install the assembly in a fully open position during a hot summer day or in a fully closed position on a cold winter day. This section discusses the installation of joint seal assemblies and explains the criteria used to verify that JSA movement limits are not exceeded as the bridge expands and contracts with temperature changes. Understanding the information in this section is also important to better understand the contractor’s shop drawing submittal and to be able to properly discuss any proposed JSA installation procedures with the Contractor at a preconstruction meeting, as outlined in Section 1-3.05, *Conducting a Preconstruction Meeting with the Contractor*. In rehabilitation projects, damage to an existing JSA is sometimes repaired by replacement of the rubber gland, or by complete removal of the unit and surrounding concrete. In this section, the complete replacement of the JSA will be discussed.

Similar to Type B joint seals, two measurements are used to describe how much movement a JSA can accommodate. These measurements are taken at the JSA opening width and can typically be found on the approved shop drawings for the JSA. For an example, see Figure 2-20 below (from EA 04-3W7604). As seen in this example, typically the JSA opening width is dimensioned with label **W**. The JSA opening width (**W**) is measured two times, one time at the maximum limit of JSA opening (**W_1**) and another time at the minimum limit of JSA opening (**W_2**).



TYPICAL JOINT SECTION

JOINT OPENING CHART					
LOCATION	MOVEMENT RATING (MR)	SKEW	WINTER	SPRING & FALL	SUMMER
RUDGEAR RD					
HINGE 1	3"	0			
HINGE 2	3"	0			
MOCOCO OVERPASS					
ABUT 1	3 1/2"	0			
HINGE	4"	32°20'24"			

REQUIRED MR = 4"
SUPPLIED MR = 4 1/2"

MINIMUM DIMENSION "A" = 1/2"
MAXIMUM DIMENSION "A" = 5"

EXACT WIDTH TO BE DETERMINED BY THE ENGINEER
MINIMUM DIM "W"=1 1/2" TO INSTALL SEAL

Figure 2-20. Diagram from a Joint Seal Assembly Shop Drawing Noting the Maximum and Minimum Opening (w)

In the previous section on Type B joint seals, it was mentioned that **W_1** and **W_2** measurements must meet three criteria to be suitable for a bridge joint. The first criterion was the following: (**W_1** – **W_2**) ≥ **MR** of the bridge joint shown on the contract plan. This criterion is also true for JSA. The remaining two criteria discussed for Type B seals, however, are not exactly applicable to JSA due to how the joint seal assembly is installed. Specifically, for Type A and Type B seals, it was mentioned that a bridge groove is created at the top of the bridge joint before the seal is placed in it. For JSA, no such bridge groove is created and instead, a blockout is created. To better understand the installation of JSA, a few details about the JSA construction process need to be explained and construction photos will be provided along the way. As shown in Figure 2-21, to install a JSA, a blockout is created at the top of the bridge joint to accommodate the placement and fit-up of the JSA.

Figure 2-21. Joint Seal Assembly Blockout and Installation

For a joint seal assembly with bridge MR of 4 inches or less, the details of the JSA, including the blockout, are provided in the contract plans as shown in the example drawing of Figure 2-22.

