South Carolina
Department of Transportation

Office of Engineering Support
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STRUCTURAL DRAWINGS AND DETAILS
Instructional Memorandum 704-FIB
FLORIDA I-BEAM
June 26, 2024

General

The Florida I-beam sizes 36”, 45”, 54”, 63”, 72”, 78”, 84” and 96” are available as standard details.

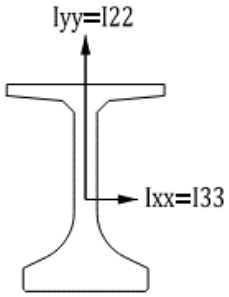
Design Criteria and Assumptions

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

Table 1 contains the section properties.

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
FIB 36	806.6	3.90	127545	81070	30735	36	16.49
FIB 45	869.6	3.87	226581	81327	31752	45	20.21
FIB 54	932.6	3.84	359929	81584	32781	54	24.04
FIB 63	995.6	3.82	530313	81842	33810	63	27.96
FIB 72	1058.6	3.80	740416	82099	34839	72	31.94
FIB 78	1100.6	3.79	903861	82270	35526	78	34.63
FIB 84	1142.6	3.78	1086919	82442	36212	84	37.34
FIB 96	1226.6	3.76	1514976	82785	37585	96	42.82



Florida I-Beam

The “Florida I-Beam Estimated Maximum Span Lengths” chart (Figure 1) is provided for preliminary information only. This chart is modeled after the charts provided by the Florida DOT and modified using SCDOT criteria to provide preliminary guidance of maximum span lengths using a limited set of design assumptions. The analysis was done using AASHTOWare BrR. The assumptions used are included with the chart.

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The maximum allowable number of prestressing strands to meet LRFD BDS splitting requirement within the allowable length from the end of the beam for the detailed vertical stirrup reinforcement is shown in Table 2.

Table 2-Maximum number of strands for splitting resistance using the standard detailing.			
Section	Maximum Number of 0.6"φ Strands	Jacking Force (kips)	Total Prestress Force (kips)
FIB 36	40	43.9	1756
FIB 45	60	43.9	2634
FIB 54	72	43.9	3161
FIB 63	72	43.9	3161
FIB 72	72	43.9	3161
FIB 78	72	43.9	3161
FIB 84	72	43.9	3161
FIB 96	72	43.9	3161

Note: Table is applicable to standard drawing detailing only. Limit may be revised based on project-specific designs.

At locations where beams are made continuous for composite dead loads and superimposed live loads, the positive moment connection is detailed at the end of the beam with extended prestressed strands. The factored positive moment resistance φMn, is set equal to 1.2*Mcr (cracking moment) of the beam using the gross section properties of the composite section and the concrete strength of the continuity diaphragm (4 ksi). A 12'-0" beam spacing was assumed.

For prestressing strands to be extended to act as reinforcement in the continuity connection, a 3'-0 1/2" minimum extension is used. For the extension length detailed, the required minimum number of extended 0.6" diameter prestressing strands per beam size is shown in Table 3.

Table 3- Required prestressing steel strands to meet 1.2 Mcr.	
Section	Minimum Number of 0.6"φ Strands Extended for 1.2 Mcr
36	6
45	6
54	6
63	8
72	8
78	8
84	8
96	8

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Florida I-Beam Estimated Maximum Span Lengths

