STATE OF NEW HAMPSHIRE

BRIDGE DESIGN MEMORANDUM

FROM: L. Robert Landry, Jr., PE
Administrator

DATE: April 4, 2018
AT (Office): Bureau of Bridge Design

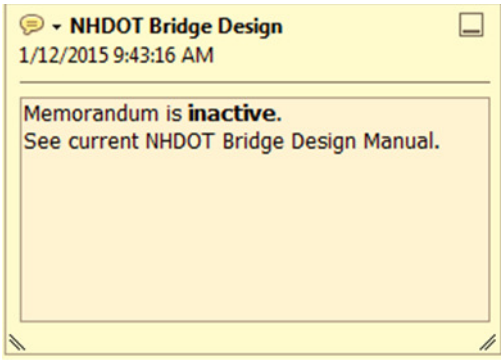
SUBJECT: **Design Memorandum 2018-02**
Preformed Closed Cell Expansion Joints

TO: **Bureau of Bridge Design Staff, Bridge Design Consultants, FHWA, NHDOT Bureaus**

The Bureau of Bridge Design is updating the Bridge Design Manual. During this process, certain design decisions are being issued for immediate implementation. Consequently, the Bridge Design Manual, Bridge Details, and Bridge Detail Sheets have been modified as follows:

A. Bridge Details:

- Substructure Details – Typ. Integral Abutment Section
- Substructure Details – Sleeper Slab Details
- Substructure Details – Sleeper Slab Bearing Strip Detail
- Substructure Details – Typ. Approach & Sleeper Slab Reinf. Section
- Substructure Details – Typ. Integral Abut. Section
- Substructure Details – Typ. Integral Abut. Reinf. Section
- Substructure Details – Typ. Approach & Sleeper Slab Plan
- Substructure Details – Sleeper Slab Elevation
- Compression Seal Expansion Joint – Sleeper Slab



B. Appendix:

- Appendix 7.4-A7, Preformed Closed Cell Expansion Joint
- Appendix 7.4-A8, NHDOT Temperature Expansion Tables

C. Summary: The above noted revisions are being implemented to specify the following:

- NHDOT policy for design and construction of preformed closed cell expansion joint has been modified. This type of expansion joint is typically used with a sleeper slab of an integral bridge. The closed cell expansion joint shall now be sized to always stay in compression throughout the full design temperature range. The designer shall size the closed cell as shown in the design example Appendix 7.4-A7 and note the size of two different manufacturers listed in the special provision. The manufacturer's design tables that allow the seal to have 30% tension shall no longer be used.
- If the total movement of the bridge exceeds the maximum movement of the preformed closed cell, the Bridge Design Chief shall determine if a different type of small movement expansion joint system shall be used as a trial, depending on the project location, or if a preformed compression seal shall be used. If a compression seal is used, steel armoring shall be detailed as part of the joint.
- Appendix 7.4-A8, NHDOT Temperature Expansion Tables have not changed. Only the Appendix number changed (i.e., formally Appendix 7.4-A7).
- The Bridge Details (.dgn and .pdf format) are located on the Bureau of Bridge Design web page: http://www.nh.gov/dot/org/projectdevelopment/bridgedesign/bridgedetails/index.htm

D. Background:

This memorandum incorporates modifications to current NHDOT Bridge Design Manual and Bridge Detail Sheets and provides the modified details on the NHDOT Bridge Design Website.

Previous projects followed the manufacturer's charts for sizing the closed cell expansion joint. The manufacturer's charts allow for the seal to be in 30% tension and 60% compression. Adhesive is applied to the seal to bond it to the concrete header. We are relying on the adhesive to work to achieve 30% tension of the seal.

The closed cell expansion joint has been used for a few projects with sleeper slabs in New Hampshire. The oldest bridge with a closed cell expansion joint with a sleeper slab was built in 2002.

On a cold day in February 2017 we inspected a closed cell expansion joint on a bridge in Enfield, NH (Main Street over Mascoma Lake). The joint was built August 2012. It is a steel girder integral bridge 340-ft. long (3 spans) with approach and sleeper slabs. Each end of the bridge has a closed cell expansion joint at the sleeper slab with 2-in. of movement. The closed cell was pulled away from the concrete headers on most of the length of the expansion joint at both ends. The plans stated to use 2.1875-in. seal width, which has a maximum opening of 2.85-in. and a total movement of 2-in. The closed cell was sized using the manufacturer design charts. The temperature on that day was 13-degrees and the joint opening measured around 2.5-in. where the closed cell material was pulled away. See enclosed pictures.

The problems with the closed cell expansion joint could be because the adhesive wasn't able to work in subzero weather, the joint wasn't constructed correctly, or the closed cell wasn't sized correctly for the full temperature range. Because this expansion joint has been failing in tension, it was decided to design the closed cell size to always stay in compression for the full temperature range. The following maximum movements normal to the joint (expansion and contraction and shrinkage) have been calculated that keep the closed cell in compression: $\leq$ 1.0-in for a steel girder; $\leq$ 3/4-in. for a concrete girder. Before a closed cell expansion joint can be used, the designer shall confirm the closed cell will stay in compression for the full temperature range as noted in the example on Appendix 7.4-A7. The contract plans shall include the new details and notes. See enclosed details.

If the expansion joint movement exceeds the maximum movement for a closed cell, the Bridge Design Chief will decide what alternative expansion joint can be used. Bridge Maintenance has been using a pre-compressed silicone-faced foam expansion joint (e.g. M-seal) on a trial basis. This material is self-expanding open-cellular foam with a silicone material on top and is designed to stay in compression. This type of joint is still under investigation on how well it works in New Hampshire. A compression seal can be used as an alternative; however steel armoring shall be detailed as part of the compression seal joint.

The approach and sleeper slabs shall be constructed to the full width, out to out deck dimension, with concrete curbs and bridge railing. The purpose of the full width approach and sleeper slabs is to direct drainage beyond the approach sleeper slab to prevent erosion under the slabs and any possible settlement. Also, since the approach slab moves with the bridge, problems could occur if the typical granite approach curb were placed along the length of the approach slab. The approach slabs for integral bridges shall also include a top reinforcing mat instead of the synthetic fiber reinforcement that is typically used. Since the bridge railing is continued on top of the approach slab, the reinforcement used for the crash test of the bridge railing needs to be constructed in the approach slab (#5 bars at 6-in. minimum, transverse). Longitudinal bars in the top mat of the approach slab shall be designed for temperature and shrinkage. All reinforcing in the approach and sleeper slabs shall be epoxy coated, unless directed otherwise by the Design Chief.

This Memorandum clarifies NHDOT's policy for the use of a preformed closed cell expansion joint system and integral approach and sleeper slabs, and incorporates the details that shall be included in the contract plans.

STATE OF NEW HAMPSHIRE
BRIDGE DESIGN MEMORANDUM

E. Implementation:

The update to the Bridge Design Manual, Bridge Details shall be implemented as of the date of this memorandum and shall be used on all applicable projects.

L. Robert Landry, Jr., PE
Administrator, Bureau of Bridge Design

Enclosures

NEW HAMPSHIRE DEPARTMENT OF TRANSPORTATION

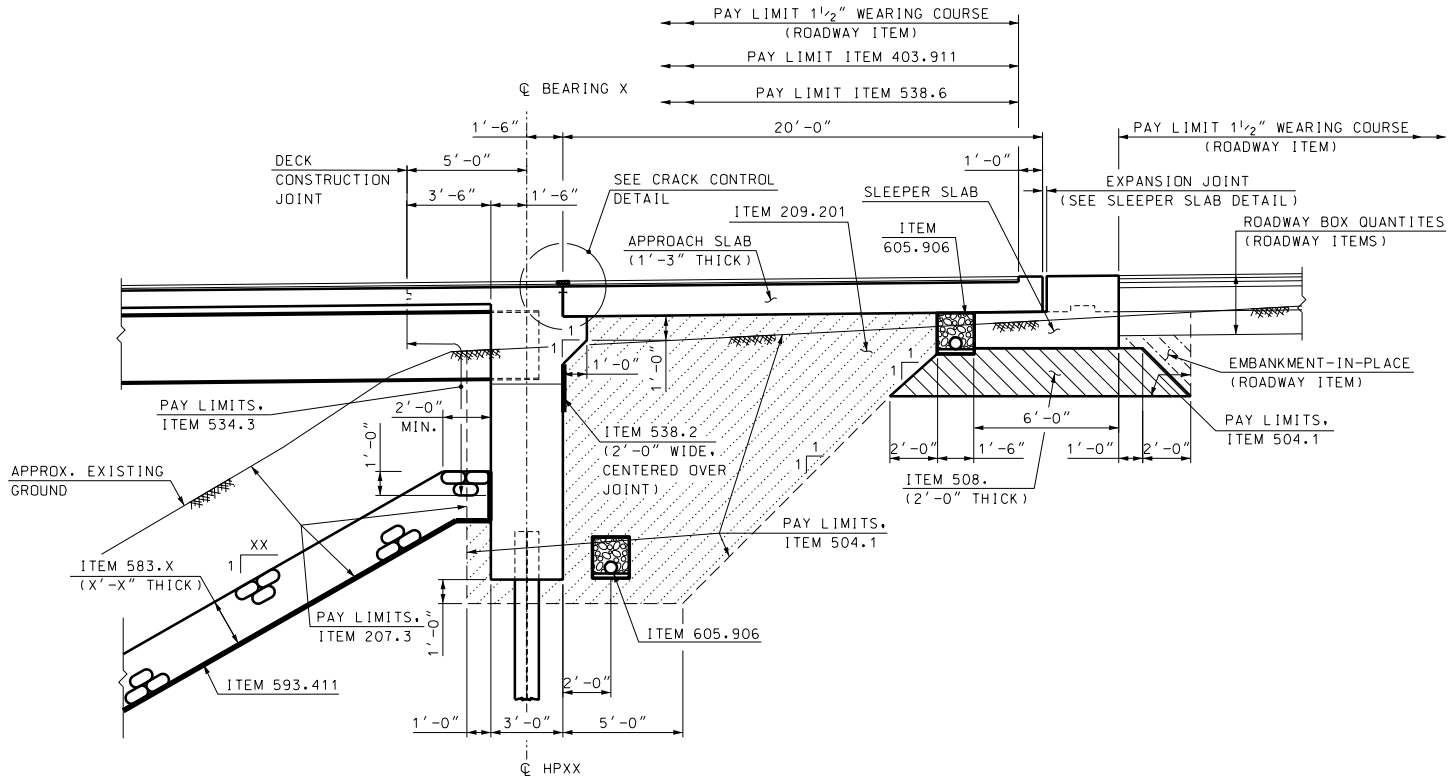
BUREAU OF BRIDGE DESIGN

DESCRIPTION:

SUBSTRUCTURE DETAILS -
TYP. INTEGRAL ABUTMENT SECTION

DATE REVISED:

4/4/2018



TYPICAL INTEGRAL ABUTMENT SECTION

MODIFY TO FIT PROJECT

NEW HAMPSHIRE DEPARTMENT OF TRANSPORTATION

BUREAU OF BRIDGE DESIGN

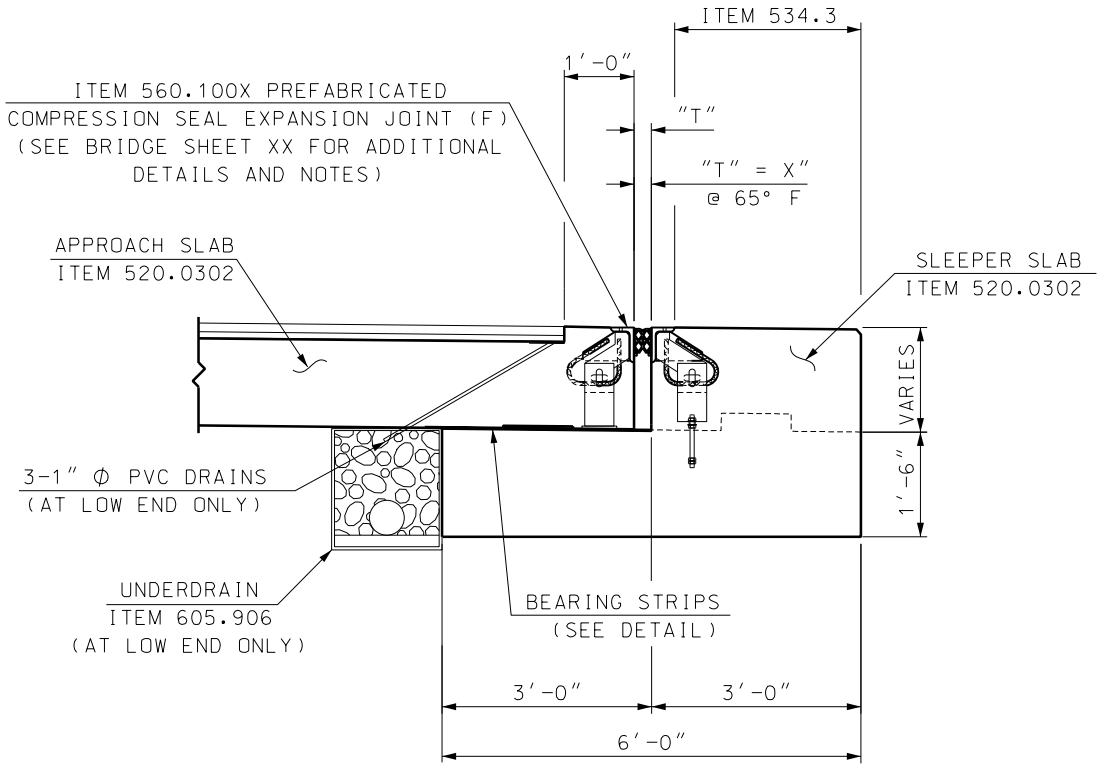
DESCRIPTION:

SUBSTRUCTURE DETAILS -

SLEEPER SLAB DETAIL COMPRESSION SEAL EXP. JT.

