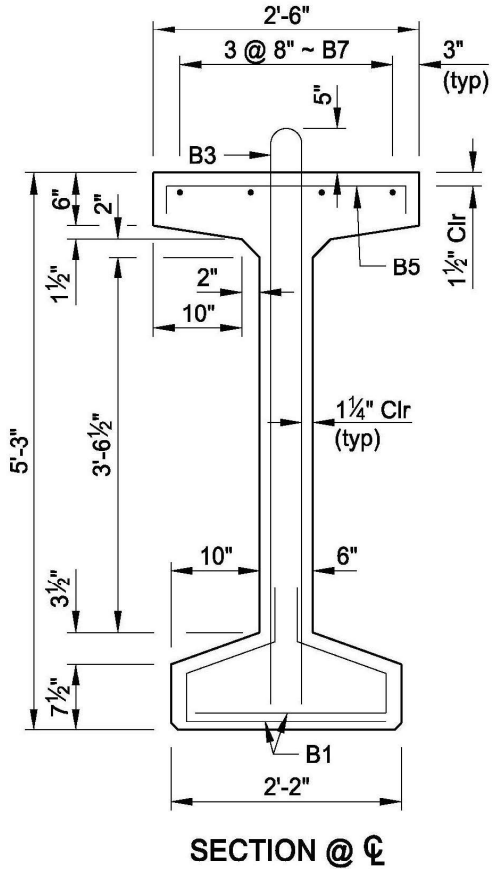
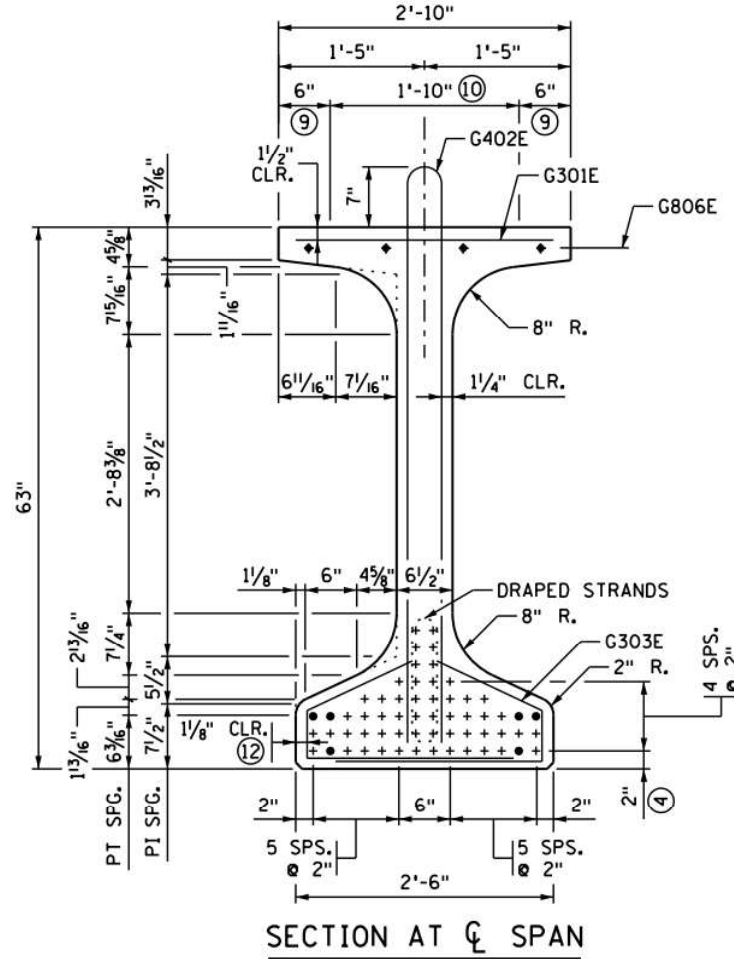


