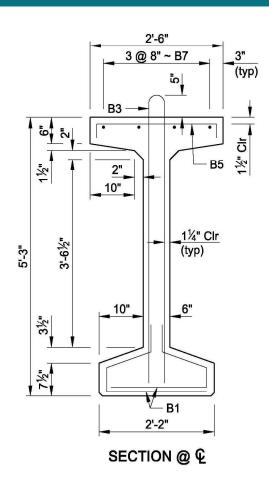
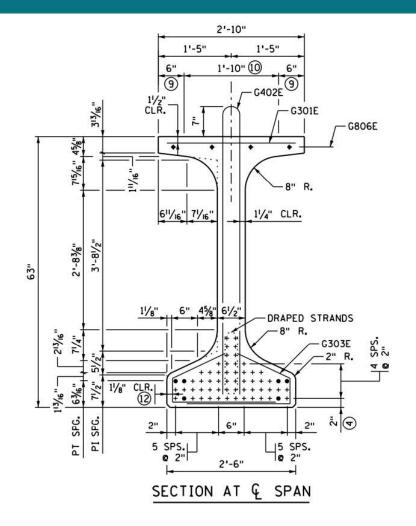
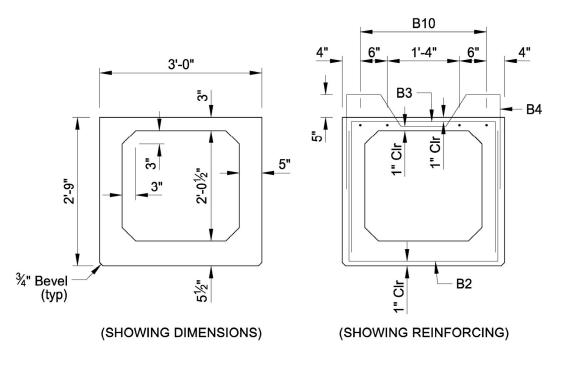
PRESTRESSED CONCRETE BEAMS BEAM SHAPES







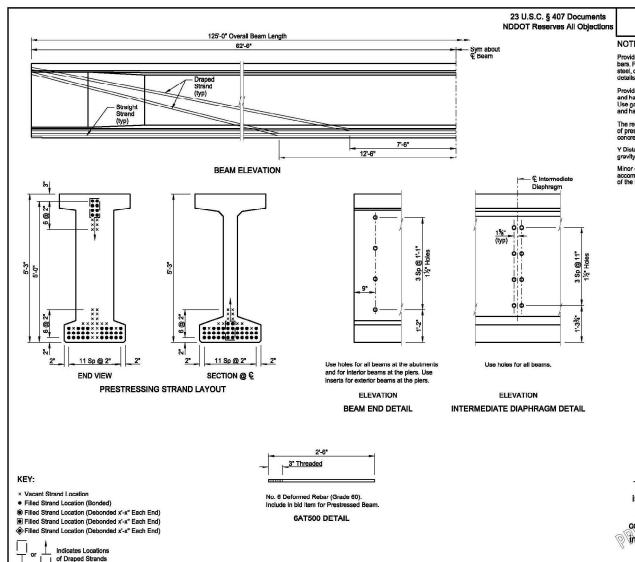
PRESTRESSED BOX BEAMS

TYPE M I-GIRDER

TYPE MN I-GIRDER



PRESTRESSED CONCRETE BEAMS **DESIGN PROCESS**



SEC PAGE ND PROJECT NUMBER

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 galavanced, epoxy-costed, stainless tisel, or non-metallic material for holes and inserts. See Slab Layout for diaphragm location

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, tware if less than 1 inch of concrete cover will be provided in the finished structure

The required Detensioning Strength indicates the minimum required concrete strength at the time of prestress transfer. The required Acceptance Strength indicates the minimum required concrete strength prior to transporting and erecting the beams.

Y Distances shown in the table are measured from the bottom of the beam to the center of gravity of the strand group listed.