DATE REVISED:

4/4/2018



TEMP (°F)	"T" (INCH)
20	XX
35	XX
50	XX
65	XX
80	XX
95	XX

MODIFY TO FIT PROJECT

SLEEPER SLAB DETAIL FOR COMPRESSON SEAL EXPANSION JOINT (ITEM 560.100X)

NEW HAMPSHIRE DEPARTMENT OF TRANSPORTATION

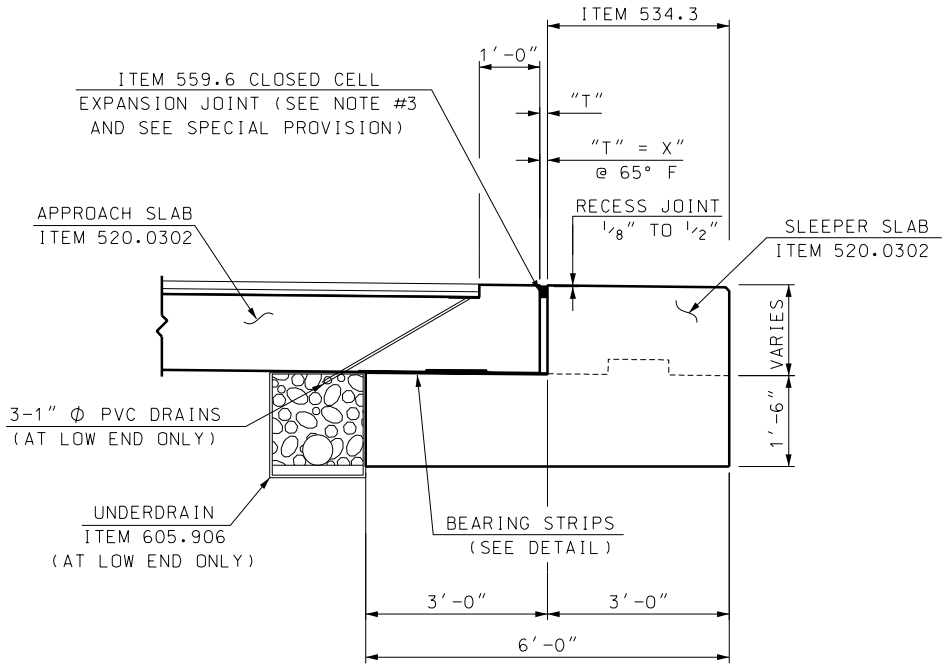
BUREAU OF BRIDGE DESIGN

DESCRIPTION:

SUBSTRUCTURE DETAILS -
SLEEPER SLAB DETAIL CLOSED CELL EXP. JT.

DATE REVISED:

4/4/2018



TEMP (°F)	"T" (INCH)
20	XX
35	XX
50	XX
65	XX
80	XX
95	XX

SLEEPER SLAB DETAIL FOR CLOSED CELL EXPANSION JOINT (ITEM 559.6)

MODIFY TO FIT PROJECT

SLEEPER SLAB CLOSED CELL EXPANSION JOINT NOTES

1. ITEM 559.6, PREFORMED CLOSED CELL EXPANSION JOINT SYSTEM (F), INCLUDES CLOSED CELL EXPANSION MATERIAL AND JOINT ADHESIVE AS NOTED IN THE SPECIAL PROVISION.
2. MINIMUM WIDTH "T" FOR INSTALLATION = XX" (APPROX. 65°F OR LESS).
3. THE CONTRACTOR SHALL USE CLOSED CELL *WABO EVAZOTE UV, EV X.XXXX BY WATSON BOWMAN ACME OR PLY-SEAL XE BEIGE #X.X BY POLYSET CO.* THE CLOSED CELL EXPANSION MATERIAL HAS BEEN DESIGNED TO STAY IN COMPRESSION. THIS DESIGN INCLUDES MOVEMENT DUE TO TEMPERATURE, SKEW, SHRINKAGE, AND MINIMUM INSTALLATION.
4. VALUES IN THE TEMPERATURE ADJUSTMENT TABLE ARE FOR ADJUSTING THE EXPANSION JOINT ASSEMBLY IMMEDIATELY PRIOR TO POURING THE CONCRETE BLOCKOUTS.
5. THE JOINT OPENING "T" MAY BE FORMED WITH OTHER CLOSED CELL EXPANSION MATERIAL NOTED ON THE QPL UNDER ITEM 559E. THE MATERIAL LISTED ON THE QPL IS DIFFERENT THAN ITEM 559.6. IF THE MATERIAL LISTED ON THE QPL IS USED FOR FORMING, THE MATERIAL CAN STAY IN THE JOINT HOWEVER, THE THICKNESS OF THE FORM MATERIAL MUST BE THE DIMENSION "T" OF THE JOINT OPENING FOR THE AMBIENT TEMPERATURE AT THE TIME OF THE CONCRETE POUR.
6. DO NOT USE EXTRUDED POLYSTRENE (XPS) RIGID FOAM NOTED ON THE QPL UNDER ITEM 520 M. FOR FORMING THE JOINT OPENING "T" UNLESS IT CAN BE COMPLETELY REMOVED FROM THE JOINT OPENING. THIS MATERIAL DOES NOT COMPRESS AND EXPAND.

NEW HAMPSHIRE DEPARTMENT OF TRANSPORTATION

BUREAU OF BRIDGE DESIGN

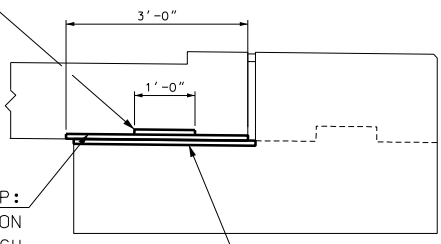
DESCRIPTION:

SUBSTRUCTURE DETAILS -
SLEEPER SLAB BEARING STRIP DETAIL

DATE REVISED:

4/4/2018

APPROACH SLAB STRIP:
AT INTERMEDIATE LOCATIONS, BOND RUBBER BACKED SIDE OF A 1'-0" WIDE STRIP TO TOP OF THE APPROACH SLAB STRIP ALONG THE WIDTH OF THE APPROACH SLAB STRIP.



BEARING STRIPS
(RUBBER BACKED UHMW-PE, 1/4" THICK MIN. 3/8" MAX.)
(SEE QUALIFIED PRODUCTS LIST, SECTION 520 FOR MATERIALS & BONDING AGENT) (ALL COSTS SUBSIDIARY TO ITEM 520.0302)

APPROACH SLAB STRIP:
EMBED 3'-0" WIDE SECTION (RUBBER SIDE UP) INTO APPROACH SLAB FOR THE ENTIRE WIDTH.

SLEEPER SLAB STRIP:
GRIND TOP OF SLEEPER SLAB TO A SMOOTH FLAT SURFACE AND BOND RUBBER BACKED SIDE OF 3'-0" WIDE SECTION TO TOP OF SLEEPER SLAB FOR THE ENTIRE LENGTH.

SLEEPER SLAB
BEARING STRIP DETAIL

NOT TO SCALE

MODIFY TO FIT PROJECT

NEW HAMPSHIRE DEPARTMENT OF TRANSPORTATION

BUREAU OF BRIDGE DESIGN

DESCRIPTION:

SUBSTRUCTURE DETAILS -
TYP. APPR. & SLEEPER SLAB REINF. SECTION

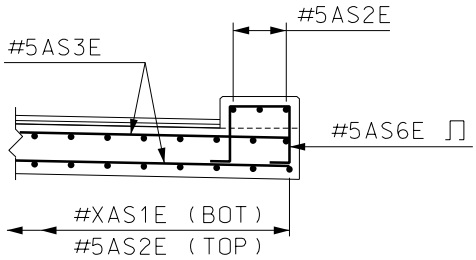
DATE REVISED:

4/4/2018

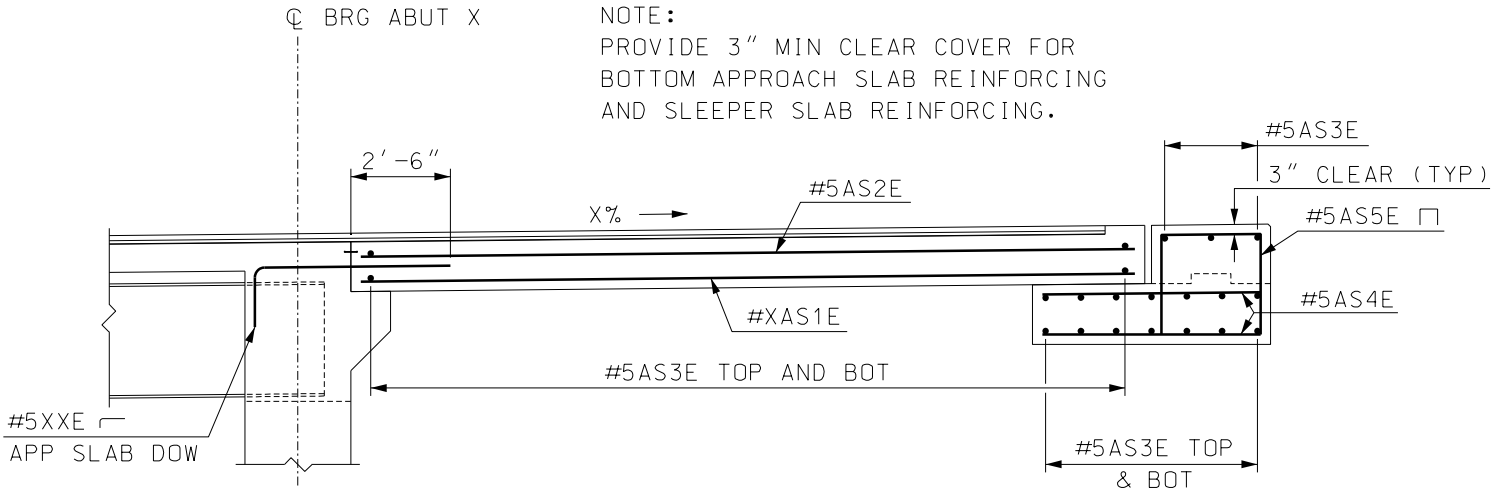
APPROACH AND SLEEPER SLABS NOTES

1. APPROACH SLABS SHALL BE POURED FULL WIDTH AFTER THE CONCRETE DECK HAS BEEN CONSTRUCTED.
2. CONCRETE FOR APPROACH SLABS AND SLEEPER SLABS SHALL BE PAID FOR UNDER ITEM 520.0302, CONCRETE CLASS AA, APPROACH SLABS (QC/QA) (F).
3. 3-1" Ø PVC DRAINS SHALL BE INSTALLED (AT THE LOW END ONLY, BOTH CURB LINES) IN A 1/2" DEPRESSION. SET PIPES TO DRAIN INTO THE UNDERDRAIN BELOW THE APPROACH SLAB.
4. UNDERDRAINS SHALL MEET THE REQUIREMENTS OF SECTION 605. UNDERDRAINS SHALL BE PERFORATED, PLACED ON A PREPARED SURFACE WITH THE PERFORATIONS FACING DOWN, AND ON A MINIMUM SLOPE OF 2%. UNDERDRAIN SHALL BE CONTINOUS ALONG THE FULL WIDTH OF THE SLEEPER SLAB. PIPE INVERTS SHALL EXTEND A MINIMUM OF 3" BEYOND THE TOP SURFACE OF THE STONE SLOPE. WITNESS MARKERS SHALL BE PLACED AT THE OUTLET OF EACH DRAIN PIPE.
5. ITEM 534.3, WATER REPELLENT (SILANE-SILOXANE), SHALL BE APPLIED TO THE EXPOSED CONCRETE ON THE TOP OF THE SLEEPER SLAB AND THE APPROACH SLAB ARMOR.