PRESTRESSED CONCRETE BEAMS

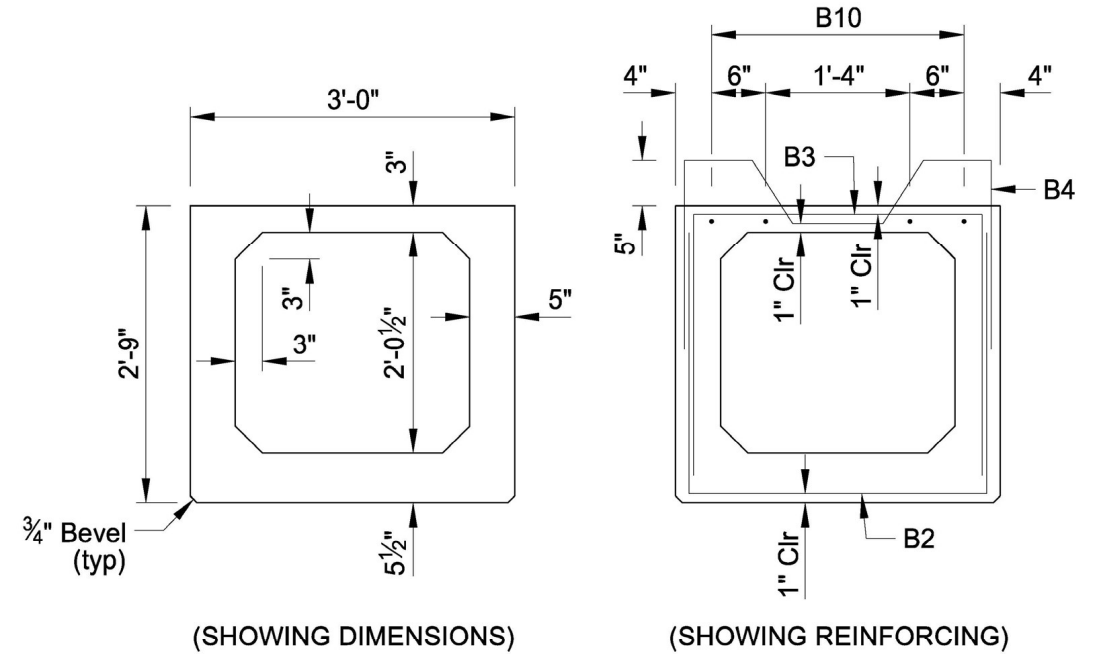
BEAM SHAPES



TYPE M I-GIRDER



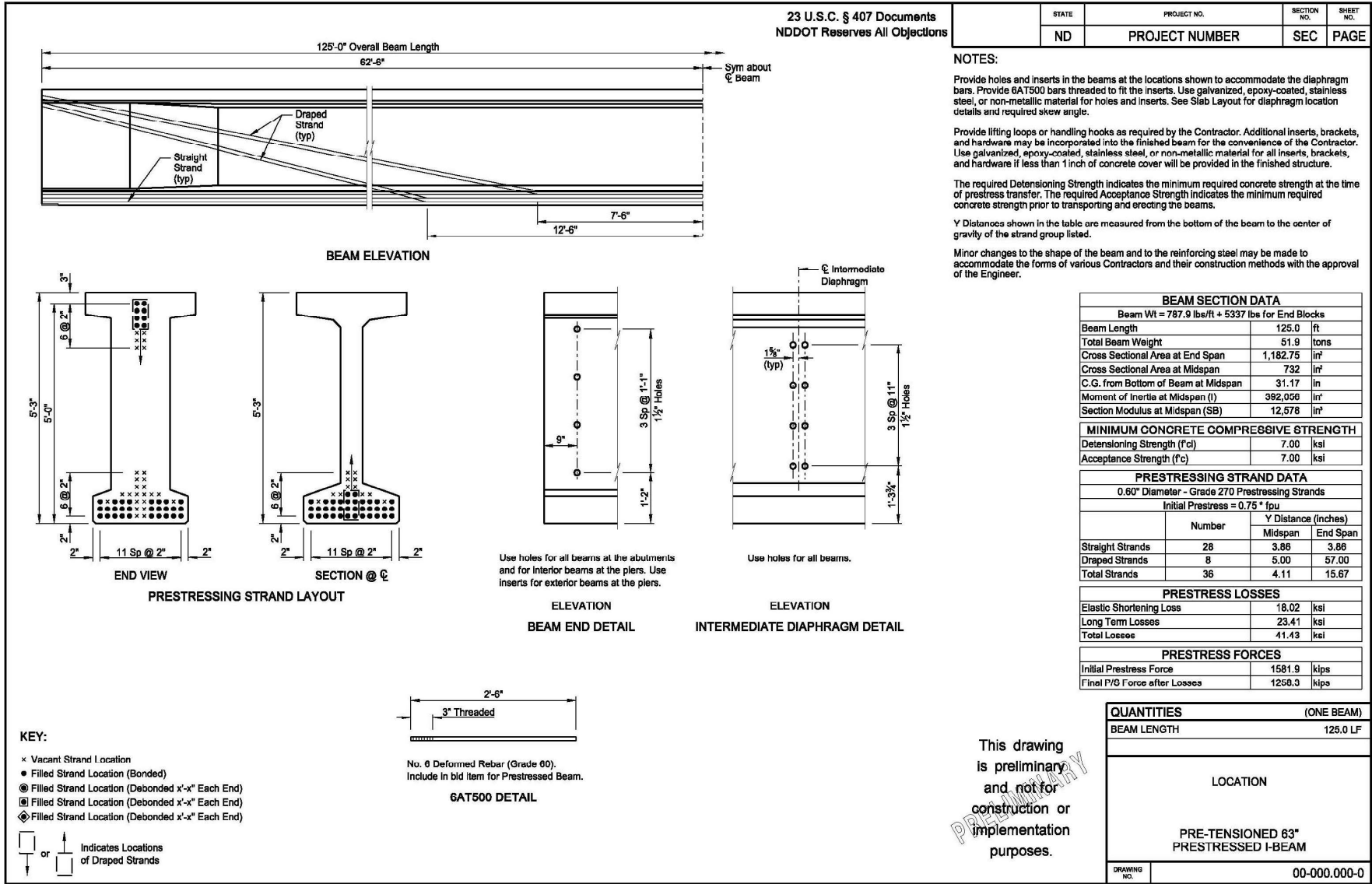
TYPE MN I-GIRDER



PRESTRESSED BOX BEAMS

PRESTRESSED CONCRETE BEAMS

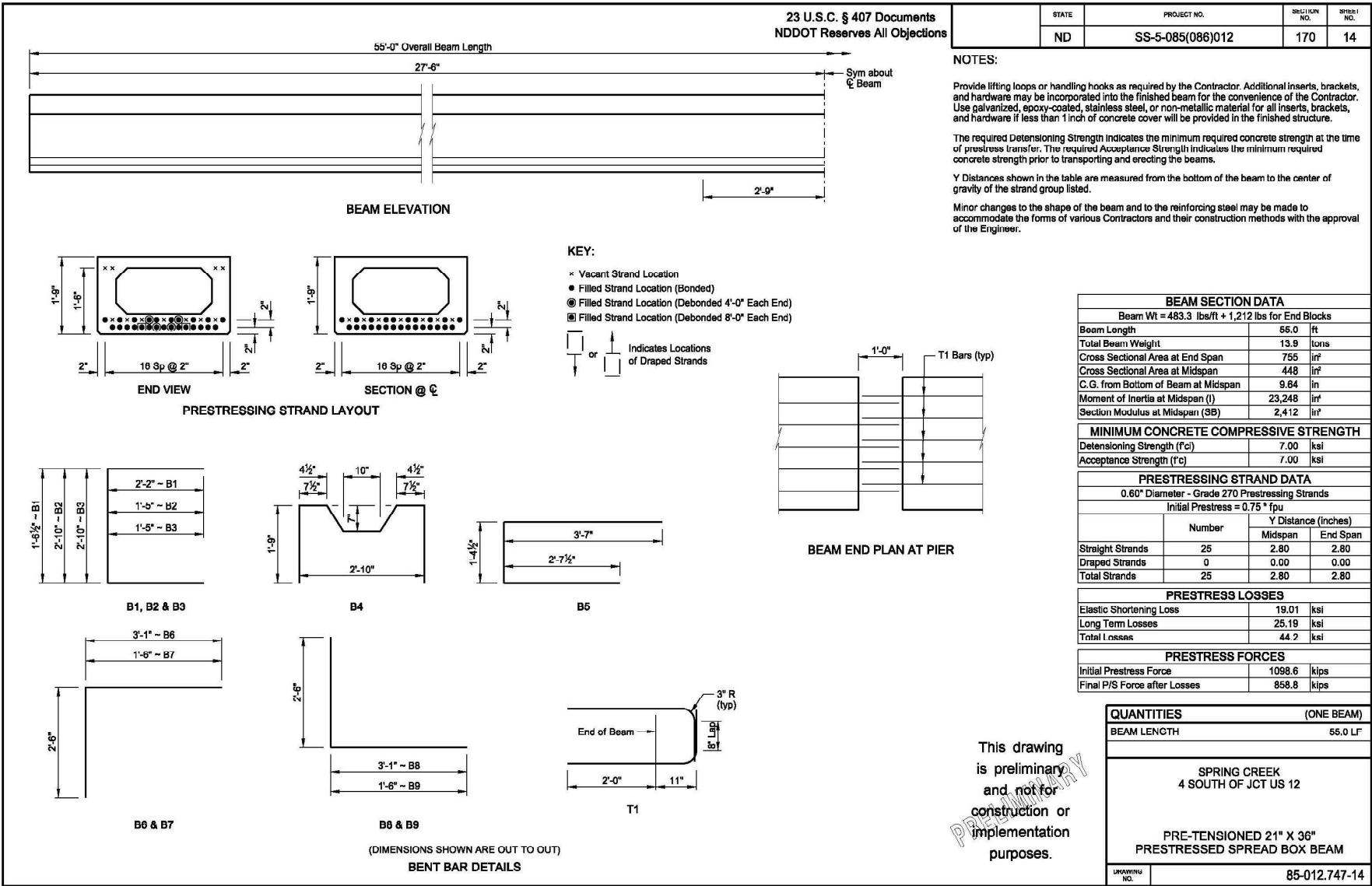
DESIGN PROCESS



FULL GIRDER DESIGN

- Used for project at Sterling Interchange constructed in 2025
- Will see new process on future projects
- All Design Data and Details, including P/S Strand Pattern, fully designed and detailed in the plans
- Need to add diagram for predicted camber?

PRESTRESSED CONCRETE BEAMS DESIGN PROCESS

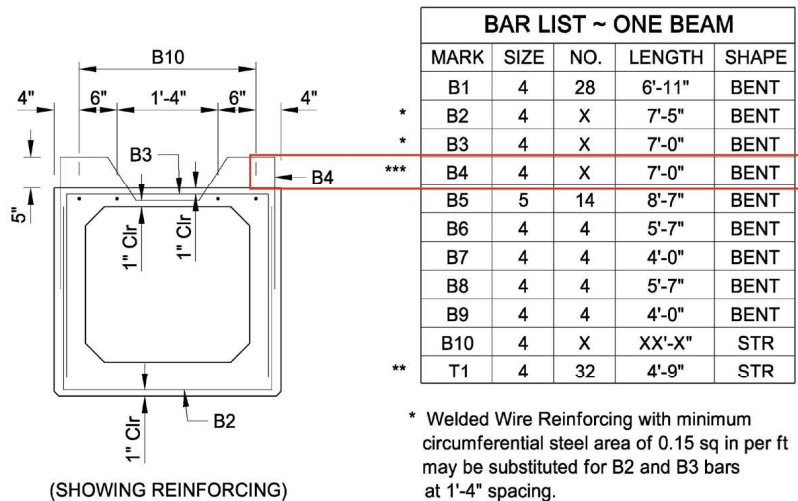


FULL GIRDER DESIGN

