SECTION 10
DECK JOINTS

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10.1 GENERAL

The selection and layout of deck joints shall allow for deformations due to temperature and time dependent causes, be consistent with the proper functioning of the bridge, be able to stand up to vehicular live load, and provide a water tight seal to prevent roadway runoff from falling on the structural members below.

The number of movable deck joints in a structure should be minimized. Continuous deck/superstructure systems should be used and, where appropriate, integral bridges.

Several joint types are recommended below for different situations. Other joints may be used, provided that **CTDOT** has approved them.

10.1.1 Location of Joints

Deck joints should be avoided at or near points of sag vertical curves.

Deck joints at abutments shall be located behind the abutment backwall so that any leakage of the joint would not damage the structural elements below. An exception to this may be for modular joints where future maintenance is required. In this case, the joint may have to be placed in front of the backwall.

Generally, open finger joints shall only be used behind the abutment backwall where the water and debris can be intercepted by a concrete drainage structure. (See **BDM** [Division 3])

10.1.2 Skew Effects

Provisions shall be made in the joint design for both lateral and longitudinal movement based on the geometry of the deck and the design of bearings and keeper assemblies. For bridges with complicated deck configurations, a thermal expansion analysis of the deck should be done in order to determine the thermal movements relative to the bridge joints.

10.1.3 Curvature Effects

For curved superstructures, provisions shall be made in the joint design for both lateral and longitudinal movement based on the geometry of the deck and the design of bearings. Generally, the direction of movement of the superstructure may be assumed to be parallel to the chord of the deck centerline taken from the joint to the neutral point of the superstructure as defined in **BDM** [9.1.2].

10.1.4 Temperature Range

The temperature range used for the calculation of thermal movement of deck joints shall be 120°F. This temperature range is based on a mean low temperature of -10°F and a mean high temperature of +110°F. The median temperature for design of joints shall be +50°F.

10.1.5 Coefficient of Thermal Expansion

For the design of deck joints, a coefficient of thermal expansion shall be taken as 6.4×10^{-6}/ºF. This equates to approximately 2¾" total movement for a 300-foot long bridge.

10.1.6 Movement Due to Seismic Events

If the bridge is designed for seismic events where significant movement is important to the proper function of bridge elements (such as seismic isolation bearings), the movement due to seismic forces shall be accommodated in the design of the joints. For other bridges, the joint need not be designed for seismic movement, and should not be designed to survive the seismic event undamaged.

10.2 TRANSVERSE JOINTS *(Rev. 04/19)*

10.2.1 Fixed Joints

For fixed joints at abutments and piers, an asphaltic plug joint is preferable to a sawed and sealed joint.

Although the asphaltic plug joint is more expensive than a sawed and sealed joint to install and is prone to rutting under heavy wheel loads and shoving under heavy braking forces, it handles settlement at abutments better and the exact placement of the joint is not so critical to its functioning.

10.2.2 Expansion Joints

10.2.2.1 Box Culverts and Rigid, Buried Structures

It is not recommended to install transverse joints in the pavement for buried structures.

10.2.2.2 Span Bridges

10.2.2.2.1 Joints with Thermal Movement Range (TMR) up to ½ inch *(Rev. 12/19)*

For thermal movement ranges up to ½ inch, it is not recommended to install transverse joints in the pavement for bridges with slab over backwall.

For all other situations, it is recommended to install asphaltic plug expansion joints as specified in **BDM** [12.2.2.2].

10.2.2.2.2 Joints with Thermal Movement Range (TMR) above ½ inch up to 1 ½ Inches

For deck joints at or beyond the back of the abutment backwall, first consideration shall be given to specifying an asphaltic plug expansion joint. Include a table on the plans specifying the thermal movement range at all asphaltic plug joint locations.

For joints located over the bridge seat or over pin and hanger expansion devices, specify a preformed joint seal secured between elastomeric concrete headers. Include a table on the plans specifying three products and corresponding installation information.