MODIFY TO FIT PROJECT



SECTION C-C



TYP APPROACH AND SLEEPER SLAB REINFORCEMENT

NEW HAMPSHIRE DEPARTMENT OF TRANSPORTATION

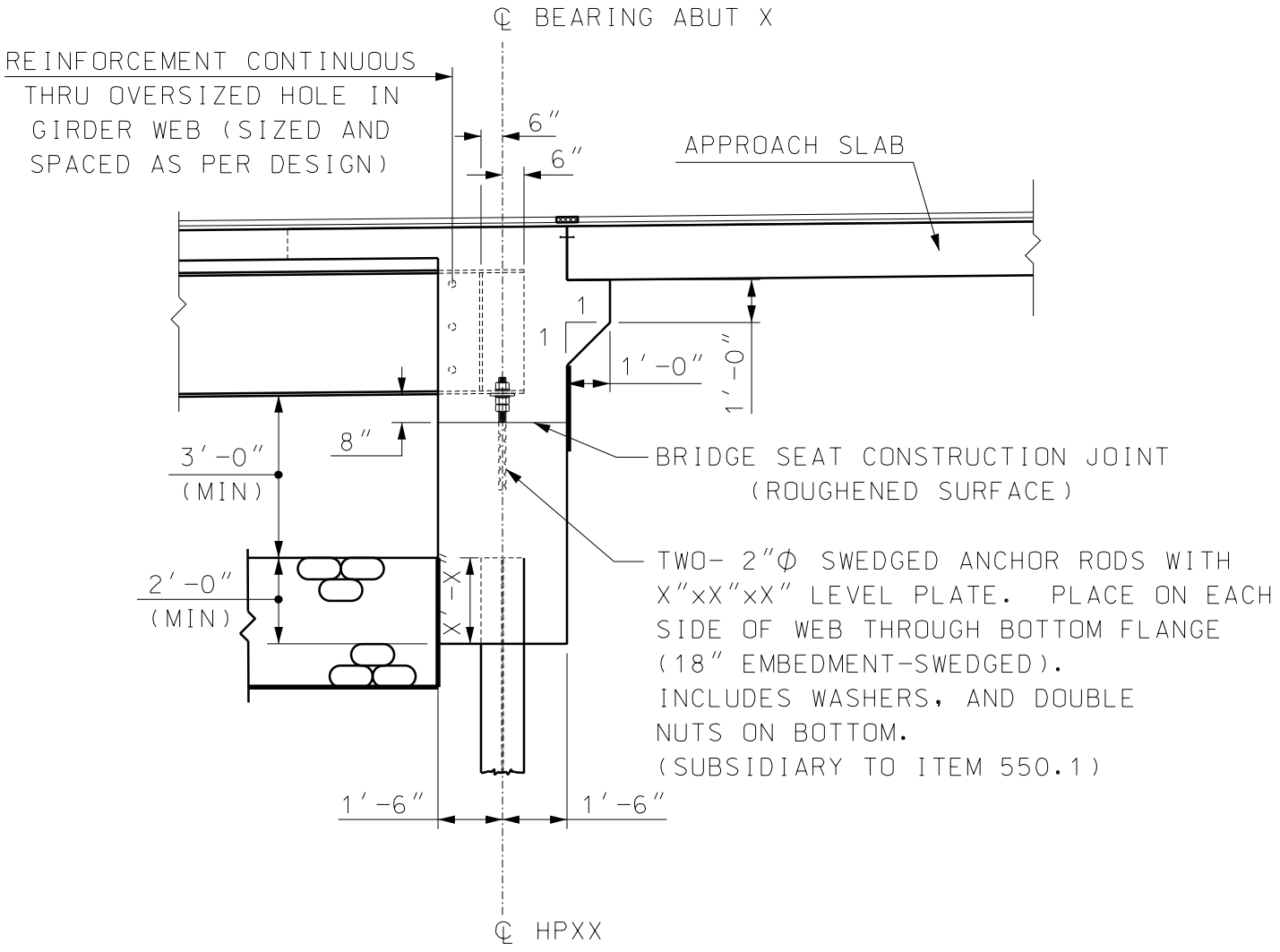
BUREAU OF BRIDGE DESIGN

DESCRIPTION:

SUBSTRUCTURE DETAILS -
TYP. INTEGRAL ABUT. SECTION

DATE REVISED:

4/4/2018



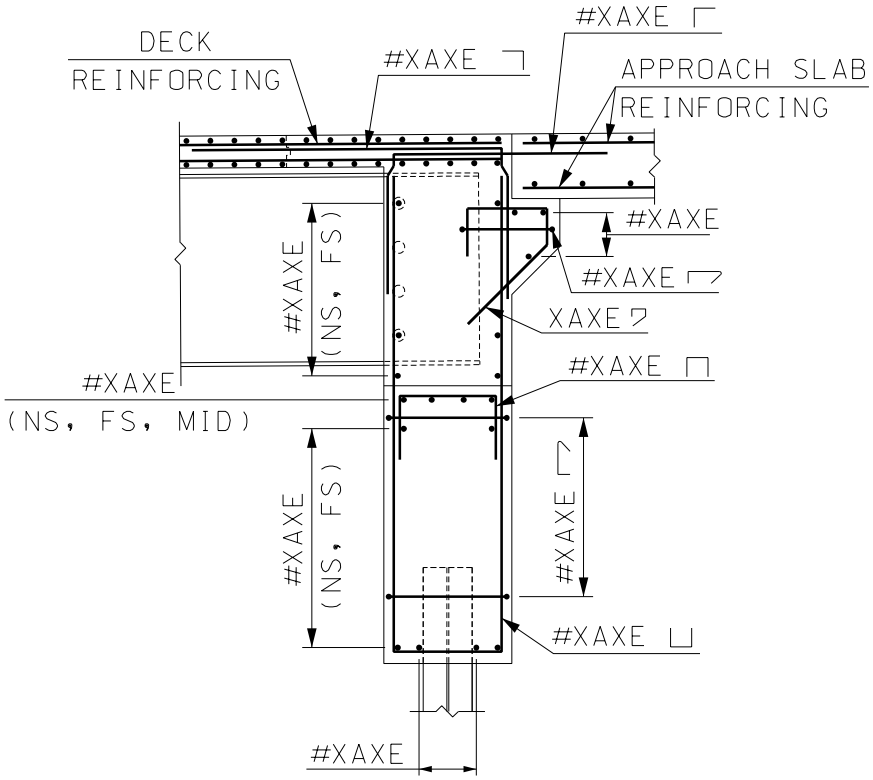
TYPICAL INTEGRAL ABUTMENT SECTION

MODIFY TO FIT PROJECT

NEW HAMPSHIRE DEPARTMENT OF TRANSPORTATION

BUREAU OF BRIDGE DESIGN

DESCRIPTION:	DATE REVISED:
SUBSTRUCTURE DETAILS - TYP. INTEGRAL ABUT. REINF. SECTION	4/4/2018



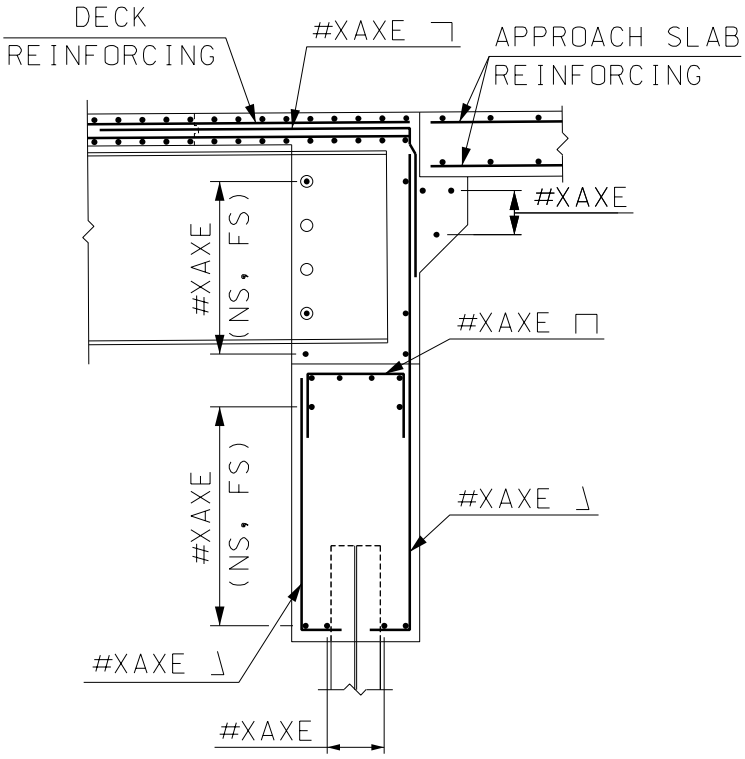
SECTION BETWEEN GIRDERS

MODIFY TO FIT PROJECT

NEW HAMPSHIRE DEPARTMENT OF TRANSPORTATION

BUREAU OF BRIDGE DESIGN

DESCRIPTION:	DATE REVISED:
SUBSTRUCTURE DETAILS - TYP. INTEGRAL ABUT. REINF. SECTION	4/4/2018



SECTION AT GIRDERS

MODIFY TO FIT PROJECT

NEW HAMPSHIRE DEPARTMENT OF TRANSPORTATION

BUREAU OF BRIDGE DESIGN

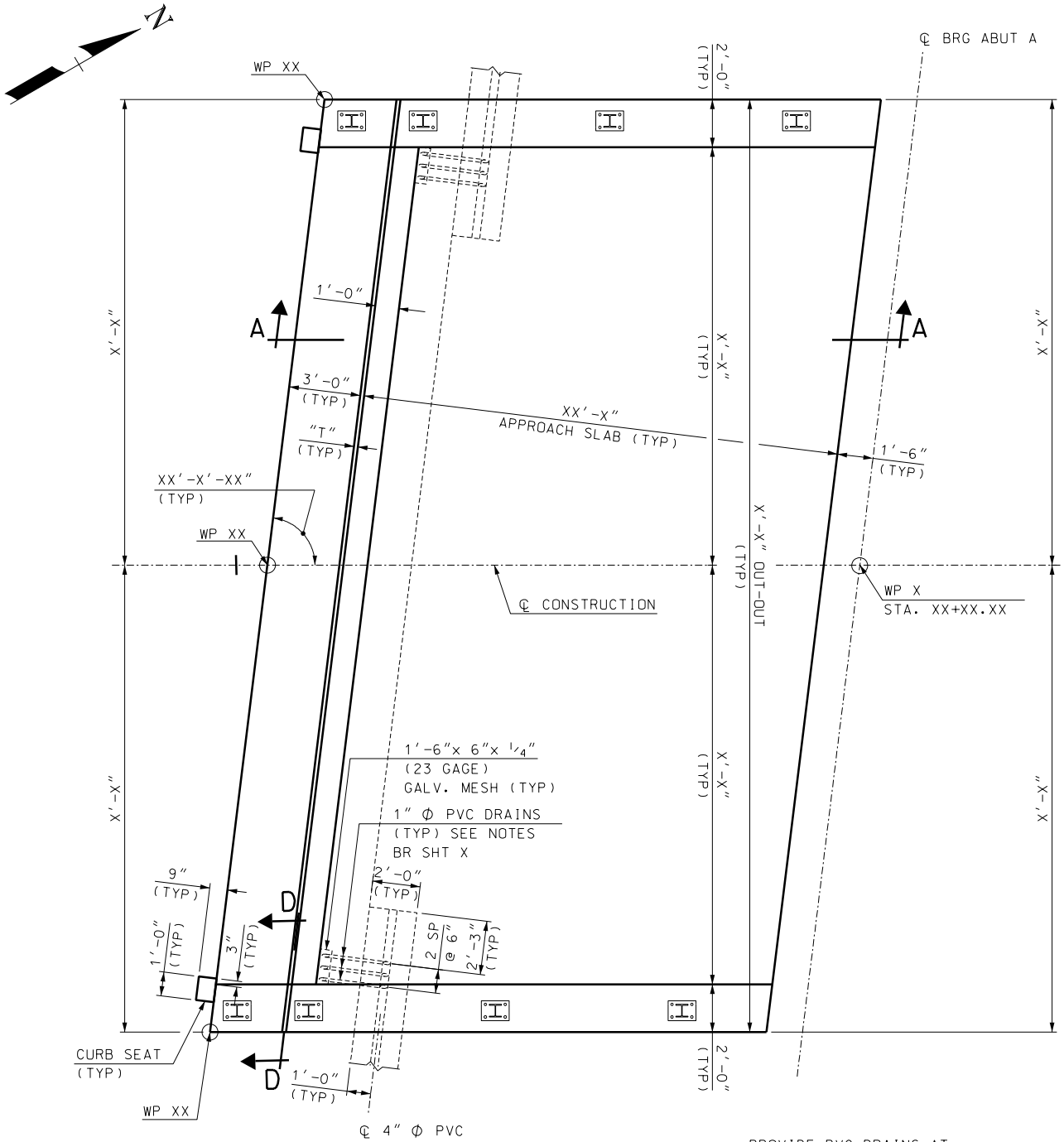
DESCRIPTION:

SUBSTRUCTURE DETAILS -

TYP. APPROACH AND SLEEPER SLAB PLAN

DATE REVISED:

