INTEGRAL POST-TENSIONED PIER CAP - A SOLUTION TO SKEW AND CLEARANCE PROBLEMS

SR-16 CENTER ST. BRIDGE
UNION AVE. TO JACKSON AVE. – HOV PROJECT

Lou H. Tran, P.E.
Washington State Department of Transportation

Geometric Challenges

CONSTRAINTS

- Vertical and Horizontal Alignments
- Approaches
- Construction
- Aesthetics

AVANTAGES OF USING POST-TENSIONED CAP BEAM

Geometric Aspect

- Eliminate Skew
- Increase vertical clearance
- Reduce the bridge embankments
- Provide Aesthetics

Structural Aspect

- Provide lighter crossbeam
- Design efficient girders
- Enhance the EQ resistance

Fabrication/Construction Aspects

- Provide simple fabrication
- Provide simple erection

- Maintenance Aspect
- Eliminate bearings at intermediate piers

- Cost Aspect
- Provide short term and long term saving

Reinforced Concrete Single Columns Pier Caps

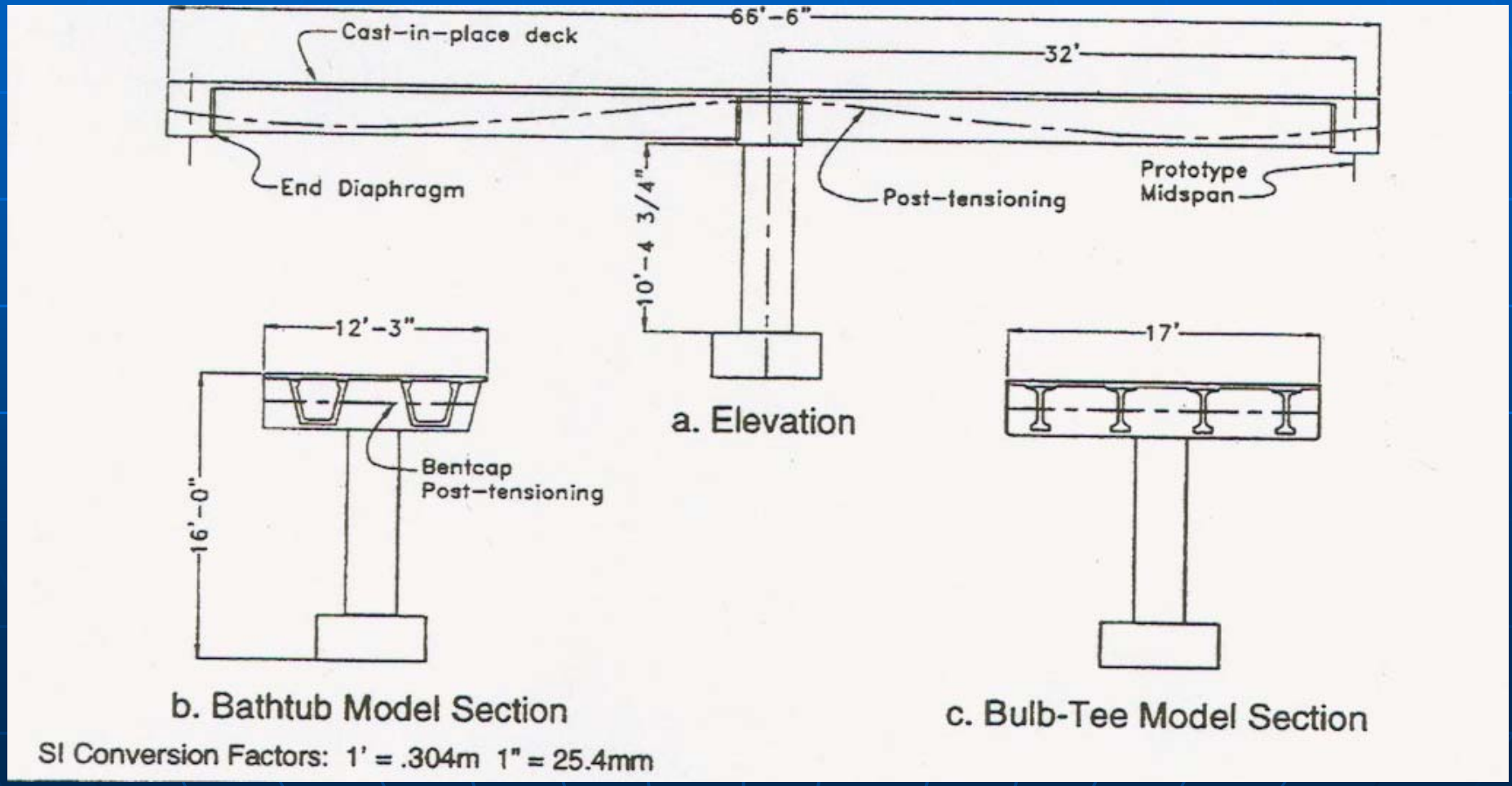
Reinforced Concrete Multi-Column Pier Caps

