CHAPTER 14 – JOINTS AND BEARINGS

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14.4—MOVEMENTS AND LOADS

14.4.2—Design Requirements

The following shall supplement *A14.4.2*.

Bearings and joints shall be designed to accommodate thermal movement for the temperature range specified in *D3.12.2.1*.

The movements due to concrete creep and shrinkage shall be estimated in accordance to *D3.12.5*.

Movement due to shrinkage and creep may be neglected for rehabilitation projects where concrete superstructure elements have been in place for at least one year. Shrinkage and creep in concrete elements typically dissipates one year after casting.

14.5—BRIDGE JOINTS

The following shall supplement A14.5.

The following definitions shall apply when calculating joint movements and joint openings.

Δ_{TOTAL} = Total joint movement (movement range), measured in the direction of travel (in.)

Δ_{MIN} = Minimum joint opening, measured in the direction of travel at maximum temp. (in.)

$\Delta_{MIN} \geq 1$”

Δ_{MAX} = Maximum joint opening, measured in the direction of travel at minimum temp. (in.)

$\Delta_{MAX} \leq 4.5$”

P_{88° = Joint opening at 88°F, measured perpendicular to the centerline of the joint (in.)

P_{68° = Joint opening at 68°F, measured perpendicular to the centerline of the joint (in.)

P_{48° = Joint opening at 48°F, measured perpendicular to the centerline of the joint (in.)

Expansion joints shall be selected in accordance with the Joint Selection Table below.

The following shall supplement *AC14.5*.

Δ_{MIN} is limited to ≥ 1 inch to prevent joint jamming under extreme high temperatures in Louisiana hot summer. Δ_{MAX} is increased to 4.5 inches from 4 inches as specified in *A14.5.3.2* to utilize more economical preformed neoprene and silicone joints. The chances of having consistent extreme cold temperatures in Louisiana is rare, therefore the frequency of exceeding 4” maximum opening is very low and will only be temporary occurrences.

Symbol “Δ” represents joint movements or joint openings measured in the direction of travel, which are related to design requirements.

Symbol “P” represents joint openings measured perpendicular to the centerline of the joint, which are related to joint installation.

Contractors may not be able to install joints at the assumed design temperature of 68^0 F, therefore joint openings at three typical Louisiana temperatures (88^0 F, 68^0 F, and 48^0 F) are provided in “Joint Data Table” to assist installation.

Joint Selection Table

Total Joint Movement (Movement Range), Δ total	**Joint Type[1]**	**Application Guidance**				
		New Construction	**Joint Replacement/ Rehab.**	**Standard Plans, Designed by EOR, or Designed by Manufacturer**	**Specification Sections**	**Pay Item**
≤ 0.5 ”	Poured Silicone Joint	Allowed in slab span bridges only	Allowed	Slab Span and Misc. Span Details Standard Plans	815 1005.02.3 1005.02.4	815-03-00300 Joint Seal (Poured)
≤ 3.5”	Preformed Neoprene Joint (Strip Seal)	Allowed	Allowed	Misc. Span Details Standard Plans - Preformed Neoprene Joint	815 1005.05.1	815-02-00100 Sealed Expansion Joint (End Dams and Preformed Neoprene Seal)
	Preformed Silicone Joint	See Note 2	Allowed	Misc. Span Details Standard Plans - Preformed Silicone Joint	815 1005.05.2	815-02-00200 Sealed Expansion Joint (End Dams and Preformed Silicone Seal)
> 3.5”	Finger Joint[4]	Allowed	Allowed	Designed by EOR or Manufacturer[3]	815[5]	815-02-00400 Sealed Expansion Joint (Finger)
	Modular Joint[4]	Allowed	Allowed	Designed by EOR or Manufacturer[3]	815[5]	815-02-00300 Sealed Expansion Joint (Modular)
	Flexible Plug Joint[4]	See Note 2	See Note 2	Designed by Manufacturer[3]	Requires Special Provisions	Requires new pay item

Notes:

1. All expansion joints shall be sealed. Open joints are not allowed. For concrete pavement relief/expansion joints see Standard Plan CP-01, Standard Plans for approach slab, and Standard Plans for concrete expansion joint for overlay projects.
2. Requires approval from the Bridge Design Engineer Administrator and for pilot projects only.
3. When designed by Manufacturer, design requirements (load, translation, rotation, etc.) shall be provided in project plans by the EOR.
4. For all joints designed by EOR or manufacturer (Finger Joints, Modular Joints, and Flexible Plug Joints), the following note shall be included in project plans: “The contractor shall hold a pre-installation meeting with the EOR and manufacturer representative prior to installation to review joint installation procedures and QC/QA measures to ensure successful installation.”.
5. The EOR shall review Section 815 to determine if special provisions are needed.

