South Carolina
Department of Transportation

Office of Engineering Support
803-737-1377 | 803-766-1022 Fax

STRUCTURAL DRAWINGS AND DETAILS
Instructional Memorandum 704-ABB
Adjacent Prestressed Concrete Box Beams
June 26, 2024

General

The box beam details are available in standard span lengths of 80 feet, 90 feet, and 100 feet. Typical sections are provided for bridge roadway widths of 27'-10", 33'-10", and 39'-10" and include the MASH Barrier Parapet along each side. The standards are available in +15-degree skew, no skew, and -15-degree skew.

Design Criteria and Assumptions

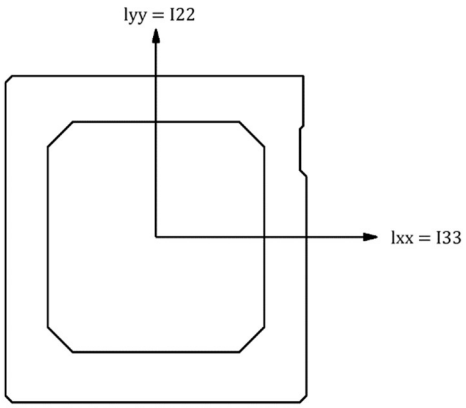
Design Specifications: AASHTO LRFD Bridge Design Specifications, 9th Edition | 2020 (herein referred to as BDS)

Live Load: AASHTO HL-93 Loading

Table 1 contains the section properties that were used in design. The 80-ft and 90-ft spans were designed using the (SC) BII-36 section and the 100-ft span was designed using the (SC) BIII-36 section.

Table 1 – Section Properties for Prestressed Sections

Section	(in^2) Area	Vol/Surf	(in^4) I33=Ixx	(in^4) I22=Iyy	(in^4) J=Torsional Constant	(in) H nominal	(in) CG to bottom
(SC) BII-36 Ext L	639.8	3.54	87014	97126	148870	33	16.20
(SC) BII-36 Ext R	639.8	3.54	87014	97126	148870	33	16.20
(SC) BII-36 Int	633.6	3.49	86378	95228	146443	33	16.11
(SC) BIII-36 Ext L	699.8	3.52	134287	111667	197357	39	19.14
(SC) BIII-36 Ext R	699.8	3.52	134287	111667	197357	39	19.14
(SC) BIII-36 Int	693.6	3.48	133228	109768	194600	39	19.03



Box Beam Section

Post Office Box 191
955 Park Street, Room 409
Columbia, SC 29202-0191

www.scdot.org
An Equal Opportunity
Affirmative Action Employer
855-GO-SCDOT (855-467-2368)

An asphalt wearing surface was assumed for all designs. Table 2 contains the asphalt thicknesses that were used to calculate the dead load of the wearing surface for stress considerations. A unit weight of 140 pcf was used for the asphalt wearing surface. A camber of zero was assumed at the final stage when calculating the dead load and no allowance was made for vertical curvature. The dead load of the asphalt wearing surface was distributed equally among all the beams in the span. The predicted camber of the 90' span is larger than the cambers of the 80' and 100' spans. Therefore, a greater thickness of asphalt was assumed for the 90' span to ensure that a minimum asphalt thickness of 2 inches could be maintained.

Table 2 – Asphalt Thicknesses Used to Determine Design Dead Load of the Wearing Surface

Span Length/Roadway Width	Asphalt Thickness at Gutter Line (inches)	Asphalt Thickness at Crown Point of Roadway (inches)
80’ Span, 27’-10” Roadway	3.9375	7.3125
80’ Span, 33’-10” Roadway	3.9375	8.0
80’ Span, 39’-10” Roadway	3.9375	8.75
90’ Span, 27’-10” Roadway	5.0	8.375
90’ Span, 33’-10” Roadway	5.0	9.0625
90’ Span, 39’-10” Roadway	5.0	9.8125
100’ Span, 27’-10” Roadway	3.9375	7.3125
100’ Span, 33’-10” Roadway	3.9375	8.0
100’ Span, 39’-10” Roadway	3.9375	8.75

It is assumed that the existing asphalt will be removed and replaced with the same thickness in the event of roadway resurfacing. Therefore, no allowance was made for a future wearing surface loading.