- New box beam sheets developed for project to be bid for 2026 construction
- All Design Data and Details, including P/S Strand Pattern, fully designed and detailed in the plans
- Need to add diagram for predicted camber?

PRESTRESSED CONCRETE BEAMS

BEAM DETAILS



BAR LIST ~ ONE BEAM				
MARK	SIZE	NO.	LENGTH	SHAPE
B1	4	28	6'-11"	BENT
B2	4	X	7'-5"	BENT
B3	4	X	7'-0"	BENT
B4	4	X	7'-0"	BENT
B5	5	14	8'-7"	BENT
B6	4	4	5'-7"	BENT
B7	4	4	4'-0"	BENT
B8	4	4	5'-7"	BENT
B9	4	4	4'-0"	BENT
B10	4	X	XX'-X"	STR
T1	4	32	4'-9"	STR

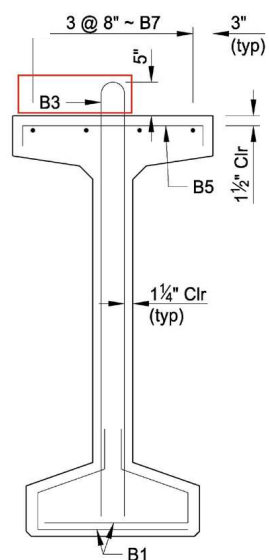
** Field bend as shown with a 2½" minimum bar bend diameter (Grade 60).