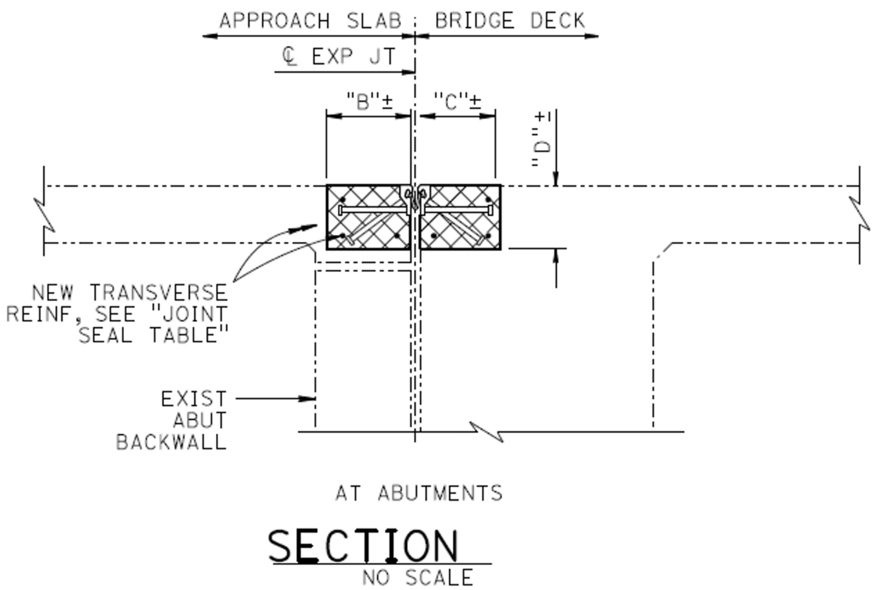


Figure 2-22. Details of Blockout

In the above example drawing, dimensions **B** and **C** are the widths of the blockout that are provided in the contract plans. These two dimensions are specified to be larger than the overall width of the JSA to provide sufficient room for adjustment of the JSA opening width (**W**) at the time of installation. Only after the JSA opening width (**W**) has been appropriately set, concrete is poured into the block out to permanently attach the JSA to the bridge. After the placement of concrete in the blocked-out recess, any changes in bridge joint width will result in a corresponding change in JSA opening width. (Please note, to allow for free movement of the joint seal after concrete pour, SC staff need to verify that any locking mechanism used to set the JSA opening is removed/released immediately after the concrete pour). For proper installation of JSA, the JSA **opening width** must meet the following criteria:

- $\mathbf{W_1}$ limit of JSA ≥ (JSA opening width when widest, W-max). In other words, this equation states that the maximum expected JSA opening width (i.e., when the structure temperature is the lowest, resulting in contraction of the bridge deck) must not exceed the JSA limit of maximum opening given by the manufacturer.
- $\mathbf{W_2}$ limit of JSA ≤ (JSA opening width when narrowest, W-min). In other words, this equation states that the minimum expected JSA opening width (i.e., when the structure temperature is the highest, resulting in expansion of the bridge deck) must be equal to or greater than the JSA ($\mathbf{W_2}$) limit of minimum opening. The $\mathbf{W_2}$ limit is determined as the greater of ½ inch or the limit given by the manufacturer.

As stated in the above criteria, the narrowest and the widest expected JSA opening widths need to be determined. It should be evident that direct field measurement of the narrowest and widest JSA opening width is not practical since it requires the superstructure to reach the highest and lowest expected temperatures. Later in the chapter, the methods and calculations used to estimate the narrowest and widest anticipated JSA opening width based on the opening and temperature measurements taken at the time of installation will be discussed. This topic will be discussed in Section 2-3.06, *Joint Movement Calculations and Movement Recording*.

To summarize the above discussion, the JSA opening width set at the time of installation will determine the JSA maximum and minimum openings (corresponding to min and max expected bridge deck temperature). For proper installation of JSA, it needs to be verified that JSA maximum and minimum openings never exceed the JSA limits of $\mathbf{W_1}$ and $\mathbf{W_2}$. If the JSA movement range were exactly equal to the bridge joint movement range, that would mean that the JSA maximum and minimum opening would have to be the same as $\mathbf{W_1}$ and $\mathbf{W_2}$ limits; this would require the JSA to be installed at a very specific and precise opening. However, because each company that manufactures JSA only makes a limited number of assemblies, the actual movement accommodation for the approved JSA will likely be greater than the actual specified joint movement range on the plans. Because of this, a range of openings would likely be acceptable when setting a joint seal assembly. The procedure used to determine the "range" of acceptable JSA opening at the time of installation will be discussed in Section 2-3.06, *Joint Movement Calculations and Movement Recording.*

Earlier it was mentioned that for a joint seal assembly with MR of 4 inches or less, the contract plans provide details of the required blocked-out recess. However, it should also be mentioned that for a joint seal assembly with MR of 4 inches or less, the *Special Provisions* permit alternative joint seal assemblies which the Contractor may use instead of the joint seal assembly detailed on the contract plans. If the Contractor proposes to use an alternative joint seal assembly, the Contractor is required to submit shop drawings for each alternative joint seal assembly electronically to sc.office.associates@dot.ca.gov, per the standard specifications. Final draft shop drawings are resubmitted for authorization and use as working drawings. Shop drawings and calculations must be sealed and signed by an engineer who is registered as a civil engineer. A certificate of compliance stating materials and fabrication comply with specifications must accompany each JSA when it arrives at the job site. After receiving the shop drawings, SC staff should verify that a copy of the submittal is also provided for an informal review by the Joint Seal Committee and by Bridge Design. If an alternate joint seal assembly is incorporated into the contract work, the Structure Representative should make the necessary changes on the as-built project plans to indicate the details of the alternative joint seal assembly. An additional sheet may be necessary to show the as-built details; do not simply submit the shop drawings as as-built project plans.