The typical cross section was considered to be Type (g) as shown in Table 4.6.2.2.1-1 of the BDS. Moment and shear distribution factors were calculated based on the condition of the beams being connected only enough to prevent relative vertical displacement at the interface, but not sufficiently to act as a unit.

Design Tension Stresses (Stresses at Service III Limit State after Losses) in the Precompressed Tensile Zone, assuming uncracked sections, was limited to 0 ksi (no tension) at mid-span.

The tensile stresses at release were limited to 0.2 ksi to minimize the potential for cracking at the top of the ends of the beams.

For stress considerations, the Hand Formed Mash Barrier Parapet, having a cross sectional area of 3.5 ft^2 and a unit weight of 0.525 kips per linear foot, was distributed equally to the 3 outermost beams on each side of the span (0.175 kips per linear foot per beam along the entire length of span). When determining deflection values to be placed on the plans, the dead load from the Hand Formed Mash Barrier Parapets was distributed equally to all beams of the span.

Prestress losses were determined in accordance with BDS Article 5.9.3 for pretensioned members. The prestress losses include the following assumptions:

- Relative humidity of 70%,

- Initial concrete strength, f'ci = 5.0 ksi for the 80-ft and 90-ft spans,
- Initial concrete strength, f'ci = 5.6 ksi for the 100-ft span,
- Final 28-day concrete strength, f'c = 7.0 ksi for the 80-ft and 90-ft spans,
- Final 28-day concrete strength, f'c = 7.5 ksi for the 100-ft span,
- Unit weight of unreinforced concrete, γ_c = 147 pcf for the 80-ft and 90-ft spans, based on BDS Table 3.5.1-1,
- Unit weight of unreinforced concrete, γ_c = 148 pcf for the 100-ft span, based on BDS Table 3.5.1-1,
- Modulus of elasticity of prestressing strand of 28,500 ksi,
- 0.6-inch Diameter (A_{ps} = 0.217 in^2), Grade 270, Low-Relaxation prestressing strand, and
- Long-term losses based on approximate methods per BDS Article 5.9.3.3.

Table 3 contains camber and deflections that were used to calculate the wearing surface thickness. For a span having a constant grade, normal crown, and 0-degree skew, the asphalt thicknesses given in Table 3 accommodate the required minimum 2 inches of asphalt thickness.

Table 3 – Asphalt Thicknesses and Deflection Values for Spans with a Constant Grade and Normal Crown

Span Length / Roadway Width	Camber at Erection (inches)	DL Deflection Due to Parapets and Asphalt (inches)	*Asphalt Thickness at Gutter Line (inches)	*Asphalt Thickness at Crown Point of Roadway (inches)
80' Span 27'-10" Roadway	2.25	0.5	3.75	7.0625
80' Span 33'-10" Roadway	2.25	0.5	3.75	7.8125
80' Span 39'-10" Roadway	2.25	0.5	3.75	8.5000
90' Span 27'-10" Roadway	3.6875	0.875	4.8125	8.1250
90' Span 33'-10" Roadway	3.6875	0.875	4.8125	8.8750
90' Span 39'-10" Roadway	3.6875	0.875	4.8125	9.5625
100' Span 27'-10" Roadway	2.50	0.8125	3.6875	7.0000
100' Span 33'-10" Roadway	2.50	0.8125	3.6875	7.7500
100' Span 39'-10" Roadway	2.50	0.8125	3.6875	8.4375

* Maximum thickness shown at centerline of beam bearings. Thickness typically varies along length of beam due to camber.

The elastomeric bearing pads were designed in accordance with BDS Article 14.7.6 (Method A).

South Carolina
Department of Transportation

Office of Engineering Support
803-737-1377 | 803-766-1022 Fax

Load Rating Criteria

Load Rating Procedures: SCDOT Load Rating Guidance Document, 2019, including Technical Notes through February 14, 2024.

Load rating of the spans was performed using the following assumptions:

- An extra dead load of 0.015 KSF was applied to the load rating model to account for the possibility of a future wearing surface.
- A Final Allowable Tension limit of 0.0948*sqrt(f'c) was used for Load Rating.
- A two directional bridge was assumed having an ADT of 10,000 vpd and 15% trucks.

