MSS Box Girder Transverse Design and Analysis of Gerald Desmond Bridge Replacement

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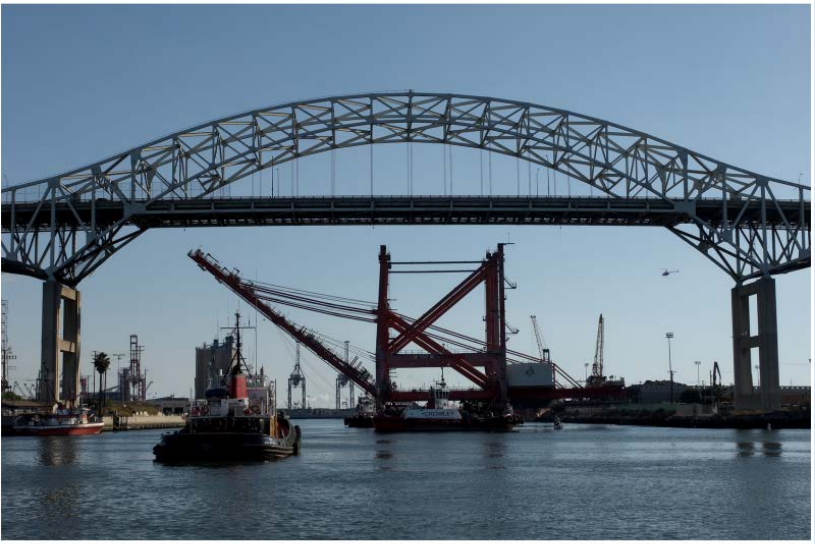
MSS Box Girder Transverse Design and Analysis

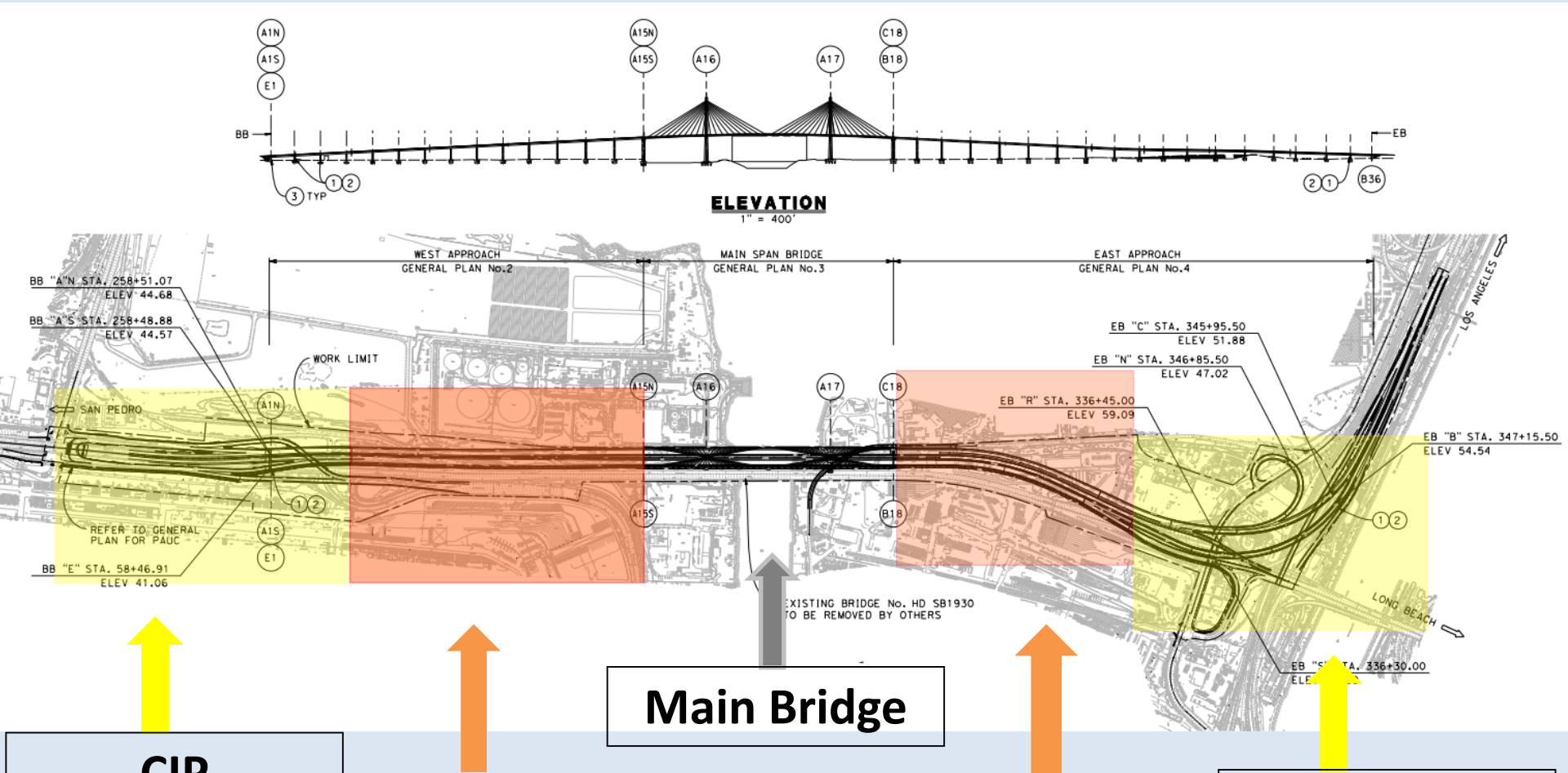
- ❑ Project Overview
- ❑ Design Considerations
- ❑ Transverse Analysis and Design
- ❑ Summary

Project Overview



- Owner:
  Port of Long Beach
- Prime Contractor:
  SFI Joint Venture
  (Shimmick/FCC/
  Impregilo)
- Designer:
  Arup/Biggs Cardosa