4/4/2018



PROVIDE PVC DRAINS AT ABUTMENT X ONLY

MODIFY TO FIT PROJECT

APPROACH AND SLEEPER SLAB MASONRY

NEW HAMPSHIRE DEPARTMENT OF TRANSPORTATION

BUREAU OF BRIDGE DESIGN

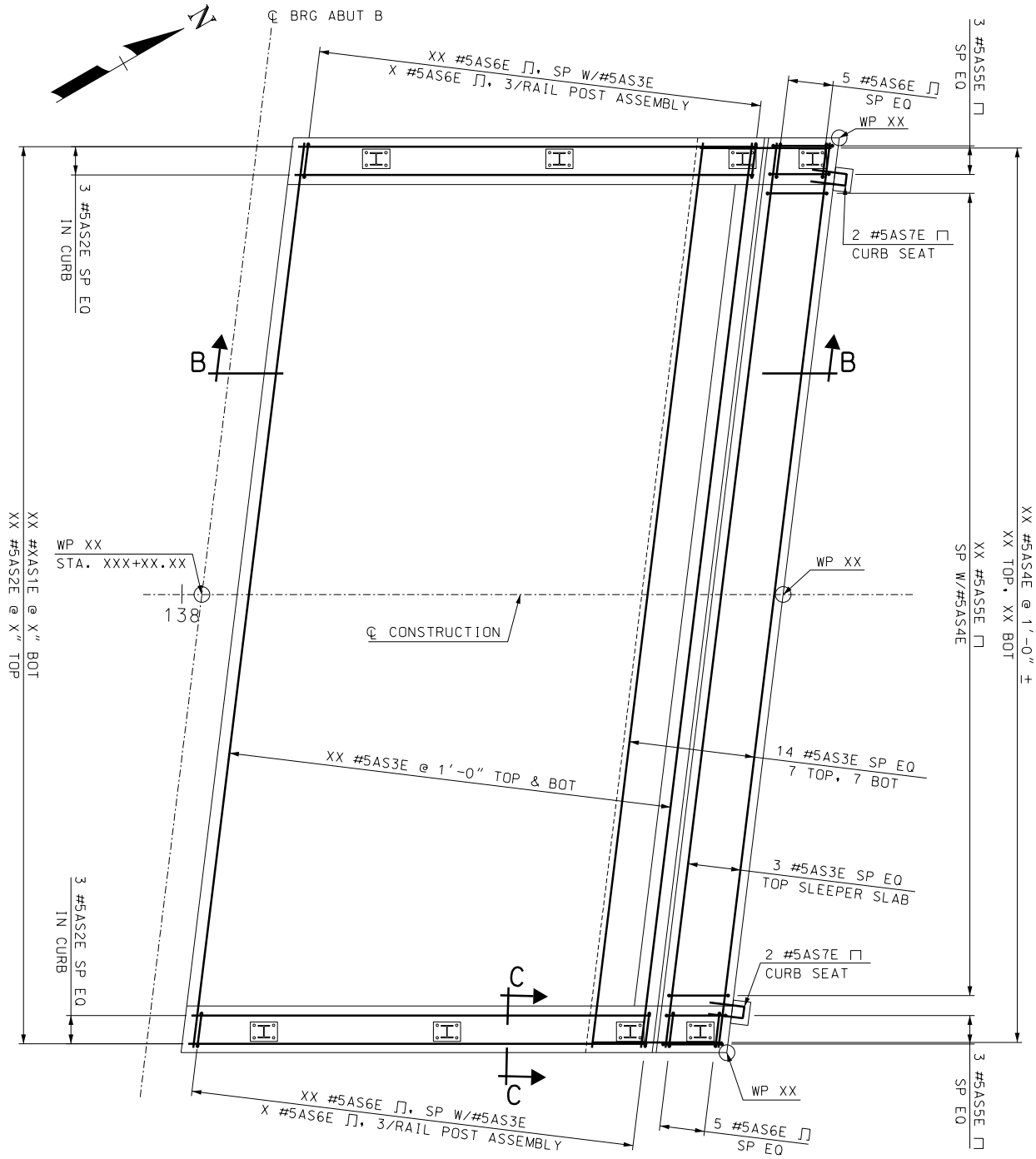
DESCRIPTION:

SUBSTRUCTURE DETAILS -

TYP. APPROACH AND SLEEPER SLAB PLAN

DATE REVISED:

4/4/2018



AS = REBAR DESIGNATION FOR ABUT A & B
APPROACH SLAB AND SLEEPER SLAB

MODIFY TO FIT PROJECT

APPROACH AND SLEEPER SLAB REINFORCEMENT

NEW HAMPSHIRE DEPARTMENT OF TRANSPORTATION

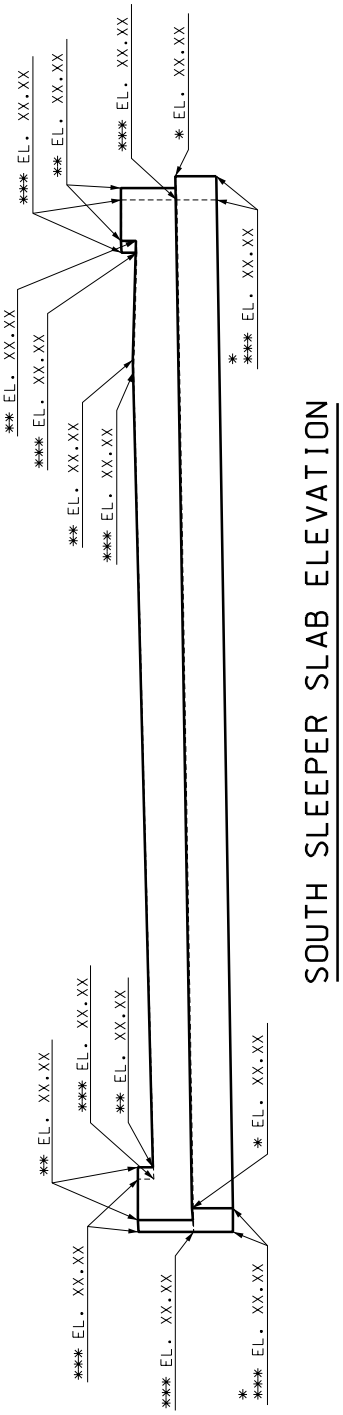
BUREAU OF BRIDGE DESIGN

DESCRIPTION:

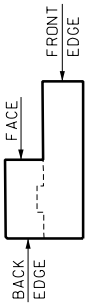
SUBSTRUCTURE DETAILS -
SLEEPER SLAB ELEVATION

DATE REVISED:

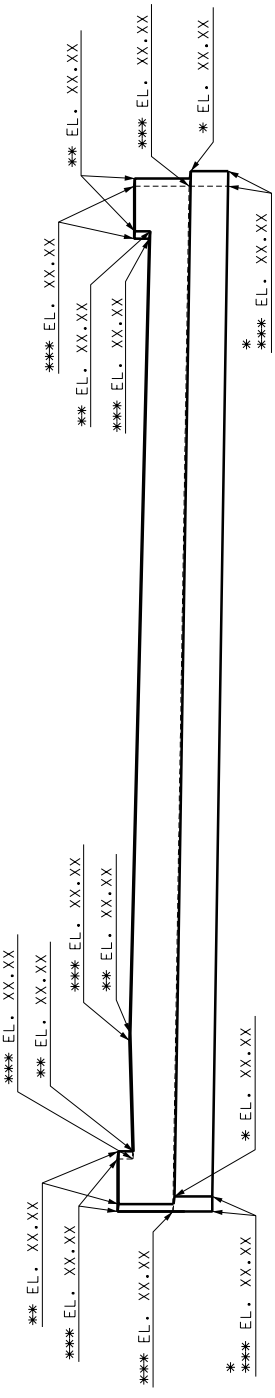
4/4/2018



SOUTH SLEEPER SLAB ELEVATION



* = ELEVATION GIVEN AT SLEEPER SLAB FRONT EDGE
** = ELEVATION GIVEN AT SLEEPER SLAB FACE
*** = ELEVATION GIVEN AT SLEEPER SLAB BACK EDGE



NORTH SLEEPER SLAB ELEVATION

MODIFY TO FIT PROJECT

Preformed Closed Cell Expansion Joint Limitations

A preformed closed cell expansion joint may be used with the following limitations. See p. 7.4-A7-3 for design notations and p. 7.4-A7-4 for design examples):

- 1/4" < total movement of expansion joint measured normal to the joint (expansion, contraction and shrinkage) ≤ 1" (steel girder); ≤ 3/4" (concrete girder).
- Skew of joint ≤ 20°
  ⇒ Typically used with sleeper slab of integral abutments. Skew limit of integral abutments is ≤ 20°.
- The preformed closed cell expansion joint shall always be in compression (i.e., the nominal width shall be greater than the calculated maximum joint opening).
- Maximum roadway surface gap (measured along center line of bridge) ≤ 4.0" *(AASHTO LRFD14.5.3.2)*.
- The closed cell size and manufacturer's names shall be noted on the plans. A minimum of two manufacturers shall be noted.
- A temperature setting chart and notes shall be shown on the plans.
- See Special Provision Item 559.6, Preformed Closed Cell Expansion Joint System (F) for additional information.
- See Chapter 6, Appendix 6.4-B2 for sleeper slab details.

Note: The following tables show values for closed cell expansion joint seals Watson-Bowman Evazote UV and Polyset Ply-Seal XE Beige. The maximum normal movement (temperature and shrinkage) is noted with the corresponding seal size that will remain in compression for the design temperature range.

Closed Cell Sizing Chart (Steel Girder):

$M_{t\ normal}$ (max)	Joint Type	Nominal Width (in.)	Joint Opening (in.)	
			Minimum	Install
1”	UV 3.4375	3.4375	1.38	2.75
	XE #3.5	3.5	1.4	2.75
7/8”	UV 3.1250	3.1250	1.25	2.50
	XE #3.25	3.25	1.3	2.50
3/4”	UV 2.8125	2.8125	1.12	2.25
	XE #3.0	3.0	1.2	2.25
5/8”	UV 2.5000	2.5	1.0	2.0
	XE #2.75	2.75	1.1	2.0
1/2”	UV 1.875	1.875	0.75	1.5
	XE #2.0	2.0	0.8	1.5
3/8”	UV 1.5625	1.5625	0.63	1.25
	XE #1.63	1.625	0.6	1.25

Closed Cell Sizing Chart (Concrete Girder):

$M_{t\ normal}$ (max)	Joint Type	Nominal Width (in.)	Joint Opening (in.)	
			Minimum	Install
3/4”	UV 3.7500	3.7500	1.5	3.0
	XE #4.0	4.0	1.6	3.0
5/8”	UV 3.4375	3.4375	1.38	2.75
	XE #3.5	3.5	1.4	2.75
1/2”	UV 2.8125	2.8125	1.12	2.25
	XE #3.0	3.0	1.2	2.25
3/8”	UV 2.1875	2.1875	0.88	1.75
	XE #2.38	2.375	0.9	1.75

Expansion Joint Design Notations

M_t = Movement due to temperature (inches)
= $\alpha \cdot L_{trib} \cdot \Delta T \cdot$ (12 in./1ft.)

- ΔT = bridge superstructure average temperature range as a function of bridge type and location
  - = 80° F (0° F to $^{+}$80° F) for concrete bridges
  - = 125° F ($^{-}$20° F to $^{+}$105° F) for steel bridges
- L_{trib} = tributary length of the structure subject to expansion or contraction
- α = Coefficient of thermal expansion
  - = 0.0000060 in./in./°F for concrete
  - = 0.0000065 in./in./°F for steel

M_s = Movement due to shrinkage after construction (inches) (concrete beams)
= $\beta \cdot \mu \cdot L_{trib}$

- β = shrinkage coefficient for reinforced concrete, 0.0002
- μ = factor accounting for restraining effect imposed by superstructure elements installed before the concrete slab is cast
  - = 0.5 for precast prestressed concrete girders
  - = 0.8 for concrete box girders and T-beams
  - = 1.0 for concrete flat slabs

M_p = Movement parallel to joint (inches)

M_n = Movement normal to joint (inches)

γ_{TU} = Load factor for force effect due to uniform temperature, 1.2

θ = Skew angle

"T" = Joint opening normal to joint for the installation chart (inches)

A = Joint opening normal to joint

W = Nominal uncompressed width of expansion seal (inches)

W_{min} = Minimum expansion width (inches)

W_{max} = Maximum expansion width (inches)

$W_{install}$ = Expansion width at installation (inches)

T_{min} = Minimum superstructure temperature
= (0° for concrete bridges, $^{-}$20° F for steel bridges)

T_{max} = Maximum superstructure temperature
= ($^{+}$80° F for concrete bridges, $^{+}$105° F for steel bridges)

$T_{install}$ = Minimum installation superstructure temperature
= $^{+}$65° F (all bridges)

Closed Cell Expansion Joint Design Example

Design Procedure

A. Movement Calculations

$M_t = (\alpha)(L_{trib})\ (\Delta T)(\ \gamma_{TU})(12"/')$

$M_s = (\beta)(\mu)(L_{trib})(12"/')$ (= 0 for steel bridges)

$M_{t\ longitudinal} = (M_t + M_s)$

$M_{t\ normal} = M_t \cos\theta$

$M_{s\ normal} = M_s \cos\theta$ (= 0 for steel bridges)

$M_p = (M_t + M_s)\sin\theta$

$M_n = (M_t + M_s)\cos\theta$

$\Delta T_{ratio\ min} = (T_{install}\text{-}T_{min})/(\Delta T)$

$\Delta T_{ratio\ max} = (T_{max}\text{-}T_{install})/(\Delta T)$

B. Select Size from Manufacturer's chart.

C. Check Joint Opening for Install, Max. and Min. Temperatures

1. Install Temp. (65° F):

$A_{install}$ = manufacturer's min. install width

$\Rightarrow$ Set $A_{install}$

2. Min. Temp. :

$A_{max} = A_{install} + [(\Delta T_{ratio\ min} \cdot M_{t\ normal}) + M_{s\ normal}] \leq$ nominal width

3. Max. Temp.:

$A_{min} = A_{install} - (\Delta T_{ratio\ max} \cdot M_{t\ normal}) \geq$ manufacturer's minimum opening

$\Rightarrow$ Confirm two different manufacturer seals (same install dimension) meet all requirements.