Instructions to Designer

The Engineer must determine if the standard design and details for the precast prestressed concrete box beams are adequate for project specific use. At a minimum, consider the following items:

- Review the vertical profile of the roadway through the box beam bridge. Considering the camber of the beams, skew effects, and use of multiple spans of different lengths, determine the asphalt wearing surface thickness needed to maintain a minimum thickness of 2 inches on the bridge. For multi-span bridges, the top of beams shall match from span to span at the interior bents. If loading is increased beyond the original design assumptions listed in Table 2, reevaluate the design of the beams.
- Provide the appropriate Prestressed Concrete Box Beam Typical Superstructure Section sheet(s). For multi-span bridges with both 80' and 90' spans, utilize one Typical Superstructure Section sheet to represent both spans. Two examples of this are provided in the Plan Sequence tables. For this case, update the title block of the sheet and the cross references for the tie rod pocket detail and deck drain locations to reflect both span lengths.
- Wherever "X" or "#" is used, replace with project specific values.
- Input wearing surface thicknesses on the "Prestressed Concrete Box Beam Typical Superstructure Section" sheet:
  - Input values needed for wearing surface thickness based on profile, skew, and camber. A minimum thickness of 2 inches must be maintained.
  - For bridges with multiple spans or skews, the asphalt thicknesses should either be dual dimensioned or provided in tables as required by design. In some cases, the asphalt thickness along the gutter line may not be symmetrical about the centerline of the bridge.
- Input the missing information in the "Dead Load Deflection & Camber" table on the "Prestressed Concrete Box Beam XX' Span" sheet. Input the value needed for deflection due to barrier parapets and asphalt wearing surface. Then subtract the deflection from the camber and input the final camber value.
- Verify that bicycle or sidewalk accommodation is not a project requirement. If the bridge needs to be designed to accommodate bicyclists or sidewalks, a redesign of the beams and rails will be required.
- The combination of profile grade, skew, and roadway cross slope can sometimes result in theoretical bent cap elevations that would twist the box beams. Verify that the longitudinal and transverse bent cap slopes will permit proper seating of the box beams. In some cases, the beams may need to be superelevated to ensure the bottoms of the beams in an individual span remain in the same plane.

South Carolina
Department of Transportation

Office of Engineering Support
803-737-1377 | 803-766-1022 Fax

- ☐ If the roadway is superelevated, transversely slope the beams and provide a uniformly thick asphalt wearing surface across the cross slope.
- ☐ Revise the barrier reinforcement details if the cross slope of the superelevated beams is greater than 2%.
- ☐ On the “Prestressed Concrete Box Beam General Details 1 Of 2” sheet, input the appropriate Bearing Design Load. The details shown on the plans and values shown on Table 2 result in the following values for maximum dead load plus live load (without Impact):
  - 80-ft Span = 96 KIPS
  - 90-ft Span = 106 KIPS
  - 100-ft Span = 115 KIPS

  If more than one span length is used for the bridge, include the load for the longer span. Do not show more than one load for a bridge.
- ☐ Revise decks drains if necessary for site conditions.
- ☐ For each span, ensure that one end has fixed bearings, and the other end has expansion bearings. This is detailed on the bridge plan and profile sheet.
- ☐ Verify that the A08 dowels detailed on the “Prestressed Concrete Box Beam General Details 2 Of 2” sheet are adequate to meet the project specific requirements. Increase the size of the dowels and modify the bearing details if necessary.

Post Office Box 191
955 Park Street, Room 409
Columbia, SC 29202-0191

www.scdot.org
An Equal Opportunity
Affirmative Action Employer
855-GO-SCDOT (855-467-2368)

