

Index 21800 Series Post-Tensioning

Design Criteria

AASHTO LRFD Bridge Design Specifications; Structures Design Guidelines (SDG); Specifications Sections 452, 453, 462, 938 and 960.

Design Assumptions and Limitations

Indexes 21801, 21802 and 21803 depict various details and requirements for post-tensioning systems used on Department projects. Use these Standards with **Specifications** Sections 452, 453, 462, 938 and 960 and the Approved Post Tensioning Systems List on the SDO website.

Plan Content Requirements

In the Structures Plans:

Design and detail post tensioning tendons and include quantity, geometry, anchorage protection and stressing information on the plans in accordance with these Standards. In cases where the tendon types and anchorage protection details shown in the Standards are not sufficient to meet project specific requirements, obtain Department approval to supplement the drawings with project specific details.

Design and detail using the following standard tendon sizes utilizing 0.6 inch diameter strands: 4, 7, 12, 15, 19, 27 and 31. Design and detail using the following standard bar tendon diameters: $\frac{5}{8}$, $\frac{3}{4}$, 1, $1\frac{1}{4}$, $1\frac{3}{8}$, $1\frac{3}{4}$, $2\frac{1}{2}$, and 3 inch.

For projects on which permanent post tensioning bar tendons are utilized, complete the "Post-Tensioning Bar Tendon Data Table" shown in [Figure 1](#) and include it in the plans. The following is a column-by-column description of the information to be used when filling out the data table:

Bar Tendon Designation: Indicate the bar tendon designation using a number or letter and number combination.

No. Required: Indicate the total number of required bar tendons of a given designation.

Bar Size: Indicate the bar diameter.

Bar Length: Indicate the bar tendon length measured from anchorage to anchorage (front face of bearing plate).

Stressing Force/Bar: Indicate the stressing force per bar.

Stressing End: Indicate the stressing end as follows:

Ahead Station - Live/stressing end is at the ahead station anchorage for horizontally oriented tendons or at the top anchorage of vertically oriented tendons.

Back Station - Live/stressing end is at the back station anchorage for horizontally oriented tendons or at the bottom anchorage of vertically oriented tendons.

Elongation: Indicate the total theoretical elongation due to stressing.

Tendon Profile: Indicate the tendon profile, e.g. F9, as shown on Index 21801 or a custom tendon profile. Include the geometric effects of the profile grade and cross slope on tendon geometry when determining the appropriate tendon profile.

Filler Material: Indicate the use of grout or flexible filler.

Anchorage Protection Type: Indicate the anchorage protection type using the requirements stated below.

For projects on which strand post tensioning tendons are utilized, complete the "Post-Tensioning Strand Tendon Data Table" shown in [Figure 2](#) and include it in the structures plans. The following is a column-by-column description of the information to be used when filling out the data table:

Strand Tendon Designation: Indicate the strand tendon designation using a number or letter and number combination.

No. Required: Indicate the total number of required strand tendons of a given designation.

Tendon Size: Indicate the number and size of strands, e.g. 12-0.6.

Tendon Length: Indicate the strand tendon length measured from anchorage to anchorage (front face of anchorage/bearing plate).

Ahead Station Stressing Force per Tendon: Indicate the stressing force per tendon at the ahead station.

Back Station Stressing Force per Tendon: Indicate the stressing force per tendon at the back station.

Stressing End: Indicate the stressing end as follows:

Ahead Station - Live/stressing end is at the ahead station anchorage for horizontally oriented tendons or at the top anchorage of vertically oriented tendons.

Back Station - Live/stressing end is at the back station anchorage for horizontally oriented tendons or at the bottom anchorage of vertically oriented tendons.

Elongation: Indicate the total theoretical elongation due to stressing.

Tendon Profile: Indicate the tendon profile, e.g. F1, as shown on Index 21801 or a custom tendon profile. Include the geometric effects of the profile grade and cross slope on tendon geometry when determining the appropriate tendon profile.

Filler Material: Indicate the use of grout or flexible filler.

Anchorage Protection Type: Indicate the anchorage protection type using the requirements stated below.

Use the following guide to determine the appropriate tendon profile for typical strand, wire and bar tendons as applicable.