$\Rightarrow$ The designer shall use judgment if $T_{install}$ needs to be adjusted in order to get a certain size seal to work. However, the designer needs to be aware what the install temperature will most likely be (i.e. summer construction). If the designer decides the seal needs to be installed at a temperature lower than 65° F, the $T_{install}$ needs to be noted on the plan and approved by the Design Chief.

D. Calculate Temperature Adjustment Table

Calculate $M_{15°\ normal}$ *without* load factor, γ_{TU}

Closed Cell Expansion Joint Design Example (con't)

Design Example

- **Steel girder**
- L_{trib} = 170' ÷ 2 expansion joints = 85'
- Skew angle = 0°
- Expansion joint at both sleeper slabs on each approach.
- Value of Constants:

  $\theta = 0°$
  $\alpha = 0.0000065$ in./in./°F
  $L_{trib} = 85'$
  $\Delta T = 125°$ F (-20° F to $^{+}105°$ F)
  $T_{install} = 65°$ F
  $\gamma_{TU} = 1.2$

A. Movement Calculations

$M_t = (\alpha)(L_{trib})(\Delta T)(\gamma_{TU})$
$= (0.0000065$ in./in./°F$)(85')(125°$ F$)(1.2)(12"/')$
$= 1.0"$

$M_{t\ normal} = M_t \cos\theta$
$= (1.0")\cos 0°$
$= 1.0"$

$M_s = 0$

$M_n = (M_t + M_s)\cos\theta$
$= (1.0" + 0)\cos 0°$
$= 1.0"$

$M_p = (M_t + M_s)\sin\theta$
$= (1.0" + 0")\sin 0°$
$= 0"$

$\Delta T_{ratio\ min} = (T_{install} - T_{min})/(\Delta T)$
$= (65°$ F $- (-20°$F$))/(125°$ F$)$
$= 0.680$

$\Delta T_{ratio\ max} = (T_{max} - T_{install})/(\Delta T)$
$= (105°$ F $- 65°$ F$)/(125°$ F$)$
$= 0.320$

$M_{t\ longitudinal} = (M_t + M_s) = 1.0"$

$M_{total\ normal} = (M_{t\ normal} + M_{s\ normal}) = 1.0" \leq 1"$ (max. movement)

$\theta = 0° \leq 20°$

$\Rightarrow$ **OK**

Closed Cell Expansion Joint Design Example (con't)

B. Select Size from Manufacturer's Chart.

Joint Type	Nominal Width (in.)	Joint Opening (in.)	
		Minimum	Install
UV 3.4375	3.4375	1.38	2.75
XE #3.5	3.5	1.4	2.75

C. Check Joint Opening for Install, Max. and Min. Temperatures

1. Install Temp. (65° F):

$A_{install}$ = manufacturer's min. install width
= 2.75"

$\Rightarrow$ Set $A_{install}$ = 2.75"

2. Min. Temp. :

$A_{max} = A_{install} + [(\Delta T_{ratio\ min} \cdot M_{t\ normal}) + M_{s\ normal}] \leq$ nominal width

A_{max} = 2.75" + [(0.680 · 1.0") + 0]
= 3.43" < 3.4375" in compression **O.K.**
< 3.5"
≤ 4.0" (*AASHTO LRFD 14.5.3.2)*

3. Max. Temp. :

$A_{min} = A_{install} - (\Delta T_{ratio\ max} \cdot M_{t\ normal}) \geq$ manufacturer's min. opening
A_{min} = 2.75" – (0.320· 1.0")
= 2.43" > 1.38" **O.K**.
> 1.4" **O.K.**

$\Rightarrow$ **Use: Watson-Bowman UV 3.4375** ***or***
Ply-Seal XE Beige #3.5

D. Calculate Temperature Adjustment Table

$\Rightarrow$ Note: Calculate $M_{15°\ normal}$ *without* load factor, γ_{TU}

$M_{15°\ normal}$ = $(\alpha)(L_{trib})(15°)(12"/')\cos 0°$
= (0.0000065 in./in./°F)(85')(15°F)(12"/')cos0°
= 0.10"

Closed Cell Expansion Joint Design Example (con't)

"T" at 20° F = $A_{install}$ + (3)($M_{15° normal}$) = 3.05"
35° F = $A_{install}$ + (2)($M_{15° normal}$) = 2.95"
50° F = $A_{install}$ + (1)($M_{15° normal}$) = 2.85"
65° F = $A_{install}$ = 2.75"
80° F = $A_{install}$ - (1)($M_{15° normal}$) = 2.65"
95° F = $A_{install}$ - (2)($M_{15° normal}$) = 2.55"

Temperature Adjustment Table	
Temperature	**"T"**
20° F	3 1/16"
35° F	2 15/16"
50° F	2 7/8"
65° F	2 3/4"
80° F	2 5/8"
95° F	2 9/16"

Notes on Plans (Sample):

1. Item 559.6, Preformed Closed Cell Expansion Joint System (F) includes closed cell expansion material and joint adhesive as noted in the special provision.
2. Minimum width "T" for closed cell installation = 2 3/4" (Approx. 65° F or less).
3. The Contractor shall use closed cell *Wabo Evazote UV 3.4375 by Watson Bowman Acme* or *Ply-Seal XE Beige #3.5 by Polyset Co.* The closed cell expansion material has been designed to stay in compression. This design includes movement due to temperature, skew, shrinkage, and minimum installation.
4. Values in the Temperature Adjustment Table are for adjusting the expansion joint assembly immediately prior to pouring the concrete blockouts.
5. The joint opening "T" may be formed with other closed cell expansion material noted on the QPL under Item 559 E. The material listed on the QPL is different than Item 559.6. If the material listed on the QPL is used for forming, the material can stay in the joint. *However,* the thickness of the form material must be the dimension "T" of the joint opening for the ambient temperature at the time of the concrete pour, and a portion removed to the depth of the expansion joint material after the concrete sets.
6. Do not use extruded polystrene (XPS) rigid foam noted on the QPL under Item 520 M for forming the joint opening "T" *unless* it can be completely removed from the joint opening. This material does not compress and expand.

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EXPANSION TABLE

(*Including* **γTU**, Load factor for force effect due to uniform temperature):

STEEL: $M_t = (\Delta T)*(\alpha)*(L)*(\gamma TU)$

ΔT= 125° (-20°F to +105°F) (NHDOT Bridge Design Manual, Chap. 7, Sec. 7.4)

α = 6.5 x 10^{-6} IN/IN/°F (AASHTO 6.4.1)

γTU = 1.2 (AASHTO 3.4.1-1)

SPAN LENGTH (FT)	M_t (IN)	SPAN LENGTH (FT)	M_t (IN)	SPAN LENGTH (FT)	M_t (IN)	SPAN LENGTH (FT)	M_t (IN)
1	0.01	26	0.30	51	0.60	76	0.89
2	0.02	27	0.32	52	0.61	77	0.90
3	0.04	28	0.33	53	0.62	78	0.91
4	0.05	29	0.34	54	0.63	79	0.92
5	0.06	30	0.35	55	0.64	80	0.94
6	0.07	31	0.36	56	0.66	81	0.95
7	0.08	32	0.37	57	0.67	82	0.96
8	0.09	33	0.39	58	0.68	83	0.97
9	0.11	34	0.40	59	0.69	84	0.98
10	0.12	35	0.41	60	0.70	85	0.99
11	0.13	36	0.42	61	0.71	86	1.01
12	0.14	37	0.43	62	0.73	87	1.02
13	0.15	38	0.44	63	0.74	88	1.03
14	0.16	39	0.46	64	0.75	89	1.04
15	0.18	40	0.47	65	0.76	90	1.05
16	0.19	41	0.48	66	0.77	91	1.06
17	0.20	42	0.49	67	0.78	92	1.08
18	0.21	43	0.50	68	0.80	93	1.09
19	0.22	44	0.51	69	0.81	94	1.10
20	0.23	45	0.53	70	0.82	95	1.11
21	0.25	46	0.54	71	0.83	96	1.12
22	0.26	47	0.55	72	0.84	97	1.13
23	0.27	48	0.56	73	0.85	98	1.15
24	0.28	49	0.57	74	0.87	99	1.16
25	0.29	50	0.59	75	0.88	100	1.17

SPAN LENGTH (FT)	M_t (IN)	SPAN LENGTH (FT)	M_t (IN)	SPAN LENGTH (FT)	M_t (IN)	SPAN LENGTH (FT)	M_t (IN)
101	1.18	126	1.47	151	1.77	176	2.06
102	1.19	127	1.49	152	1.78	177	2.07
103	1.21	128	1.50	153	1.79	178	2.08
104	1.22	129	1.51	154	1.80	179	2.09
105	1.23	130	1.52	155	1.81	180	2.11
106	1.24	131	1.53	156	1.83	181	2.12
107	1.25	132	1.54	157	1.84	182	2.13
108	1.26	133	1.56	158	1.85	183	2.14
109	1.28	134	1.57	159	1.86	184	2.15
110	1.29	135	1.58	160	1.87	185	2.16
111	1.30	136	1.59	161	1.88	186	2.18
112	1.31	137	1.60	162	1.90	187	2.19
113	1.32	138	1.61	163	1.91	188	2.20
114	1.33	139	1.63	164	1.92	189	2.21
115	1.35	140	1.64	165	1.93	190	2.22
116	1.36	141	1.65	166	1.94	191	2.23
117	1.37	142	1.66	167	1.95	192	2.25
118	1.38	143	1.67	168	1.97	193	2.26
119	1.39	144	1.68	169	1.98	194	2.27
120	1.40	145	1.70	170	1.99	195	2.28
121	1.42	146	1.71	171	2.00	196	2.29
122	1.43	147	1.72	172	2.01	197	2.30
123	1.44	148	1.73	173	2.02	198	2.32
124	1.45	149	1.74	174	2.04	199	2.33
125	1.46	150	1.76	175	2.05	200	2.34

EXPANSION TABLE

(*Including* **γTU**, Load factor for force effect due to uniform temperature):

STEEL: $M_t = (\Delta T)*(\alpha)*(L)*(\gamma TU)$

$\Delta T = 125°$ **(-20°F to +105°F)** (NHDOT Bridge Design Manual, Chap. 7, Sec. 7.4)

$\alpha = 6.5 \times 10^{-6}$ IN/IN/°F (AASHTO 6.4.1)

γTU = 1.2 (AASHTO 3.4.1-1)

SPAN LENGTH (FT)	M_t (IN)	SPAN LENGTH (FT)	M_t (IN)	SPAN LENGTH (FT)	M_t (IN)	SPAN LENGTH (FT)	M_t (IN)
201	2.35	226	2.64	251	2.94	276	3.23
202	2.36	227	2.66	252	2.95	277	3.24
203	2.38	228	2.67	253	2.96	278	3.25
204	2.39	229	2.68	254	2.97	279	3.26
205	2.40	230	2.69	255	2.98	280	3.28
206	2.41	231	2.70	256	3.00	281	3.29
207	2.42	232	2.71	257	3.01	282	3.30
208	2.43	233	2.73	258	3.02	283	3.31
209	2.45	234	2.74	259	3.03	284	3.32
210	2.46	235	2.75	260	3.04	285	3.33
211	2.47	236	2.76	261	3.05	286	3.35
212	2.48	237	2.77	262	3.07	287	3.36
213	2.49	238	2.78	263	3.08	288	3.37
214	2.50	239	2.80	264	3.09	289	3.38
215	2.52	240	2.81	265	3.10	290	3.39
216	2.53	241	2.82	266	3.11	291	3.40
217	2.54	242	2.83	267	3.12	292	3.42
218	2.55	243	2.84	268	3.14	293	3.43
219	2.56	244	2.85	269	3.15	294	3.44
220	2.57	245	2.87	270	3.16	295	3.45
221	2.59	246	2.88	271	3.17	296	3.46
222	2.60	247	2.89	272	3.18	297	3.47
223	2.61	248	2.90	273	3.19	298	3.49
224	2.62	249	2.91	274	3.21	299	3.50
225	2.63	250	2.93	275	3.22	300	3.51