South Carolina
Department of Transportation

Office of Engineering Support
803-737-1377 | 803-766-1022 Fax

Applicable Drawings

DGN File Name	Drawing Number	Sheet Title
704_ABB_80	704-ABB.S080.R28.SK-15	Prestressed Concrete Box Beam 80’ Span, 27’-10” Roadway (-15° Skew)
	704-ABB.S080.R28.SK000	Prestressed Concrete Box Beam 80’ Span, 27’-10” Roadway (0° Skew)
	704-ABB.S080.R28.SK015	Prestressed Concrete Box Beam 80’ Span, 27’-10” Roadway (+15° Skew)
	704-ABB.S080.R34.SK-15	Prestressed Concrete Box Beam 80’ Span, 33’-10” Roadway (-15° Skew)
	704-ABB.S080.R34.SK000	Prestressed Concrete Box Beam 80’ Span, 33’-10” Roadway (0° Skew)
	704-ABB.S080.R34.SK015	Prestressed Concrete Box Beam 80’ Span, 33’-10” Roadway (+15° Skew)
	704-ABB.S080.R40.SK-15	Prestressed Concrete Box Beam 80’ Span, 39’-10” Roadway (-15° Skew)
	704-ABB.S080.R40.SK000	Prestressed Concrete Box Beam 80’ Span, 39’-10” Roadway (0° Skew)
	704-ABB.S080.R40.SK015	Prestressed Concrete Box Beam 80’ Span, 39’-10” Roadway (+15° Skew)
704_ABB_80_DTLS	704-ABB.S080.SK-15.D01	Prestressed Concrete Box Beam 80’ Span – Details 1 of 2 (-15° Skew)
	704-ABB.S080.SK000.D01	Prestressed Concrete Box Beam 80’ Span – Details 1 of 2 (0° Skew)
	704-ABB.S080.SK015.D01	Prestressed Concrete Box Beam 80’ Span – Details 1 of 2 (+15° Skew)
	704-ABB.S080.SK-15.D02	Prestressed Concrete Box Beam 80’ Span – Details 2 of 2 (-15° Skew)
	704-ABB.S080.SK000.D02	Prestressed Concrete Box Beam 80’ Span – Details 2 of 2 (0° Skew)
	704-ABB.S080.SK015.D02	Prestressed Concrete Box Beam 80’ Span – Details 2 of 2 (+15° Skew)
704_ABB_90	704-ABB.S090.R28.SK-15	Prestressed Concrete Box Beam 90’ Span, 27’-10” Roadway (-15° Skew)
	704-ABB.S090.R28.SK000	Prestressed Concrete Box Beam 90’ Span, 27’-10” Roadway (0° Skew)
	704-ABB.S090.R28.SK015	Prestressed Concrete Box Beam 90’ Span, 27’-10” Roadway (+15° Skew)
	704-ABB.S090.R34.SK-15	Prestressed Concrete Box Beam 90’ Span, 33’-10” Roadway (-15° Skew)
	704-ABB.S090.R34.SK000	Prestressed Concrete Box Beam 90’ Span, 33’-10” Roadway (0° Skew)
	704-ABB.S090.R34.SK015	Prestressed Concrete Box Beam 90’ Span, 33’-10” Roadway (+15° Skew)
	704-ABB.S090.R40.SK-15	Prestressed Concrete Box Beam 90’ Span, 39’-10” Roadway (-15° Skew)
	704-ABB.S090.R40.SK000	Prestressed Concrete Box Beam 90’ Span, 39’-10” Roadway (0° Skew)
	704-ABB.S090.R40.SK015	Prestressed Concrete Box Beam 90’ Span, 39’-10” Roadway (+15° Skew)
704_ABB_90_DTLS	704-ABB.S090.SK-15.D01	Prestressed Concrete Box Beam 90’ Span – Details 1 of 2 (-15° Skew)
	704-ABB.S090.SK000.D01	Prestressed Concrete Box Beam 90’ Span – Details 1 of 2 (0° Skew)
	704-ABB.S090.SK015.D01	Prestressed Concrete Box Beam 90’ Span – Details 1 of 2 (+15° Skew)
	704-ABB.S090.SK-15.D02	Prestressed Concrete Box Beam 90’ Span – Details 2 of 2 (-15° Skew)
	704-ABB.S090.SK000.D02	Prestressed Concrete Box Beam 90’ Span – Details 2 of 2 (0° Skew)
	704-ABB.S090.SK015.D02	Prestressed Concrete Box Beam 90’ Span – Details 2 of 2 (+15° Skew)