P/T Integral Single Column Pier Caps

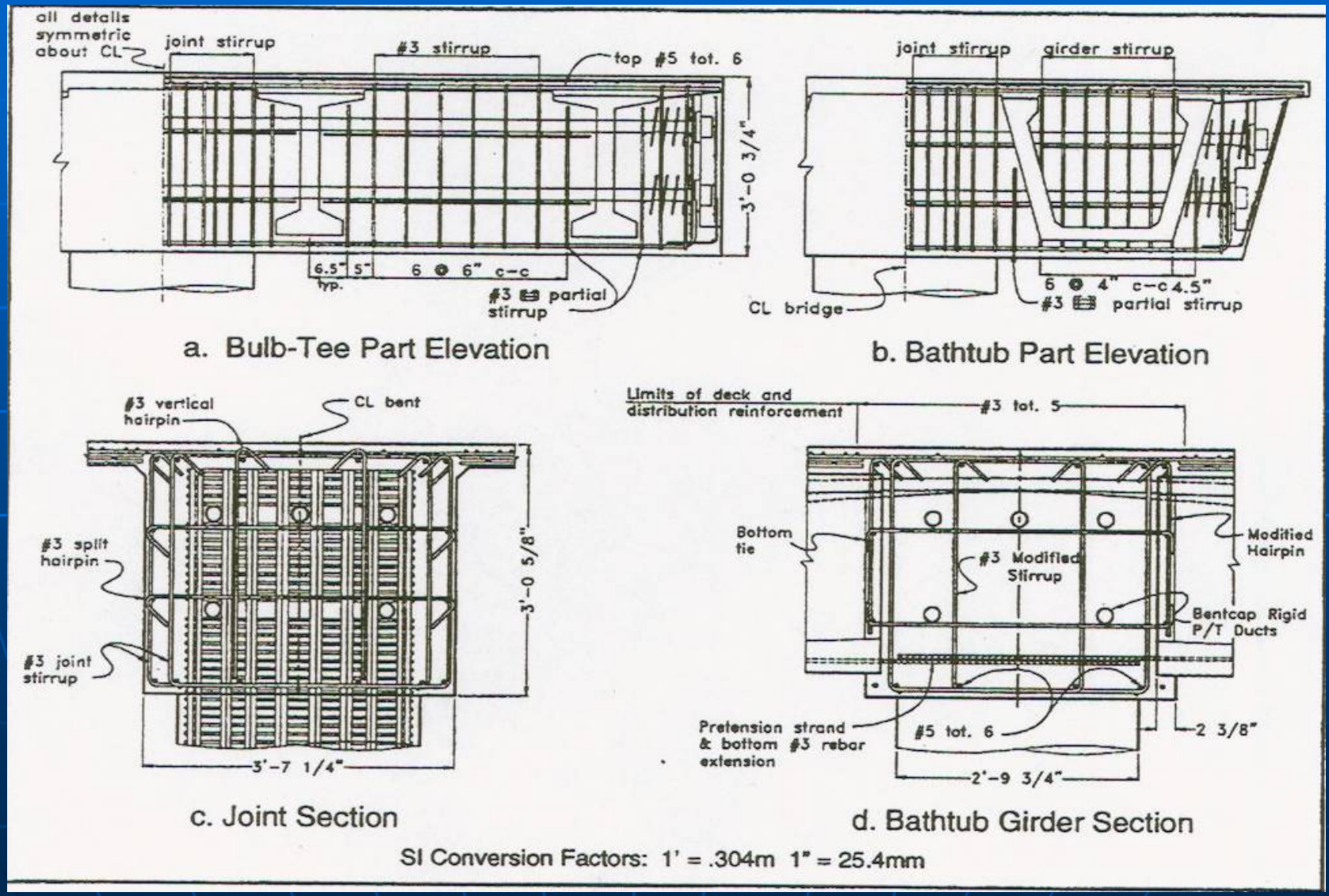
P/T Integral Single Column Pier Caps

P/T Integral Multiple Column Pier Caps

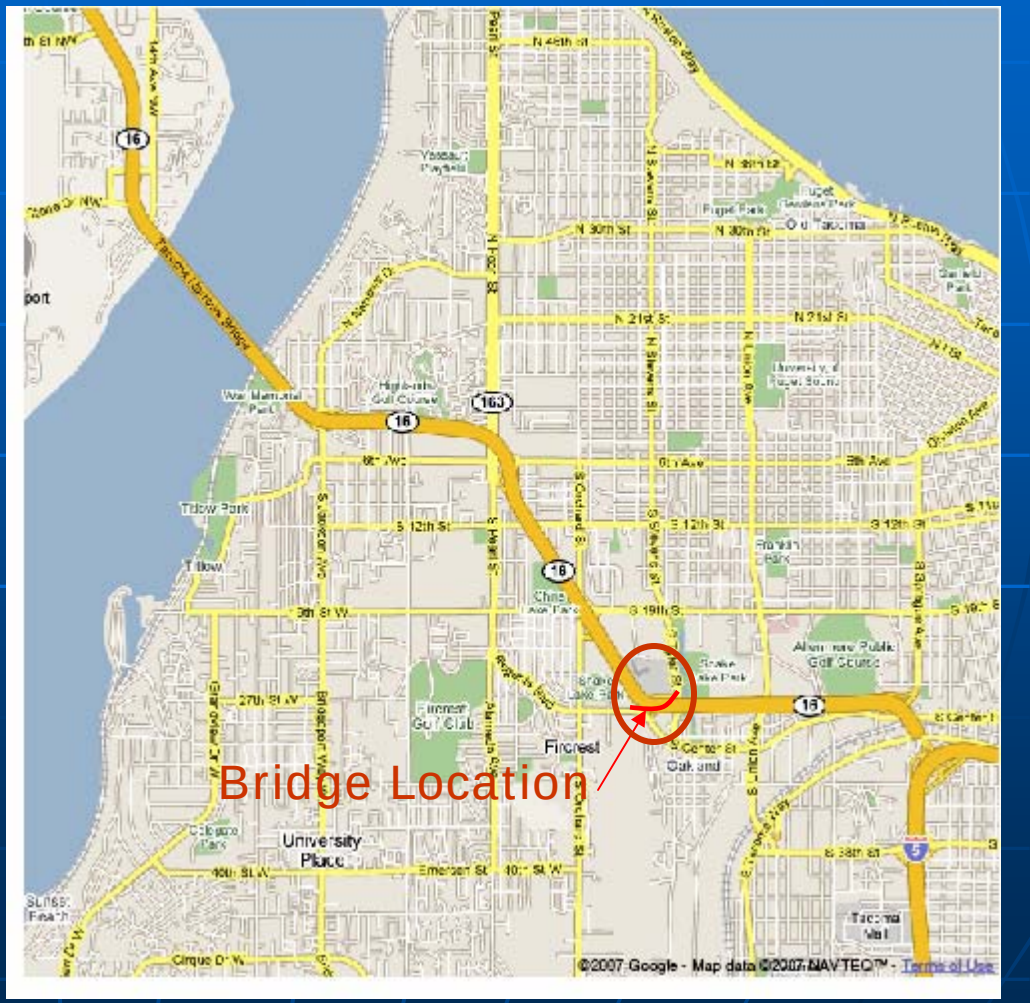
P/T Integral Single Column Pier Cap - Concrete Structure



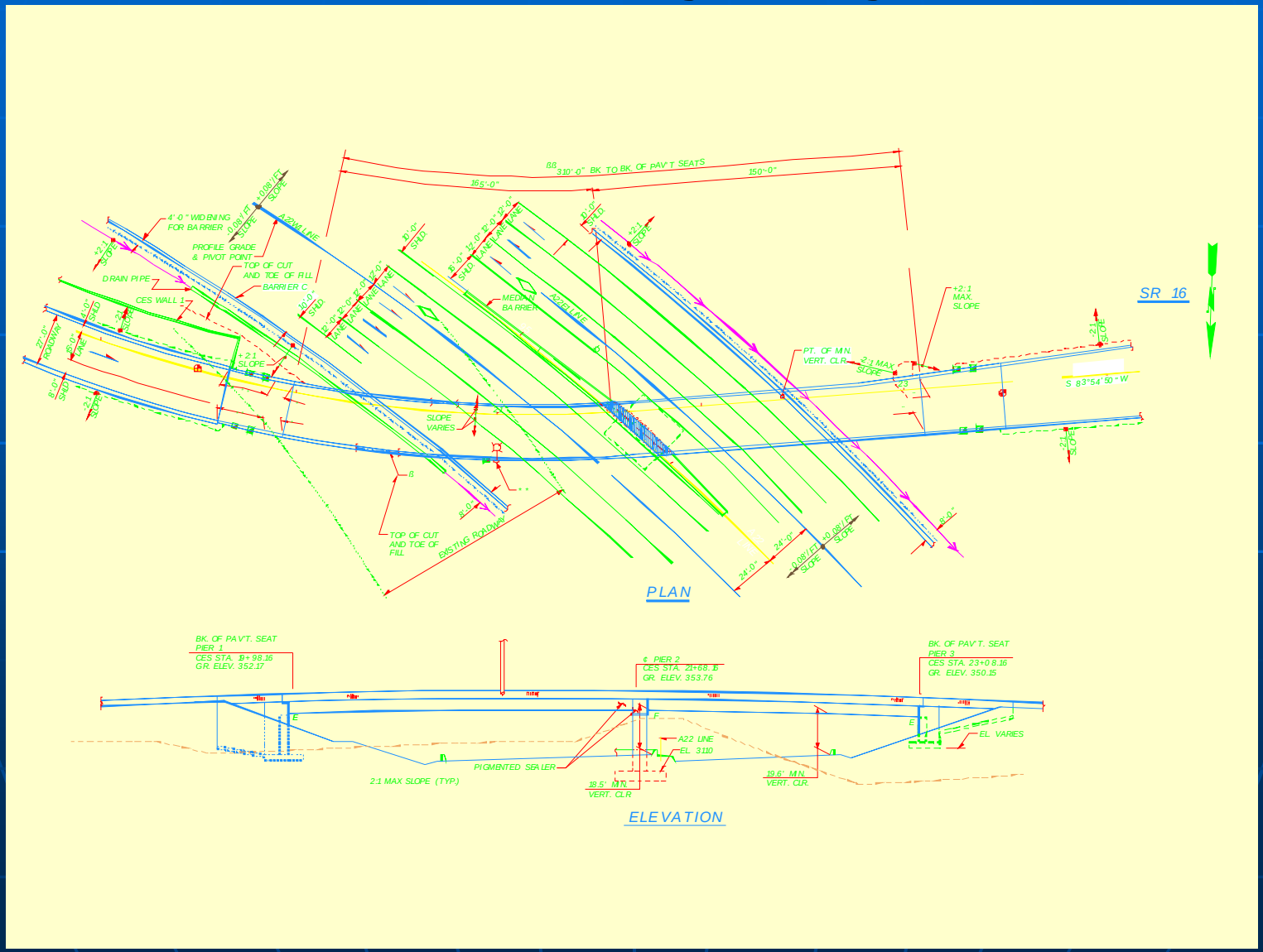
P/T Integral Single Column Pier Cap - Concrete Structure