Project Overview



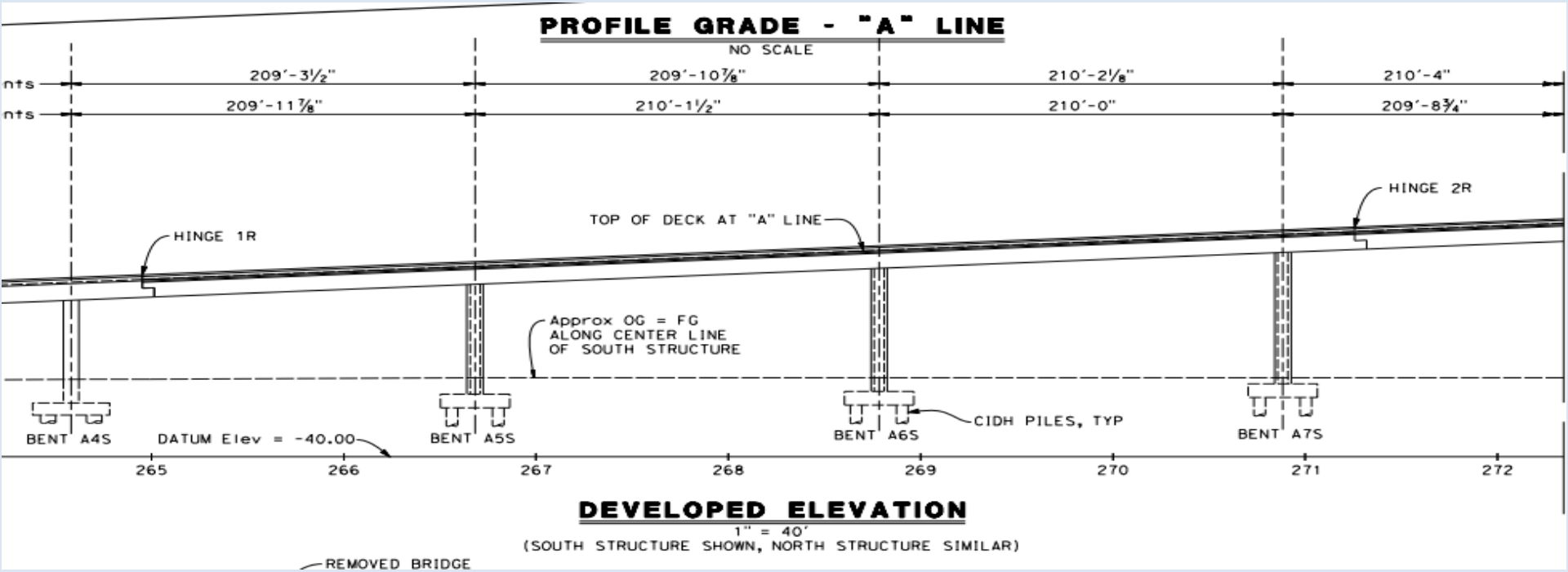
CIP
PT BOX

Movable Scaffolding System
MSS

Main Bridge

CIP
PT BOX

Project Overview



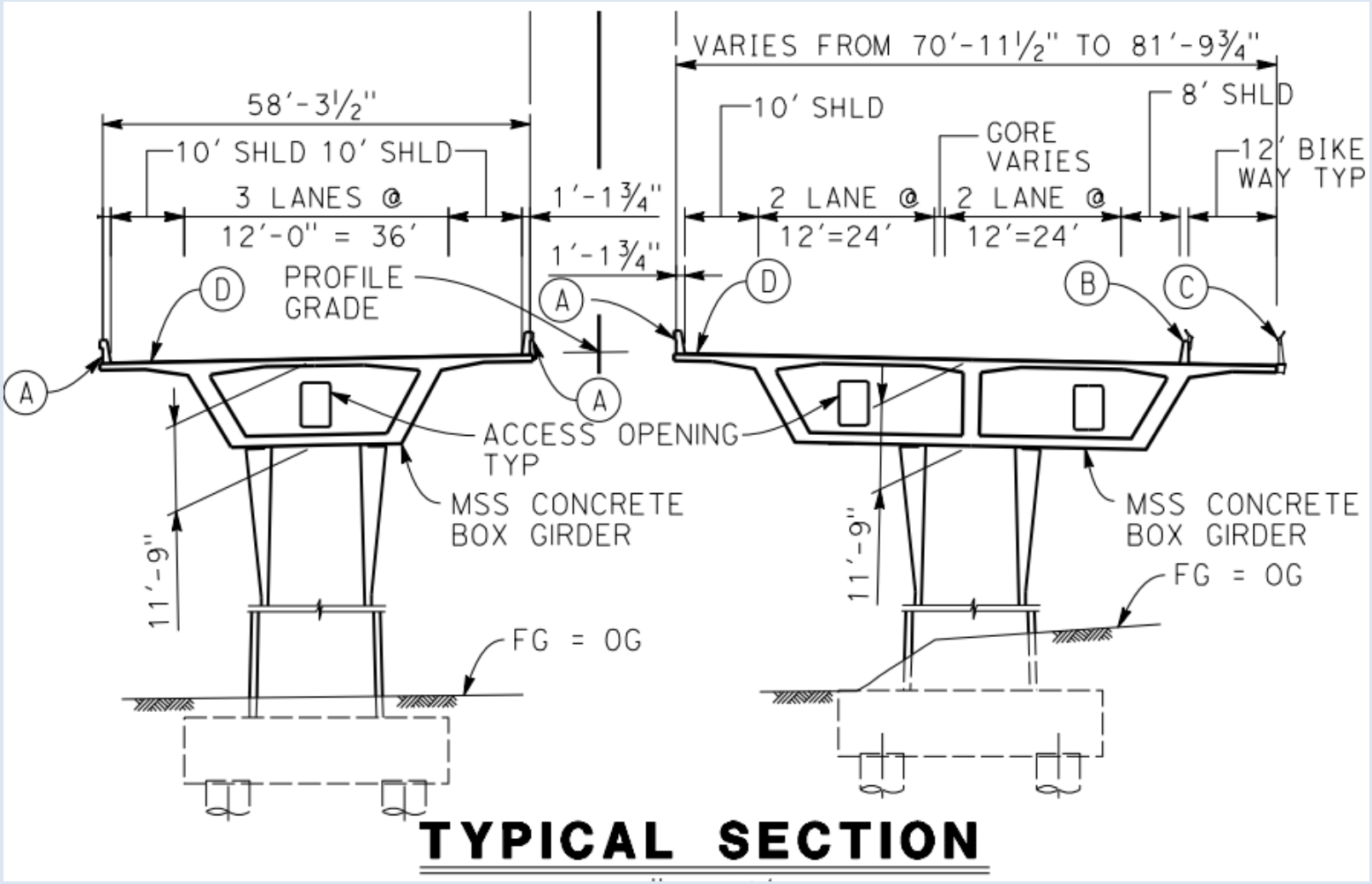
Total Length: 1.4 m,

MSS Span: 200’ to 230’