*** Epoxy Coated

BAR LIST ~ ONE BEAM				
MARK	SIZE	NO.	LENGTH	SHAPE
B1	3	X	3'-9"	BENT
B2	3	34	2'-10"	BENT
B3	4	X	11'-6"	BENT
B4	4	16	8'-5"	BENT
B5	3	X	2'-9"	BENT
B6	5	8	6'-11"	BENT
B7	5	X	XX'-X"	STR
B8	5	24	4'-0"	STR

* Field bend as shown (Grade 40).

** Epoxy Coated.



GIRDER DETAILS

- Reinforcing steel extending out of the girders into the bridge deck needs to be epoxy coated.
- Inserts, brackets, and hangers permanently incorporated into the girders need to be galvanized, epoxy-coated, stainless steel, or other non-metallic material.

NOTES:

Provide holes and inserts in the beams at the locations shown to accommodate the diaphragm bars. Provide 6AT500 bars threaded to fit the inserts. Use galvanized, epoxy-coated, stainless steel, or non-metallic material for holes and inserts. See Slab Layout for diaphragm location details and required skew angle.

Provide lifting loops or handling hooks as required by the Contractor. Additional inserts, brackets, and hardware may be incorporated into the finished beam for the convenience of the Contractor. Use galvanized, epoxy-coated, stainless steel, or non-metallic material for all inserts, brackets, and hardware if less than 1 inch of concrete cover will be provided in the finished structure.

PRESTRESSED CONCRETE BEAMS

NEW BEAM DETAILS

REBAR BEND DIAMETER – AASHTO vs. CRSI

- NDDOT Std Specs require rebar to be fabricated in accordance with CRSI Manual of Standard Practice
- Current CRSI Manual requires larger bend diameter for stirrups & ties
- Use of larger bend diameter requires either change to location of P/S strands or reduction to clear cover in bottom flange
- NDDOT preference is to continue to use the smaller bend diameter previously used by CRSI and still in use by ACI and AASHTO.
- Added a note to the beam sheets specifying the required bend radius for each bar size used in the P/S beams

Table 1. Comparison of minimum inside diameters of bends for 90-degree bend of stirrups and ties

Reinforcing bar size	CRSI ¹ Table 7-2	ACI 318-19 ² Table 25.3.2	AASHTO ³ Table 5.10.2.3-1	ASTM A615/A615M-20 ⁴ Table 3 pin diameter
No. 3	2 in. ($5.3d_b$)	$4.0d_b$	$4.0d_b$	$3.5d_b$ for Grades 40 and 60
No. 4	2½ in. ($5.0d_b$)	$4.0d_b$	$4.0d_b$	
No. 5	3¼ in. ($5.2d_b$)	$4.0d_b$	$4.0d_b$	$5.0d_b$ for Grades 80 and 100

Note: d_b = reinforcing bar diameter. AASHTO and ACI 318-19 require $6.0d_b$ for general-use bars. This table does not apply to galvanized or epoxy-coated reinforcing bars.

Table: Dr. Krista Brown.

NOTES:

All bar dimensions shown are out-to-out.

Unless noted otherwise, bend bars to the bend diameter (D) listed below.

#3 Bar- D = 1½"

#4 Bar- D = 2"

#5 Bar- D = 2½"

BAR LIST ~ ONE BEAM				
MARK	SIZE	NO.	LENGTH	SHAPE
B1	3	X	3'-9"	BENT
B2	3	34	2'-10"	BENT
** B3	4	X	11'-6"	BENT
B4	4	16	8'-5"	BENT
B5	3	X	2'-9"	BENT
B6	5	8	6'-11"	BENT
B7	5	X	XX'-X"	STR
* B8	5	24	4'-0"	STR

* Field bend as shown (Grade 40).