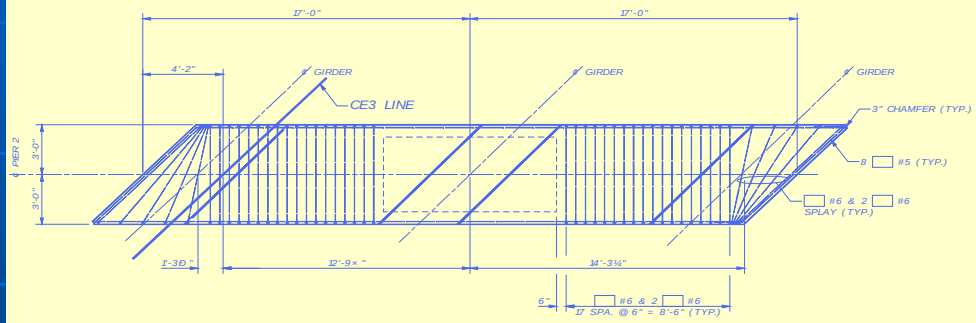
PROJECT LOCATION



Preliminary Layout

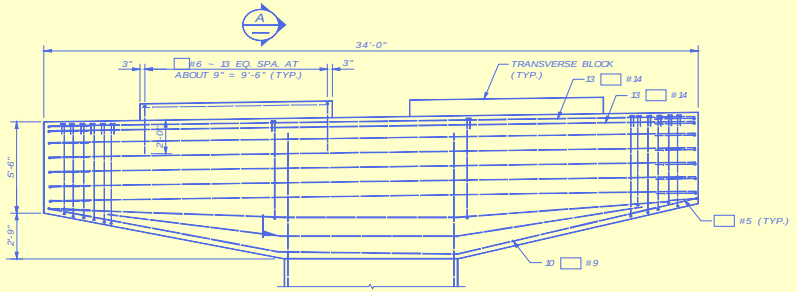


Preliminary Cross Beam

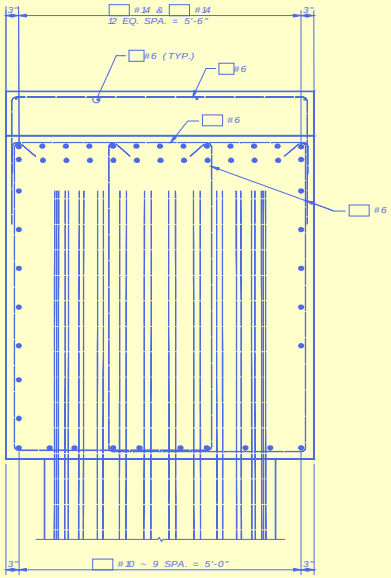


PLAN

TRANSVERSE BLOCK REINFORCEMENT NOT SHOWN FOR CLARITY

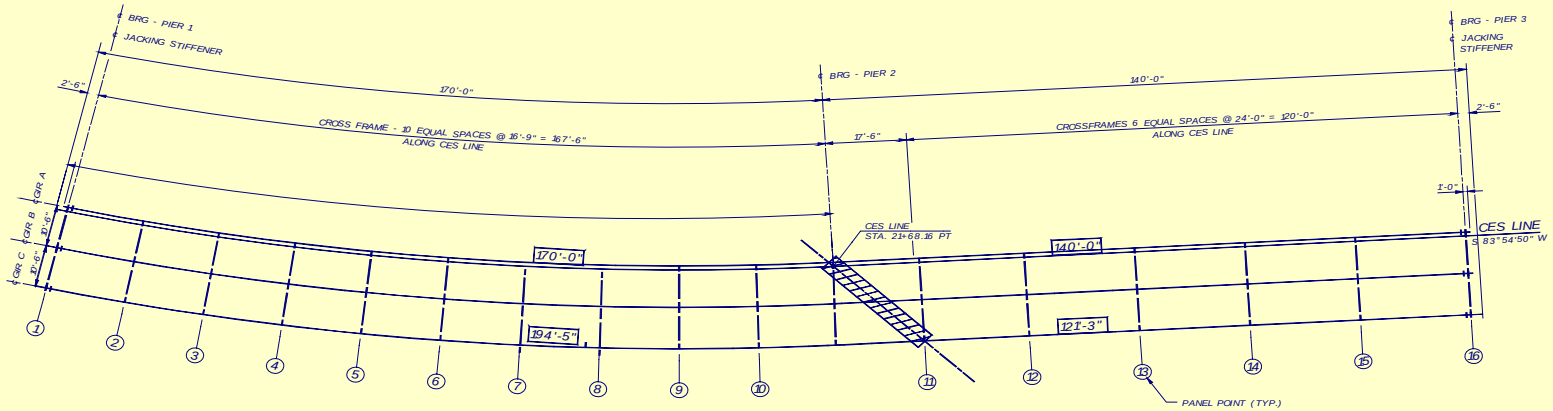


ELEVATION



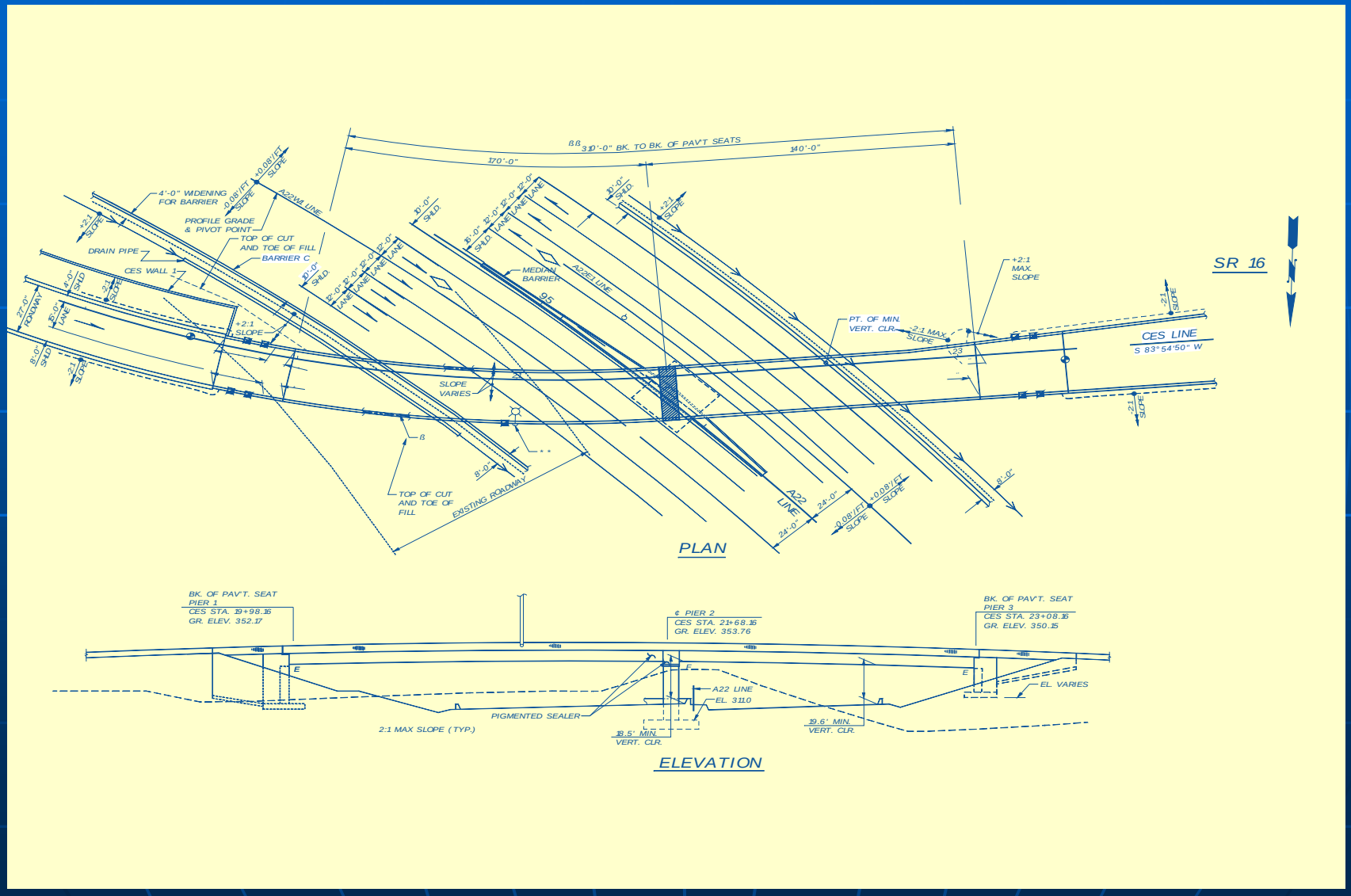