Minor changes to the shape of the beam and to the reinforcing steel may be made to accommodate the forms of various Contractors and their construction methods with the approva

В	EAM SECTION	DATA	
Beam Wt = 7	787.9 lbs/ft + 5337 l	bs for End Bl	ocks
Beam Length	125.0	ft	
Total Beam Weight		51.9	tons
Cross Sectional Area	1,182.75	in²	
Cross Sectional Area	732	in²	
C.G. from Bottom of	31.17	in	
Moment of Inertia at	392,056	in'	
Section Modulus at N	12,578	in³	
MINIMUM CONG	CRETE COMPR	E88IVE 81	RENGTH
Detensioning Strengt	th (f'ci)	7.00	ksi
Acceptance Strength	7.00	ksi	
PRES"	TRESSING STR	AND DATA	1
0.60" Diame	ter - Grade 270 Pre	estressing Str	ands
Ir	nitial Prestress = 0.7	75 * fpu	
	Number	Y Distance (inches)	
	Number	Midspan	End Span
Straight Strands	28	3.86	3.86
Draped Strands	8	5.00	57.00
Total Strands	36	4.11	15.67
P	RESTRESS LO	SSES	
Elastic Shortening Lo	18.02	ksi	
Long Term Losses	23.41	ksi	
Total Losses	41.43	ksi	
Р	RESTRESS FO	RCES	
Initial Prestress Force	1581.9	kips	
Final P/S Force after	1258.3	kips	

This drawing is preliminary and not for construction or implementation purposes.

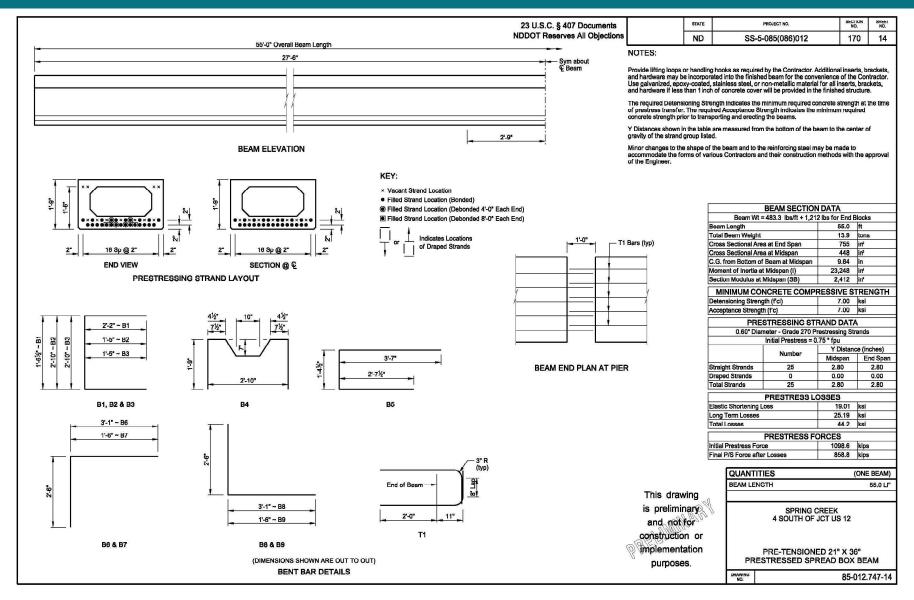
QUANTITIES BEAM LENGTH 125.0 LF LOCATION PRE-TENSIONED 63" PRESTRESSED I-BEAM 00-000.000-0

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?



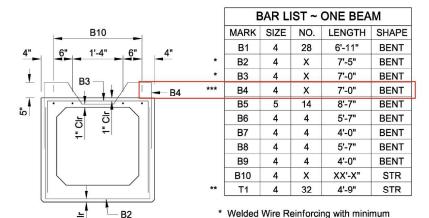
PRESTRESSED CONCRETE BEAMS DESIGN PROCESS



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?





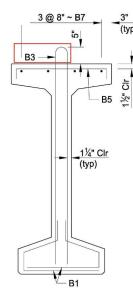
(SHOWING REINFORCING)

- circumferential steel area of 0.15 sq in per ft may be substituted for B2 and B3 bars at 1'-4" spacing.
- ** Field bend as shown with a $2\frac{1}{2}$ " minimum bar bend diameter (Grade 60).