The Joint Data Table (including all definitions and notes) below shall be prepared by the EOR for all joint types and included in project plans. The contractor is required to provide joint as-built data including installation temperature, joint opening at installation temperature, and manufacturer's name and product type.

Two design aids are included in Appendix A – Expansion Length Examples and Appendix B – Example Joint Data Table. Appendix A provides guidance on determining joint expansion length for various span arrangements. Appendix B provides an example "Joint Data Table" and demonstrates detailed calculations to determine the information needed for the Joint Data Table.

MicroStation cell for "Joint Data Table" is available in the CADconform Library.

Joint Data Table

Bent No.	**Skew Angle**[2]	**Joint Type**	**Design Data**[1]				**As-Built Data**[3]		
			Δ_{TOTAL}	**P_{88°**[2]	**P_{68°**[2]	**P_{48°**[2]	**T**	**P_{T°**	**Manufacturer/Product Type**

Definitions:

Δ_{TOTAL} = Total joint movement (movement range), measured in the direction of travel (in.)
P_{88° = Joint opening at 88°F, measured perpendicular to the centerline of the joint (in.)
P_{68° = Joint opening at 68°F, measured perpendicular to the centerline of the joint (in.)
P_{48° = Joint opening at 48°F, measured perpendicular to the centerline of the joint (in.)
T = Installation temperature, ambient temperature at the scheduled installation time (°F)
P_{T° = Joint opening at T °F, measured perpendicular to the centerline of the joint (in.)

Notes:

1. The selected product shall provide the total joint movement (movement range) as specified. Joint openings at 88°F, 68ºF, and 48°F shall be as specified. If a joint is installed at temperatures other than 88°F, 68ºF, and 48°F, the joint opening shall be interpolated from the given temperatures. The contractor shall verify the minimum installation opening for the selected product.
2. Skew Angle shall be considered in product selection. For expansion joints with combination of skew and non-skew portion (such as skew expansion joints for LG Girders, see LG Common Details, Sht. 3 of 11), P_{88°, P_{68° and P_{48° shown are for the skew portion of the joint, the non-skew portion shall be set accordingly.
3. As-Built Data shall be submitted by the Contractor to EOR for review and conditional approval at least 15 days prior to joint installation. If the temperature drastically changes after the conditional approval, the contractor is responsible for revising the data and resubmitting for final approval. The final as-built data shall be documented in as-built plans.

14.6—REQUIREMENTS FOR BEARINGS

The following shall supplement *A14.6.*

Bearings shall be selected in accordance with the Bearing Selection Table.

Steel-reinforced elastomeric bearings shall be designed using Method B as specified in *A14.7.5*. Method A as specified in *A14.7.6* is not allowed. The steel reinforcement shall be a nominal 1/8" thick ASTM A36 steel plate. The exterior and interior layer of elastomer shall be 1/4" and 1/2" respectively.

Access to bearings for inspection, maintenance and replacement shall be provided.

Dead load reactions at bearings shall be shown in the Girder Data Table.

Risers to support bearings shall be level with minimum thickness of 4 inches. For sloped girders, additional requirements for girder ends and bearing design per "Sloped Girder Requirements Table" shall be incorporated in design.

The following shall supplement *AC14.6*.

Steel-Reinforced elastomeric bearings are the simplest, most economical of all bridge bearings and have shown good field performance.

Dead load reactions are provided to facilitate girder jacking operations when required.