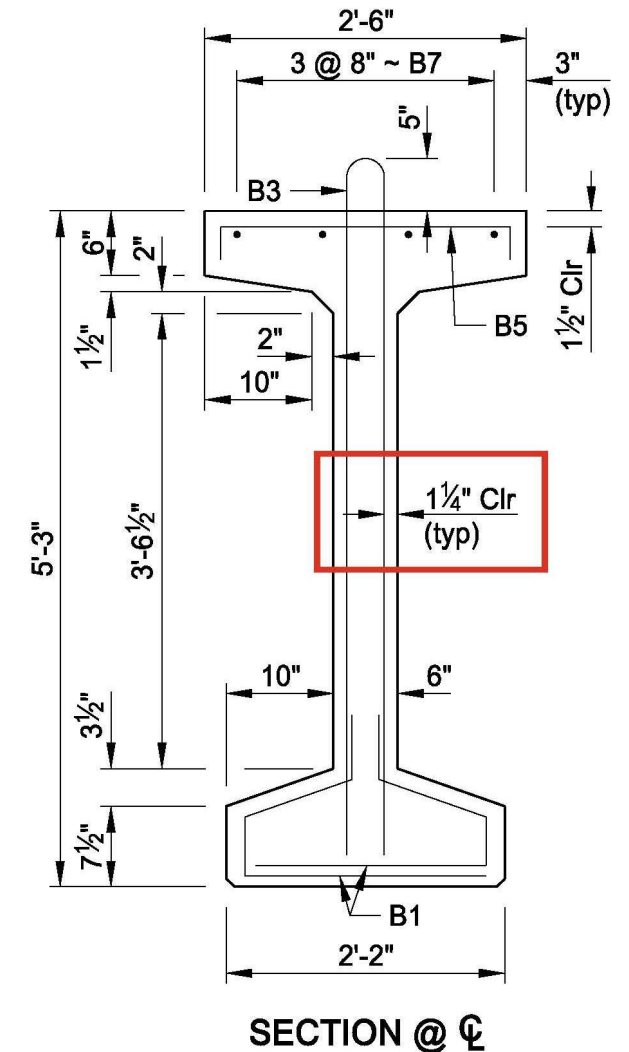
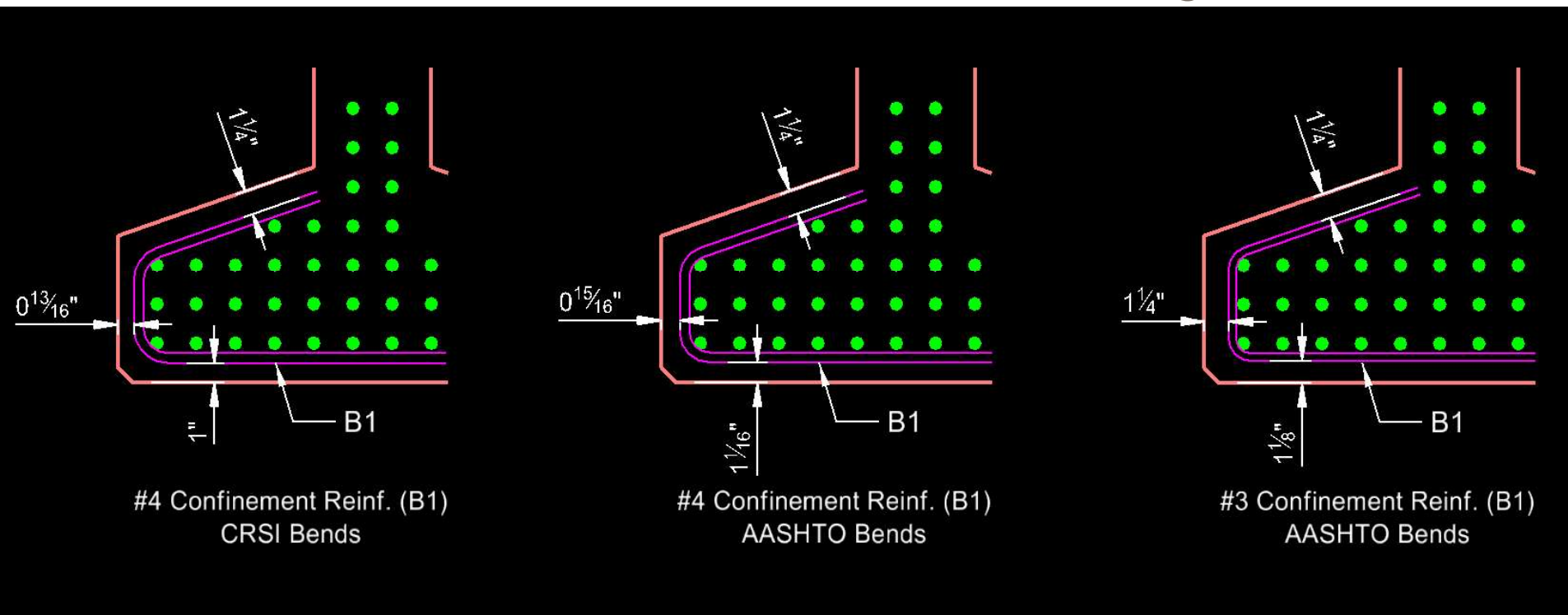
** Epoxy Coated.

PRESTRESSED CONCRETE BEAMS

NEW BEAM DETAILS

I-GIRDER BOTTOM FLANGE REINFORCEMENT

- Detail sheet specifies 1 1/4" cover required to all surfaces
- CADD drawings with rebar drawn to correct diameter and bends showed less than 1" of cover provided to B1 bars in bottom flange
- Use of larger bend diameter requires either change to location of P/S strands or reduction in clear cover in bottom flange