SECTION A

Framing with Skew

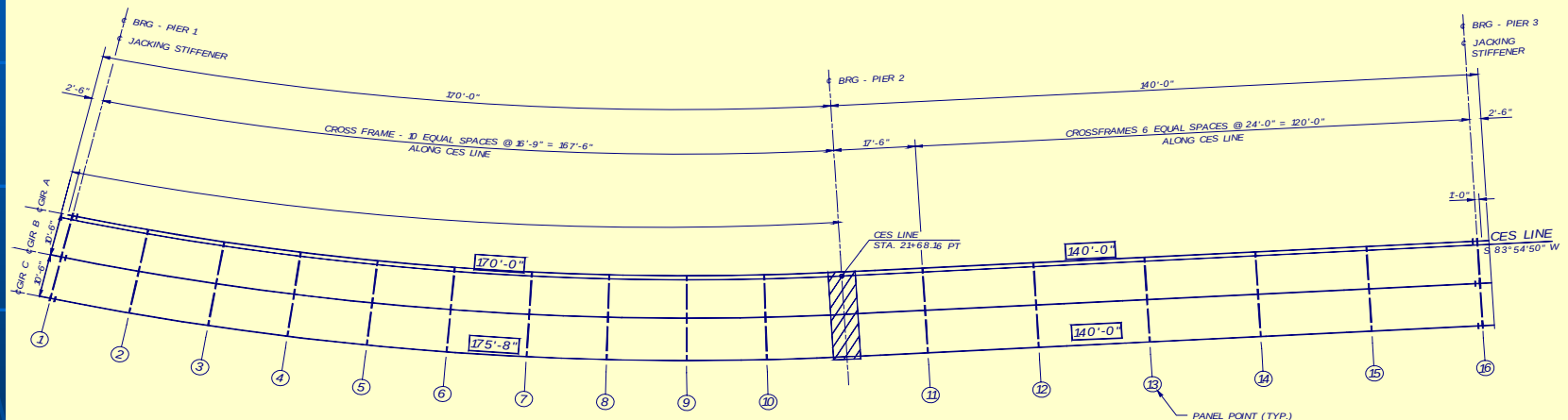


FRAMING PLAN

Revised Layout

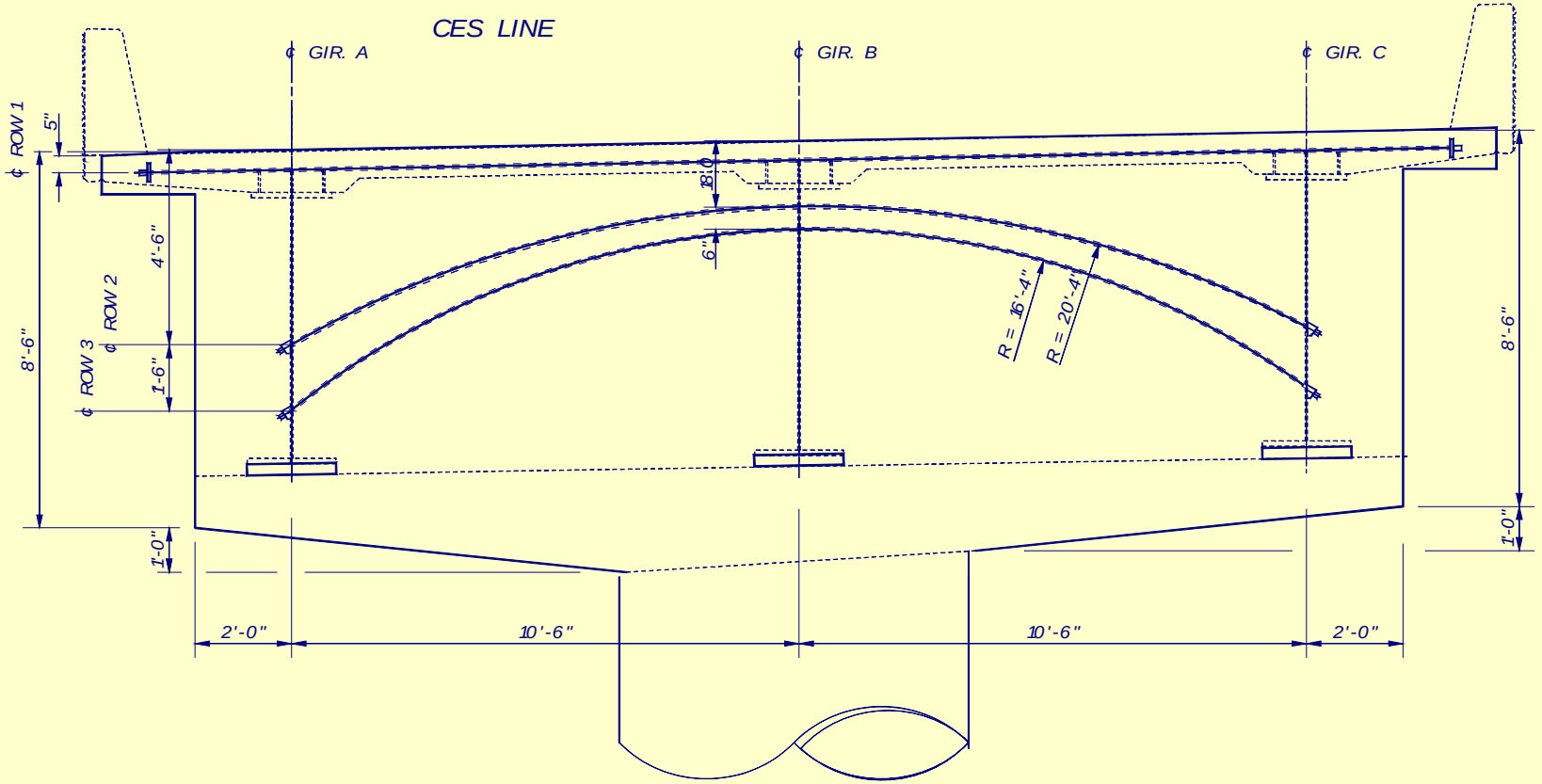


Framing without Skew

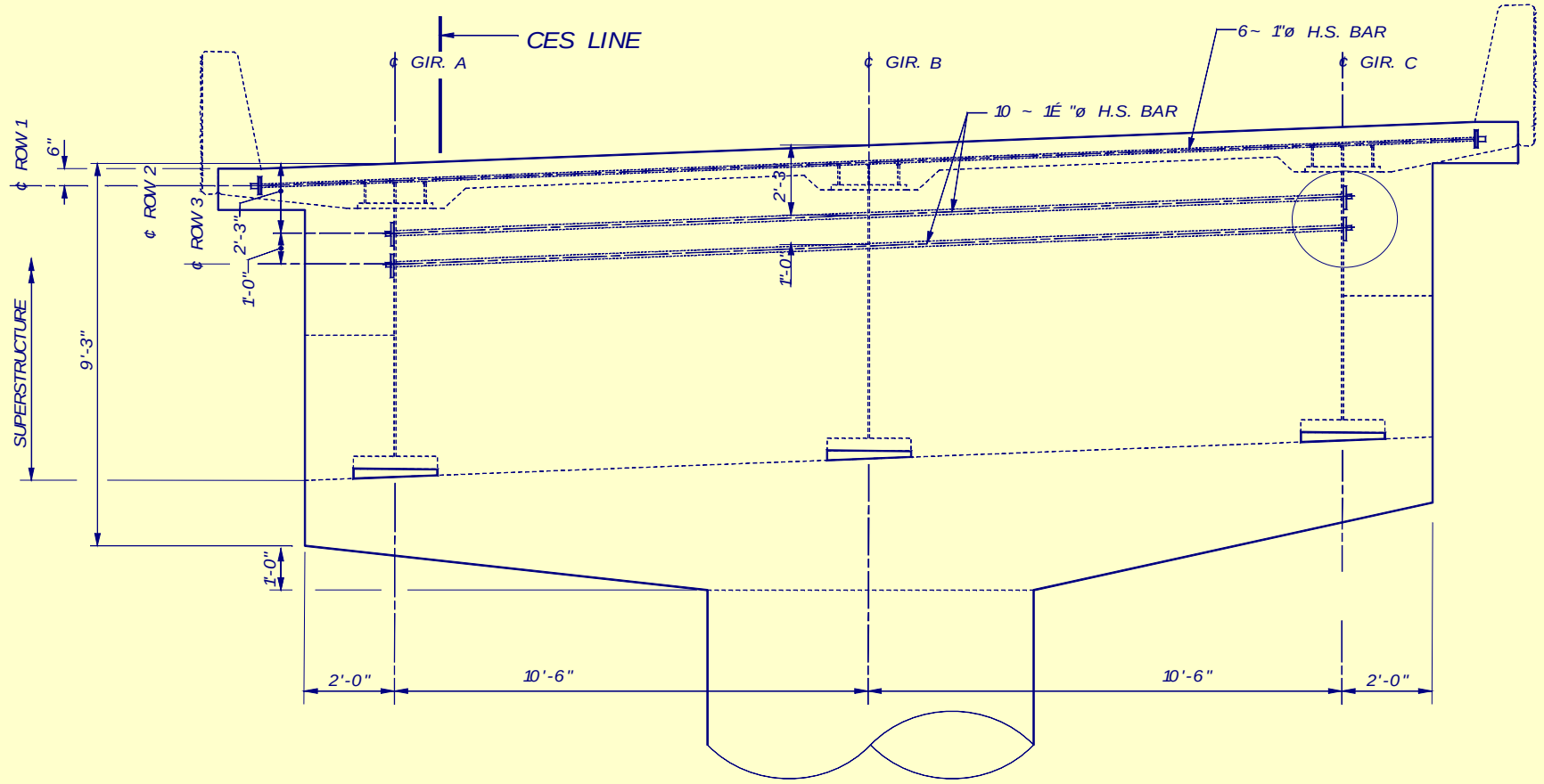


FRAMING PLAN

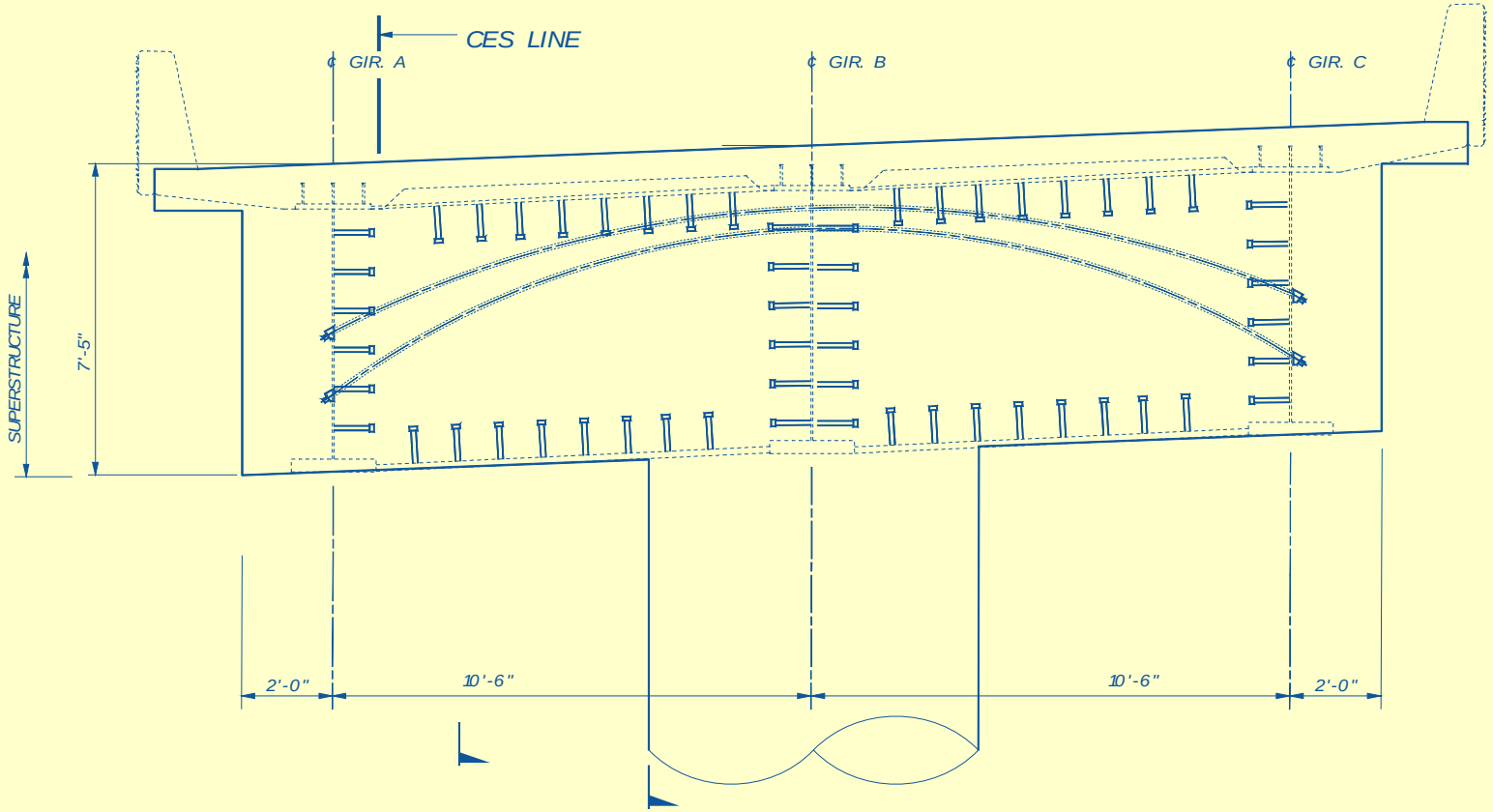
DESIGN CONCEPTS OF P/T INTEGRAL CAP BEAM


CES LINE
℄ GIR. A
℄ GIR. B
℄ GIR. C