Bent Height: 70ft above Ground

Project Overview

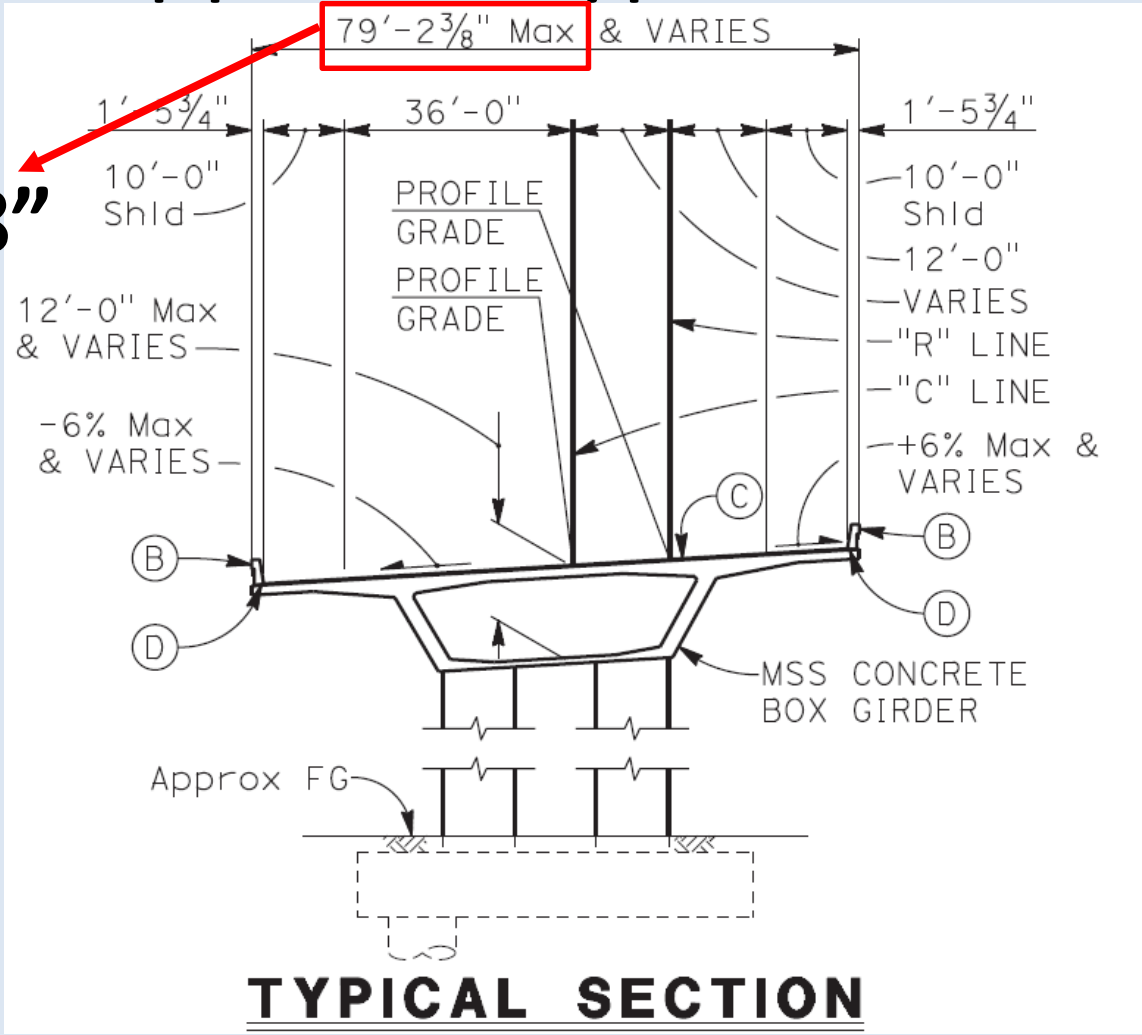
West Approach Typical Section



Project Overview

East Approach Typical Section

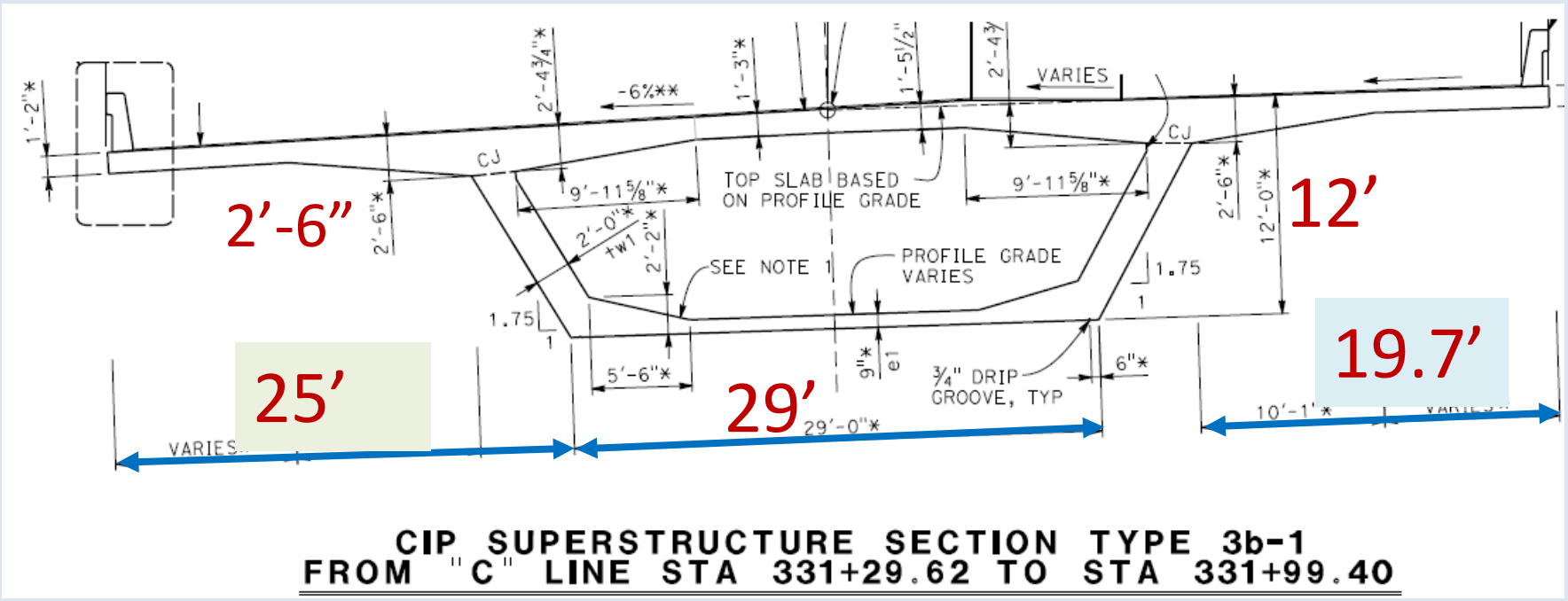
79’-2 3/8”