Bearing Selection Table

Priority	Bearing Type	General Guidance	
1	Steel-Reinforced Elastomer Bearings	Standard Bearings	Nine Standard Bearings (Type B1-B9) are developed for non-skew LG girder bridges and shall be used whenever possible (see BDEM Part III Chapter 1 for design assumptions, design charts and examples). For slightly skewed LG girder bridges, these standard bearings may still be used, however the EOR shall check for skew condition per AASHTO Spec.
		Non-Standard Bearings	Non-standard steel-reinforced elastomer bearings including circular bearings are typically needed for steel girder bridges, highly skewed bridges, curved bridges, or other types of bridges.
	Plain Elastomer Bearings	Plain elastomer bearings can be used as fixed bearings and bearings to support approach slab and slab span bridge.	
2	Disc Bearings	Disc bearings should be used when design conditions exceed the limits of steel-reinforced elastomer bearings. Disc bearings are typically designed by manufactures, however design conditions (loads, translation, rotation, etc.) shall be provided in plans by the EOR.	
3	Spherical Bearing	Spherical bearings should be used when design conditions exceed the limits of steel-reinforced elastomer bearings and disc bearings. Spherical bearings are typically designed by manufactures, however design conditions (loads, translation, rotation, etc.) shall be provided in plans by the EOR.	

Notes:

1. Roller bearings and rocker bearings are not allowed.
2. Use of pot bearing or other types of bearings requires approval from the Bridge Design Engineer Administrator.
3. See Section 814 of Louisiana Standard Specifications for Roads and Bridges for bearing specifications. EOR shall also prepare project specific specifications for Disc Bearings and Spherical Bearings and request the contractor to hold a pre-installation meeting with the manufacturer and the EOR to discuss installation plan and review QC/QA process to ensure successful installation.

Sloped Girder Requirements Table

Slope of Girder "SL" (%)	Girder Ends and Bearing Design Requirements[1]
SL ≤ 1%	Use leveled riser. Additional rotation due to slope of girder shall be included in bearing design.
SL > 1%	Use leveled riser with beveled plate at girder ends. The slope of beveled plate should match the girder slope to provide a leveled contact surface with bearing. If not, additional rotation due to slope difference between girder and beveled plate shall be included in bearing design.
Note: 1. Refer to Part III Chapter 1 Section 1.2.1 for the application of these requirements when developing standard steel-reinforced elastomeric bearing types B1-B9 for LG girders.	

14.7—SPECIAL DESIGN PROVISIONS FOR BEARINGS

14.7.5—Elastomeric Pads and Steel-Reinforced Elastomeric Bearings—Method B

14.7.5.2—Material Properties

The following shall supplement *A14.7.5.2*.

The elastomer shall have a specified shear modulus, G, of 0.15 ksi at 73ºF.

Due to the variation of the shear modulus, use 1.15G for the calculation of the shear deformation force and use 0.85G for all other calculations.

C14.7.5.2

The following shall supplement *AC14.7.5.2*.

Although constituent elastomer has historically been specified by durometer hardness, shear modulus is the most important physical property of the elastomer for purposes of bearing design. Research has concluded that shear modulus may vary significantly among compounds of the same hardness.

14.7.5.3—Design Requirements

14.7.5.3.2—Shear Deformations

The following shall supplement *A14.7.5.3.2*.

Refer to D14.4.2 for requirements on thermal movement and movements due to concrete creep and shrinkage.

Shear deformation caused by braking force due to HL-93 loading shall be restricted to no more than 10% of total elastomer thickness h_{rt}. Do not apply LADV-11 magnification factor for shear deformation check due to braking force.

C14.7.5.3.2

The following shall supplement *AC14.7.5.3.2*.

14.8—LOAD PLATES AND ANCHORAGE FOR BEARINGS

14.8.3—Anchorage and Anchor Bolts

14.8.3.1—General

The following shall supplement *A14.8.3.1*.