SPAN LENGTH (FT)	M_t (IN)	SPAN LENGTH (FT)	M_t (IN)	SPAN LENGTH (FT)	M_t (IN)	SPAN LENGTH (FT)	M_t (IN)
301	3.52	326	3.81	351	4.11	376	4.40
302	3.53	327	3.83	352	4.12	377	4.41
303	3.55	328	3.84	353	4.13	378	4.42
304	3.56	329	3.85	354	4.14	379	4.43
305	3.57	330	3.86	355	4.15	380	4.45
306	3.58	331	3.87	356	4.17	381	4.46
307	3.59	332	3.88	357	4.18	382	4.47
308	3.60	333	3.90	358	4.19	383	4.48
309	3.62	334	3.91	359	4.20	384	4.49
310	3.63	335	3.92	360	4.21	385	4.50
311	3.64	336	3.93	361	4.22	386	4.52
312	3.65	337	3.94	362	4.24	387	4.53
313	3.66	338	3.95	363	4.25	388	4.54
314	3.67	339	3.97	364	4.26	389	4.55
315	3.69	340	3.98	365	4.27	390	4.56
316	3.70	341	3.99	366	4.28	391	4.57
317	3.71	342	4.00	367	4.29	392	4.59
318	3.72	343	4.01	368	4.31	393	4.60
319	3.73	344	4.02	369	4.32	394	4.61
320	3.74	345	4.04	370	4.33	395	4.62
321	3.76	346	4.05	371	4.34	396	4.63
322	3.77	347	4.06	372	4.35	397	4.64
323	3.78	348	4.07	373	4.36	398	4.66
324	3.79	349	4.08	374	4.38	399	4.67
325	3.80	350	4.10	375	4.39	400	4.68

EXPANSION TABLE:

(*Without* **γTU**, Load factor):

STEEL: $M_t = (\Delta T)^*(\alpha)^*(L)$

ΔT= **125° (-20°F to +105°F)** (NHDOT Bridge Design Manual, Chap. 7, Sec. 7.4)

$\alpha = 6.5 \times 10^{-6}$ **IN/IN/°F** (AASHTO 6.4.1)

SPAN LENGTH (FT)	M_t (IN)	SPAN LENGTH (FT)	M_t (IN)	SPAN LENGTH (FT)	M_t (IN)	SPAN LENGTH (FT)	M_t (IN)
1	0.01	26	0.25	51	0.50	76	0.74
2	0.02	27	0.26	52	0.51	77	0.75
3	0.03	28	0.27	53	0.52	78	0.76
4	0.04	29	0.28	54	0.53	79	0.77
5	0.05	30	0.29	55	0.54	80	0.78
6	0.06	31	0.30	56	0.55	81	0.79
7	0.07	32	0.31	57	0.56	82	0.80
8	0.08	33	0.32	58	0.57	83	0.81
9	0.09	34	0.33	59	0.58	84	0.82
10	0.10	35	0.34	60	0.59	85	0.83
11	0.11	36	0.35	61	0.59	86	0.84
12	0.12	37	0.36	62	0.60	87	0.85
13	0.13	38	0.37	63	0.61	88	0.86
14	0.14	39	0.38	64	0.62	89	0.87
15	0.15	40	0.39	65	0.63	90	0.88
16	0.16	41	0.40	66	0.64	91	0.89
17	0.17	42	0.41	67	0.65	92	0.90
18	0.18	43	0.42	68	0.66	93	0.91
19	0.19	44	0.43	69	0.67	94	0.92
20	0.20	45	0.44	70	0.68	95	0.93
21	0.20	46	0.45	71	0.69	96	0.94
22	0.21	47	0.46	72	0.70	97	0.95
23	0.22	48	0.47	73	0.71	98	0.96
24	0.23	49	0.48	74	0.72	99	0.97
25	0.24	50	0.49	75	0.73	100	0.98

SPAN LENGTH (FT)	M_t (IN)	SPAN LENGTH (FT)	M_t (IN)	SPAN LENGTH (FT)	M_t (IN)	SPAN LENGTH (FT)	M_t (IN)
101	0.98	126	1.23	151	1.47	176	1.72
102	0.99	127	1.24	152	1.48	177	1.73
103	1.00	128	1.25	153	1.49	178	1.74
104	1.01	129	1.26	154	1.50	179	1.75
105	1.02	130	1.27	155	1.51	180	1.76
106	1.03	131	1.28	156	1.52	181	1.76
107	1.04	132	1.29	157	1.53	182	1.77
108	1.05	133	1.30	158	1.54	183	1.78
109	1.06	134	1.31	159	1.55	184	1.79
110	1.07	135	1.32	160	1.56	185	1.80
111	1.08	136	1.33	161	1.57	186	1.81
112	1.09	137	1.34	162	1.58	187	1.82
113	1.10	138	1.35	163	1.59	188	1.83
114	1.11	139	1.36	164	1.60	189	1.84
115	1.12	140	1.37	165	1.61	190	1.85
116	1.13	141	1.37	166	1.62	191	1.86
117	1.14	142	1.38	167	1.63	192	1.87
118	1.15	143	1.39	168	1.64	193	1.88
119	1.16	144	1.40	169	1.65	194	1.89
120	1.17	145	1.41	170	1.66	195	1.90
121	1.18	146	1.42	171	1.67	196	1.91
122	1.19	147	1.43	172	1.68	197	1.92
123	1.20	148	1.44	173	1.69	198	1.93
124	1.21	149	1.45	174	1.70	199	1.94
125	1.22	150	1.46	175	1.71	200	1.95

EXPANSION TABLE:

(*Without* **γTU**, Load factor):

STEEL: $M_t = (\Delta T)^*(\alpha)^*(L)$

$\Delta T = 125°$ **(-20°F to +105°F)** (NHDOT Bridge Design Manual, Chap. 7, Sec. 7.4)

$\alpha = 6.5 \times 10^{-6}$ **IN/IN/°F** (AASHTO 6.4.1)

SPAN LENGTH (FT)	M_t (IN)	SPAN LENGTH (FT)	M_t (IN)	SPAN LENGTH (FT)	M_t (IN)	SPAN LENGTH (FT)	M_t (IN)
201	1.96	226	2.20	251	2.45	276	2.69
202	1.97	227	2.21	252	2.46	277	2.70
203	1.98	228	2.22	253	2.47	278	2.71
204	1.99	229	2.23	254	2.48	279	2.72
205	2.00	230	2.24	255	2.49	280	2.73
206	2.01	231	2.25	256	2.50	281	2.74
207	2.02	232	2.26	257	2.51	282	2.75
208	2.03	233	2.27	258	2.52	283	2.76
209	2.04	234	2.28	259	2.53	284	2.77
210	2.05	235	2.29	260	2.54	285	2.78
211	2.06	236	2.30	261	2.54	286	2.79
212	2.07	237	2.31	262	2.55	287	2.80
213	2.08	238	2.32	263	2.56	288	2.81
214	2.09	239	2.33	264	2.57	289	2.82
215	2.10	240	2.34	265	2.58	290	2.83
216	2.11	241	2.35	266	2.59	291	2.84
217	2.12	242	2.36	267	2.60	292	2.85
218	2.13	243	2.37	268	2.61	293	2.86
219	2.14	244	2.38	269	2.62	294	2.87
220	2.15	245	2.39	270	2.63	295	2.88
221	2.15	246	2.40	271	2.64	296	2.89
222	2.16	247	2.41	272	2.65	297	2.90
223	2.17	248	2.42	273	2.66	298	2.91
224	2.18	249	2.43	274	2.67	299	2.92
225	2.19	250	2.44	275	2.68	300	2.93

SPAN LENGTH (FT)	M_t (IN)	SPAN LENGTH (FT)	M_t (IN)	SPAN LENGTH (FT)	M_t (IN)	SPAN LENGTH (FT)	M_t (IN)
301	2.93	326	3.18	351	3.42	376	3.67
302	2.94	327	3.19	352	3.43	377	3.68
303	2.95	328	3.20	353	3.44	378	3.69
304	2.96	329	3.21	354	3.45	379	3.70
305	2.97	330	3.22	355	3.46	380	3.71
306	2.98	331	3.23	356	3.47	381	3.71
307	2.99	332	3.24	357	3.48	382	3.72
308	3.00	333	3.25	358	3.49	383	3.73
309	3.01	334	3.26	359	3.50	384	3.74
310	3.02	335	3.27	360	3.51	385	3.75
311	3.03	336	3.28	361	3.52	386	3.76
312	3.04	337	3.29	362	3.53	387	3.77
313	3.05	338	3.30	363	3.54	388	3.78
314	3.06	339	3.31	364	3.55	389	3.79
315	3.07	340	3.32	365	3.56	390	3.80
316	3.08	341	3.32	366	3.57	391	3.81
317	3.09	342	3.33	367	3.58	392	3.82
318	3.10	343	3.34	368	3.59	393	3.83
319	3.11	344	3.35	369	3.60	394	3.84
320	3.12	345	3.36	370	3.61	395	3.85
321	3.13	346	3.37	371	3.62	396	3.86
322	3.14	347	3.38	372	3.63	397	3.87
323	3.15	348	3.39	373	3.64	398	3.88
324	3.16	349	3.40	374	3.65	399	3.89
325	3.17	350	3.41	375	3.66	400	3.90

EXPANSION TABLE

(*Including* **γTU**, Load factor for force effect due to uniform temperature):

CONCRETE: $M_t = (\Delta T)*(\alpha)*(L)*(\gamma TU)$

ΔT= 80° (0°F to +80°F) (NHDOT Bridge Design Manual, Chap. 7, Sec. 7.4)

$\alpha = 6.0 \times 10^{-6}$ IN/IN/°F (AASHTO 5.4.2.2)

γTU = 1.2 (AASHTO 3.4.1-1)

SPAN LENGTH (FT)	M_t (IN)	SPAN LENGTH (FT)	M_t (IN)	SPAN LENGTH (FT)	M_t (IN)	SPAN LENGTH (FT)	M_t (IN)
1	0.01	26	0.18	51	0.35	76	0.53
2	0.01	27	0.19	52	0.36	77	0.53
3	0.02	28	0.19	53	0.37	78	0.54
4	0.03	29	0.20	54	0.37	79	0.55
5	0.03	30	0.21	55	0.38	80	0.55
6	0.04	31	0.21	56	0.39	81	0.56
7	0.05	32	0.22	57	0.39	82	0.57
8	0.06	33	0.23	58	0.40	83	0.57
9	0.06	34	0.24	59	0.41	84	0.58
10	0.07	35	0.24	60	0.41	85	0.59
11	0.08	36	0.25	61	0.42	86	0.59
12	0.08	37	0.26	62	0.43	87	0.60
13	0.09	38	0.26	63	0.44	88	0.61
14	0.10	39	0.27	64	0.44	89	0.62
15	0.10	40	0.28	65	0.45	90	0.62
16	0.11	41	0.28	66	0.46	91	0.63
17	0.12	42	0.29	67	0.46	92	0.64
18	0.12	43	0.30	68	0.47	93	0.64
19	0.13	44	0.30	69	0.48	94	0.65
20	0.14	45	0.31	70	0.48	95	0.66
21	0.15	46	0.32	71	0.49	96	0.66
22	0.15	47	0.32	72	0.50	97	0.67
23	0.16	48	0.33	73	0.50	98	0.68
24	0.17	49	0.34	74	0.51	99	0.68
25	0.17	50	0.35	75	0.52	100	0.69

SPAN LENGTH (FT)	M_t (IN)	SPAN LENGTH (FT)	M_t (IN)	SPAN LENGTH (FT)	M_t (IN)	SPAN LENGTH (FT)	M_t (IN)
101	0.70	126	0.87	151	1.04	176	1.22
102	0.71	127	0.88	152	1.05	177	1.22
103	0.71	128	0.88	153	1.06	178	1.23
104	0.72	129	0.89	154	1.06	179	1.24
105	0.73	130	0.90	155	1.07	180	1.24
106	0.73	131	0.91	156	1.08	181	1.25
107	0.74	132	0.91	157	1.09	182	1.26
108	0.75	133	0.92	158	1.09	183	1.26
109	0.75	134	0.93	159	1.10	184	1.27
110	0.76	135	0.93	160	1.11	185	1.28
111	0.77	136	0.94	161	1.11	186	1.29
112	0.77	137	0.95	162	1.12	187	1.29
113	0.78	138	0.95	163	1.13	188	1.30
114	0.79	139	0.96	164	1.13	189	1.31
115	0.79	140	0.97	165	1.14	190	1.31
116	0.80	141	0.97	166	1.15	191	1.32
117	0.81	142	0.98	167	1.15	192	1.33
118	0.82	143	0.99	168	1.16	193	1.33
119	0.82	144	1.00	169	1.17	194	1.34
120	0.83	145	1.00	170	1.18	195	1.35
121	0.84	146	1.01	171	1.18	196	1.35
122	0.84	147	1.02	172	1.19	197	1.36
123	0.85	148	1.02	173	1.20	198	1.37
124	0.86	149	1.03	174	1.20	199	1.38
125	0.86	150	1.04	175	1.21	200	1.38

EXPANSION TABLE

(*Including* **γTU**, Load factor for force effect due to uniform temperature):