*** Epoxy Coated

BAR LIST ~ ONE BEAM				
MARK	SIZE	NO.	LENGTH	SHAPE
B1	3	Х	3'-9"	BENT
B2	3	34	2'-10"	BENT
** B3	4	Х	11'-6"	BENT
B4	4	16	8'-5"	BENT
B5	3	Х	2'-9"	BENT
В6	5	8	6'-11"	BENT
B7	5	Х	XX'-X"	STR
* B8	5	24	4'-0"	STR

^{*} Field bend as shown (Grade 40)



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.



^{**} Epoxy Coated.

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	CRSI¹Table 7-2	ACI 318-19 ² Table 25.3.2	AASHTO³ Table 5.10.2.3-1	ASTM A615/ A615M-20 ⁴ Table 3 pin diameter
No. 3 No. 4	2 in. $(5.3d_b)$ 2½ in. $(5.0d_b)$	4.0 <i>d</i> _b 4.0 <i>d</i> _b	$4.0d_b$ $4.0d_b$	$3.5d_b$ for Grades 40 and $605.0d_b for Grades80$ and 100
No. 5	3¼ in. (5.2d _b)	$4.0d_b$	$4.0d_b$	

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,

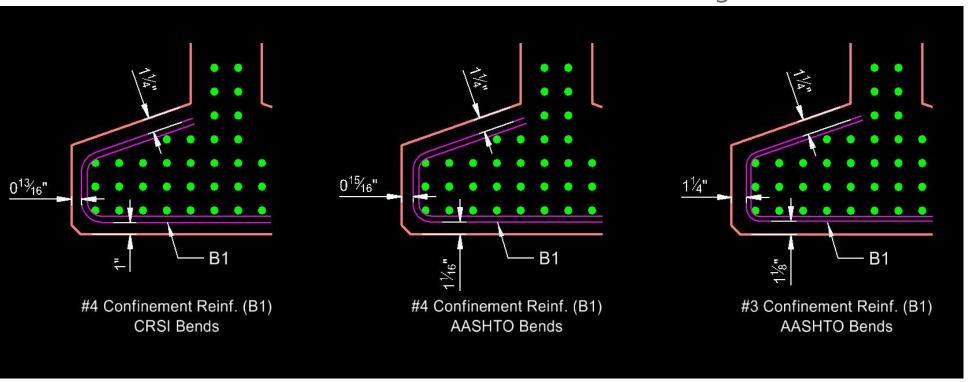
BAR LIST ~ ONE BEAM					
MARK	SIZE	NO.	LENGTH	SHAPE	
B1	3	X	3'-9"	BENT	
B2	3	34	2'-10"	BENT	
** B3	4	X	11'-6"	BENT	
B4	4	16	8'-5"	BENT	
B5	3	Х	2'-9"	BENT	
В6	5	8	6'-11"	BENT	
B7	5	Х	XX'-X"	STR	
* B8	5	24	4'-0"	STR	

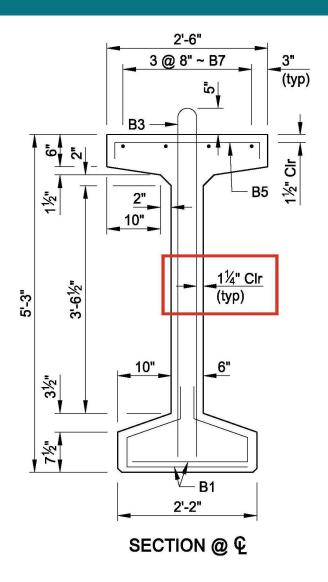
Fleld bend as shown (Grade 40).

^{**} Epoxy Coated.