Elastomeric bearings can be placed without anchorage if adequate friction is available. A design coefficient of friction of 0.2 can be used between elastomer and clean concrete or steel. The

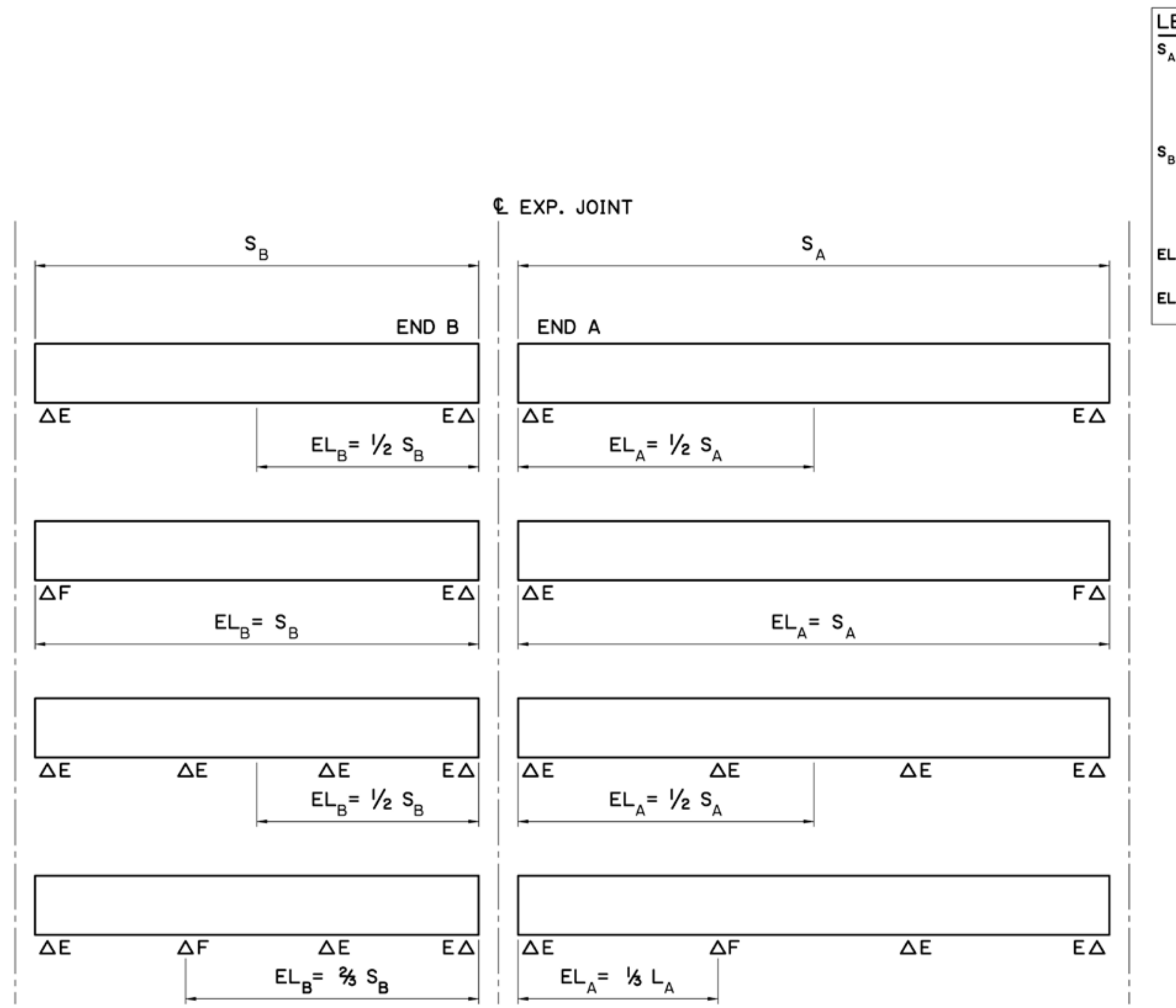
C14.8.3.1

These requirements are based on best practices learned from NCHRP US Scan Project 17-03, Experiences in the Performance of Bridge Bearings and Expansion Joints Used for Highway Bridges.

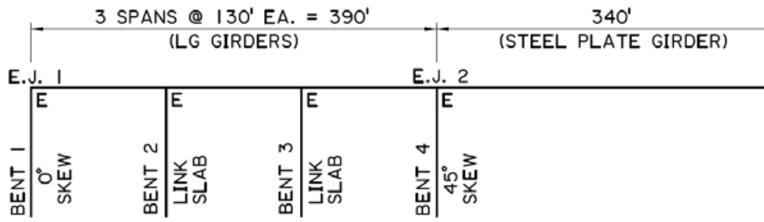
lateral force due to shear deformation must be less than the friction resistance, which equals to dead load times the friction coefficient, to prevent slippage.