CONCRETE: $M_t = (\Delta T)*(\alpha)*(L)*(\gamma TU)$

$\Delta T = 80°$ **(0°F to +80°F)** (NHDOT Bridge Design Manual, Chap. 7, Sec. 7.4)

$\alpha = 6.0 \times 10^{-6}$ **IN/IN/°F** (AASHTO 5.4.2.2)

γTU = 1.2 (AASHTO 3.4.1-1)

SPAN LENGTH (FT)	M_t (IN)	SPAN LENGTH (FT)	M_t (IN)	SPAN LENGTH (FT)	M_t (IN)	SPAN LENGTH (FT)	M_t (IN)
201	1.39	226	1.56	251	1.73	276	1.91
202	1.40	227	1.57	252	1.74	277	1.91
203	1.40	228	1.58	253	1.75	278	1.92
204	1.41	229	1.58	254	1.76	279	1.93
205	1.42	230	1.59	255	1.76	280	1.94
206	1.42	231	1.60	256	1.77	281	1.94
207	1.43	232	1.60	257	1.78	282	1.95
208	1.44	233	1.61	258	1.78	283	1.96
209	1.44	234	1.62	259	1.79	284	1.96
210	1.45	235	1.62	260	1.80	285	1.97
211	1.46	236	1.63	261	1.80	286	1.98
212	1.47	237	1.64	262	1.81	287	1.98
213	1.47	238	1.65	263	1.82	288	1.99
214	1.48	239	1.65	264	1.82	289	2.00
215	1.49	240	1.66	265	1.83	290	2.00
216	1.49	241	1.67	266	1.84	291	2.01
217	1.50	242	1.67	267	1.85	292	2.02
218	1.51	243	1.68	268	1.85	293	2.03
219	1.51	244	1.69	269	1.86	294	2.03
220	1.52	245	1.69	270	1.87	295	2.04
221	1.53	246	1.70	271	1.87	296	2.05
222	1.53	247	1.71	272	1.88	297	2.05
223	1.54	248	1.71	273	1.89	298	2.06
224	1.55	249	1.72	274	1.89	299	2.07
225	1.56	250	1.73	275	1.90	300	2.07

SPAN LENGTH (FT)	M_t (IN)	SPAN LENGTH (FT)	M_t (IN)	SPAN LENGTH (FT)	M_t (IN)	SPAN LENGTH (FT)	M_t (IN)
301	2.08	326	2.25	351	2.43	376	2.60
302	2.09	327	2.26	352	2.43	377	2.61
303	2.09	328	2.27	353	2.44	378	2.61
304	2.10	329	2.27	354	2.45	379	2.62
305	2.11	330	2.28	355	2.45	380	2.63
306	2.12	331	2.29	356	2.46	381	2.63
307	2.12	332	2.29	357	2.47	382	2.64
308	2.13	333	2.30	358	2.47	383	2.65
309	2.14	334	2.31	359	2.48	384	2.65
310	2.14	335	2.32	360	2.49	385	2.66
311	2.15	336	2.32	361	2.50	386	2.67
312	2.16	337	2.33	362	2.50	387	2.67
313	2.16	338	2.34	363	2.51	388	2.68
314	2.17	339	2.34	364	2.52	389	2.69
315	2.18	340	2.35	365	2.52	390	2.70
316	2.18	341	2.36	366	2.53	391	2.70
317	2.19	342	2.36	367	2.54	392	2.71
318	2.20	343	2.37	368	2.54	393	2.72
319	2.20	344	2.38	369	2.55	394	2.72
320	2.21	345	2.38	370	2.56	395	2.73
321	2.22	346	2.39	371	2.56	396	2.74
322	2.23	347	2.40	372	2.57	397	2.74
323	2.23	348	2.41	373	2.58	398	2.75
324	2.24	349	2.41	374	2.59	399	2.76
325	2.25	350	2.42	375	2.59	400	2.76

EXPANSION TABLE:

(*Without* **γTU**, Load factor):

CONCRETE: $M_t = (\Delta T)^*(\alpha)^*(L)$

$\Delta T = 80°$ **(0°F to +80°F)** (NHDOT Bridge Design Manual, Chap. 7, Sec. 7.4)

$\alpha = 6.0 \times 10^{-6}$ **IN/IN/°F** (AASHTO 5.4.2.2)

SPAN LENGTH (FT)	M_t (IN)	SPAN LENGTH (FT)	M_t (IN)	SPAN LENGTH (FT)	M_t (IN)	SPAN LENGTH (FT)	M_t (IN)
1	0.01	26	0.15	51	0.29	76	0.44
2	0.01	27	0.16	52	0.30	77	0.44
3	0.02	28	0.16	53	0.31	78	0.45
4	0.02	29	0.17	54	0.31	79	0.46
5	0.03	30	0.17	55	0.32	80	0.46
6	0.03	31	0.18	56	0.32	81	0.47
7	0.04	32	0.18	57	0.33	82	0.47
8	0.05	33	0.19	58	0.33	83	0.48
9	0.05	34	0.20	59	0.34	84	0.48
10	0.06	35	0.20	60	0.35	85	0.49
11	0.06	36	0.21	61	0.35	86	0.50
12	0.07	37	0.21	62	0.36	87	0.50
13	0.07	38	0.22	63	0.36	88	0.51
14	0.08	39	0.22	64	0.37	89	0.51
15	0.09	40	0.23	65	0.37	90	0.52
16	0.09	41	0.24	66	0.38	91	0.52
17	0.10	42	0.24	67	0.39	92	0.53
18	0.10	43	0.25	68	0.39	93	0.54
19	0.11	44	0.25	69	0.40	94	0.54
20	0.12	45	0.26	70	0.40	95	0.55
21	0.12	46	0.26	71	0.41	96	0.55
22	0.13	47	0.27	72	0.41	97	0.56
23	0.13	48	0.28	73	0.42	98	0.56
24	0.14	49	0.28	74	0.43	99	0.57
25	0.14	50	0.29	75	0.43	100	0.58

SPAN LENGTH (FT)	M_t (IN)	SPAN LENGTH (FT)	M_t (IN)	SPAN LENGTH (FT)	M_t (IN)	SPAN LENGTH (FT)	M_t (IN)
101	0.58	126	0.73	151	0.87	176	1.01
102	0.59	127	0.73	152	0.88	177	1.02
103	0.59	128	0.74	153	0.88	178	1.03
104	0.60	129	0.74	154	0.89	179	1.03
105	0.60	130	0.75	155	0.89	180	1.04
106	0.61	131	0.75	156	0.90	181	1.04
107	0.62	132	0.76	157	0.90	182	1.05
108	0.62	133	0.77	158	0.91	183	1.05
109	0.63	134	0.77	159	0.92	184	1.06
110	0.63	135	0.78	160	0.92	185	1.07
111	0.64	136	0.78	161	0.93	186	1.07
112	0.65	137	0.79	162	0.93	187	1.08
113	0.65	138	0.79	163	0.94	188	1.08
114	0.66	139	0.80	164	0.94	189	1.09
115	0.66	140	0.81	165	0.95	190	1.09
116	0.67	141	0.81	166	0.96	191	1.10
117	0.67	142	0.82	167	0.96	192	1.11
118	0.68	143	0.82	168	0.97	193	1.11
119	0.69	144	0.83	169	0.97	194	1.12
120	0.69	145	0.84	170	0.98	195	1.12
121	0.70	146	0.84	171	0.98	196	1.13
122	0.70	147	0.85	172	0.99	197	1.13
123	0.71	148	0.85	173	1.00	198	1.14
124	0.71	149	0.86	174	1.00	199	1.15
125	0.72	150	0.86	175	1.01	200	1.15

EXPANSION TABLE:

(*Without* **γTU**, Load factor):

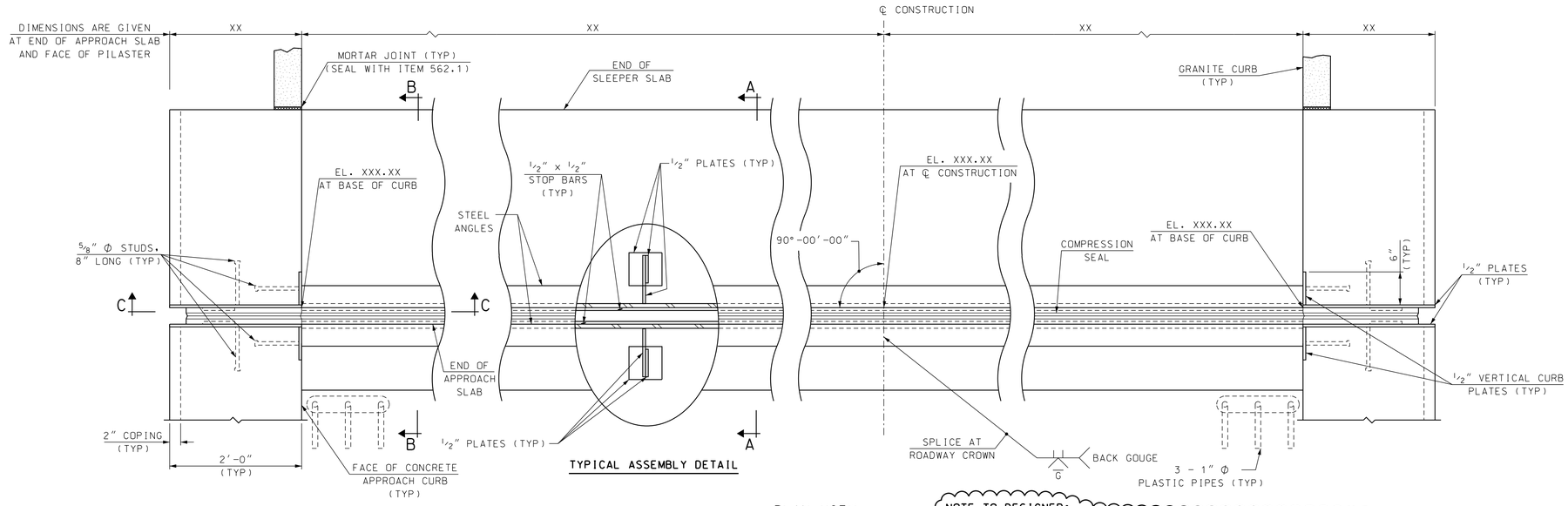
CONCRETE: $M_t = (\Delta T)^*(\alpha)^*(L)$

$\Delta T = 80°$ **(0°F to +80°F)** (NHDOT Bridge Design Manual, Chap. 7, Sec. 7.4)

$\alpha = 6.0 \times 10^{-6}$ **IN/IN/°F** (AASHTO 5.4.2.2)

SPAN LENGTH (FT)	M_t (IN)	SPAN LENGTH (FT)	M_t (IN)	SPAN LENGTH (FT)	M_t (IN)	SPAN LENGTH (FT)	M_t (IN)
201	1.16	226	1.30	251	1.45	276	1.59
202	1.16	227	1.31	252	1.45	277	1.60
203	1.17	228	1.31	253	1.46	278	1.60
204	1.18	229	1.32	254	1.46	279	1.61
205	1.18	230	1.32	255	1.47	280	1.61
206	1.19	231	1.33	256	1.47	281	1.62
207	1.19	232	1.34	257	1.48	282	1.62
208	1.20	233	1.34	258	1.49	283	1.63
209	1.20	234	1.35	259	1.49	284	1.64
210	1.21	235	1.35	260	1.50	285	1.64
211	1.22	236	1.36	261	1.50	286	1.65
212	1.22	237	1.37	262	1.51	287	1.65
213	1.23	238	1.37	263	1.51	288	1.66
214	1.23	239	1.38	264	1.52	289	1.66
215	1.24	240	1.38	265	1.53	290	1.67
216	1.24	241	1.39	266	1.53	291	1.68
217	1.25	242	1.39	267	1.54	292	1.68
218	1.26	243	1.40	268	1.54	293	1.69
219	1.26	244	1.41	269	1.55	294	1.69
220	1.27	245	1.41	270	1.56	295	1.70
221	1.27	246	1.42	271	1.56	296	1.70
222	1.28	247	1.42	272	1.57	297	1.71
223	1.28	248	1.43	273	1.57	298	1.72
224	1.29	249	1.43	274	1.58	299	1.72
225	1.30	250	1.44	275	1.58	300	1.73