For a joint seal assembly greater than 4 inches, refer to the *Standard Specifications* Section 51-2.02E, *Modular Joint Seal Assemblies with a Movement Range Over 4 inches*. The Contractor is required to submit shop drawings for each joint seal assembly. The Contractor must also notify the Engineer of their submittal. The Contractor must include in the notification the date and contents of the submittal. If requested, the Contractor must submit supplemental calculations for each proposed alternative joint seal assembly. Shop drawings and calculations must be sealed and signed by an engineer who is registered as a civil engineer in California. Joint seal work shall not start until the shop drawings have been authorized.

SC staff need to refer to the *Special Provisions* for details concerning the installation of modular joint seal assemblies. Any questions can be directed to the SC Bridge Construction Engineer (BCE) or the Division of Engineering Services (DES) Joint and Bearings Technical Specialist.

During the installation of the joint seal assembly greater than 4 inches, the following items need to be field verified:

1. Assemblies must be capable of adjustment to the "a" dimension.
2. The assembly CIP anchorage components form a mechanical connection between the joint components and the concrete deck.
3. Dimensions for positioning the assembly during installation normal to the longitudinal axis of the assembly, disregarding the skew of the deck expansion joint.
4. Deck surfaces must comply with Section 51-1.03F(5), *Finishing Roadway Surfaces,* before placing joint seal assemblies and anchorages.
5. That each assembly is placed into a blocked-out recess in the concrete deck surface.
6. That the depth and width of the recess allow the installation of the assembly anchorage components or anchorage bearing surface to the lines and grades shown. Watch for areas where grout intrusion into a cell can occur. Ensure proper concrete consolidation under support boxes.
7. Except for primary reinforcement, reinforcement continues through the recess construction joint into the recess and engages anchorage components of the assembly.
8. Each assembly is installed with a watertight, continuous return 6 inches up into barriers at the low side of the deck.
9. Neoprene glands must be continuous without field splices or joints.
10. A qualified representative of the assembly manufacturer must be present and/or available during installation, as outlined in *Standard Specifications* Section 51-2.02E(1)(d)(ii), *Quality Control*.

Another note regarding joint seal assemblies: when setting the joint seal assembly into the joint, be sure that the assembly is **below** the concrete surface by ¼ to ½ inch. This is critical as the assembly will see quite a bit of undue punishment due to impact if it is set above the concrete surface, as illustrated in Figure 2-23. Use a straight edge to span the blocked-out recess just before placement of concrete and insist that the assembly be lowered if necessary, regardless of difficulty. If the joint seal assembly is placed correctly at an acceptable width, it should provide many years of maintenance-free protection.