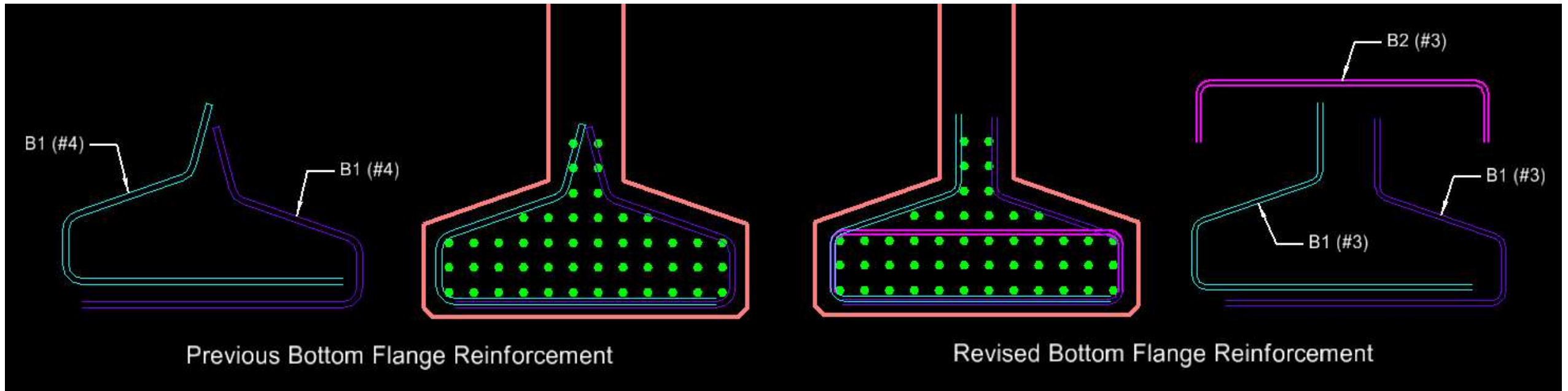


PRESTRESSED CONCRETE BEAMS

NEW BEAM DETAILS

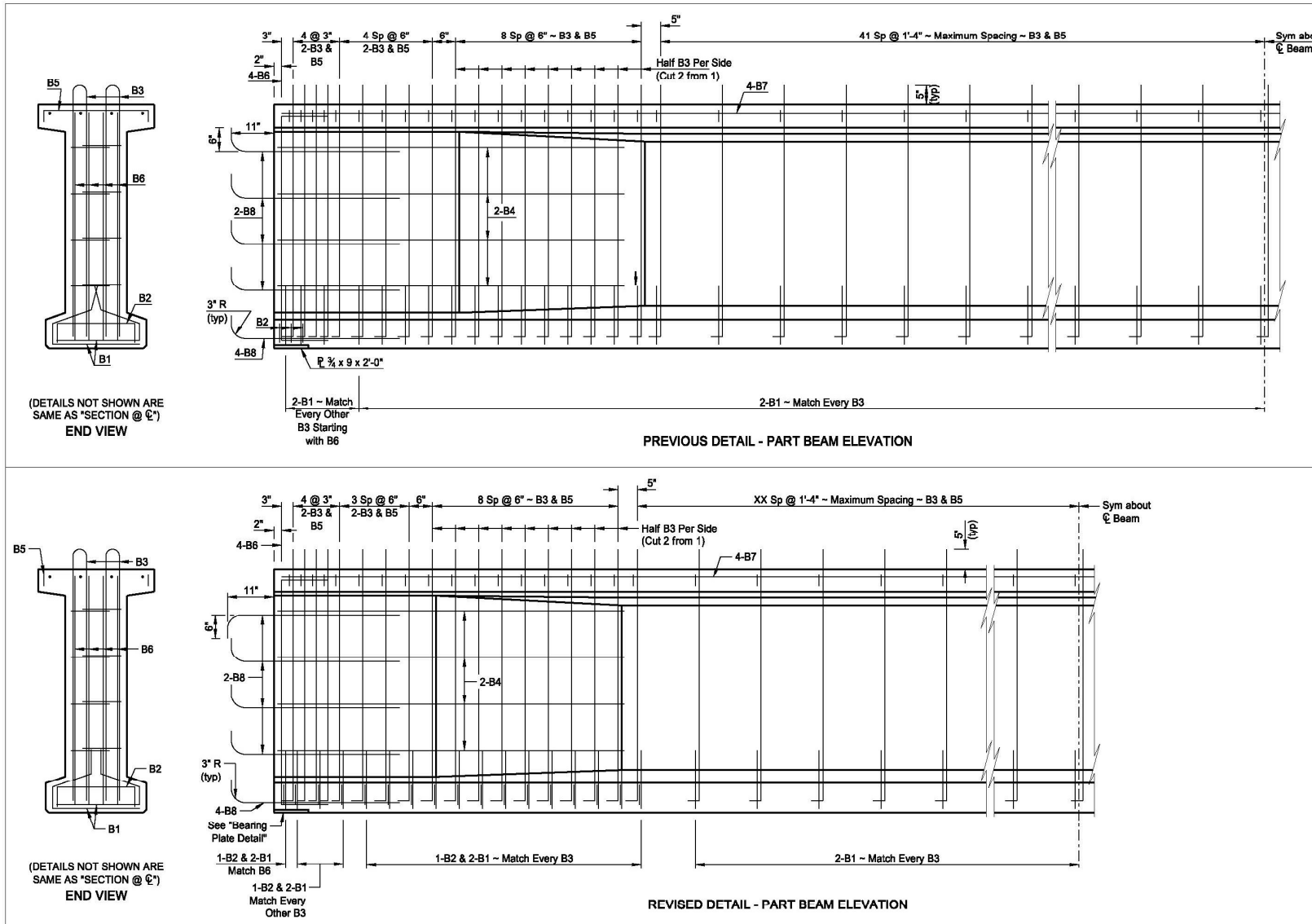
I-GIRDER BOTTOM FLANGE REINFORCEMENT

- Changes to meet AASHTO requirements for confinement reinforcement
 - B1 bar changed to #3 bar (AASHTO Min for confinement)
 - Modified B2 to be placed for distance of $1.5(H)$ from girder ends
 - Modified top leg of B1 to vertical to avoid conflict with draped strands



