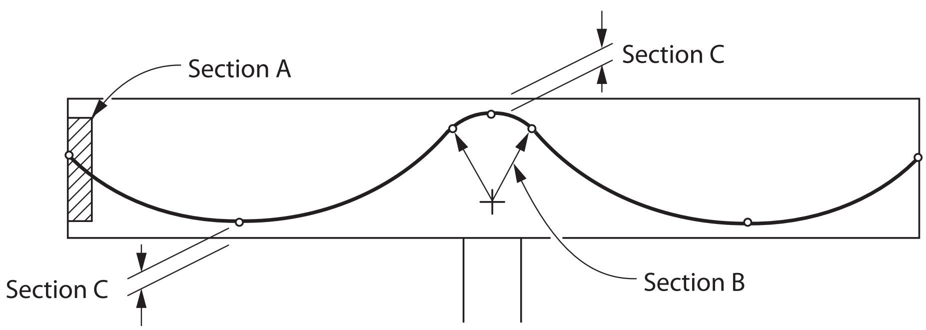
11-28 PRESTRESS CLEARANCES FOR CAST-IN-PLACE PRESTRESSED BOX GIRDER STRUCTURES

General

This memo is divided into three sections. Section A addresses anchorage space requirements needed during the stressing operation. Section B gives recommendations for tendon and duct curvature. Section C provides guidance to determine maximum cable path eccentricities.



Section A – Clearance Requirements at Anchorage Zones

During the jacking operation, there are space requirements needed to accommodate the placement of the jack, along with the contractor's personnel.

Recommendations for Stem Width and Anchorage Space for Cast-in-Place, Post-tensioned Box Girders

Jacking Force (kips / girder)	Minimum Stem Thickness (inches)	Anchorage Space Requirements	
		Width (inches)	Height (inches)
0 – 1,200	12	27	27
1,200 – 2,400	12	27	48
2,400 – 3,600	12	27	69
3,600 – 4,800	12	27	90
4,800 – 6,000	12 *	27	111

* Additional design considerations should be investigated. Contact the Post-tensioned Concrete Committee for further information.

Recommended Minimum Diaphragm Widths as a Function of Skew

Boxes with Vertical Exterior Girders		
Skew Angle (degrees)	**Minimum Diaphragm Thickness At Abutments (1)**	**Minimum Diaphragm Thickness At Hinges (2)**
0 – 14	2' – 6"	2' – 0" *
15 – 29	3' – 3"	2' – 9"
30 – 44	4' – 0"	3' – 6"
45 – 55	4' – 9"	4' – 3"

* To accommodate spiral

Boxes at Sloped Exterior Girders				
Skew Angle (degrees)	**Minimum Diaphragm Thickness At Abutments (1)**		**Minimum Diaphragm Thickness At Hinges (2)**	
	P_J <2400 kips	P_J >2400 kips	P_J <2400 kips	P_J >2400 kips
0 – 14	3'-0"	3'-3"	2'-8"	3'-0"
15 – 29	3'-4"	4'-3"	3'-4"	4'-0"
30 – 44	4'-0"	5'-0"	3'-8"	4'-8"
45 – 55	4'-4"	5'-6"	4'-0"	5'-3"

Note: P_J is per girder

The minimum diaphragm thicknesses shown above are required in order to satisfy the B8-5 Standard Plan 1'-6" clearance requirement between the prestress blockout and the interior face of diaphragm (Figure A-2). However, AASHTO LRFD General Zone requirements may influence or control the diaphragm thickness. The additional thickness required at sloped exterior girders is only necessary at exterior bays. Sloped exterior girders are assumed to be 1:2. For flatter slopes, diaphragm thickness should be investigated. See Figure A-2 for skewed exterior girder geometry.