Project Overview

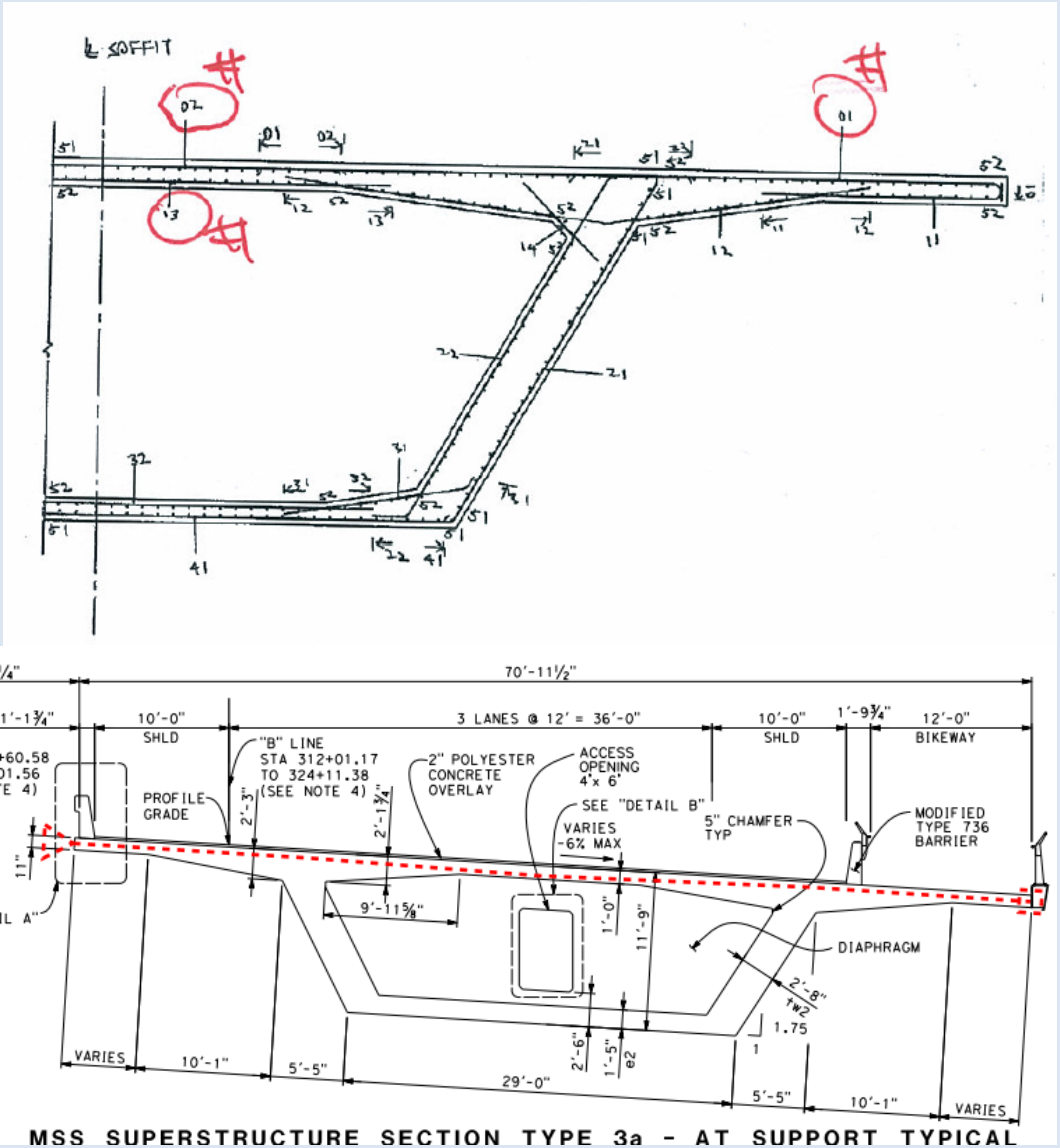
East Approach Typical Section

79ft



CIP SUPERSTRUCTURE SECTION TYPE 3b-1
FROM "C" LINE STA 331+29.62 TO STA 331+99.40

Project Overview



Bidding Design:

Reinforced Concrete Transverse Deck

Final Design:

Transverse PT Deck

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Project Overview

Design Considerations

Analysis Methods

Conclusions

Design Considerations

1. Future Maintenance
   a) ½” scarification with 2.5” overlay
   b) 1” scarification with 3.0” overlay
   c) 1.5” scarification with 4.0” overlay

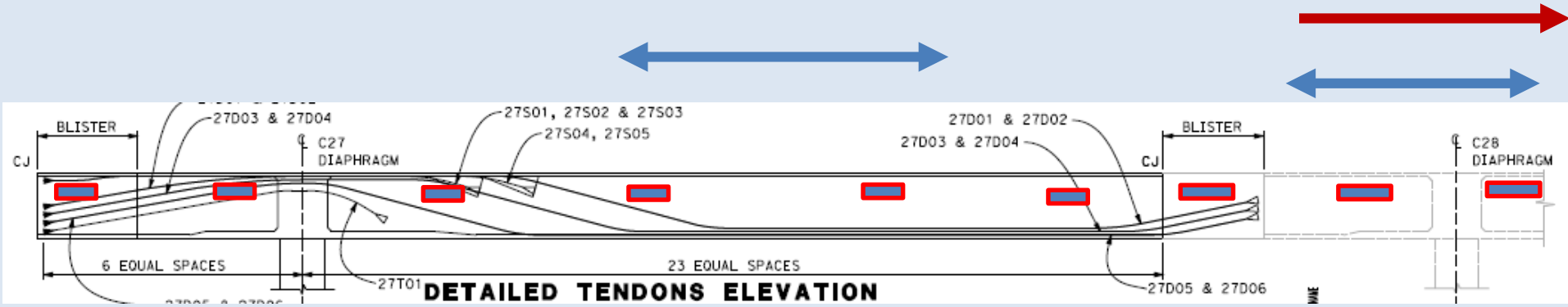
2. Construction Sequence

- Do Transverse PT first

or

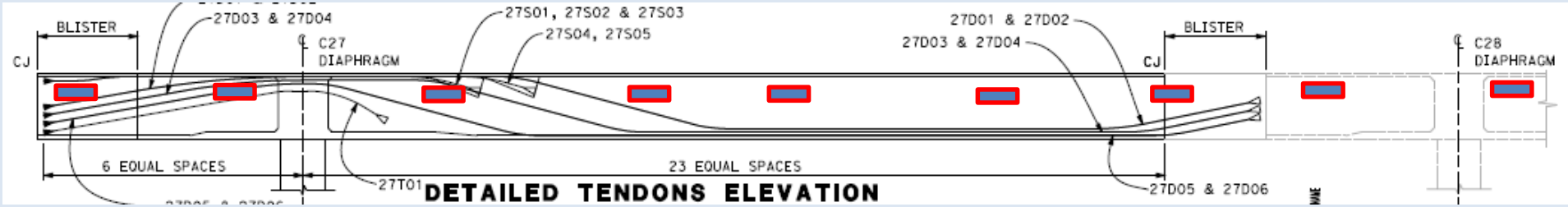
- Do Girder Longitudinal Post-Tensioning First

Construction Trans. PT Prior to Longitudinal PT



1. Construction Transverse PT for one span, then install Longitudinal PT
2. Move MSS to next span
3. Repeat till complete entire frame/approach spans