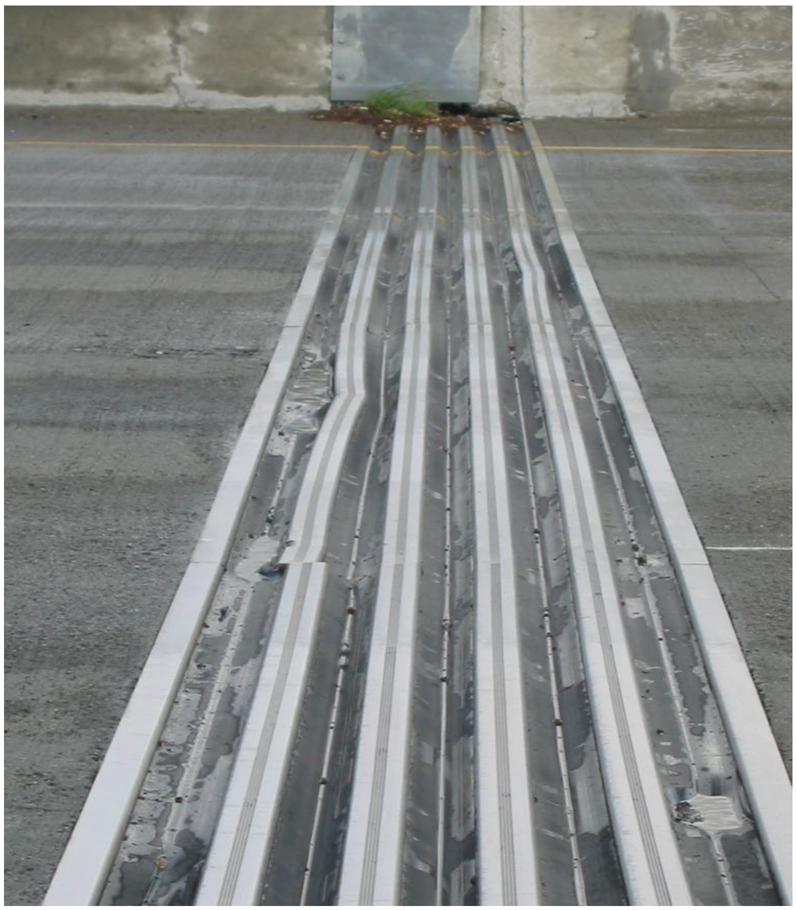


Figure 2-23. Damage to Modular Joint Seal Assembly Due to Repeated Impact

Oftentimes, it becomes necessary to replace a joint seal assembly during overnight traffic closures. Depending on closure windows, the Contractor has two options. These options include full replacement within one shift or utilizing a temporary plate to span the area that is removed. Per *Standard Specifications* Section 48-4, *Temporary Structures – Temporary Decking*, the Contractor may submit a plan for temporarily bridging the gap after the old assembly is removed. If this option is utilized, the Contractor will submit the plan and the SR will review and authorize the plan similar to a falsework or shoring review.

The current practice is for the Bridge Design Project Engineer to put temporary decking details on the contract drawings; see Chapter 6, Deck Plates, of the *Temporary Structures Manual*. Even with a design on the plans, the Contractor is still required to submit a contingency plan to illustrate how they will proceed with the work within the closure windows that are available. It is best if the shop drawings for the assembly are reviewed at the same time as this submittal. The placement of splices in the joint seal assembly and the location of the individual plates need to work together; see Figure 2-24. It is important to note that the splice in the joint assembly needs to be authorized, defined, and marked on the shop drawings.

Figure 2-24. Placement of Splices in the Joint Seal Assembly

The typical taper of concrete overlay leading up to the steel plate should be per the *Standard Specifications* Section 7-1.03, *Legal Relations and Responsibility to the Public – Public Convenience.* The taper and plates must meet the friction requirements in the specifications. Materials for tapers must comply with *Standard Specifications* Section 60-3.02B(2), *Existing Structures – Rapid Setting Concrete*. Keep in mind that this material must be strong enough to withstand the loads placed on it as well as be easily removed after it is no longer needed.

With these temporary deck plating systems, maintenance in heavy traffic areas can be a concern. The longer they are in place, the greater the likelihood that there will be problems. A failure of the temporary deck taper, the plates, or anchor bolts could result in the need for an emergency closure to repair any damage. While these systems are in place, the SR and Assistant Structure Representative should make regular inspections of the system.

2-3.05 Asphaltic Plug

Project administration and field inspection of asphaltic plug joints is relatively simple. The Contractor will submit shop drawings for review and authorization. Working drawings will also be submitted for final authorization and use during construction. METS will receive a 10-pound binder sample that will be used in the asphaltic plug mix for testing and authorization.

When inspecting this work, the following verifications need to be made:

1. Removal verification:
    a. Ensure that existing expansion dams and asphaltic concrete are removed according to the limits shown in the contract plans.
2. Installation verification:
    a. Confirm that the shop drawings are followed during installation.
3. Surface preparation:
    a. After removal, verify that block-out surfaces receiving the asphaltic plug joint seal are dry and clean. Cleaning should be done using an abrasive blast.
    b. Before cleaning, ensure the joint is covered/protected to prevent material from entering it.
4. Backer rod placement:
    a. After cleaning, place the backer rod inside the joint. The backer rod holds the bridging plate in place at the top of the joint gap.
5. Bridging plate installation:
    a. Verify that the bridging plate is centered above the joint gap.
    b. If the joint length exceeds the length of the individual plate delivered to the site, simply butt the bridging plates together; do not overlap them. See Figure 2-25 for an illustration of a bridging plate and an asphaltic plug joint.