I-GIRDER BOTTOM FLANGE REINFORCEMENT

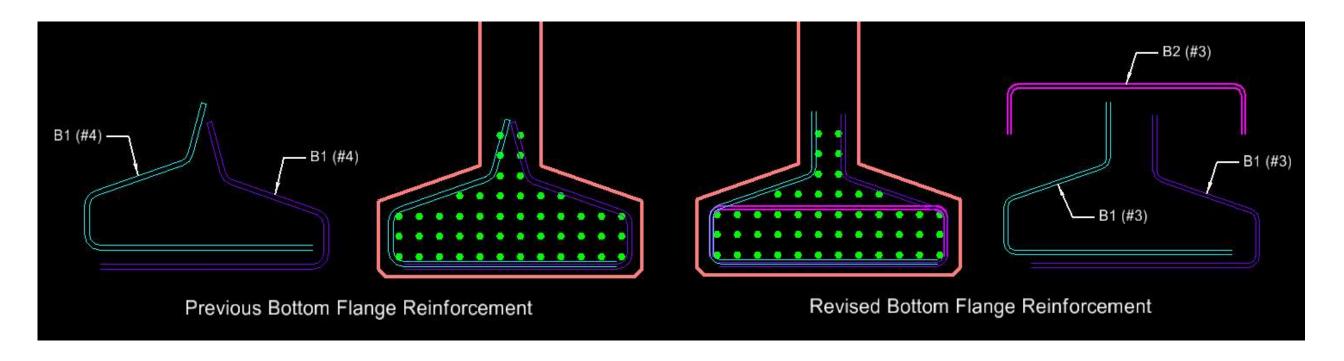
- Detail sheet specifies 1 ¼" cover required to all surfaces
- CADD drawings with rebar drawn to correct diameter and bends showed less than 1" of cover provided to B1 bars in bottom flange
- Use of larger bend diameter requires either change to location of P/S strands or reduction in clear cover in bottom flange