Filler Material	Tendon Profile	Typical Use
Flexible	F1	Internal tendons in beams, girders, flat slabs or straddle pier caps
	F2	External tendons in box girders
	F3	External tendons in U-girders
	F4	Internal tendons in hammerhead or C-pier caps
	F5	Internal tendons in beams, girders, flat slabs, straddle pier caps or footings
	F6	Internal tendons in hammerhead or C-pier caps
	F7	Internal tendons in beams, girders, flat slabs, straddle pier caps or footings
	F8	Tendons in pier columns or walls
	F9	Tendons in pier columns, webs of box girders or walls
	F10	Internal tendons in hammerhead or C-pier caps
	F11	Internal tendons in beams, girders, flat slabs, straddle pier caps, footings or bottom continuity tendons in box girders constructed using the balanced cantilever method
	F12	Top external continuity tendons in end spans of box girders
	F13	Bottom external continuity tendons in end spans of box girders
	F14	Top external continuity tendons and general use
Grout	G1	Internal tendons in flat slabs
	G2	Transverse internal tendons in the top slabs of box girders
	G3	Longitudinal internal tendons in the top slabs of box girders constructed using the balanced cantilever method
	G4	Internal tendons in single span flat slabs
	G5	General use primarily in deck slabs
	G6	Internal tendons in pier columns, webs of box girders or walls

If necessary, custom tendon profiles may be used and/or the note(s) below the Data Tables may be modified on a project by project basis to better define unusual or unique tendon profiles or arrangements. Custom tendon profiles or modifications to the notes must comply with requirements of the **Structures Manual** and be consistent with the **Specifications**. If custom tendon profiles are used:

1. Detail the tendon profiles in a manner consistent with Index 21801;
2. Label the custom tendon profiles "C1, C2, etc.";
3. Add the following to Footnote 2 beneath the appropriate Data Table if the custom tendon profiles are not shown on the same sheet as the Data Table:
See Sheet BX-XX for "C" tendon profiles.

Indicate the anchorage protection type using the following descriptions in conjunction with the following figure and the details shown on Index 21802.

Type 1 - Anchorage protection used for exposed surfaces for tendons on Segmental Box Girder Superstructures, Integral or Straddle Pier Caps, Footings, or ends of spliced Girder Segments.

Type 2 - Anchorage protection used for tendons anchoring in top flange blockouts.

Type 3A - Top inspected anchorage protection used for cantilever tendons on Segmental Box Girder Superstructures constructed using precast balanced cantilever method.

Type 3B - Top inspected anchorage protection used for cantilever tendons on Segmental Box Girder Superstructures constructed using cast-in-place balanced cantilever method.

Type 4 - Anchorage protection used for tendons on the top surfaces of Piers and for exposed blisters in I-Girders.

Type 5 - Anchorage protection used for tendons with interior blisters on Segmental Box Girder Superstructures.

Type 6 - Anchorage protection used for tendons on Flat Slab Superstructures.

Type 7 - Anchorage protection used for transverse tendons (generally 4 strands or less) on Segmental Box Girder Superstructures and other transversely post-tensioned superstructures.

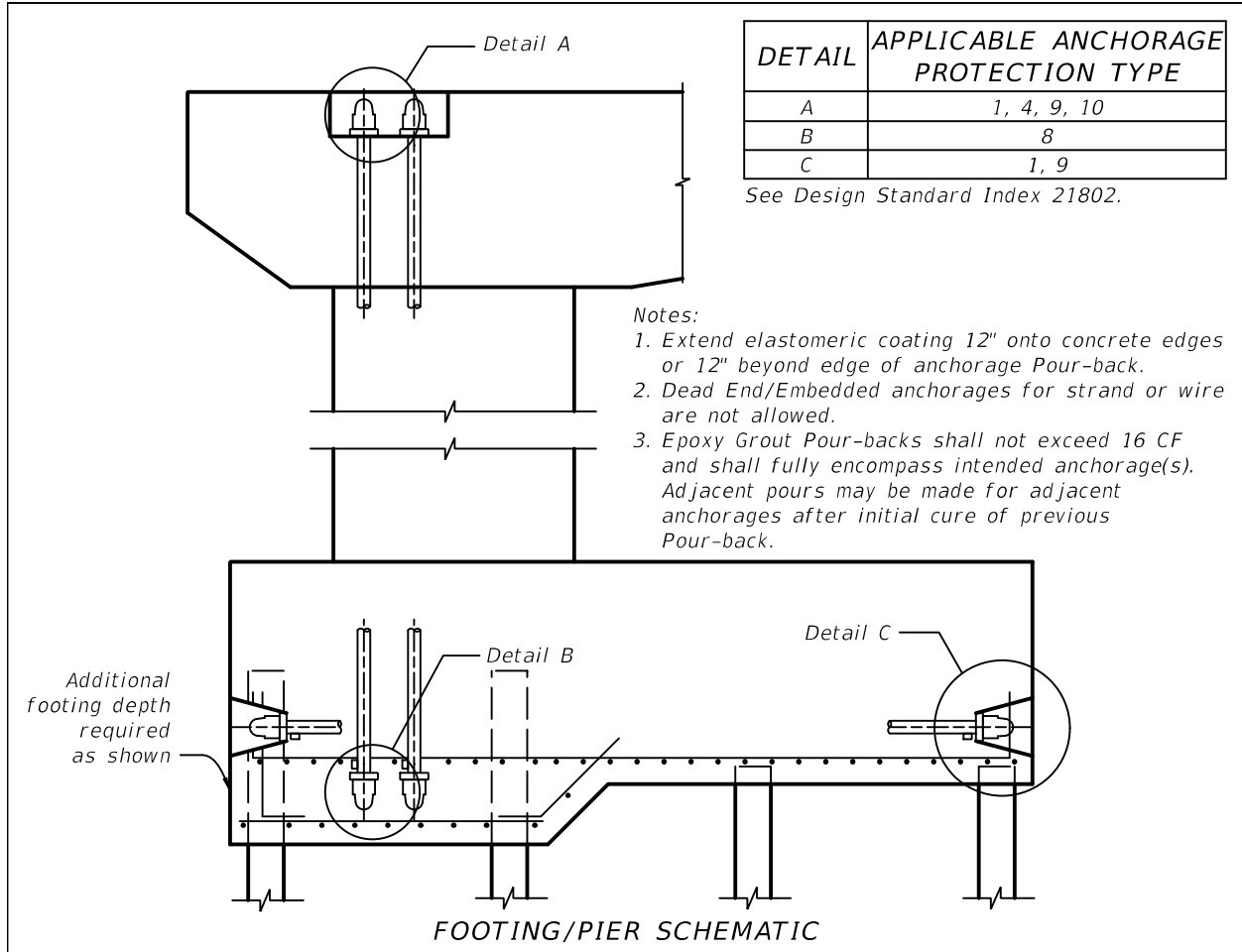
Type 8 - Dead end anchorage protection used for vertical bar tendons.