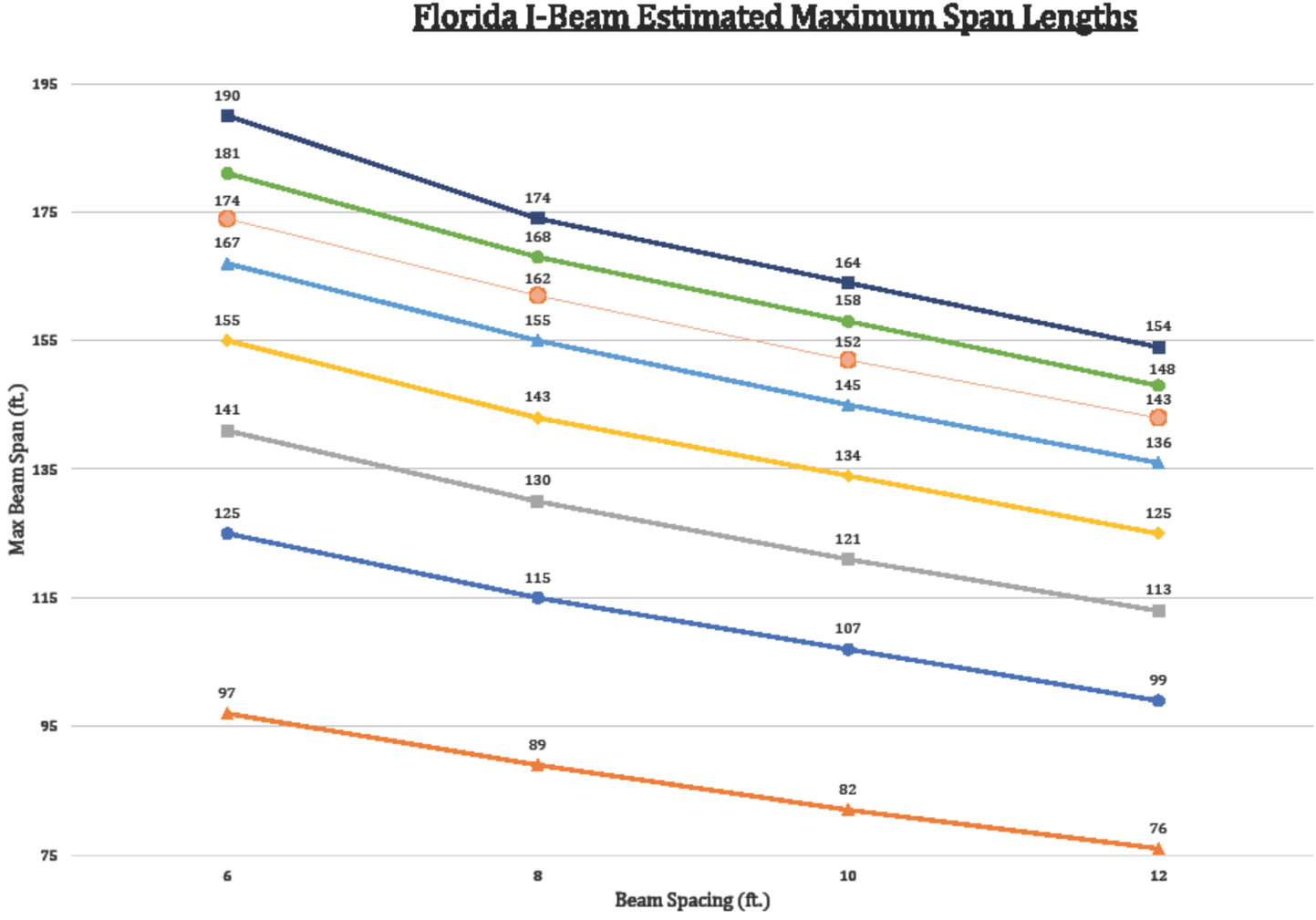

Chart Design Assumptions:

Geometry

- Simple span
- Interior Beam Design
- Spans shown are bearing to bearing
- 6 Beams in Bridge Section
- Deck Overhang of 3'-6"
- Deck Thickness of $8\frac{1}{2}$" is used for 6', 8', and 10' spacing; 9" for 12' spacing (including sacrificial wearing surface)
- $\frac{1}{4}$" sacrificial wearing surface included in deck self-weight but excluded from thickness used for structural capacity

Materials

- Beam Concrete Strength:
  - 9 ksi @ Final
  - 6.5 ksi @ Release
- Deck Concrete Strength:
  - 4.0 ksi @ Final
- 0.6" Diameter 270ksi LR 7-wire strands

Loads

- HL-93, SCDOT Legal, Emergency, & Permit Vehicles
- 16 psf for SIP form weight
- 15 psf for future wearing surface distributed evenly over all beams
- Haunch neglected for section properties, but added as weight; 3" uniform thickness
- 2 MASH Hand-Formed Barriers distributed evenly over all beams
- Steel Intermediate Cross Frames spaced per DM0311

Analysis

- Severe Corrosive Environment ($0.0948 * \sqrt{f'_c}$)
- Tension @ top of beam limited to 200 psi
- No Elastic Gains