See the Guide Sheets for typical details. The Designer is responsible for modifying these sheets as applicable for each project. For guidance on selecting and specifying a preformed joint seal, see 10.2.2.2.1.

Where one or more of the following conditions exist, the asphaltic plug expansion joint may not be appropriate:

- Heavy wheels from trucks may cause rutting
- Frequent braking forces from traffic are likely to shove the pavement
- The span contributing to expansion exceeds 100 feet
- The skew of the joint, in combination with the thermal movement range, exceeds the manufacturer's recommendation for the joint
- The combined grade and cross slope of the roadway is greater than 6%

10.2.2.2.3 Joints with Thermal Movement Range (TMR) above 1 ½ Inches up to 3 Inches

Specify a preformed joint seal secured between elastomeric concrete headers or between two concrete surfaces. Include a table on the plans specifying three products and corresponding installation information.

To install a preformed joint seal, there must be a joint gap in which to secure the sealing gland. This gap may be formed between the following components:

- Deck ends
- A backwall and a deck end
- A deck end with a double backwall
- A deck end and an approach slab
- A deck end with an approach structure

- Two parapet ends
- Two sidewalks

The deck joint gap (the gap between the tops of headers, measured perpendicular to the joint) shall conform to the joint manufacturer's recommendations for depth of shelf, minimum gap and minimum gap at installation. The deck joint gap will vary, depending on temperature. The gap will be maximum when the temperature is at its lowest (assumed to be -10^{o}F). Although preformed joint seals (and other single gap systems, such as strip seals) are available for movement ranges larger than 3 inches, **LRFD** [14.5.3.2] limits the roadway surface gap, W, measured in the direction of travel, to 4 inches for single gaps. This is to ensure that the riding surface is not impaired, to prevent damage to vehicles and to ensure the safety of motorcyclists, bicycles and pedestrians.

The roadway surface gap is the result of combining the gap at installation with the thermal movement of the joint as the bridge contracts in addition to time-dependent movement. The Deck Joint Gap at Installation shall be set by the Designer with consideration for the maximum roadway surface gap. A joint with a thermal movement range of 3 inches will likely test the 4-inch maximum roadway surface gap limit set by the **LRFD**. **CTDOT** will allow up to a 4-inch roadway surface gap at 20^{o}F. This will allow use of the single-gap joint in larger ranges of thermal movement. When the roadway surface gap at 20^{o}F is greater than 4 inches, another type of joint shall be considered.

For each product, manufacturers typically identify the preformed joint seal by its nominal capacity (the manufacturer's recommended movement capacity of the seal in a joint installed perpendicular to the direction of movement). Designers shall select products from at least three manufacturers and list those products in a table on the contract plans using the manufacturers' designations. A template for this table is available for use under Guide Sheets. One table shall be included with at least three products for each expansion joint location (for example, "Abutment No. 1," shall be included beside, "Description of Joint Location," at the top of the table for the Abutment No. 1 joint). Should there be products from less than three manufacturers that meet the design requirements, the Designer shall follow **CTDOT** ECD-2016-1 for proprietary product approval.

To assist Designers with selection of a preformed joint seal, an Excel spreadsheet is available under Guide Sheets. Notes below the spreadsheet are provided to assist Designers with the use of the program. Designers shall be responsible for selecting a properly designed joint seal for the specific joint conditions. The spreadsheet is only a guide. Note that the spreadsheet is formatted similar to the Table template. This is to facilitate the transfer of design information into the Table template for inclusion in the plans.

When Designers propose preformed joint seals in bridge deck joints that pass through sidewalks, only foam-supported silicone joint seals shall be specified for that deck joint and the sidewalk joint. It is preferable to use the same joint seal in the parapet as well to allow the same joint gap in the parapet, sidewalk and deck. See the Guide Sheets for typical details at sidewalks.