℄ ROW 1
5"
18"
6"
4'-6"
℄ ROW 2
℄ ROW 3
1'-6"
8'-6"
R = 16'-4"
R = 20'-4"
8'-6"
1'-0"
1'-0"
2'-0"
10'-6"
10'-6"
2'-0"

ELEVATION

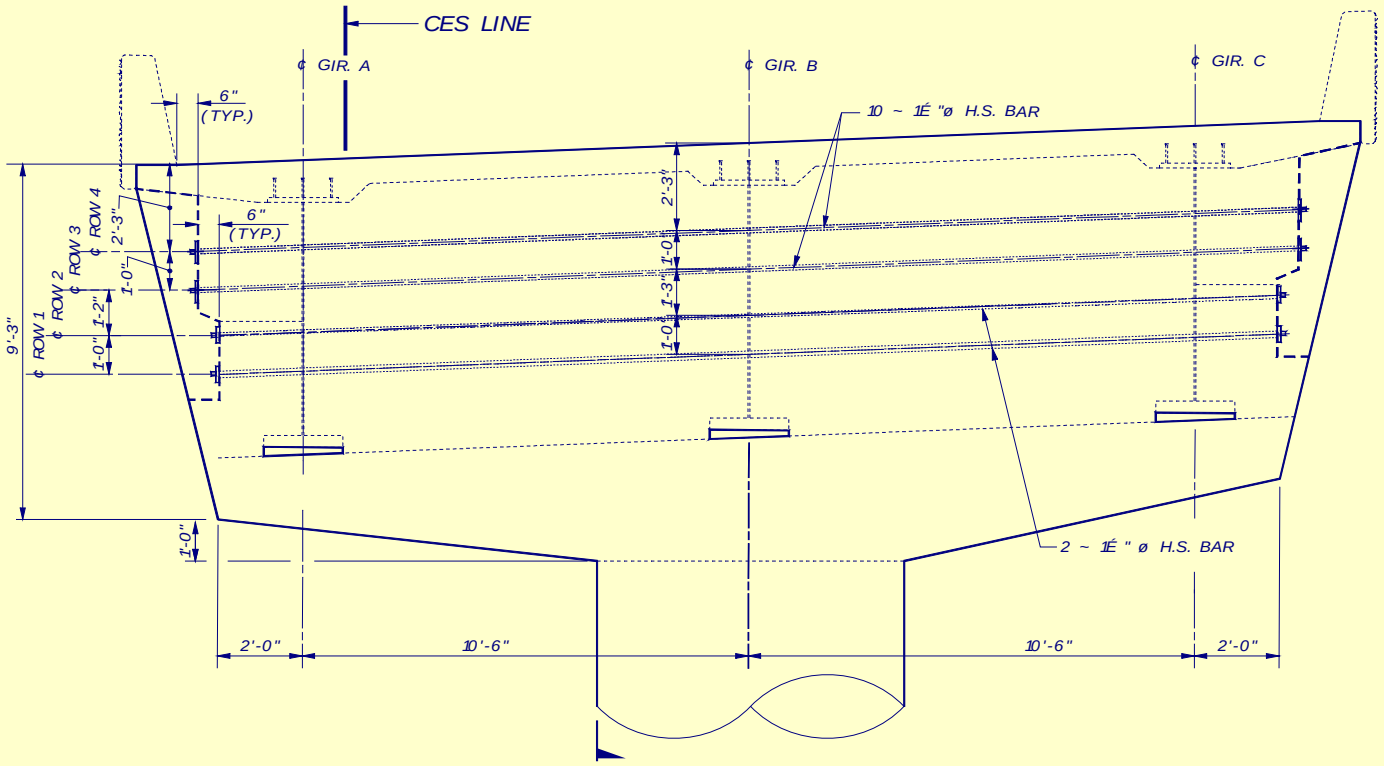

CES LINE
℄ GIR. A
℄ GIR. B
℄ GIR. C
6~ 1"ø H.S. BAR
10 ~ 1É "ø H.S. BAR
℄ ROW 1
℄ ROW 2
℄ ROW 3
6"
2'-3"
1'-0"
2'-3"
1'-0"
SUPERSTRUCTURE
9'-3"
1'-0"
2'-0"
10'-6"
10'-6"
2'-0"