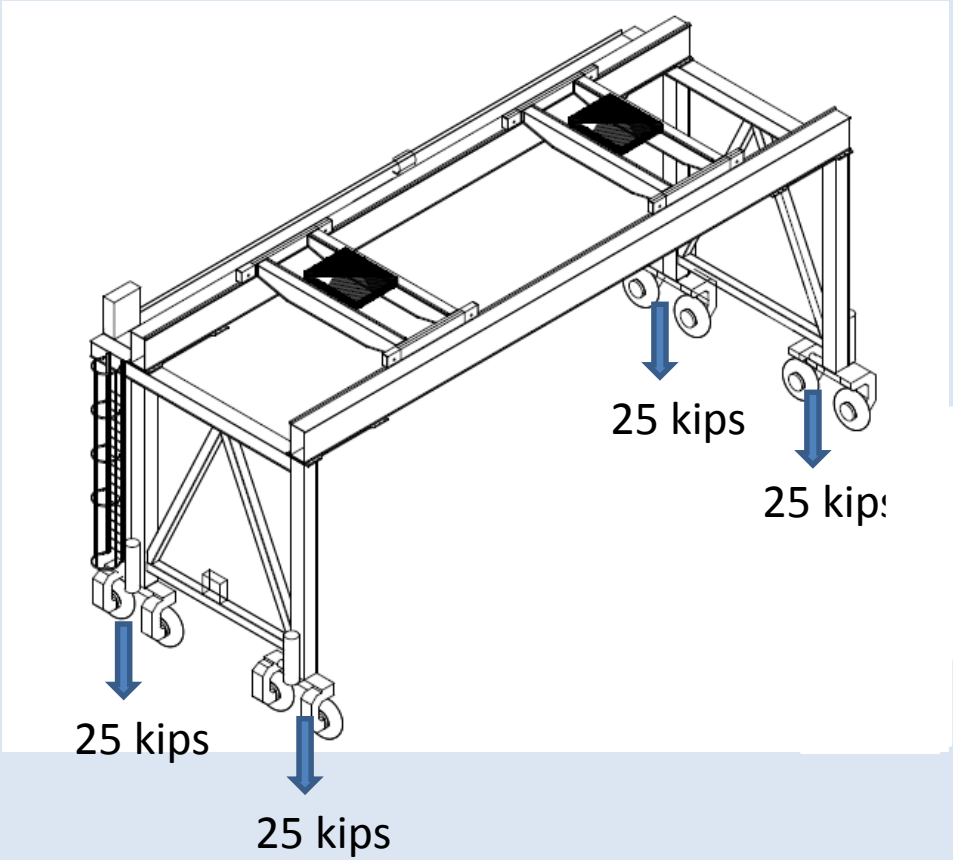
Construction Trans. PT after Longitudinal PT



1. Construction one span longitudinal PT
2. Move MSS to next span
3. When all spans are done longitudinal PT, install transverse PT for entire frame/approach spans