Compressive stress at elastomeric bearings due to dead load shall be greater than 200 psi to prevent bearing walking.

APPENDIX A—EXPANSION LENGTH EXAMPLES



APPENDIX B—EXAMPLE JOINT DATA TABLE



Given: Coefficient of Thermal Expansion (concrete) = 0.000006 in./in./°F
Coefficient of Thermal Expansion (steel) = 0.0000065 in./in./ °F
Coefficient of Shrinkage and Creep (simple concrete spans) = 1” per 325’ span=0.00308 in./ft.
Coefficient of Shrinkage and Creep (continuous concrete deck units or steel spans)
= 0.5” per 325’ span = 0.00154 in./ft.
Total Temperature Range of Expansion (concrete) = 85 °F (18 °F to 103 °F)
Total Temperature Range of Expansion (steel) = 120 °F (0 °F to 120 °F)

Minimum Recommended Joint Opening for Seal Installation			
Total Joint Movement	**3"**	**4"**	**5"**
Preformed Neoprene:			
Watson Bowman	1.5"	1.5"	2"
D.S. Brown	n/a	2"	3"
Preformed Silicone:			
RJ Watson	1.25"	2.5"	2.75"

Definitions:

Δ_{TOTAL} = Total joint movement, measured in the direction of travel (in.)
Δ_{MIN} = Minimum joint opening, measured in the direction of travel at max. temp. (in.) ≥ 1”
Δ_{MAX} = Maximum joint opening, measured in the direction of travel at min. temp. (in.) ≤ 4.5”
$P_{88°}$ = Joint opening at 88°F, measured perpendicular to the centerline of the joint (in.)
$P_{68°}$ = Joint opening at 68°F, measured perpendicular to the centerline of the joint (in.)
$P_{48°}$ = Joint opening at 48°F, measured perpendicular to the centerline of the joint (in.)

E.J. 1: 3-span LG girder continuous deck floating unit with a total length of 390’
Expansion Length = 390’ / 2 = 195’
Δ_{TOTAL} = [Load Factor] * [Coefficient of Thermal Expansion (concrete)] * [Total Temperature Range] * [Expansion Length] + [Coefficient of Shrinkage and Creep] * [Expansion Length]
= [1.2] * [0.000006] * [85] * [195 * 12] + [0.00154] * [195]
= 1.73 inches < 3.5”, Use 3” Preformed Neoprene Joint
Assume Δ_{MIN} = 1 in.
$\Delta_{MAX} = \Delta_{MIN} + \Delta_{TOTAL}$
= 1 + 1.73 = 2.73 inches

$P_{88°}$ = Δ_{MIN} + [Load Factor] * [Coefficient of Thermal Expansion (concrete)] * [Temperature Differential (from max to 88°)] * [Expansion Length]

= 1 + [1.2] * [0.000006] * [103° - 88°] * [195 * 12]

= 1.25 inches

$P_{68°}$ = 1 + [1.2] * [0.000006] * [103° - 68°] * [195 * 12] = 1.59 inches

$P_{48°}$ = 1 + [1.2] * [0.000006] * [103° - 48°] * [195 * 12] = 1.92 inches

Note: The minimum recommended installation widths for preformed neoprene and preformed silicone seals with 3” movement capacity is 1.25 to 1.5 inches, depending on manufacturer. If possible, $P_{88°}$ value should accommodate the minimum installation opening of 1.5” for ease of installation in summer season. If not possible, the contractor will need to install joint at colder temperatures.

For this joint $P_{88°}$ value is slightly small when using a Δ_{MIN} = 1 inch. Since Δ_{TOTAL} is only 1.73 inches, we can allow Δ_{MIN} = 1.5 inches. This results in a Δ_{MAX} = 3.23 inches, which is still less than the allowable 4.5”.