Post Office Box 191
955 Park Street, Room 409
Columbia, SC 29202-0191

South Carolina
Department of Transportation

Office of Engineering Support
803-737-1377 | 803-766-1022 Fax

DGN File Name (Continued)	Drawing Number (Continued)	Sheet Title (Continued)
704_ABB_100	704-ABB.S100.R28.SK-15	Prestressed Concrete Box Beam 100’ Span, 27’-10” Roadway (-15° Skew)
	704-ABB.S100.R28.SK000	Prestressed Concrete Box Beam 100’ Span, 27’-10” Roadway (0° Skew)
	704-ABB.S100.R28.SK015	Prestressed Concrete Box Beam 100’ Span, 27’-10” Roadway (+15° Skew)
	704-ABB.S100.R34.SK-15	Prestressed Concrete Box Beam 100’ Span, 33’-10” Roadway (-15° Skew)
	704-ABB.S100.R34.SK000	Prestressed Concrete Box Beam 100’ Span, 33’-10” Roadway (0° Skew)
	704-ABB.S100.R34.SK015	Prestressed Concrete Box Beam 100’ Span, 33’-10” Roadway (+15° Skew)
	704-ABB.S100.R40.SK-15	Prestressed Concrete Box Beam 100’ Span, 39’-10” Roadway (-15° Skew)
	704-ABB.S100.R40.SK000	Prestressed Concrete Box Beam 100’ Span, 39’-10” Roadway (0° Skew)
	704-ABB.S100.R40.SK015	Prestressed Concrete Box Beam 100’ Span, 39’-10” Roadway (+15° Skew)
704_ABB_100_DTLS	704-ABB.S100.SK-15.D01	Prestressed Concrete Box Beam 100’ Span – Details 1 of 2 (-15° Skew)
	704-ABB.S100.SK000.D01	Prestressed Concrete Box Beam 100’ Span – Details 1 of 2 (0° Skew)
	704-ABB.S100.SK015.D01	Prestressed Concrete Box Beam 100’ Span – Details 1 of 2 (+15° Skew)
	704-ABB.S100.SK-15.D02	Prestressed Concrete Box Beam 100’ Span – Details 2 of 2 (-15° Skew)
	704-ABB.S100.SK000.D02	Prestressed Concrete Box Beam 100’ Span – Details 2 of 2 (0° Skew)
	704-ABB.S100.SK015.D02	Prestressed Concrete Box Beam 100’ Span – Details 2 of 2 (+15° Skew)
704_ABB_TYPSEC	704-ABB.S080.TYP.R28	PSC Box Beam, Typical Superstructure Section, 27’-10” Roadway, (80’ Span)
	704-ABB.S080.TYP.R34	PSC Box Beam, Typical Superstructure Section, 33’-10” Roadway, (80’ Span)
	704-ABB.S080.TYP.R40	PSC Box Beam, Typical Superstructure Section, 39’-10” Roadway, (80’ Span)
	704-ABB.S090.TYP.R28	PSC Box Beam, Typical Superstructure Section, 27’-10” Roadway, (90’ Span)
	704-ABB.S090.TYP.R34	PSC Box Beam, Typical Superstructure Section, 33’-10” Roadway, (90’ Span)
	704-ABB.S090.TYP.R40	PSC Box Beam, Typical Superstructure Section, 39’-10” Roadway, (90’ Span)
	704-ABB.S100.TYP.R28	PSC Box Beam, Typical Superstructure Section, 27’-10” Roadway, (100’ Span)
	704-ABB.S100.TYP.R34	PSC Box Beam, Typical Superstructure Section, 33’-10” Roadway, (100’ Span)
	704-ABB.S100.TYP.R40	PSC Box Beam, Typical Superstructure Section, 39’-10” Roadway, (100’ Span)
704_ABB_GD	704-ABB.GD01.SK-15	Prestressed Concrete Box Beam General Details 1 of 2 (-15° Skew)
	704-ABB.GD01.SK000	Prestressed Concrete Box Beam General Details 1 of 2 (0° Skew)
	704-ABB.GD01.SK015	Prestressed Concrete Box Beam General Details 1 of 2 (+15° Skew)
	704-ABB.GD02	Prestressed Concrete Box Beam General Details 2 of 2

Post Office Box 191
955 Park Street, Room 409
Columbia, SC 29202-0191

www.scdot.org
An Equal Opportunity
Affirmative Action Employer
855-GO-SCDOT (855-467-2368)

South Carolina
Department of Transportation

Office of Engineering Support
803-737-1377 | 803-766-1022 Fax

Plan Sheet Sequence

Below are two examples that illustrate the Department's recommended sequencing of the box beam superstructure plans.