Type 9 - Anchorage protection used for bar tendons on Segmental Box Girder Pier Diaphragms, Footings, top surfaces of Piers, Integral or Straddle Pier Caps, etc.

Type 10 - Anchorage protection used for bar tendons on the top surfaces of Piers.

Types 11 & 12 - Anchorage protection used for bar tendons primarily on Integral or Straddle Pier Caps.

Anchorage Protection Types for Footing and Pier Post-Tensioning Applications



Payment

Item number	Item description	Unit Measure
462-2-AA	Post Tensioning Tendons	LB
462-3	Additional Post Tensioning in Segmental Box Span <i>Note: Use for rehabilitation projects only</i>	EA

Figure 1 Post-Tensioning Bar Tendon Data Table

POST-TENSIONING BAR TENDON DATA TABLE											Table Date 07-01-16	
BAR DESIGNATION	NO. REQUIRED	BAR SIZE	BAR LENGTH (Ft-in)	STRESSING FORCE PER BAR (kips)	STRESSING END ¹	ELONGATION (in)	TENDON PROFILE ²	FILLER MATERIAL	ANCHORAGE PROTECTION TYPE ³			
									AHEAD STA.	BACK STA.		

For non-longitudinal bars, ahead-station denotes left anchorage, back-station denotes right anchorage (looking ahead-station). For mostly vertical bars, ahead-station denotes top anchorage, back-station denotes bottom anchorage.

¹ Stressing End Definitions:
 - Ahead Station: Bar Live/Stressing End is ahead-station anchorage.
 - Back Station: Bar Live/Stressing End is back-station anchorage.

² See Post-Tensioning Tendon Profiles, Design Standards Index 21801.

³ See Post-Tensioning Anchorage Protection, Design Standards Index 21802.

Figure 2 Post-Tensioning Strand Tendon Data Table

POST-TENSIONING STRAND TENDON DATA TABLE													Table Date 07-01-16	
TENDON DESIGNATION	NO. REQUIRED	TENDON SIZE	TENDON LENGTH (Ft-in)	AHEAD-STATION STRESSING FORCE PER TENDON (kips)	BACK-STATION STRESSING FORCE PER TENDON (kips)	FORCE @ AHEAD-STATION END AFTER ANCHOR SET (kips)	FORCE @ BACK-STATION END AFTER ANCHOR SET (kips)	STRESSING END ¹	THEORETICAL ELONGATION @ AHEAD-STATION END (in)	THEORETICAL ELONGATION @ BACK-STATION END (in)	TENDON PROFILE ²	FILLER MATERIAL	ANCHORAGE PROTECTION TYPE ³	
													AHEAD STA.	BACK STA.

In general, for non-longitudinal tendons, ahead-station denotes left anchorage, back-station denotes right anchorage (looking ahead-station). For mostly vertical tendons, ahead-station denotes top anchorage, back-station denotes bottom anchorage.