Figure 2-25. Plate over Joint Installed

6. Joint seal asphalt binder mix installation (see Figure 2-26):
   a. Install the joint seal material according to the manufacturer's instructions.
   b. Verify that a technical representative from the joint seal manufacturer is present during the installation.

Figure 2-26. Asphalt Binder Mix Is Placed

7. Binder material verification:
   a. Ensure that binder materials delivered to the job site are labeled with the manufacturer's name and lot number.

2-3.06 Overview of Joint Movement Calculations and Movement Recording

This section will describe how bridge movement calculations and Form BD-0307, *Joint Movement Calculations* (previously designated as Form DS-D-0129), are used for the proper installation of Type B joint seal and joint seal assemblies. However, it should be evident that joint movement calculations apply to any other type of seal (i.e., bridge movement is not dependent on the joint seal type used!). To proceed with the bridge movement calculation discussion in this section, it is useful to briefly summarize the material that has been presented so far. For all types of joint seals discussed in this chapter, the movement of bridge joints due to temperature changes is accommodated by the corresponding changes in a joint seal dimension.

Joint seals have a limit on how much movement they can accommodate. Manufacturers provide data and measurements describing the limit of their seal. For example, it was explained that for pourable seals (Type A & AL), manufacturers provide strain capacity data (maximum strain capacity for compression and tension), for Type B seal manufacturers provide $\mathbf{W_1}$ and $\mathbf{W_2}$ for seal width limits (i.e. maximum and minimum seal width limits), and for JSA seal manufacturers provide $\mathbf{W_1}$ and $\mathbf{W_2}$ for the seal opening width limits (i.e. maximum and minimum seal opening limits). Using temperature and dimension measurements for the bridge joint at the time of its installation, it needs to be verified that the joint seal limits are not exceeded if the bridge temperature reaches the maximum or minimum anticipated values. To determine a bridge joint dimension at a temperature different from the installation temperature, use Form BD-0307, *Joint Movement Calculations,* to calculate bridge joint movement corresponding to temperature changes. This form is typically included in the RE pending file for a specific contract and bridge. However, if missing, it can be obtained from the Designer of Record. An example of this form is shown in Figure 2-29. It is the Structure Representative's responsibility to:

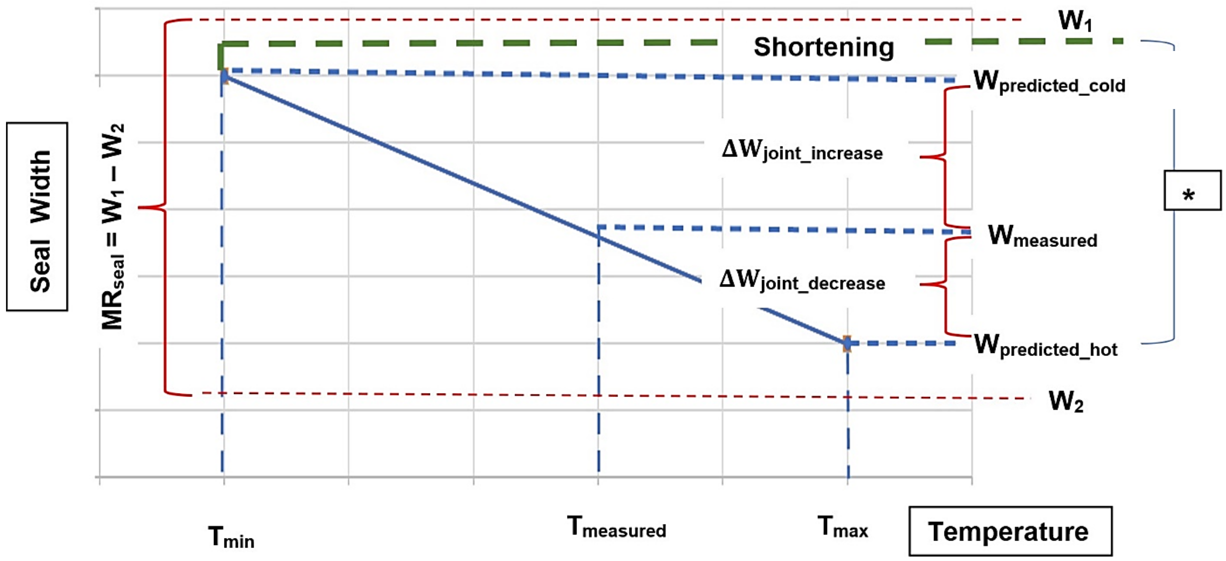
- Determine/confirm the proper groove width or installation width for the joint seal used, and complete the applicable portions of Form BD-0307, *Joint Movements Calculations*.
- Install movement recording scribes on all expansion joints.