Span arrangement of 80'-90'-80' with a -15 degree skew and a roadway width of 33'-10"	
Drawing Number	**Sheet Title**
704-ABB.S080.R34.SK-15	Prestressed Concrete Box Beam 80' Span, 33'-10" Roadway (-15° Skew)
704-ABB.S090.R34.SK-15	Prestressed Concrete Box Beam 90' Span, 33'-10" Roadway (-15° Skew)
704-ABB.S080.TYP.R34 *	Prestressed Concrete Box Beam, Typical Superstructure Section, 33'-10" Roadway, (80' Span) *
704-ABB.S080.SK-15.D01	Prestressed Concrete Box Beam 80' Span – Details 1 of 2 (-15° Skew)
704-ABB.S080.SK-15.D02	Prestressed Concrete Box Beam 80' Span – Details 2 of 2 (-15° Skew)
704-ABB.S090.SK-15.D01	Prestressed Concrete Box Beam 90' Span – Details 1 of 2 (-15° Skew)
704-ABB.S090.SK-15.D02	Prestressed Concrete Box Beam 90' Span – Details 2 of 2 (-15° Skew)
704-ABB.GD01.SK-15	Prestressed Concrete Box Beam General Details 1 of 2 (-15° Skew)
704-ABB.GD02	Prestressed Concrete Box Beam General Details 2 of 2

* This plan sheet sequence example requires the sheet title to be updated to "Prestressed Concrete Box Beam, Typical Superstructure Section, 33'-10" Roadway, (80' & 90' Span)"

Span arrangement of 90'-100'-80' with no skew and a roadway width of 39'-10"	
Drawing Number	**Sheet Title**
704-ABB.S090.R40.SK000	Prestressed Concrete Box Beam 90' Span, 39'-10" Roadway (0° Skew)
704-ABB.S100.R40.SK000	Prestressed Concrete Box Beam 100' Span, 39'-10" Roadway (0° Skew)
704-ABB.S080.R40.SK000	Prestressed Concrete Box Beam 80' Span, 39'-10" Roadway (0° Skew)
704-ABB.S080.TYP.R40 **	Prestressed Concrete Box Beam, Typical Superstructure Section, 39'-10" Roadway, (80' Span) **
704-ABB.S100.TYP.R40	Prestressed Concrete Box Beam, Typical Superstructure Section, 39'-10" Roadway, (100' Span)
704-ABB.S090.SK000.D01	Prestressed Concrete Box Beam 90' Span – Details 1 of 2 (0° Skew)
704-ABB.S090.SK000.D02	Prestressed Concrete Box Beam 90' Span – Details 2 of 2 (0° Skew)
704-ABB.S100.SK000.D01	Prestressed Concrete Box Beam 100' Span – Details 1 of 2 (0° Skew)
704-ABB.S100.SK000.D02	Prestressed Concrete Box Beam 100' Span – Details 2 of 2 (0° Skew)
704-ABB.S080.SK000.D01	Prestressed Concrete Box Beam 80' Span – Details 1 of 2 (0° Skew)
704-ABB.S080.SK000.D02	Prestressed Concrete Box Beam 80' Span – Details 2 of 2 (0° Skew)
704-ABB.GD01.SK000	Prestressed Concrete Box Beam General Details 1 of 2 (0° Skew)
704-ABB.GD02	Prestressed Concrete Box Beam General Details 2 of 2

** This plan sheet sequence example requires the sheet title to be updated to "Prestressed Concrete Box Beam, Typical Superstructure Section, 39'-10" Roadway, (80' & 90' Span)"

Post Office Box 191
955 Park Street, Room 409
Columbia, SC 29202-0191

www.scdot.org
An Equal Opportunity
Affirmative Action Employer
855-GO-SCDOT (855-467-2368)