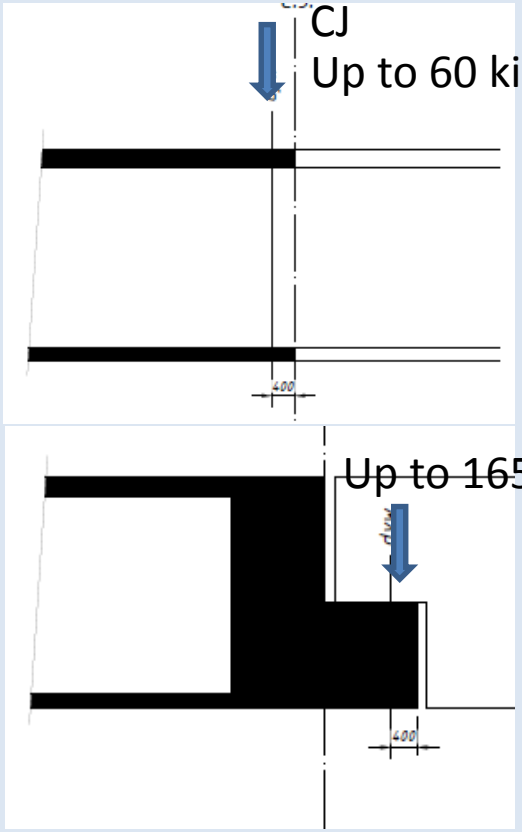
3. Construction Loads

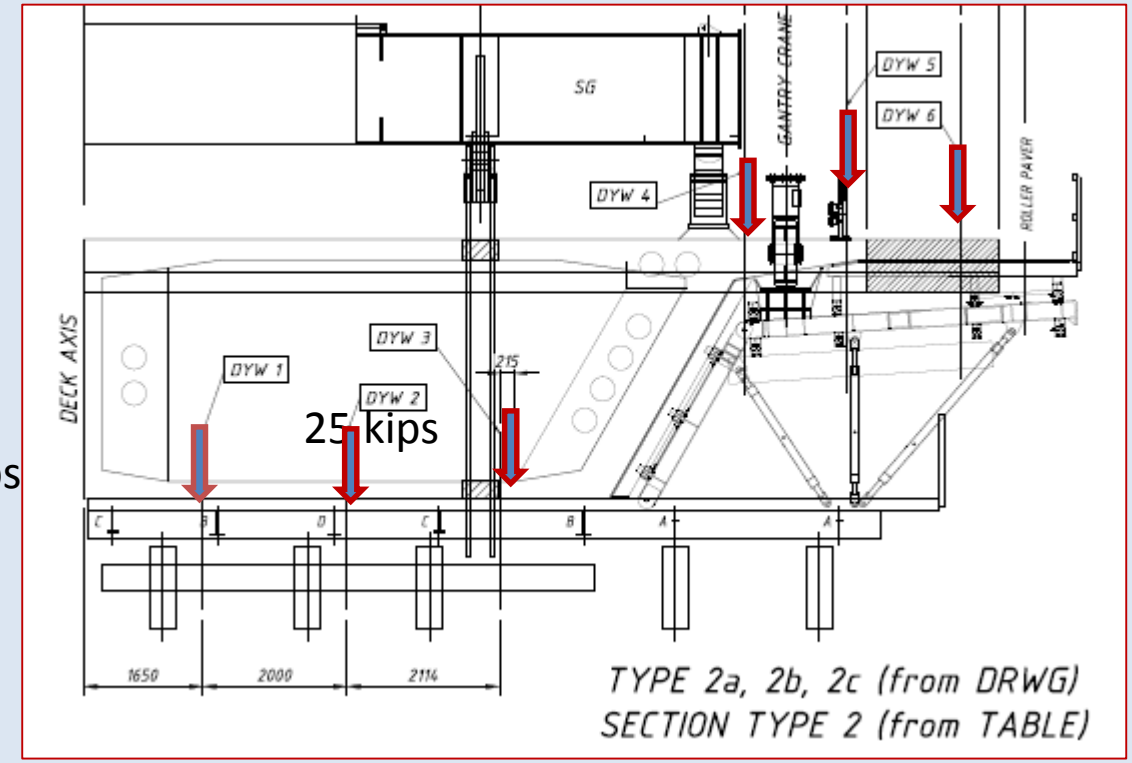
1) Gantry Crane



3. Construction Loads

2) MSS Clamping Loads





3. Construction Loads

3) Stressing Cart

Design Considerations

3. Construction Loads

4) Materials

- Steel
- Strands
- Grout

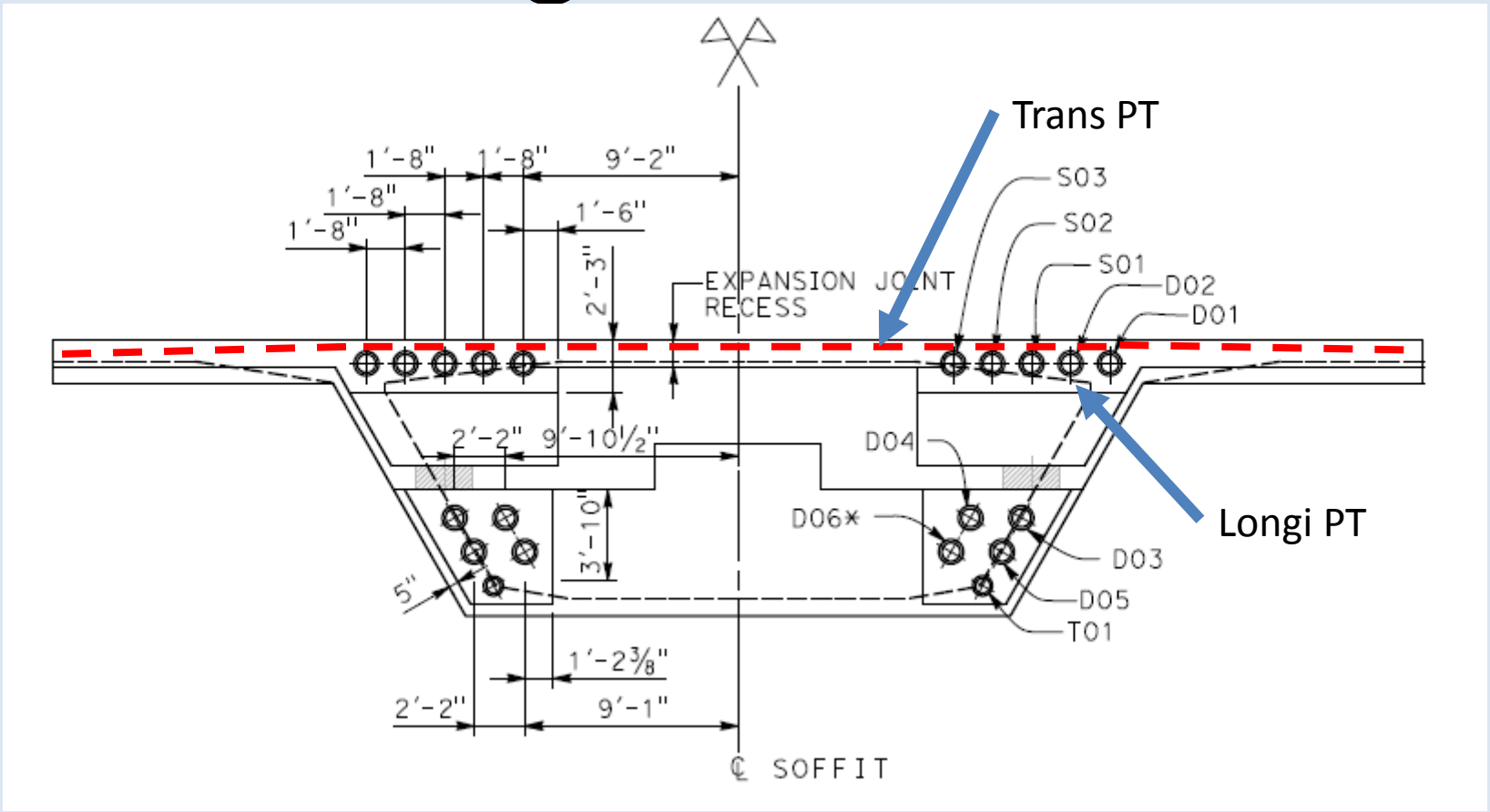
3. Construction Loads
Load Combination

LRFD 3.4.2	LRFD 5.14.2.3.4
1.25(DC+DW)	1.10(DC+DW)
1.5LL	1.3LL~~+A+AI~~

Min M = 1.2Mcr, or 1.33Mu

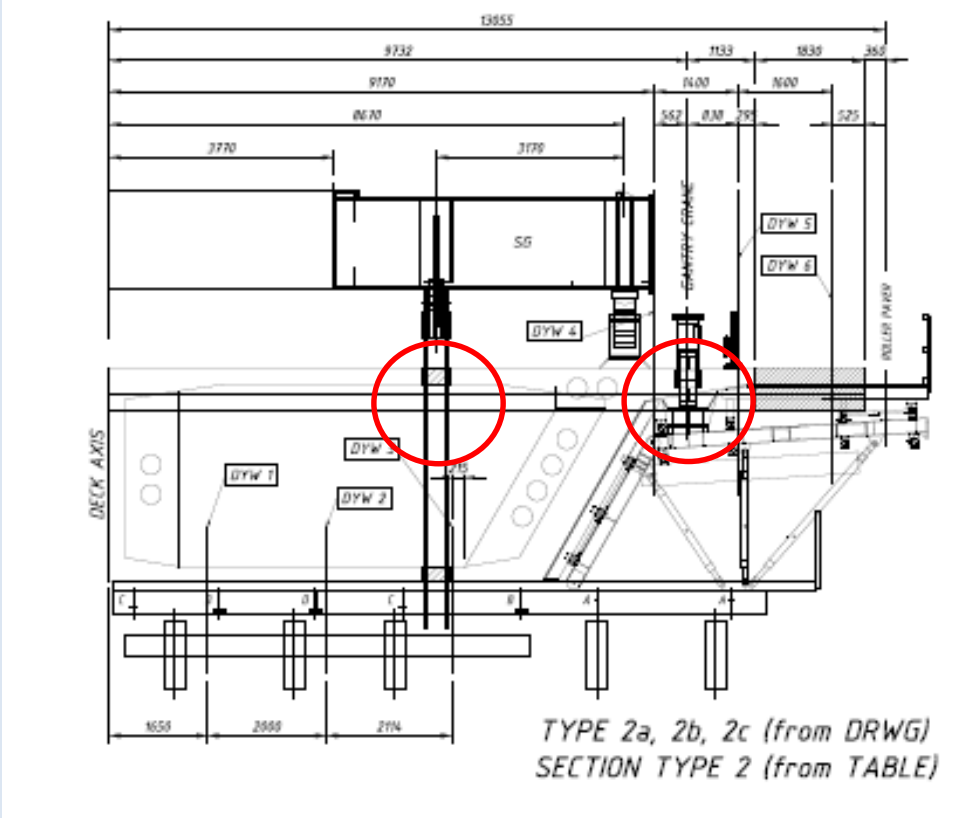
4. Other Effects

- **Longitudinal PT Effects**



4. Other Effects

- MSS Opening



Design Considerations

4. Other Effects

- Temperature Gradient
- Shrinkage and Creep
- Live Load and PT Second Effect

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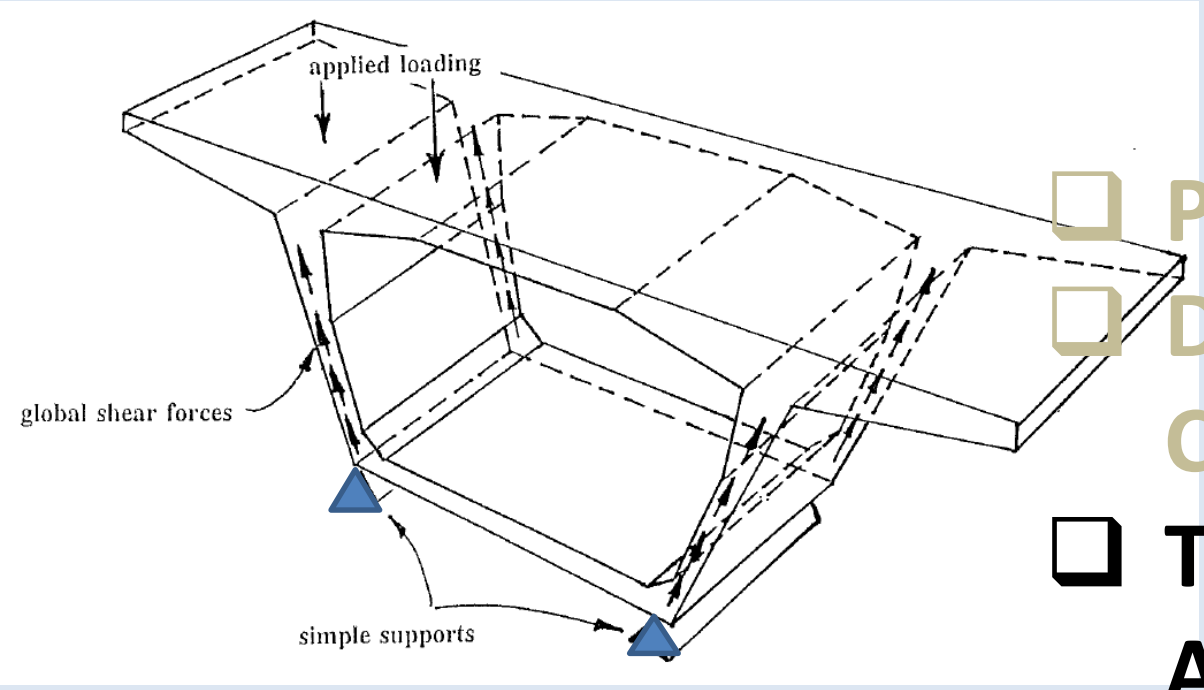

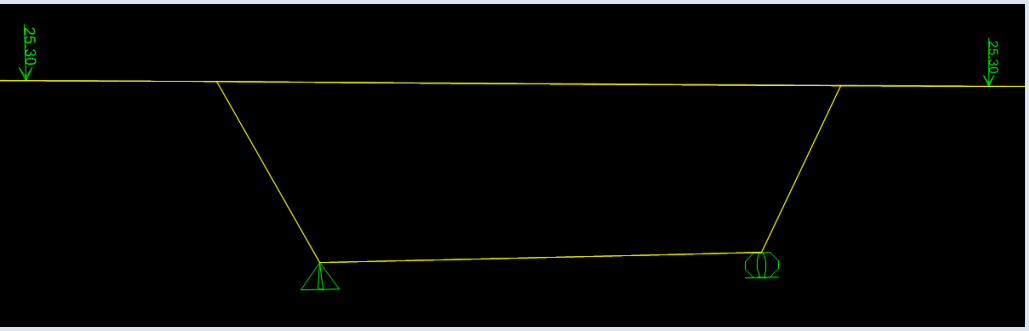

- Project Overview
- Design Considerations
- **Transverse Analysis and Design**
- Conclusions

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Box Transverse Design

- Dead Load Analysis
- Live Load Analysis
- Transverse Post-tensioning
- Temperature, Shrinkage and Creep
- Construction Load
- Top and Bottom Slab Design
  Longitudinal PT Bursting Effect
- Web Design: Combined longitudinal shear/torsion and transverse Bending

Live Load Analysis

4.6.2.9.4—Transverse Analysis

- Simplified Method
- Influence Surface (Homberg and Pucher Charts)
- Elastic 3D Analysis

Simplified Method - Interior Region

Table 4.6.2.1.3-1—Equivalent Strips

Type of Deck	Direction of Primary Strip Relative to Traffic	Width of Primary Strip (in.)
Concrete:		
• Cast-in-place	Overhang	$45.0 + 10.0X$
	Either Parallel or Perpendicular	$+M$: $26.0 + 6.6S$ $-M$: $48.0 + 3.0S$
• Cast-in-place with stay-in-place concrete formwork	Either Parallel or Perpendicular	$+M$: $26.0 + 6.6S$ $-M$: $48.0 + 3.0S$
• Precast, post-tensioned	Either Parallel or Perpendicular	$+M$: $26.0 + 6.6S$ $-M$: $48.0 + 3.0S$