Before starting discussion of the Joint Movement Calculations form, the following simplifications and clarifications are made:

1. Only Type B-compression seal terms are used in this discussion, but the concepts apply equally well to joint seal assemblies (JSA). A comparison of Sections 2-3.03, *Type B-Compression Seals,* and 2-3.04, *Assemblies,* shows that both seals are similar in many aspects. For example, both seal types are described by parameters $\mathbf{W_1}$ and $\mathbf{W_2}$. Also, movement range of the seal $\mathbf{MR_{seal}}$

for both types is simply (**W_1** – **W_2**). For the following discussion, the only difference is that when talking about Type B-compression, the discussion pertains to the “groove width” (or sometimes referred to as “saw cut width” or “joint seal width”) but when talking about assemblies the discussion pertains to joint seal “assembly opening”. In short, when talking about “groove width” in the following discussion, the reader should simply replace the “groove width” with “assembly opening” to apply the discussion for joint seal assembly. To avoid confusion and be brief, the same sentences for joint seal assembly work will not be repeated.

2. In discussing joint movement calculations, a variable will be introduced, which is the measured groove width. As covered in Section 2-3.03 *Type B-Compression Seals,* the installation of Type B-compression seals is discussed for both new construction as well as for rehabilitation projects. That section mentioned that in rehabilitation project, there is already an existing groove. So when **$W_{measured}$** is used in a rehabilitation project, it should be easily understood that it refers to an existing groove. But in new construction, there is initially no groove, and the use of the variable **$W_{measured}$** might sound confusing because there is nothing to measure initially. However, it should be noted that in new construction, a groove is eventually created by saw-cutting. Therefore, in new construction, **$W_{measured}$** simply refers to the groove to be sawcut.
3. The groove width along a joint seal may vary slightly due to prior repair, construction tolerance, etc. As such, when determining **$W_{measured}$** the widest point on the groove needs to be measured. Also, the existing groove width typically ends up becoming larger by about 1/2 inch due to saw-cutting to remove the old seal. Therefore, **$W_{measured}$** is the final width of a groove measured after modification(s).
4. To aid with our discussion, the graph of Seal Width vs Superstructure Temperature with Shortening shown in Figure 2-27 below is often referred to.



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

$MR_{joint} = \Delta W_{joint\_increase} + \Delta W_{joint\_decrease}$+Shortening

Figure 2-27. Graph of Seal Width vs Superstructure Temperature with Shortening

By looking at Form BD-0307, *Joint Movement Calculations*, the top fields/entries on the form are the Maximum Temperature (**T_{max}**) and Minimum Temperature (**T_{min}**). These two items are shown in Figure 2-27 and reflect the highest and lowest predicted temperature of the superstructure during the service life of the bridge. The values of **T_{max}** and **T_{min}** are provided by the Designer. Next, additional information can be seen on the form that is used by the Designer to calculate the **MR** for each joint.

It is important to realize (**T_{max}**, **T_{min}**, & **MR_{joint}**) are three data values that are always found on the Joint Movement Calculations form. These three pieces of information are needed for proper installation of joint seal.

When looking at the Joint Movement Calculations form, the fields in the sheet can be divided into the following two categories:

1. Bridge joint information - All the information provided by the Designer pertaining to a bridge joint. This information includes **T_{max}**, **T_{min}**, and **MR_{joint}**. This information is known before the start of the construction.
2. Seal information - All the fields in this category are filled out by SC staff, based on seal material proposed by the Contractor, field conditions observed by SC staff during the seal installation, and the corresponding calculations performed by SC staff to determine suitability of a seal. In following discussions, steps SC staff need to take to complete this category will be covered.