The foam-supported silicone joint seals are preferred at sidewalk joints because they meet ADA requirements when installed as shown in the Typical Details. Since the sidewalk curb height is too low to allow a V-shaped seal from the deck joint to turn up the curb and rise sufficiently beneath a foam-supported seal in the sidewalk, both the deck joint and the sidewalk preformed joint seal shall be the foam-supported type.

10.2.2.2.4 Joints with Thermal Movement Range (TMR) between 3 Inches and 4 Inches *(Rev. 04/19)*

For joints where the total movement is between 3 inches and 4 inches, the first preference for joints should be Reinforced Concrete Headers with a Neoprene Strip Seal and anchored extrusions.

Designers shall compute the roadway surface gap, W, at 20^{o}F. Should W exceed 4 inches, another type of joint shall be considered.

Strip seal joints in sidewalks shall be covered with sliding steel plates, detailed to meet ADA requirements. The steel plates shall be anchored into the sidewalk on both sides of the joint. See the Guide Sheets for typical details at sidewalks.

10.2.2.2.5 Joints with Thermal Movement Range (TMR) > 4 Inches

10.2.2.2.5.1 Joints at Abutments

10.2.2.2.5.1.1 Modular Joints

Modular expansion joints may be used at abutments, provided that the distance between the abutment backwall and the ends of the beams and diaphragms is kept to 2 feet minimum in order to facilitate inspection and future maintenance.

10.2.2.2.5.1.2 Finger Joints

Where a proper drainage structure can be constructed behind the abutment backwall, an open finger joint can be considered. The drainage structure should be provided with an access door or manhole for cleaning. The structure should also be connected to a storm drainage system or a standard outlet. Where the bottom of the drainage structure is not the top of the abutment footing, a 2-foot deep sump should be detailed to catch sediment.

10.2.2.2.5.2 Joints at Piers

10.2.2.2.5.2.1 Modular Joints

The first preference for joint type at piers should be Modular expansion joints. The distance between adjacent diaphragms shall be kept to 2 feet minimum in order to facilitate inspection and future maintenance. The beam-ends may be kept closer if proper maintenance can be accomplished. Joint manufacturers should be contacted for specific requirements for each joint.

10.2.2.2.5.2.2 Finger Joints

Where the location of the joint is at the crest of a vertical curve, an open finger joint can be considered. A drainage trough shall be provided that is connected to a proper piping system (**BDM** [11]).

10.2.2.2.6 Joints at Skewed Bridges

Designers shall consider skew of the joint relative to the direction and magnitude of thermal expansion when selecting and sizing the joint.

Each product manufacturer provides guidance as to how skew affects the way that product functions. Designers shall become familiar with how each type of joint functions to ensure that joints are properly designed.

10.2.2.2.6.1 Asphaltic Plug Expansion Joints

Manufacturers limit the skew at which the joint may be installed. Typically, this skew is 45 degrees. Asphaltic plug expansion joints should generally not be specified for skews greater than 45 degrees.

10.2.2.2.6.2 Preformed Silicone Joint Seals

Preformed Silicone Joint Seals are divided into two groups for this discussion:

- V-shaped silicone joint seals
- Foam-supported silicone joint seals

10.2.2.2.6.2.1 V-shaped Silicone Joint Seals

V-shaped silicone joint seals are designed to prevent tension from occurring in the seal or in the bonding point. The seal is adhered to both sides of the joint at the time of installation. Thermal movement causes the gap to open and close in the direction of travel for bridges on tangent alignments. When the seal is installed in a joint that is skewed to the direction of travel, the seal experiences relative movements between both sides of the seal. The movement can be described as two components:

- normal to the joint
- movement parallel to the joint (also known as “racking”)

Seals in non-skewed joints experience movement predominantly normal to the joint. Seals in joints oriented normal to the roadway can reach their nominal capacity in thermal movement because this is how they are designed.