Adjust Δ_{MIN} = 1.5 inches

$P_{88°}$ = 1.25 + 0.5 = 1.75 inches

$P_{68°}$ = 1.59 + 0.5 = 2.09 inches

$P_{48°}$ = 1.92 + 0.5 = 2.42 inches

E.J. 2: 3-span LG girder continuous deck floating unit (390’) and steel girder simple-span (340’), θ = 45° skew

Expansion Length (concrete) = 390’ / 2 = 195’

Expansion Length (steel) = 340’ / 2 = 170’

Δ_{TOTAL} = [Load Factor] * [Coefficient of Thermal Expansion (concrete)] * [Total Temperature Range] * [Expansion Length] + [Load Factor] * [Coefficient of Thermal Expansion (steel)] * [Total Temperature Range] * [Expansion Length] + [Coefficient of Shrinkage and Creep] * [Expansion Length]

= [1.2] * [0.000006] * [85] * [195 * 12] + [1.2] * [0.0000065] * [120] * [170 * 12] + [0.00154] * [195 + 170]

= 3.90 inches > 3.5”, Use Finger Joint

Assume Δ_{MIN} = 2 in. (Finger joint may require larger minimum opening than 1” depending on the design or product, 2” is assumed for illustrative purposes.)

$\Delta_{MAX} = \Delta_{MIN} + \Delta_{TOTAL}$

= 2 + 3.90 = 5.90 inches

$P_{88°}$ = [Δ_{MIN} + [Load Factor] * [Coefficient of Thermal Expansion (concrete)] * [Temperature Differential (from max to 88°)] * [Expansion Length] + [Load Factor] * [Coefficient of Thermal Expansion (steel)] * [Temperature Differential (from max to 88°)] * [Expansion Length]] * [cos θ]

= [2 + [1.2]*[0.000006]*[103°- 88°]*[195*12] + [1.2]*[0.0000065]*[120°- 88°]*[170*12]]*[cos 45°]

= 2.25 inches

$P_{68°}$= [2 + [1.2]*[0.000006]*[103°- 68°]*[195*12] + [1.2]*[0.0000065]*[120°- 68°]*[170*12]]*[cos 45°]

= 2.71 inches

$P_{48°}$= [2 + [1.2]*[0.000006]*[103°- 48°]*[195*12] + [1.2]*[0.0000065]*[120°- 48°]*[170*12]]*[cos 45°]

= 3.17 inches

E.J. 3: LG girder cont. deck unit with a fixed bearing, and steel girder simple-span (340'), θ = 45° skew

Expansion Length (concrete) = 130'

Expansion Length (steel) = 340' / 2 = 170'

Δ_{TOTAL} = [Load Factor] * [Coefficient of Thermal Expansion (concrete)] * [Total Temperature Range] * [Expansion Length] + [Load Factor] * [Coefficient of Thermal Expansion (steel)] * [Total Temperature Range] * [Expansion Length] + [Coefficient of Shrinkage and Creep] * [Expansion Length]

= [1.2] * [0.000006] * [85] * [130 * 12] + [1.2] * [0.0000065] * [120] * [170 * 12] + [0.00154] * [130 + 170]

= 3.33 inches < 3.5 ", Use 4" preformed Neoprene Joint

Assume Δ_{MIN} = 1 in.

$\Delta_{MAX} = \Delta_{MIN} + \Delta_{TOTAL}$

= 1 + 3.33 = 4.33 inches < 4.5"

$P_{88°}$ = [Δ_{MIN} + [Load Factor] * [Coefficient of Thermal Expansion (concrete)] * [Temperature Differential (from max to 88°)] * [Expansion Length] + [Load Factor] * [Coefficient of Thermal Expansion (steel)] * [Temperature Differential (from max to 88°)] * [Expansion Length]] * [cos θ]

= [1 + [1.2]*[0.000006]*[103°- 88°]*[130*12] + [1.2]*[0.0000065]*[120°- 88°]*[170*12]]*[cos 45°]

= 1.19 inches

$P_{68°}$= [1 + [1.2]*[0.000006]*[103°- 68°]*[130*12] + [1.2]*[0.0000065]*[120°- 68°]*[170*12]]*[cos 45°]

= 1.57 inches

$P_{48°}$= [1 + [1.2]*[0.000006]*[103°- 48°]*[130*12] + [1.2]*[0.0000065]*[120°- 48°]*[170*12]]*[cos 45°]

= 2.76 inches

Note: The minimum recommended installation widths for preformed neoprene and preformed silicone seals with 4" movement capacity is 1.5 to 2.5 inches, depending on manufacturer. For this joint, there is no room to adjust Δ_{MIN} to meet the minimum installation at $P_{88°}$. The contractor shall install the joint at colder temperatures.