Previously, it was mentioned that a joint seal groove width must never exceed the seal width limits of $\mathbf{W_1}$ and $\mathbf{W_2}$. As shown in Figure 2-27, the maximum and minimum groove widths correspond to superstructure temperature at $\mathbf{T_{min}}$ and $\mathbf{T_{max}}$, respectively. Since it is unlikely that the superstructure will be at either $\mathbf{T_{min}}$ or $\mathbf{T_{max}}$ when installing a joint seal, direct measuring of the maximum or minimum groove width is not practical. Instead, the groove width at $\mathbf{T_{min}}$ and $\mathbf{T_{max}}$ will be predicted/calculated using joint movement calculations.

For additional information on the topic of joint seals, including example calculations and supplemental information, see Appendix A, *Joint Seals – Additional Information & Examples.*

2-3.06A Joint Movement Recording

As mentioned earlier in this section, the joint movement needs to be recorded using scribes. Verify existing scribes are still in place. If they are not in place (damaged or never installed), they need to be installed as described in the following paragraph.

Scribes are to be placed at all expansion joints as shown in the instruction sheet. See Figure 2-28 for an example of a scribe. Placement of the scribes at a location other than that shown may be required when special barrier rails are used. Details on the scribes, scribe plates and epoxy, as well as installation instructions, can be found in Supplemental 1, *Instructions and Parts for Joint Scribes*, of Appendix A. Scribes, plates, and epoxy should be obtained from the District through the Resident Engineer. Skewed or extra-wide structures may require a scribe unit on the joint on both sides of the structure.

Figure 2-28. Example of a Scribe

2-3.07 Special Details

All components in a joint must be capable of withstanding more than the anticipated movement of the joint. Check details such as water stop, formed joint openings, hinge restrainers, rollers or rockers, conduits, etc., for proper setting and movement capacity. In accordance with *Standard Specifications* Section 5-1.36, *Control of Work – Property and Facility Preservation*, care should be taken so that existing utilities and encroachments spanning joints are not damaged by the cleaning operations.

For additional information covering unique joint seals, see Supplemental 3, *Open Joint and Experimental Test Seals*, of Appendix A-3, *Joint Seals – Additional Information & Examples – Supplemental Information*.

STATE OF CALIFORNIA * DEPARTMENT OF TRANSPORTATION

JOINT MOVEMENT CALCULATIONS

BD-0307

Note: Specific instructions are included as footnotes

BRIDGE DESIGN

EA	DISTRICT	COUNT	ROUT	KP	BRIDGE NAME AND NUMBER	
07-012344	7	LA	101	50.00	Example Bridge	10-0111

TYPE	TYPE ABUTMENT	TYPE BEARING
19-Span RC Box-Girder	RC Diaphragm	Elastomeric pads

1 TEMPERATURE EXTREMES *(from Preliminary Report)*

		Type of Structure	Design Range		2 THERMAL MOVEMENT (inches/100 feet)	ANTICIPATED SHORTENING (inches/100 feet)	3 MOVEMENT (inches/100
Maximum	105 °F	Steel	°F	1.2(.0000065 x 1200)	= =	+	
Minimum	20 °F	Concrete *(Conventional)*	°F	1.2(.0000060 x 1200)	= =	+	
		Concrete *(Pretensioned)*	°F	1.2(.0000060 x 1200)	= =	+ 0.12 =g	
Range	85 °F	Concrete *(Post tensioned)*	85 °F	1.2(.0000060 x 1200)	= 0.7344 =	+ =g	0.73

ITEM 1 DESIGNER	DATE	ITEM 2	DAT
Best Designer	9/30/2010	Best Checker	9/30/10

To be filled in by Division of Structures Design [b]

To be filled in by SR: [c] Best SR DATE: 2024

LOCATION	Skew (degrees) Do not use in calcs.	4 Contrib-uting 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 [d]: Catalog Number	Seal Width Limits [d]: W_1 Maximum	Seal Width Limits [d]: 5 W_2 (inches) Min. @ Temp.	Groove *(saw cut)* Width or Installation Width [e]: Structure Temp-erature	Groove *(saw cut)* Width or Installation Width [e]: 6 Adjust from Max. Temp. (inches) DelT/1x2x4/100	Groove *(saw cut)* Width or Installation Width [e]: 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 2-29. Example of Joint Movement Calculations Form Provided by Bridge Design