¹ Stressing End Definitions:
 - Ahead Station: Tendon Live/Stressing End is ahead-station anchorage.
 - Back Station: Tendon Live/Stressing End is back-station anchorage.
 - Alternate (ahead/back): Tendon Initial Live/Stressing End is ahead-station anchorage with associated elongation.
 Tendon Subsequent Live/Stressing End is back-station anchorage with associated elongation.
 - Alternate (back/ahead): Tendon Initial Live/Stressing End is back-station anchorage with associated elongation.
 Tendon Subsequent Live/Stressing End is ahead-station anchorage with associated elongation.
 - Double: Tendon Live/Stressing End is simultaneously the ahead-station and back-station anchorage with respective elongations.

² See Post-Tensioning Tendon Profiles, Design Standards Index 21801.

³ See Post-Tensioning Anchorage Protection, Design Standards Index 21802.

Sample Tables:

POST-TENSIONING BAR TENDON DATA TABLE										Table Date 07-01-16	
BAR DESIGNATION	NO. REQUIRED	BAR SIZE	BAR LENGTH (Ft-in)	STRESSING FORCE PER BAR (kips)	STRESSING END ¹	ELONGATION (in)	TENDON PROFILE ²	FILLER MATERIAL	ANCHORAGE PROTECTION TYPE ³		
									AHEAD STA.	BACK STA.	
PT-1	6	1¼ Ø	21'-9"	131	AHEAD STA.	0.940"	G5	GROUT	10	10	
PT-2	8	1½ Ø	16'-6"	165	BACK STA.	0.713"	G5	GROUT	10	10	
PT-3	24	1¾ Ø	80'-0"	280	BACK STA.	3.540"	F14	FLEXIBLE	9	8	

For non-longitudinal bars, ahead-station denotes left anchorage, back-station denotes right anchorage (looking ahead-station). For mostly vertical bars, ahead-station denotes top anchorage, back-station denotes bottom anchorage.

¹ Stressing End Definitions:

- Ahead Station: Bar Live/Stressing End is ahead-station anchorage.
- Back Station: Bar Live/Stressing End is back-station anchorage.

² See Post-Tensioning Tendon Profiles, Design Standards Index 21801.

³ See Post-Tensioning Anchorage Protection, Design Standards Index 21802.

POST-TENSIONING STRAND TENDON DATA TABLE													Table Date 07-01-16	
TENDON DESIGNATION	NO. REQUIRED	TENDON SIZE	TENDON LENGTH (Ft-in)	AHEAD-STATION STRESSING FORCE PER TENDON (kips)	BACK-STATION STRESSING FORCE PER TENDON (kips)	FORCE @ AHEAD-STATION END AFTER ANCHOR SET (kips)	FORCE @ BACK-STATION END AFTER ANCHOR SET (kips)	STRESSING END ¹	THEORETICAL ELONGATION @ AHEAD-STATION END (in)	THEORETICAL ELONGATION @ BACK-STATION END (in)	TENDON PROFILE ²	FILLER MATERIAL	ANCHORAGE PROTECTION TYPE ³	
													AHEAD STA.	BACK STA.
1	6	12-0.6	650'-0¾"	562.5	562.5	454.9	468.9	Alt. (back/ahead)	10.9	32.2	F1	FLEXIBLE	1	1
2	6	12-0.6	650'-1¾"	562.5	562.5	456.3	456.3	Alt. (back/ahead)	10.8	31.6	F1	FLEXIBLE	1	1
3	6	12-0.6	650'-3¾"	562.5	562.5	458.4	459.8	Alt. (back/ahead)	10.6	31.0	F1	FLEXIBLE	1	1
4	6	12-0.6	650'-6¼"	562.5	562.5	465.4	465.4	Alt. (back/ahead)	10.6	30.3	F1	FLEXIBLE	1	1

In general, for non-longitudinal tendons, ahead-station denotes left anchorage, back-station denotes right anchorage (looking ahead-station). For mostly vertical tendons, ahead-station denotes top anchorage, back-station denotes bottom anchorage.

¹ Stressing End Definitions:

- Ahead Station: Tendon Live/Stressing End is ahead-station anchorage.
- Back Station: Tendon Live/Stressing End is back-station anchorage.
- Alternate (ahead/back): Tendon Initial Live/Stressing End is ahead-station anchorage with associated elongation.
Tendon Subsequent Live/Stressing End is back-station anchorage with associated elongation.
- Alternate (back/ahead): Tendon Initial Live/Stressing End is back-station anchorage with associated elongation.
Tendon Subsequent Live/Stressing End is ahead-station anchorage with associated elongation.
- Double: Tendon Live/Stressing End is simultaneously the ahead-station and back-station anchorage with respective elongations.

² See Post-Tensioning Tendon Profiles, Design Standards Index 21801.

³ See Post-Tensioning Anchorage Protection, Design Standards Index 21802.