SPAN LENGTH (FT)	M_t (IN)	SPAN LENGTH (FT)	M_t (IN)	SPAN LENGTH (FT)	M_t (IN)	SPAN LENGTH (FT)	M_t (IN)
301	1.73	326	1.88	351	2.02	376	2.17
302	1.74	327	1.88	352	2.03	377	2.17
303	1.75	328	1.89	353	2.03	378	2.18
304	1.75	329	1.90	354	2.04	379	2.18
305	1.76	330	1.90	355	2.04	380	2.19
306	1.76	331	1.91	356	2.05	381	2.19
307	1.77	332	1.91	357	2.06	382	2.20
308	1.77	333	1.92	358	2.06	383	2.21
309	1.78	334	1.92	359	2.07	384	2.21
310	1.79	335	1.93	360	2.07	385	2.22
311	1.79	336	1.94	361	2.08	386	2.22
312	1.80	337	1.94	362	2.09	387	2.23
313	1.80	338	1.95	363	2.09	388	2.23
314	1.81	339	1.95	364	2.10	389	2.24
315	1.81	340	1.96	365	2.10	390	2.25
316	1.82	341	1.96	366	2.11	391	2.25
317	1.83	342	1.97	367	2.11	392	2.26
318	1.83	343	1.98	368	2.12	393	2.26
319	1.84	344	1.98	369	2.13	394	2.27
320	1.84	345	1.99	370	2.13	395	2.28
321	1.85	346	1.99	371	2.14	396	2.28
322	1.85	347	2.00	372	2.14	397	2.29
323	1.86	348	2.00	373	2.15	398	2.29
324	1.87	349	2.01	374	2.15	399	2.30
325	1.87	350	2.02	375	2.16	400	2.30

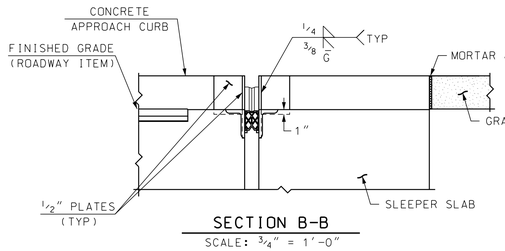


TYPICAL ASSEMBLY DETAIL

PLAN VIEW

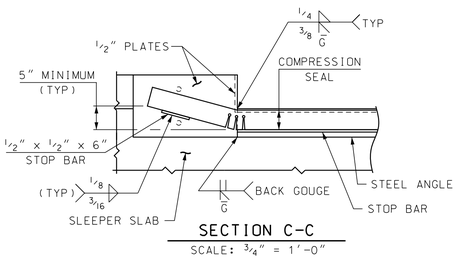
SCALE: 1" = 1'-0"

NOTE TO DESIGNER:
IF PHASE CONSTRUCTION IS REQUIRED, SPLICE SHOWN AT ROADWAY CROWN SHALL BE REPLACED WITH WELD DETAIL FOR FIELD SPLICE(S)



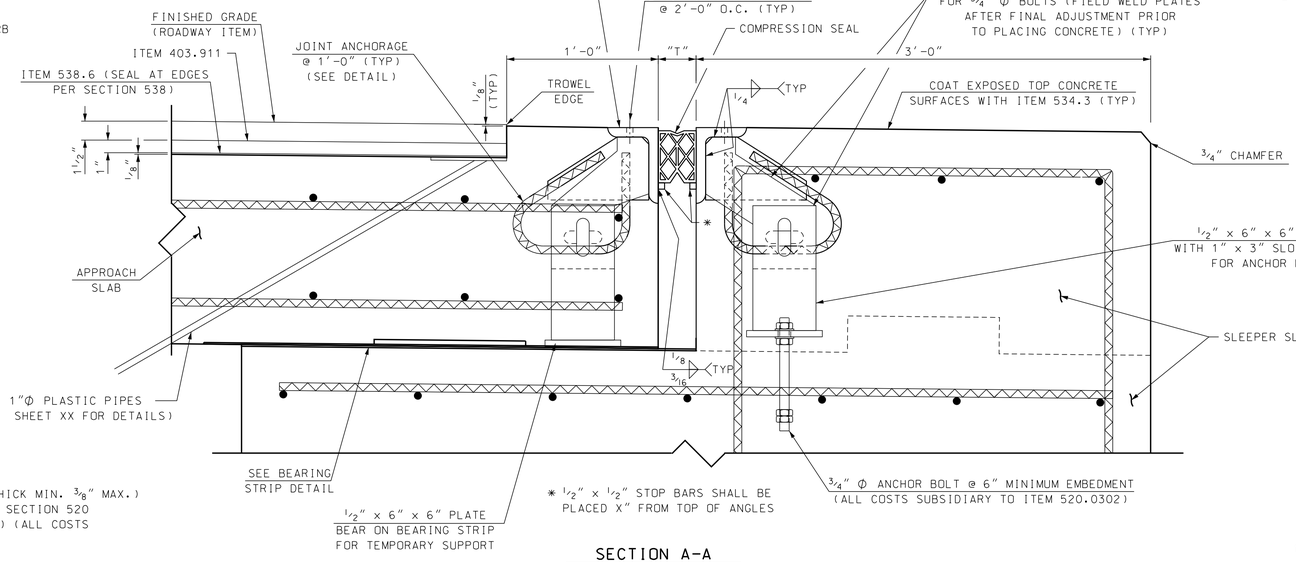
SECTION B-B

SCALE: 3/4" = 1'-0"



SECTION C-C

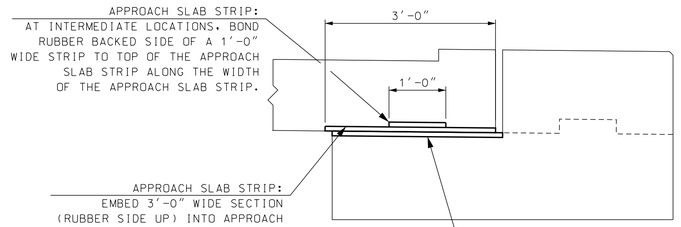
SCALE: 3/4" = 1'-0"



SECTION A-A

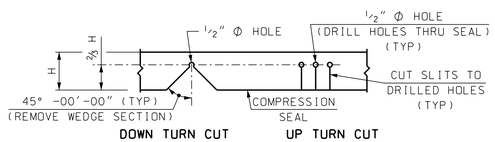
SCALE: 2" = 1'-0"

BEARING STRIPS
(RUBBER BACKED UHMW-PE, 1/4" THICK MIN. 3/8" MAX.)
(SEE QUALIFIED PRODUCTS LIST, SECTION 520 FOR MATERIALS & BONDING AGENT) (ALL COSTS SUBSIDIARY TO ITEM 520.0302)



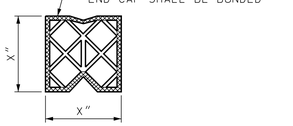
BEARING STRIP DETAIL

NOT TO SCALE



RELIEF CUT DETAILS

NOT TO SCALE

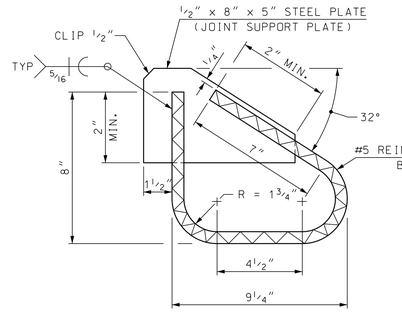


UNCOMPRESSED SEAL

NOT TO SCALE

TEMPERATURE ADJUSTMENT TABLE	
TEMPERATURE	"T"
20°F	X
35°F	X
50°F	X
65°F	X
80°F	X
95°F	X

MODIFY SHEET AS REQUIRED TO FIT PROJECT



ANCHOR DETAIL (90° CROSSING)

SCALE: 3" = 1'-0"

NOTE TO DESIGNER:
IF BRIDGE SHALL BE SKEWED, USE ANCHOR DETAIL FOR SKEWED BRIDGES

EXPANSION JOINT NOTES

(1) ALL EXPANSION JOINT STEEL, INCLUDING ANCHORS, SHALL BE GALVANIZED. STEEL ANGLES SHALL BE ASTM A572 GRADE 50. MINOR STEEL PLATES MAY CONFORM TO ASTM A36. THE ENTIRE ASSEMBLY, INCLUDING COMPRESSION SEAL, SHALL BE PAID FOR AS ITEM 560.1001, PREFABRICATED COMPRESSION SEAL EXPANSION JOINT (F).

(2) SPLICES FOR STEEL ANGLES SHALL DEVELOP FULL STRENGTH.

(3) EXPANSION JOINT OPENING SHALL BE ADJUSTED TO TEMPERATURE ANTICIPATED JUST PRIOR TO POURING CONCRETE. FINAL SETTING IN THE FIELD SHALL BE DETERMINED BY THE CONTRACT ADMINISTRATOR. SEE TEMPERATURE ADJUSTMENT TABLE & NOTES.

(4) THE COMPRESSION SEAL SHALL BE FURNISHED IN ONE CONTINUOUS LENGTH. NO SPLICES WILL BE ALLOWED. SEAL SHALL BE INSTALLED IN THE FIELD BY THE CONTRACTOR, IN ACCORDANCE WITH THE MANUFACTURER OF THE SEAL, USING AN APPROVED TOOL THAT WILL NOT DAMAGE THE SEAL.

(5) JOINT SUPPORT PLATES AND CURB PLATES SHALL BE SHOP WELDED TO EXPANSION JOINT STEEL AND SHALL BE NORMAL TO GRADE AFTER JOINT ASSEMBLY HAS BEEN ADJUSTED FOR ROADWAY CROSS-SLOPE AND GRADE. STEEL ANGLES SHALL BE ASSEMBLED WITH A CONSTANT JOINT OPENING TO ENSURE PROPER PERFORMANCE AND WATER TIGHTNESS.

(6) IMMEDIATELY AFTER THE JOINT HAS BEEN SECURED, REMOVE SHIPPING DEVICES AND GRIND SMOOTH ANY WELDS ON EXPOSED SURFACES. REPAIR ANY DAMAGE TO GALVANIZED SURFACES IN ACCORDANCE WITH SECTION 550.

(7) PROTECT TOP OF EXPANSION JOINT DURING PLACEMENT OF CONCRETE AND BITUMINOUS PAVEMENT.

(8) THE COMPRESSION SEAL HAS BEEN DESIGNED FOR A TOTAL FACTORED MOVEMENT OF XX INCHES. DESIGN INCLUDES MOVEMENT DUE TO TEMPERATURE, SKEW, SHRINKAGE AND MINIMUM INSTALLATION WIDTH. THE CONTRACTOR SHALL USE A WA-XX SEAL BY WATSON BOWMAN OR CV-XXXX BY D.S. BROWN, AS NOTED IN THE QPL.

(9) ELEVATIONS SHOWN AT TOP OF ANGLES ARE 1/8" LOWER THAN PROPOSED FINISHED ROADWAY GRADE.

(10) ANGLES 6" x 4" x 3/4" SHALL BE UTILIZED FOR SEALS LESS THAN 5" (HEIGHT). FOR SEALS GREATER THAN OR EQUAL TO 5" (HEIGHT) STEEL ANGLES SHALL BE 8" x 4" x 3/4".

(11) PRIOR TO INSTALLING THE SEAL, ALL TEMPORARY FORM WORK SHALL BE REMOVED. STEEL ANGLES AND STOP BARS SHALL BE MAINTAINED FREE FROM DIRT, WATER AND ANY OTHER LOOSE DEBRIS, WITH THE USE OF COMPRESSED AIR, TO ENSURE PROPER FIT OF THE SEAL. CARE SHALL BE TAKEN NOT TO DAMAGE GALVANIZED SURFACES.

(12) A TEMPORARY SEAL(S) SHALL BE INSTALLED PRIOR TO THE START OF THE WINTER MAINTENANCE PERIOD FOR ALL JOINT ASSEMBLIES OR PORTIONS THEREOF THAT WILL BE IN PLACE THROUGHOUT THE WINTER. ALL TEMPORARY SEALS SHALL BE REMOVED AND JOINT OPENINGS AND SUBSTRUCTURE SHALL BE CLEANED PRIOR TO INSTALLING THE FINAL SEAL. ALL COSTS SHALL BE SUBSIDIARY TO ITEM 560.1001.

TEMPERATURE ADJUSTMENT NOTES

1. "T" DIMENSIONS ARE PERPENDICULAR TO FACE SLEEPER SLAB.
2. MINIMUM "T" WIDTH FOR SEAL INSTALLATION = X" (APPROXIMATELY 65°F OR LESS).
3. VALUES IN THE TEMPERATURE ADJUSTMENT TABLE ARE FOR SETTING THE EXPANSION JOINT ASSEMBLY IMMEDIATELY PRIOR TO POURING THE DECK BLOCKOUT.

STATE OF NEW HAMPSHIRE
DEPARTMENT OF TRANSPORTATION * BUREAU OF BRIDGE DESIGN

TOWN | BRIDGE NO. | STATE PROJECT

LOCATION

COMPRESSION SEAL EXP. JOINT SLEEPER SLAB

BRIDGE SHEET OF

REVISIONS AFTER PROPOSAL		BY	DATE		BY	DATE
	DESIGNED	NHDOT	4/18	CHECKED	NHDOT	4/18
	DRAWN	PJP	4/18	CHECKED	ABH	4/18
	QUANTITIES			CHECKED		
	ISSUE DATE	4/2018		FEDERAL PROJECT NO.		SHEET NO.
	REV. DATE					

FILE NUMBER

TOTAL SHEETS

SUBDIRECTORY	.DGN LOCATOR	SHEET SCALE
English/EXP-JTS	COMP_SEAL-SLEEPER_SLAB	AS NOTED

Pictures of Closed Cell Expansion Joint (2/2017)
Enfield, NH (Main Street over Mascoma Lake)

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