Seals in skewed joints experience additional movement parallel to the joint that introduces “racking” or shear forces into the seal. This reduces the nominal capacity of the seal. Manufacturers may provide written guidance regarding how skew affects the thermal movement capacity of their seal. In lieu of manufacturer guidance, **CTDOT** offers the following design guidance for selection of V-shaped silicone seals with adjustments to the manufacturer’s recommended nominal capacity:

Skews from 0 degrees to 30 degrees: No adjustment to nominal capacity is needed.

Skews above 30 degrees to 45 degrees: Multiply the calculated TMR by a factor of 1.5. Select a seal with that nominal capacity or larger.

Skews above 45 degrees: Multiply the calculated TMR by a factor of 1.75. Select a seal with that nominal capacity or larger.

10.2.2.2.6.2.2 Foam-Supported Silicone Joint Seals

Foam-supported silicone joint seals are pre-compressed foam seals with a waterproof silicone coating. They are not affected by skew to the degree that a V-shaped joint seal is because the foam is in compression at all times. The direction of movement is less important than the magnitude of movement. Due to vector components of movement on a skewed joint, however, **CTDOT** recommends that the size of the foam-supported silicone joint seals be selected as follows:

Skews from 0 degrees to 30 degrees: Select a seal with a movement capacity 1/4” larger than the calculated TMR.

Skews above 30 degrees to 45 degrees: Select a seal with a movement capacity 1/2” larger than the calculated TMR.

Skews above 45 degrees: Select a seal with a movement capacity 3/4” larger than the calculated TMR.

10.3 LONGITUDINAL JOINTS

10.3.1 Deck Joints

Longitudinal deck joints should be avoided wherever possible due to problems with motorcycle safety and difficulties associated with the intersection of the transverse deck joints. If longitudinal joints are unavoidable, they shall be located out of the traveled way. Since differential vertical movement is common in longitudinal joints, the only joints that should be considered are Elastomeric Concrete Headers with a Preformed Joint Seal or concrete headers with a Neoprene Strip Seal. A Preformed Joint Seal is preferred.

10.3.2 Concrete Median Barrier

Vacant

10.4 JOINT SPECIFIC DESIGN REQUIREMENTS

10.4.1 Asphaltic Plug Expansion Joint System

The asphaltic plug expansion joint system shall always be placed after the final pavement has been placed on the bridge and the pavement in the area of the header has been saw cut and removed. This applies for rehabilitation and new construction.

The asphaltic plug joint should be detailed from curb to curb. The joint in the parapet should be sealed as detailed in typical details in the Guide Sheets.

10.4.2 Elastomeric Concrete Headers with Preformed Joint Seal *(Rev. 04/19)*

Elastomeric concrete headers with a Preformed Joint Seal shall always be placed after the final pavement has been placed on the bridge and approaches. This applies for rehabilitation and new construction.

The elastomeric header material should be recessed 1/8 inch below the bituminous overlay to account for long-term compaction of the bituminous overlay under traffic.

10.4.3 Reinforced Concrete Headers with a Neoprene Strip Seal *(Rev. 04/19)*

The neoprene seal should be detailed from curb to curb and up to the top of the curb portion of the parapet (approximately 11 inches above the pavement). See the Guide Sheets for typical details.

The reinforced concrete header should be recessed 1/8 inch below the bituminous overlay to account for long-term compaction of the bituminous overlay under traffic.

10.4.4 Modular Expansion Joints

The design and detailing of modular expansion joints is the responsibility of the manufacturer of the joint; however, the designer should provide the proper room in the slab for the installation of the joint. The designer may have to contact each approved manufacturer to ensure that each joint can fit within the bridge slab.

The modular joints shall be detailed from curb to curb and up to the top of the curb portion of the parapet (approximately 11 inches above the pavement). For bridges with skews, the joint system should be run into the parapet on the skew and covered with curb plates. The curb plates shall be designed to accommodate all movements, and the free edge should overlap the parapet on the trailing edge of the parapet.

Only joints that have successfully tested for fatigue and approved by **CTDOT** may be used.