E.J. 4: 3-span LG girder continuous unit with a fixed bearing

Expansion Length = 130' * 2 = 260'

Δ_{TOTAL} = [Load Factor] * [Coefficient of Thermal Expansion (concrete)] * [Total Temperature Range] * [Expansion Length] + [Coefficient of Shrinkage and Creep] * [Expansion Length]

= [1.2] * [0.000006] * [85] * [260 * 12] + [0.00154] * [260]

= 2.31 inches < 3.5", Use 3" Preformed Neoprene Joint

Assume Δ_{MIN} = 1 in.

$\Delta_{MAX} = \Delta_{MIN} + \Delta_{TOTAL}$

= 1 + 2.31 = 3.31 inches

$P_{88°} = \Delta_{MIN}$ + [Load Factor] * [Coefficient of Thermal Expansion (concrete)] * [Temperature Differential] * [Expansion Length]

= 1 + [1.2] * [0.000006] * [103° - 88°] * [260 * 12]

= 1.34 inches

$P_{68°}$ = 1 + [1.2] * [0.000006] * [103° - 68°] * [260 * 12] = 1.79 inches

$P_{48°}$ = 1 + [1.2] * [0.000006] * [103° - 48°] * [260 * 12] = 2.24 inches

Note: The minimum recommended installation widths for preformed neoprene and preformed silicone seals with 3” movement capacity is 1.25 to 1.5 inches, depending on manufacturer. The $P_{88°}$ value for this joint is slightly small when using a Δ_{MIN} = 1 inch. Since Δ_{TOTAL} is only 2.31 inches, we can allow Δ_{MIN} = 1.5 inches. This results in a Δ_{MAX} = 3.81 inches, which is less than the allowable 4.5”.

Adjust Δ_{MIN} = 1.5 inches

$P_{88°}$ = 1.34 + 0.5 = 1.84 inches

$P_{68°}$ = 1.79 + 0.5 = 2.29 inches

$P_{48°}$ = 2.24 + 0.5 = 2.74 inches

Joint Data Table

Bent No.	Skew Angle[2]	Joint Type	Design Data[1]				As-Built Data[3]		
			Δ_{TOTAL}	$P_{88°}$[2]	$P_{68°}$[2]	$P_{48°}$[2]	T	$P_{T°}$	Manufacturer/Product Type
1	0	Preformed Neoprene	1.73	1.75	2.09	2.42			
4	45	Finger Joint	3.90	2.25	2.71	3.17			
5	45	Preformed Neoprene	3.33	1.19	1.57	2.76			
8	0	Preformed Neoprene	2.31	1.84	2.29	2.74			

Definitions:

Δ_{TOTAL} = Total joint movement (movement range), measured in the direction of travel (in.)

$P_{88°}$ = Joint opening at 88°F, measured perpendicular to the centerline of the joint (in.)

$P_{68°}$ = Joint opening at 68°F, measured perpendicular to the centerline of the joint (in.)

$P_{48°}$ = Joint opening at 48°F, measured perpendicular to the centerline of the joint (in.)

T = Installation temperature, ambient temperature at the scheduled installation time (°F)

$P_{T°}$ = Joint opening at T °F, measured perpendicular to the centerline of the joint (in.)

Notes:

1. The selected product shall provide the total joint movement (movement range) as specified. Joint openings at 88°F, 68ºF, and 48°F shall be as specified. If a joint is installed at temperatures other than 88°F, 68ºF, and 48°F, the joint opening shall be interpolated from the given temperatures. The contractor shall verify the minimum installation opening for the selected product.
2. Skew Angle shall be considered in product selection. For expansion joints with combination of skew and non-skew portion (such as skew expansion joints for LG Girders, see LG Common Details, Sht. 3 of 11), $P_{88°}$, $P_{68°}$ and $P_{48°}$ shown are for the skew portion of the joint, the non-skew portion shall be set accordingly.
3. As-Built Data shall be submitted by the Contractor to EOR for review and conditional approval at least 15 days prior to joint installation. If the temperature drastically changes after the conditional approval, the contractor is responsible for revising the data and resubmitting for final approval. The final as-built data shall be documented in as-built plans.