ELEVATION



ELEVATION

REINFORCEMENT NOT SHOWN FOR CLARITY

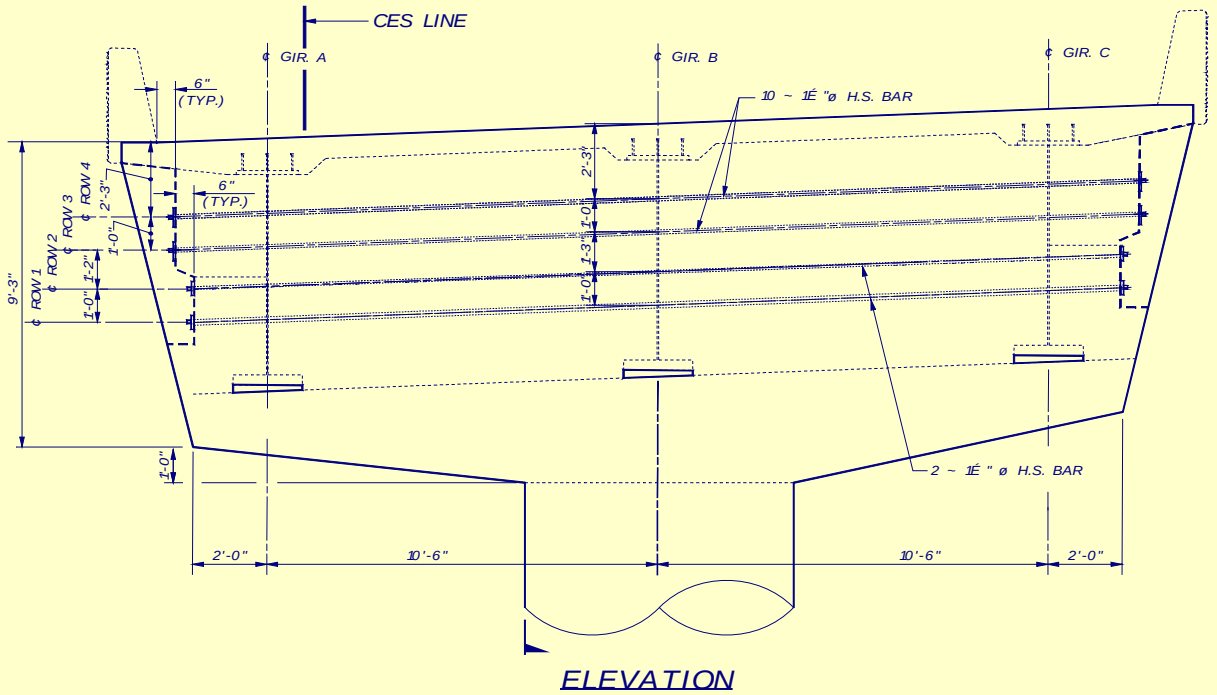

CES LINE
℄ GIR. A
℄ GIR. B
℄ GIR. C
6"
(TYP.)
10 ~ 1É "ø H.S. BAR
℄ ROW 4
℄ ROW 3
℄ ROW 2
℄ ROW 1
2'-3"
1'-0"
1'-2"
1'-0"
9'-3"
6"
(TYP.)
2'-3"
1'-0"
1'-3"
1'-0"
1'-0"
2 ~ 1É " ø H.S. BAR
2'-0"
10'-6"
10'-6"
2'-0"

ELEVATION

DESIGN ELEMENTS

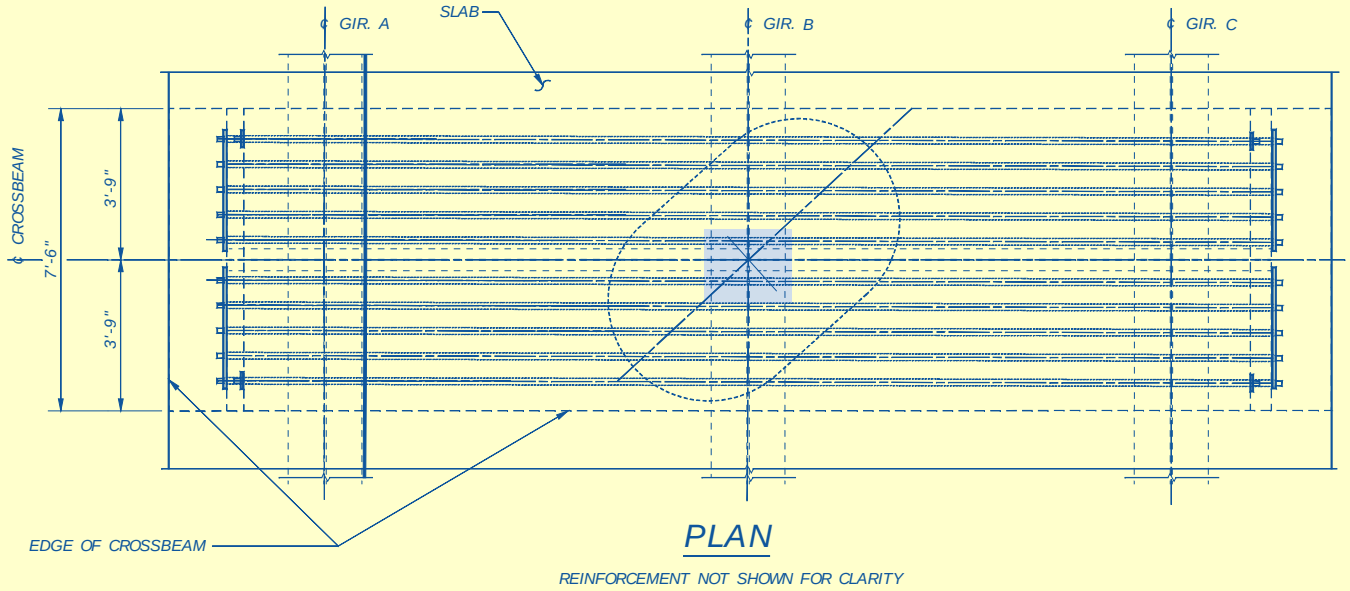
- 1. Reinforced Lower Cap Beam
- 2. Post-Tensioned Upper Cap Beam
- 3. Girders to Crossbeam Connection