PRESTRESSED CONCRETE BEAMS

NEW BEAM DETAILS

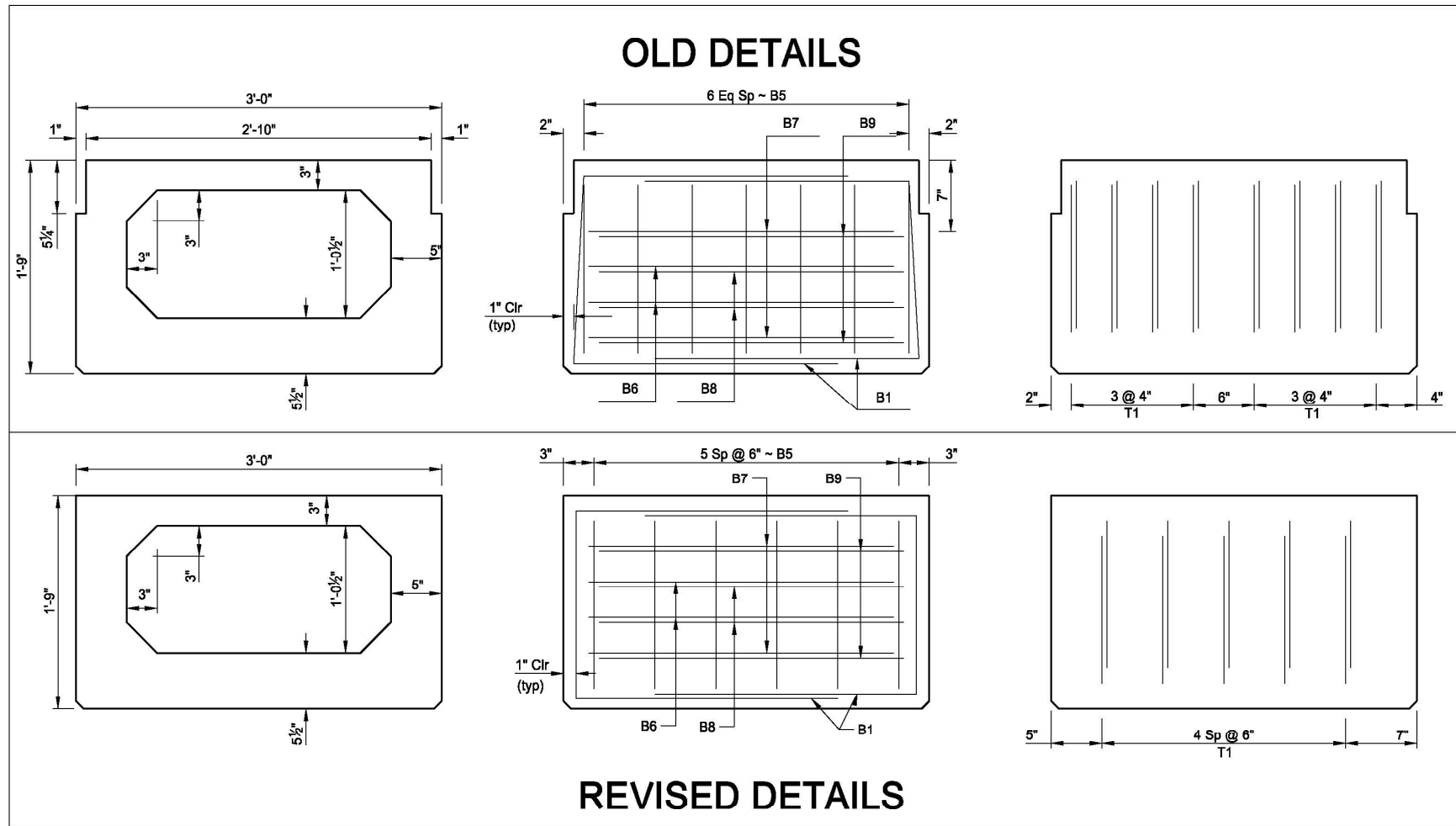


I-GIRDER BOTTOM FLANGE REINFORCEMENT

- Spacing changes for B1 & B2 bars
- B1 continues to be provided full length – 6" max spaces within 1.5(H) from beam ends
- B2 bars provided as additional confinement reinforcement within 1.5(H) from beam ends only

