

**STRUCTURAL DRAWINGS AND DETAILS**  
**Instructional Memorandum 704-MBT**  
**AASHTO Modified Bulb Tee Beam**  
 June 27, 2024

**General**

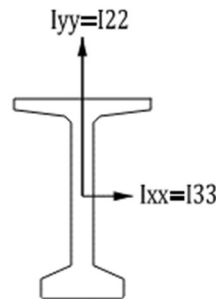
The AASHTO Modified Bulb Tee sizes 54", 63", 72", 74", and 78" are available as standard details.

**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 <sup>2</sup> ) Area	Vol / Surf	(in <sup>4</sup> ) I <sub>33</sub> =I <sub>xx</sub>	(in <sup>4</sup> ) I <sub>22</sub> =I <sub>yy</sub>	(in <sup>4</sup> ) J=Torsional Constant	(in) H nominal	(in) CG to bottom
MBT 54	706.6	3.24	277133	39960	13412	54	27.81
MBT 63	769.6	3.26	407737	40217	14441	63	32.31
MBT 72	832.6	3.27	569508	40474	15471	72	36.81
MBT 74	884.6	3.42	639430	43403	19513	74	36.59
MBT 78	874.6	3.28	695931	40646	16410	78	39.81



**AASHTO Modified Bulb Tee**

The maximum allowable number of prestressing strands to meet LRFD BDS splitting requirement assuming only the 5 pairs of N0601 vertical stirrups that are detailed at each end of the beam 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)
MBT 54	40	43.9	1756
MBT 63	48	43.9	2107
MBT 72	48	43.9	2107
MBT 74	48	43.9	2107
MBT 78	48	43.9	2107

Note: Table is applicable to standard drawing detailing only. Maximum number of strands 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  $\phi M_n$ , is set equal to  $1.2 M_{cr}$  (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. Extended strands are bent up after the girder is removed from the bed. 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 M <sub>cr</sub> .	
Section	Minimum Number of 0.6"φ Strands Extended for 1.2 M <sub>cr</sub>
MBT 54	6
MBT 63	6
MBT 72	6
MBT 74	6
MBT 78	6

## 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.
- “Modified Bulb Tee 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 “Modified Bulb Tee 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’ Modified Bulb Tee 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 “Modified Bulb Tee 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 “Prestressed Concrete Beam ‘X’ Modified Bulb Tee 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 “Prestressed Concrete Beam ‘X’ Modified Bulb Tee 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  $\frac{1}{2}$ " 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 "Modified Bulb Tee General Details" sheet.
- When a continuity diaphragm is not required delete "Half Elevation End of Beam at Interior Bent" detail.
- If draped strands are specified, the designer shall verify the hold-down force does not exceed the limit 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 "Modified Bulb Tee 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 "Modified Bulb Tee General Details" sheet.



South Carolina  
Department of Transportation

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**Applicable Drawings**

DGN File Name	Drawing Number	Sheet Title
704_MBT	704-MBT.54MOD.SPXXX	Prestressed Concrete Beam 54" Modified Bulb Tee Span X
	704-MBT.63MOD.SPXXX	Prestressed Concrete Beam 63" Modified Bulb Tee Span X
	704-MBT.72MOD.SPXXX	Prestressed Concrete Beam 72" Modified Bulb Tee Span X
	704-MBT.74MOD.SPXXX	Prestressed Concrete Beam 74" Modified Bulb Tee Span X
	704-MBT.78MOD.SPXXX	Prestressed Concrete Beam 78" Modified Bulb Tee Span X
	704-MBT.D01.MIDPNTDIA.SK000.2HOLE	Modified Bulb Tee Details Span X – Alt 1
	704-MBT.D01.MIDPNTDIA.SK000.4HOLE	Modified Bulb Tee Details Span X – Alt 2
	704-MBT.D01.THIRDPNTDIA.SK000.2HOLE	Modified Bulb Tee Details Span X – Alt 3
	704-MBT.D01.THIRDPNTDIA.SK000.4HOLE	Modified Bulb Tee Details Span X – Alt 4
	704-MBT.D01.MIDPNTDIA.SKLT.2HOLE	Modified Bulb Tee Details Span X – Alt 5
	704-MBT.D01.MIDPNTDIA.SKLT.4HOLE	Modified Bulb Tee Details Span X – Alt 6
	704-MBT.D01.THIRDPNTDIA.SKLT.2HOLE	Modified Bulb Tee Details Span X – Alt 7
	704-MBT.D01.THIRDPNTDIA.SKLT.4HOLE	Modified Bulb Tee Details Span X – Alt 8
	704-MBT.D01.MIDPNTDIA.SKRT.2HOLE	Modified Bulb Tee Details Span X – Alt 9
	704-MBT.D01.MIDPNTDIA.SKRT.4HOLE	Modified Bulb Tee Details Span X – Alt 10
	704-MBT.D01.THIRDPNTDIA.SKRT.2HOLE	Modified Bulb Tee Details Span X – Alt 11
	704-MBT.D01.THIRDPNTDIA.SKRT.4HOLE	Modified Bulb Tee Details Span X – Alt 12
	704-MBT.GD01	Modified Bulb Tee General Details

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### **Plan Sheet Sequence**

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

<i>Three span 90'-110'-90' (54" Modified Bulb Tee) with 15 degree skew left</i>	
704-MBT.54MOD.SPXXX	Prestressed Concrete Beam 54" Modified Bulb Tee Spans A & C
704-MBT.54MOD.SPXXX	Prestressed Concrete Beam 54" Modified Bulb Tee Span B
704-MBT.D01.MIDPNTDIA.SKLT.4HOLE	Modified Bulb Tee Details Span A & C
704-MBT.D01.THIRDPNTDIA.SKLT.4HOLE	Modified Bulb Tee Details Span B
704-MBT.GD01	Modified Bulb Tee General Details

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