Post-Tensioned Upper Cap Beam

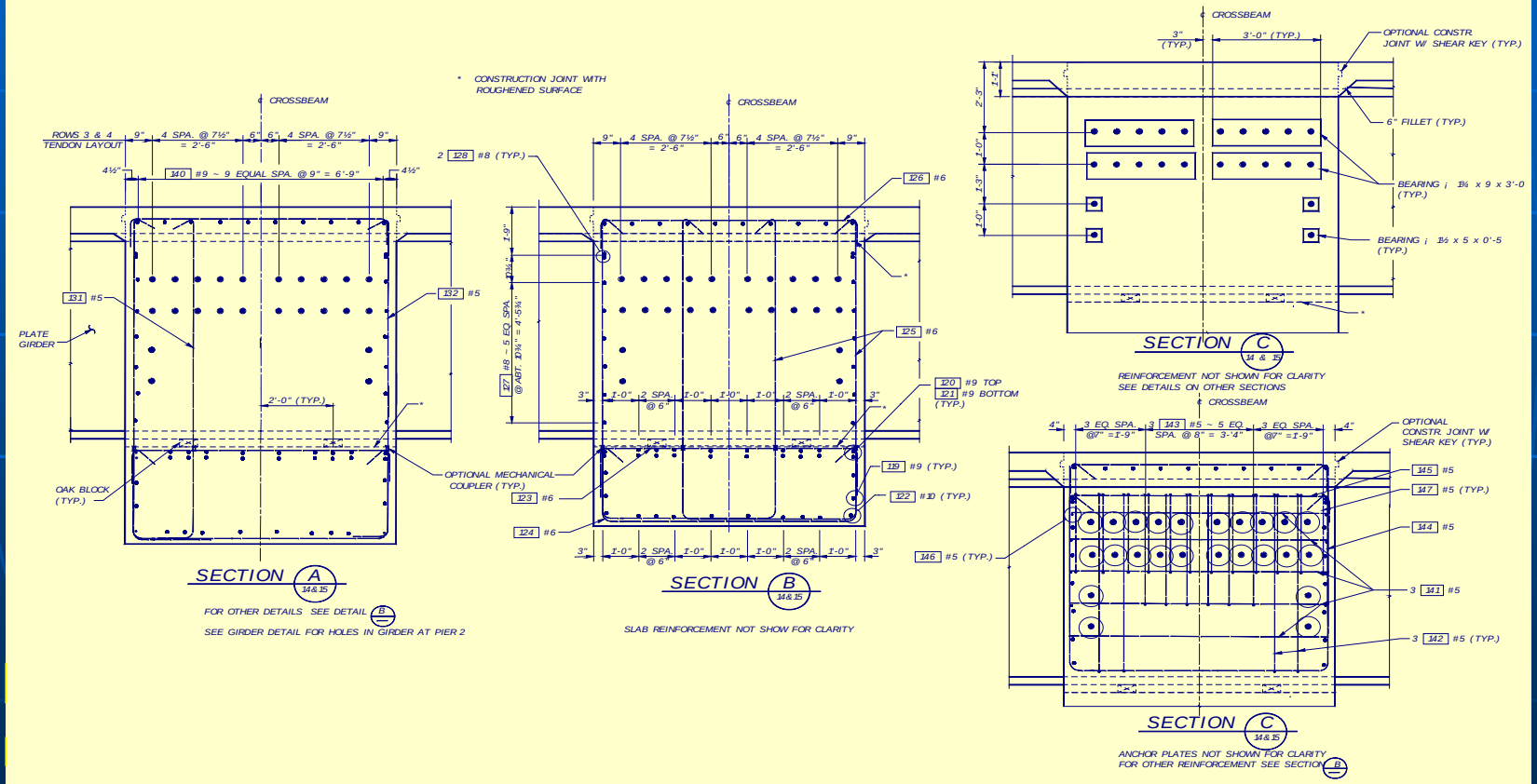


ELEVATION

Post-Tensioned Upper Cap Beam



P/T and Rebar Layout



POST-TENSIONED DESIGN

MATERIALS

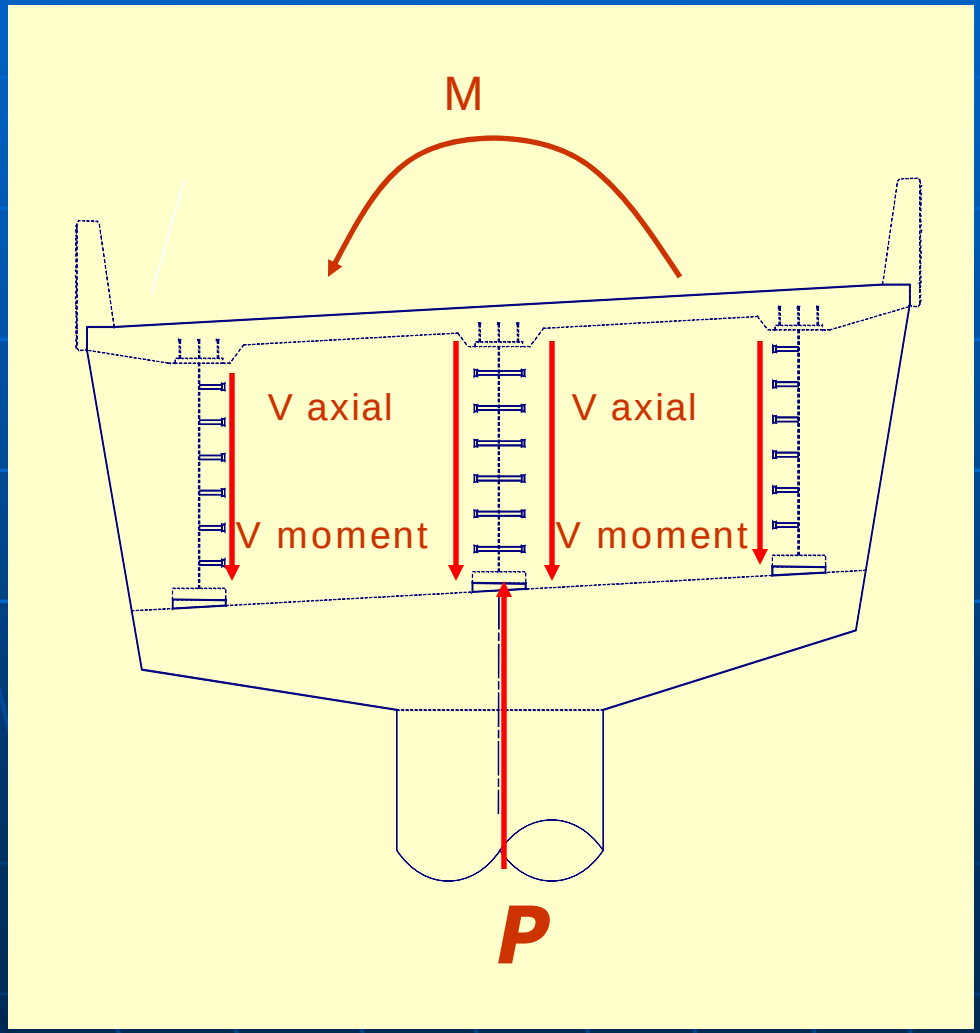
- THE CAST-IN-PLACE CONCRETE 4000PSI FOR THE CROSSBEAM.

- THE HIGH STRENGTH 1 3/8 "ø BARS, ASTM A 722 GRADE 150 f's = 150 KSI,
  - WITH A CURVATURE FRICTION COEFFICIENT, e = 0.15 AND A WOBBLE FICTION COEFFICIENT, k = 0.0002/FT.
  - THE ANCHOR SET IS 0.0".

PRESTRESSING:

- THE MINIMUM PRESTRESSING LOAD AFTER SEATING FOR THE 1 3/8"ø SHALL BE 135 KIPS.
- THE ESTIMATED PRESTRESS LOSS OF 25 KSI DUE TO STEEL RELAXATION, ELASTIC SHORTENING, CREEP AND SHRINKAGE OF CONCRETE.

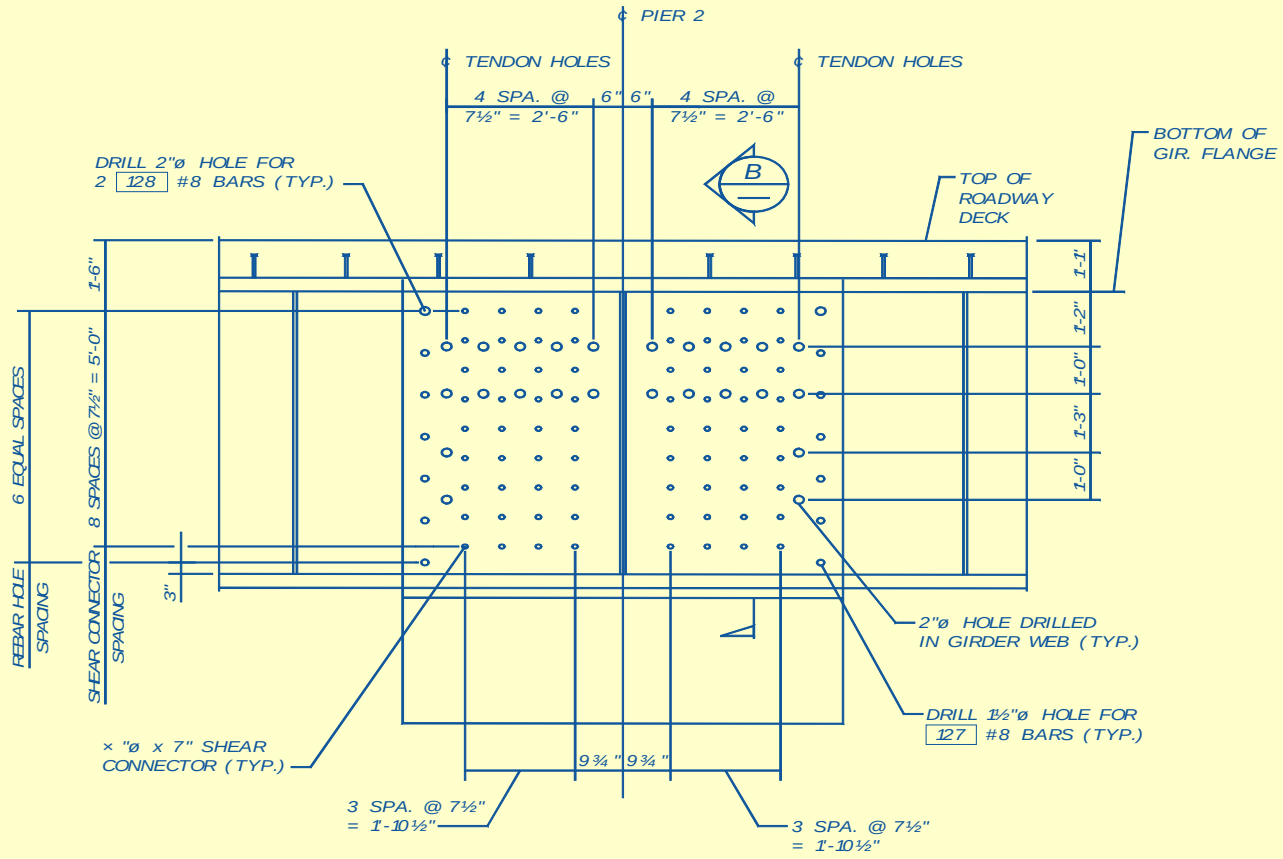
GIRDER TO CAP DESIGN



Axial and Transverse Loadings

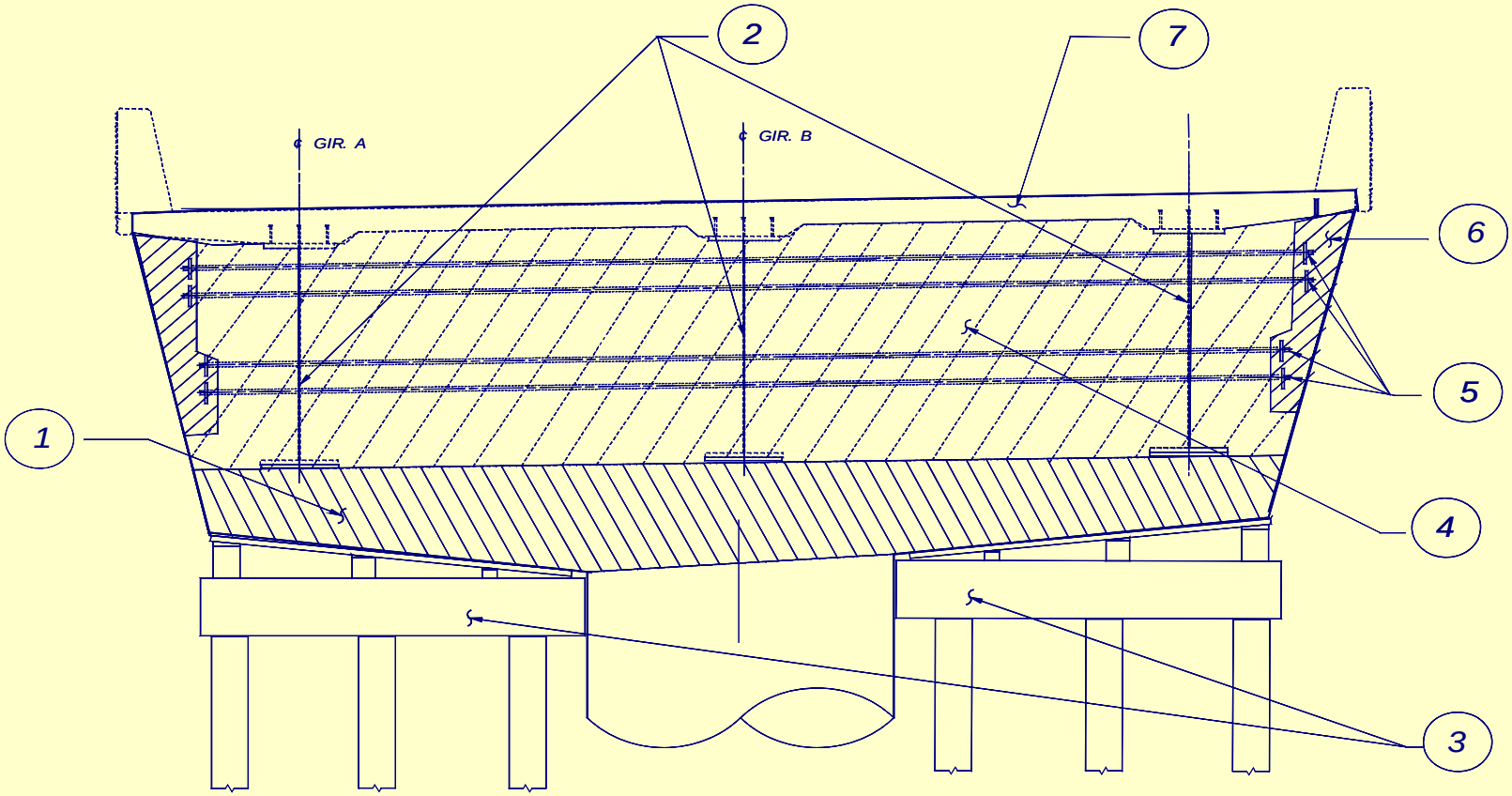
1. Service – DL + LL
2. Extreme I –DL+ EQ
3. Strength I – DL + LL
4. Fatigue I – LL