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Instructions to Designer

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

- Wherever “X” or “#” is used, replace with project specific values.
- Detail scales are listed in the drawing model for each detail in the sheet models for reference. If an individual detail scale is to be revised in the drawing model, the setting called “Propagate Annotation Scale” in the drawing model property settings must be set to “off”. Otherwise, every detail will change scale when the drawing scale is revised.
- “Florida I-Beam Details Span X” sheets are provided for no skew, left skew, and right skew. The sheets are further subdivided into options for (1) intermediate steel diaphragm or cross frame connection (two-hole and four-hole options), (2) location (midpoint of span or third points of span), and (3) whether the diaphragm line is continuous or discontinuous (single or multiple line of diaphragm holes).
- Once the correct “Florida I-Beam Details Span X” sheet(s) are chosen, delete “-Alt X” from the title block. This additional text is required as a placeholder because model names within a DGN must be unique.
- Strand patterns shown do not represent all possible strand locations. Designer may revise strand patterns for project-specific designs.
- Show the required locations of extended prestressing strands for positive moment at end of the beam in the “Strand Layout” on the “Prestressed Concrete Beam ‘X’ Florida I-Beam Span ‘X’” sheet.
- Previous standard drawings included 2” diameter holes through the beam webs to accommodate a reinforcing steel connection to an integral end bent diaphragm or interior bent continuity diaphragm, and for steel tie-bars through an end diaphragm at expansion joints. To simplify beam end zone detailing, the beam-to-web connection holes are removed from the details. For end diaphragms at expansion joints only, a positive connection of the beam web to the end diaphragm is required. The “Section At End Diaphragm” on the “Florida I-Beam General Details” sheet shows a detail of the connection using ferrule inserts with threaded reinforcing steel. Designers may propose other options, subject to SCDOT approval.
- The standard spacing dimensions for the beam end zones are intended to provide consistency among beam sizes for efficiency of fabrication. Avoid unnecessary revisions to this spacing.
- Camber table may be expanded to include multiple beam cambers separately.
- When draped strands are not used, delete the related information from the “Intermediate Diaphragm Hole Location Detail” on the “Florida I-Beam Details Span X” sheet.
- The holes in the web shown for intermediate diaphragms are intended for steel diaphragms. If concrete diaphragms are used, revise the details accordingly.
- The “Intermediate Diaphragm Reinforcement Detail” on the “Florida I-Beam Details Span X” sheet provides guidance for reinforcement of one vertical line of diaphragm holes. In cases where the bridge skew requires offset diaphragms, the distance between offset diaphragms may allow revision of this reinforcement detail to combine multiple lines together.
- When detailing beam end at an expansion joint, provide ferrule inserts (2 minimum) for the concrete end diaphragm at a 12” maximum spacing along the vertical face of the web for threaded reinforcing steel. Designate bars that require threads by adding a "T" suffix to the bar mark. The detail assumes a #5 threaded bar is used. To provide for threading

fabrication, a usable threading diameter of ½" is assumed for a #5 bar. Using the Unified Coarse Threads criteria according to ANSI B1.1, 13 threads per inch (tpi) is specified.

- When detailing skewed end diaphragms, include a note with the continuity diaphragm details to "Field bend threaded reinforcing bars to fit between reinforcing steel mats located at the faces of the end diaphragm."
- For a jointless bridge delete "Section At End Diaphragm" and "Grouted Recess At End Of Pretensioned Strand" detail on the "Florida I-Beam General Details" sheet.
- When a continuity diaphragm is not required delete "Half Elevation End of Beam at Interior Bent" detail on the "Florida I-Beam General Details" sheet.
- If draped strands are specified, the designer shall verify the hold-down force does not exceed the limits specified in the Structures Design Manual.
- Extended prestressing strands:
  - Extended prestressing strands shall be placed in a pattern that is symmetrical, or as nearly symmetrical as possible, about the centerline of the cross section, and preferably in the bottom row of strands. Strands from opposing girders shall be detailed to mesh during erection without significant conflicts. Patterns that result in directly opposing strands in the continuity diaphragm are acceptable.
  - Extended strands should be spaced as far apart as practicable.
  - Debonded strands shall not be used for the positive moment connection.
  - For exterior beams at interior bent continuity diaphragms, provide a note with continuity diaphragm details on superstructure details sheet to "See "Half Elevation End Of Beam at Interior Bent" on Florida I-Beam General Details sheet.".
  - Optionally, in lieu of extended prestressing strands, the designer may propose mild steel reinforcement.
  - Delete the prestressing strand extension detail (from the beam elevation on beam sheet(s)) for beam ends at integral end bents and expansion joints.
- Do not modify stud spacing on sole plate.
- The top four strands shall be located as shown on the standard drawing to facilitate beam fabrication.
- If no strands are debonded, delete debonding notes from "Florida I-Beam General Details" sheet.
- Provide confinement reinforcement (RD0301 pairs) in the bottom flange for the entire beam length. The reason for this provision is to mitigate transverse tie forces and shear flow due to a wide bottom flange and high jacking force associated with a higher strand capacity when compared to the SCDOT modified bulb tee beams and AASHTO beams.