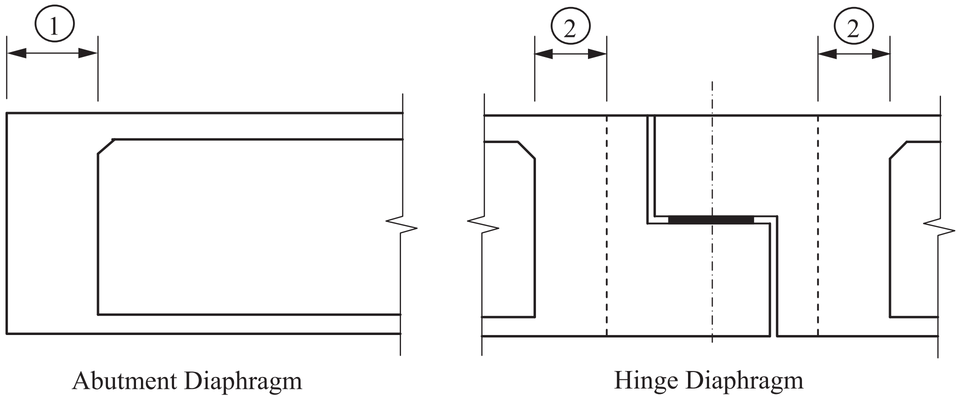
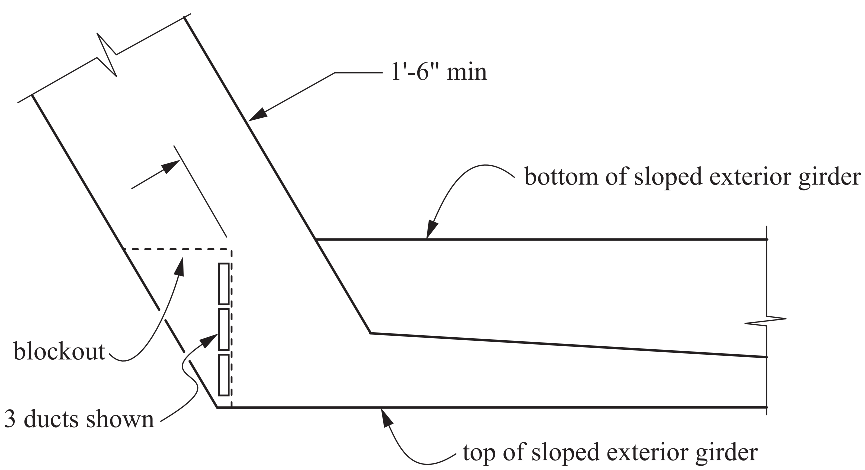


FIGURE A-1



Plan View of Skewed Abutment Diaphragm with sloped exterior girder

FIGURE A-2

Section B – Tendon and Duct Curvature

The use of sharp curvatures for the tendon path in the vertical plane can result in large radial forces equal to the stressing force divided by the radius of the tendon. Refer to AASHTO Article 5.10.4.3 for tendon and duct curvature requirements. Where tendons are in contact with one another, these radial forces can crush the ducts. Sharp duct curvatures can also make tendon installation a challenge. Locating tendon inflection points at 10% L_{span} away from the centerline of bent in continuous frames insures a smooth cable path with acceptable vertical curvature. Most CIP/PS structures have fairly flat cable paths, with the exception of some post-tensioned bent caps.

The cable path should have an equivalent circular curvature radius greater than 60 feet. If the radius is less than 60 feet, radial forces due to the prestressing should be investigated. Possible solutions include greater duct clearances than required by Standard Plan B8-5, or extra reinforcement around the duct in the region of sharp curvature.

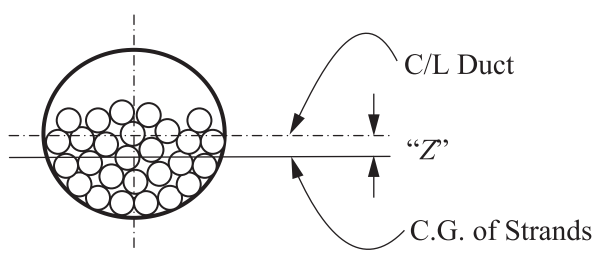
Section C – Maximum Cable Path Eccentricities

Attachment 2, "D" Chart for Cast-in-Place P/S Concrete Girders, is a quick and accurate method to locate tendon high and low points while maximizing eccentricities. Use the recommended "*D*" values as a function of P_{jack} per girder to define your initial cable path. Revise "*D*" based on the P_{jack} obtained from your initial analysis. Refine your analysis further by using the revised "*D*" value, until you reach convergence and your cable path is optimized. Refer to Standard Plan B8-5 and Memo to Designers (MTD) 11-31 for conditions that warrant the use of "Detail A".

When designing railroad bridges, American Railway Engineering and Maintenance-of-Way Association (AREMA) and individual railroad company requirements must be met. Refer to MTD Section 17, for additional design requirements.

Strands within a tendon shift to the top of duct at midspan, and the bottom of duct over the bent cap. The amount of tendon offset within the duct (the "*Z*" value) considered in the development of the "D" Chart is as follows":

Duct Size	"*Z*" Value
3" OD and less	½"
Over 3" OD to 4"	¾"
Over 4" OD	1"



Other assumptions used in the development of the Attachments 1 and 2 are as follows:

1. Girder has a width of 12 inches.
2. Chart was developed considering a variety of different jacking forces in combination with varying numbers of girders.
3. Sloped exterior girders are addressed in the chart.
4. Duct configurations for the standard girder conform to Standard Plan B8-5 requirements, and are included in this memo as Attachment 1.
5. When required for curved post-tensioned girders, duct configurations conform to clearance requirements included in MTD 11-31, "Detail A."
6. Two and one-half inches clear between stirrup and face of girder.

(original signed by Tony M. Marquez)

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