PRESTRESSED CONCRETE BEAMS

NEW BOX BEAM DETAILS

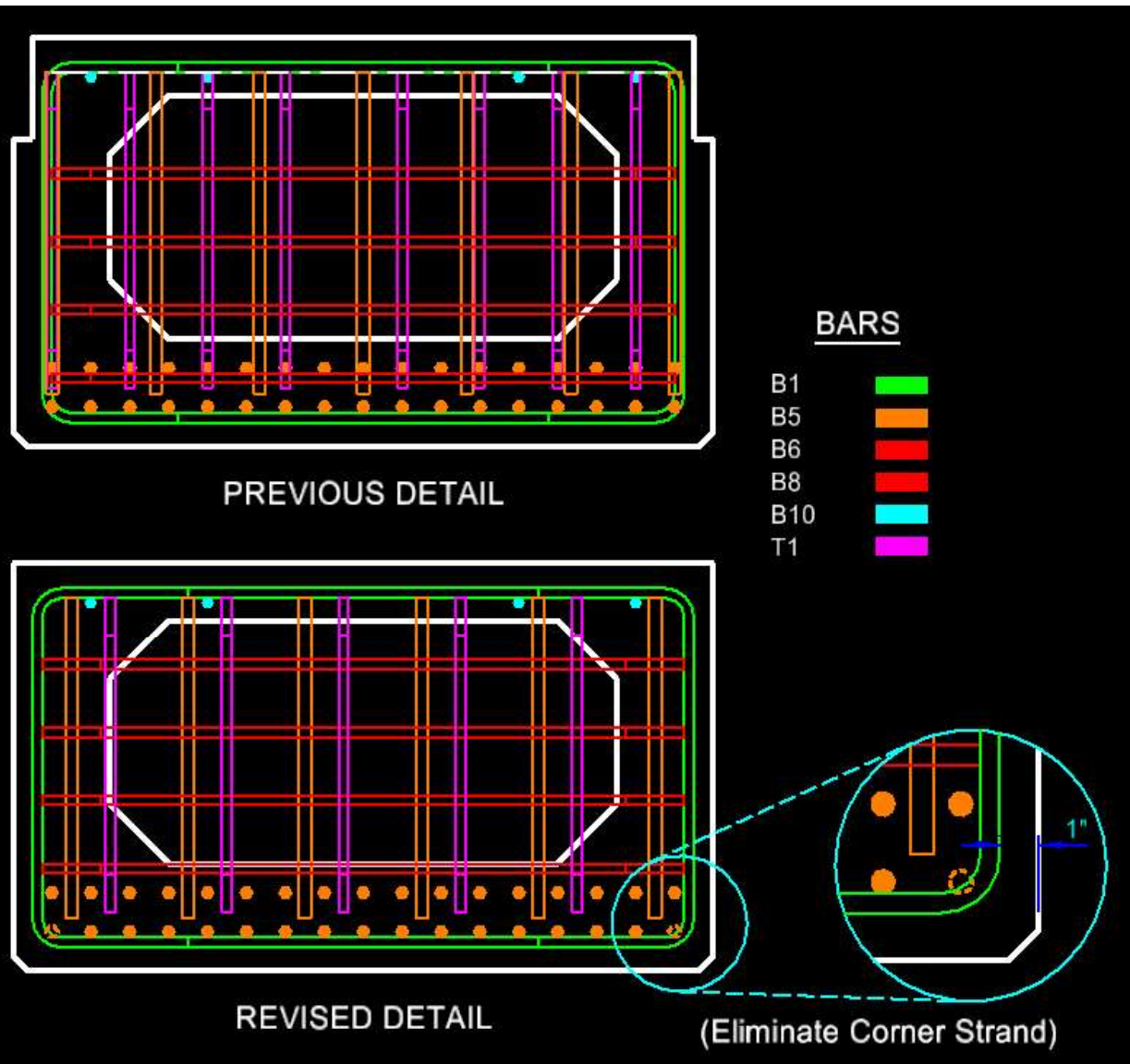


BOX BEAM CHANGES

- Eliminated formwork notch from tops of beams – No longer needed by Contractors in ND
- Will simplify detailing and placement of transverse reinf
- Reduced the number of bars at beam ends – B5 & T1 bars
- Re-spaced some bars to avoid conflicts with other bars and P/S strands.

PRESTRESSED CONCRETE BEAMS

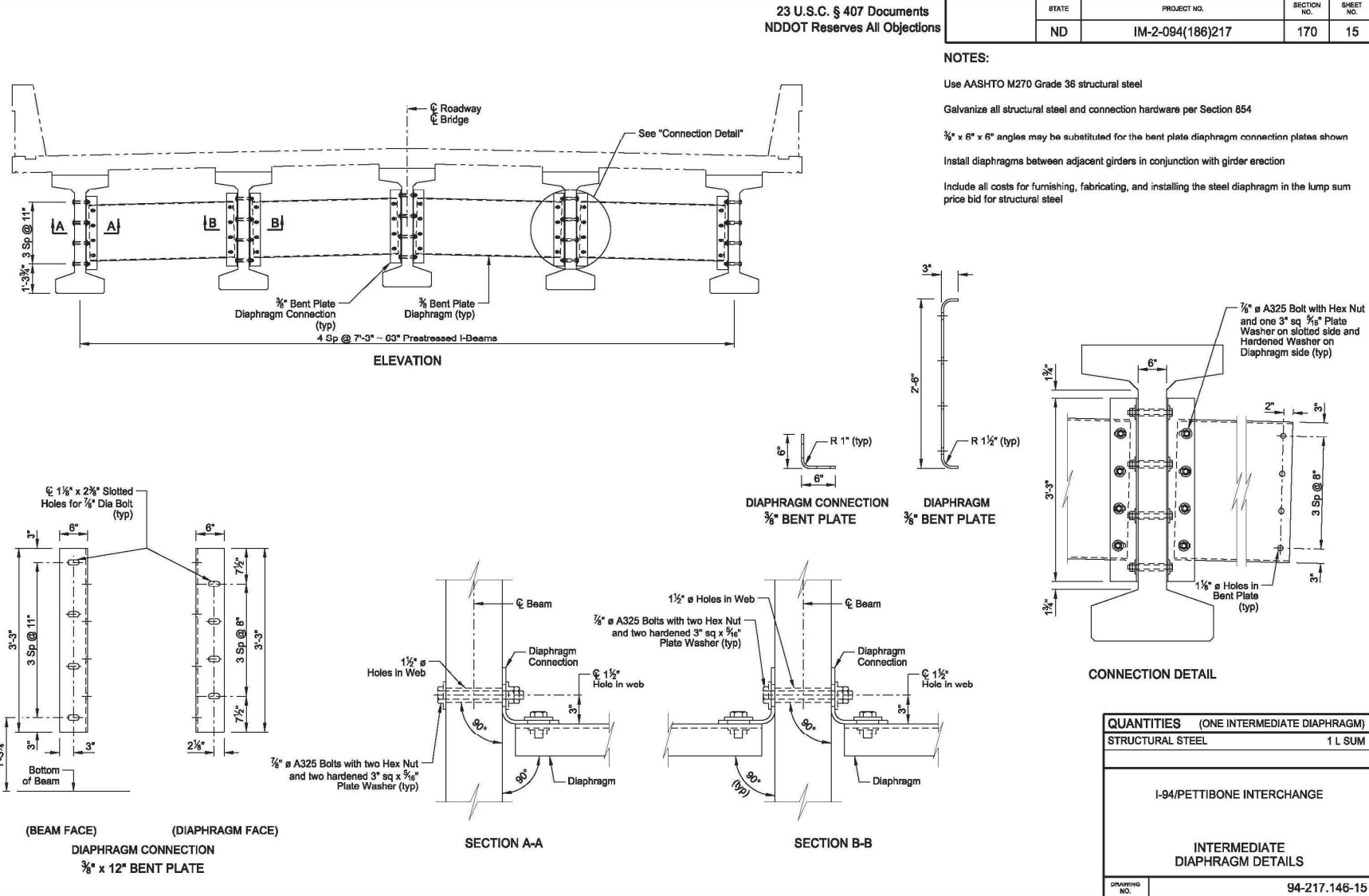
NEW BOX BEAM DETAILS



BOX BEAM CHANGES

- Spacing shown in previous detail resulted in a lot of conflicts requiring modifications by fabricators
- Forming bracket made it difficult to obtain 1" min clear cover and confine P/S strands
- Proposing to eliminate bottom corner strand from use to achieve proper clear cover to B1 bars with all strands confined

PRESTRESSED CONCRETE BEAMS I-GIRDER INTERMEDIATE DIAPHRAGMS



INTERMEDIATE DIAPHRAGMS

- Changed to steel bent plate diaphragms for upcoming project
- No significant changes to P/S beam fabrication
- Slight change to hole spacing for intermediate diaphragms
- Holes through webs will be used for interior and exterior beams

QUESTIONS & DISCUSSION