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Applicable Drawings

DGN File Name	Drawing Number	Sheet Title
704_FIB	704-FIB.36.SPXXX	Prestressed Concrete Beam 36" Florida I-Beam Span X
	704-FIB.45.SPXXX	Prestressed Concrete Beam 45" Florida I-Beam Span X
	704-FIB.54.SPXXX	Prestressed Concrete Beam 54" Florida I-Beam Span X
	704-FIB.63.SPXXX	Prestressed Concrete Beam 63" Florida I-Beam Span X
	704-FIB.72.SPXXX	Prestressed Concrete Beam 72" Florida I-Beam Span X
	704-FIB.78.SPXXX	Prestressed Concrete Beam 78" Florida I-Beam Span X
	704-FIB.84.SPXXX	Prestressed Concrete Beam 84" Florida I-Beam Span X
	704-FIB.96.SPXXX	Prestressed Concrete Beam 96" Florida I-Beam Span X
	704-FIB.D01.MIDPNTDIA.SK000.2HOLE	Florida I-Beam Details Span X – Alt 1
	704-FIB.D01.MIDPNTDIA.SK000.4HOLE	Florida I-Beam Details Span X – Alt 2
	704-FIB.D01.THIRDPNTDIA.SK000.2HOLE	Florida I-Beam Details Span X – Alt 3
	704-FIB.D01.THIRDPNTDIA.SK000.4HOLE	Florida I-Beam Details Span X – Alt 4
	704-FIB.D01.MIDPNTDIA.SKLT.2HOLE	Florida I-Beam Details Span X – Alt 5
	704-FIB.D01.MIDPNTDIA.SKLT.4HOLE	Florida I-Beam Details Span X – Alt 6
	704-FIB.D01.THIRDPNTDIA.SKLT.2HOLE	Florida I-Beam Details Span X – Alt 7
	704-FIB.D01.THIRDPNTDIA.SKLT.4HOLE	Florida I-Beam Details Span X – Alt 8
	704-FIB.D01.MIDPNTDIA.SKRT.2HOLE	Florida I-Beam Details Span X – Alt 9
	704-FIB.D01.MIDPNTDIA.SKRT.4HOLE	Florida I-Beam Details Span X – Alt 10
	704-FIB.D01.THIRDPNTDIA.SKRT.2HOLE	Florida I-Beam Details Span X – Alt 11
	704-FIB.D01.THIRDPNTDIA.SKRT.4HOLE	Florida I-Beam Details Span X – Alt 12
	704-FIB.GD01	Florida I-Beam General Details

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Plan Sheet Sequence

Below is an example that illustrates the Department's recommended sequencing.

Three span 90'-110'-90' (54" FIB) with 15 degree skew left	
704-FIB.54.SPXXX	Prestressed Concrete Beam 54" Florida I-Beam Spans A & C
704-FIB.54.SPXXX	Prestressed Concrete Beam 54" Florida I-Beam Span B
704-FIB.D01.MIDPNTDIA.SKLT.2HOLE	Florida I-Beam Details Span A & C
704-FIB.D01.THIRDPNTDIA.SKLT.2HOLE	Florida I-Beam Details Span B
704-FIB.GD01	Florida I-beam General Details

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