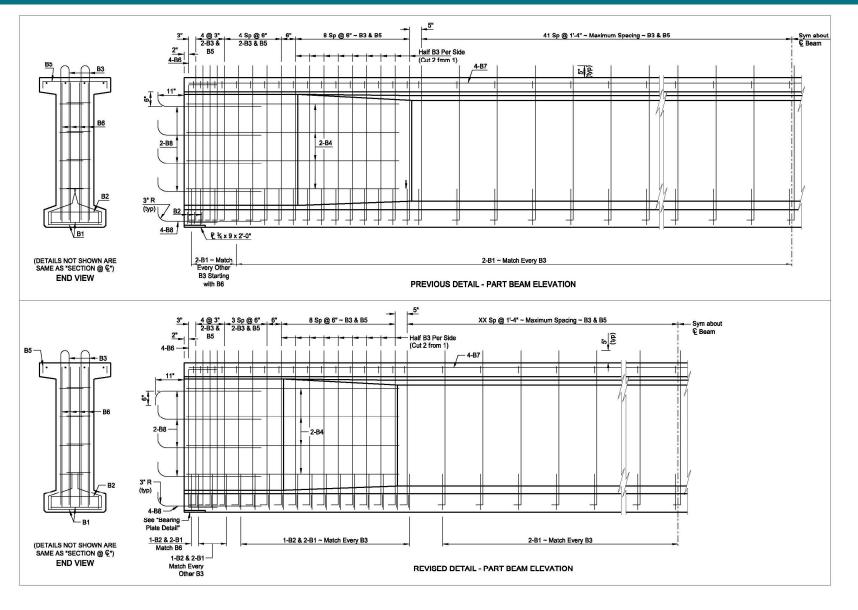




I-GIRDER BOTTOM FLANGE REINFORCEMENT

- 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

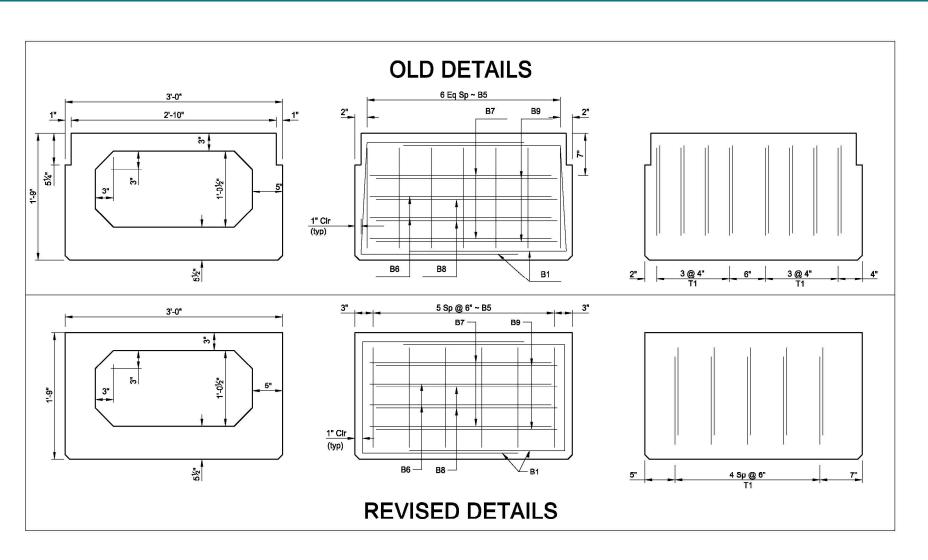




I-GIRDER BOTTOM FLANGE REINFORCEMENT

- 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

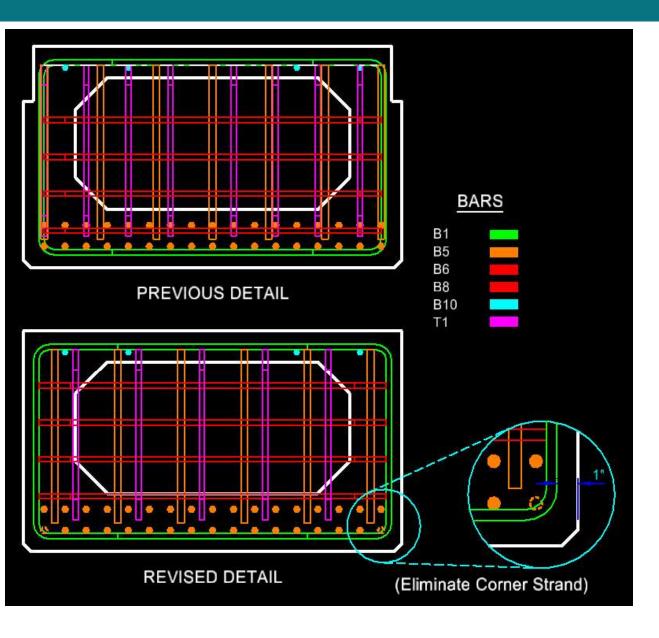




BOX BEAM CHANGES

- 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.



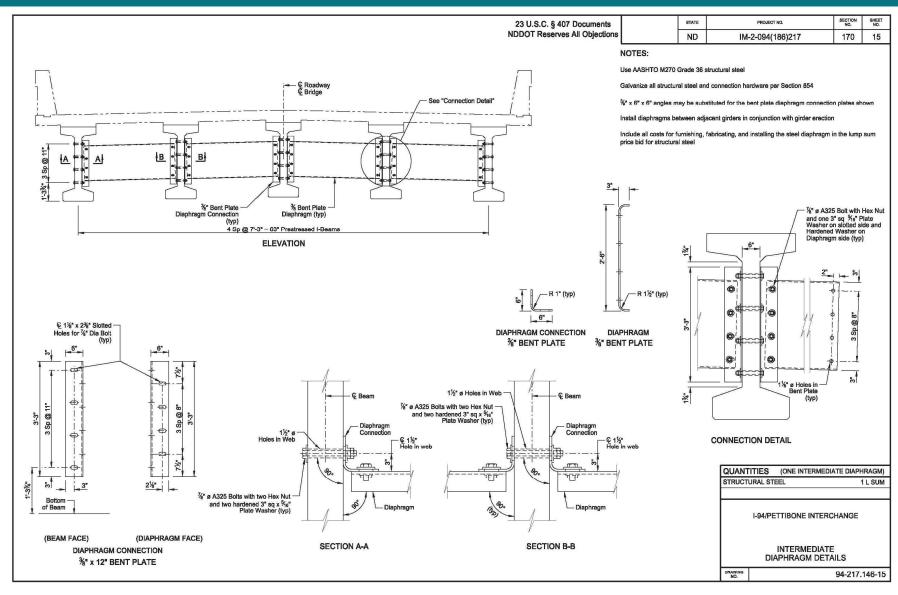


BOX BEAM CHANGES

- 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