Shear Stud Layout at Cross Beam



GIRDER A, B & C
TENDON HOLE LOCATIONS

CONSTRUCTION SEQUENCE



ELEVATION

CONSTRUCTION PICTURES


06/09/2005 08:15


09/20/2005 13:54


W24X84X42
VESI

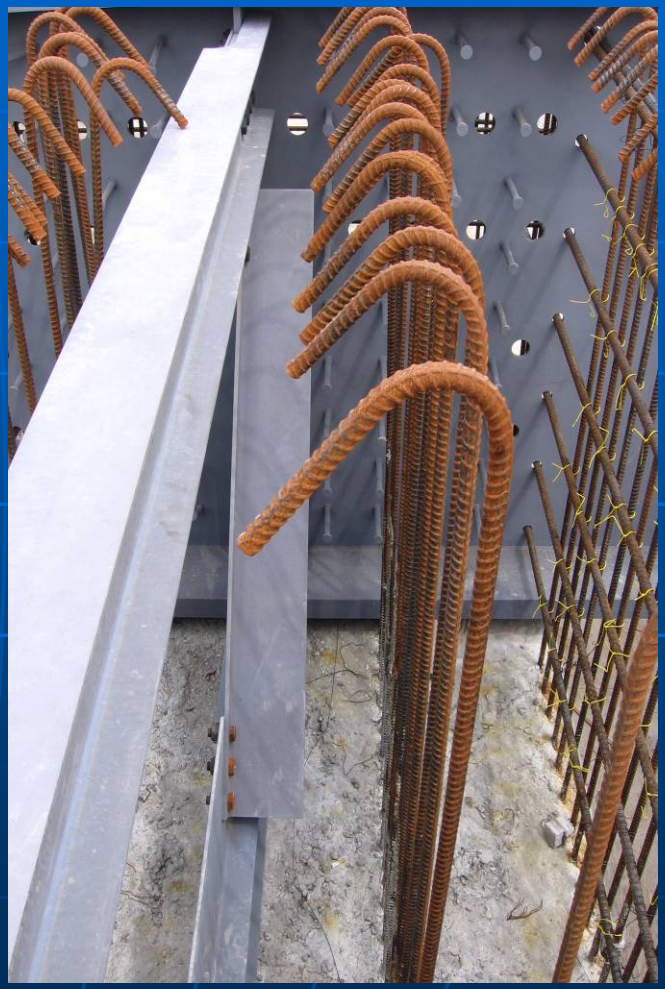

11/03/2005 14:02

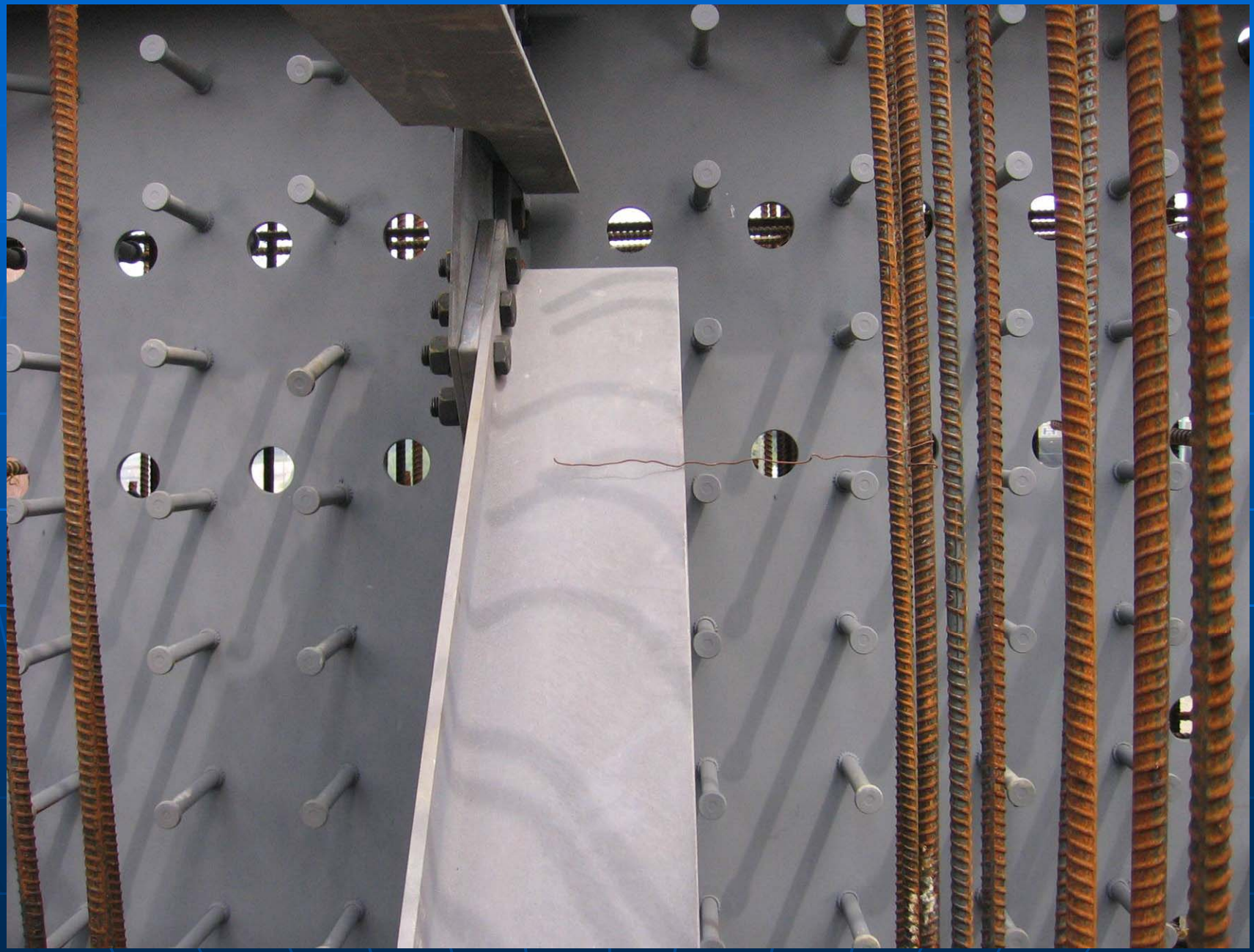

11/03/2005 14:03


05/26/2006 08:55
P&H


Genie
Snorkel
05/26/2006 08:43


04/04/2006 10:00






08/09/2006 14:02


08/16/2006 10:14


08/09/2006 14:02


08/22/2006 09:41


EXIT 2E
N Orchard St
S 19TH St
1/2 MILE
EXIT ONLY
10/31/2006 09:04


Cheney
Stadium
EXIT 2A
Tacoma
Comm Coll
EXIT 2B

LESSONS LEARNED

- Plan to use the P/T cap beam in early preliminary stage.
- Provide clear details of girders and column steel rebar region.
- Design and make room different P/T anchorage systems.
- Have good coordination between the contractors, fabricator, and steel erector.

- Credited to Tri-State City Corporation Construction Company and the WSDOT Bridge Design Team and Project Engineer Construction Office

- Questions

Thank You