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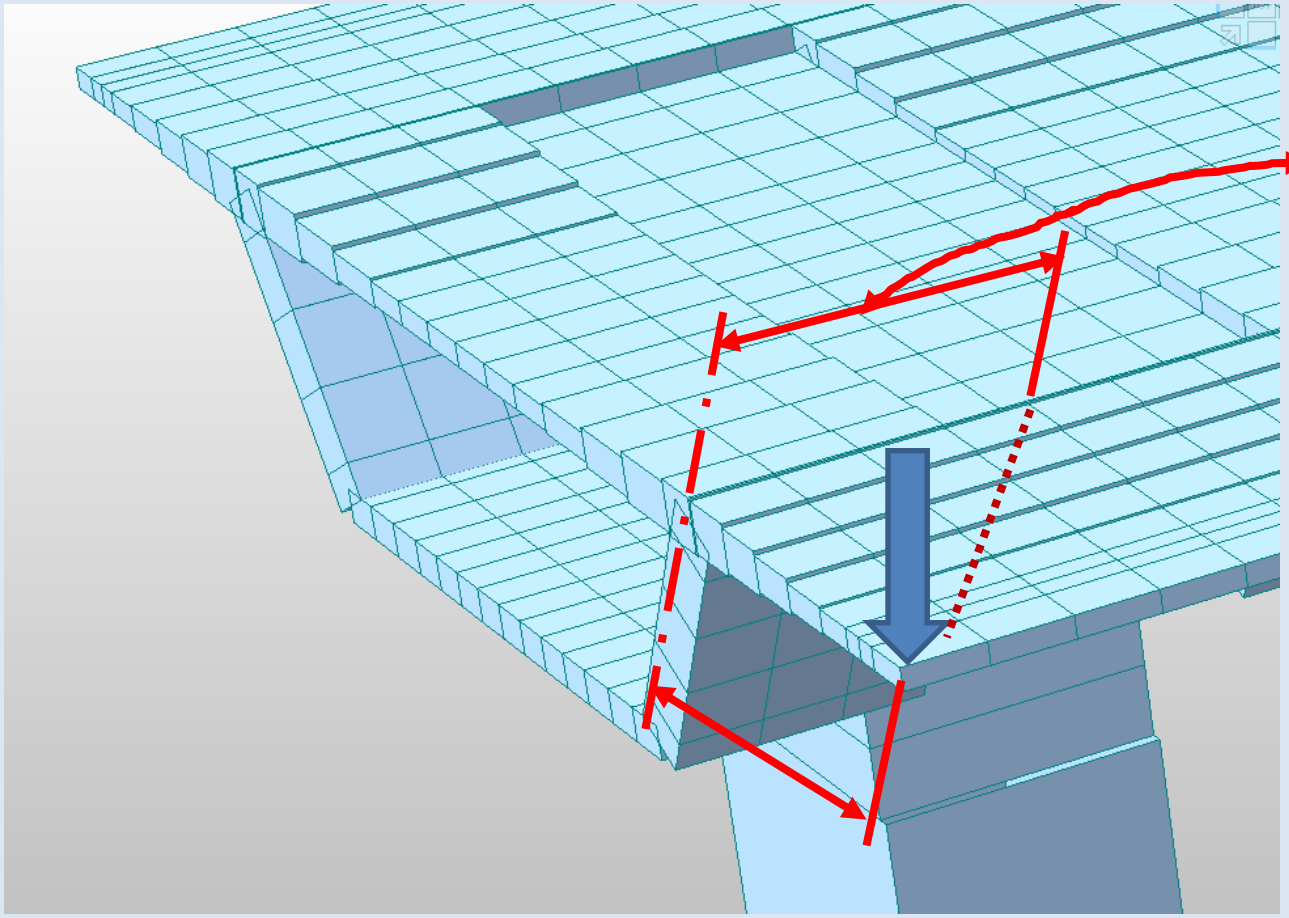
Simplified Method – End Region



Equivalent Strip Width

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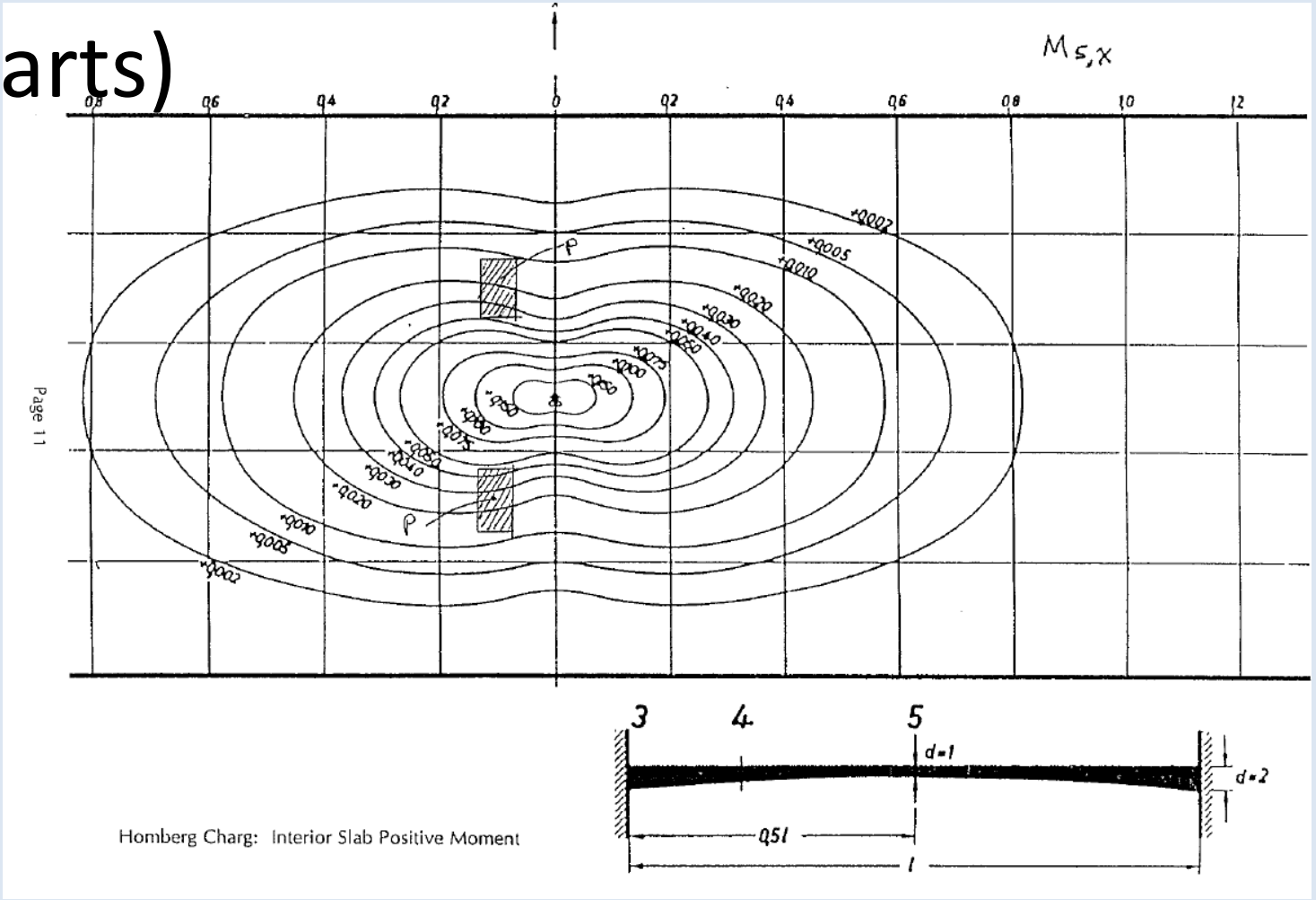
Influence Surface (Homberg and Pucher Charts)



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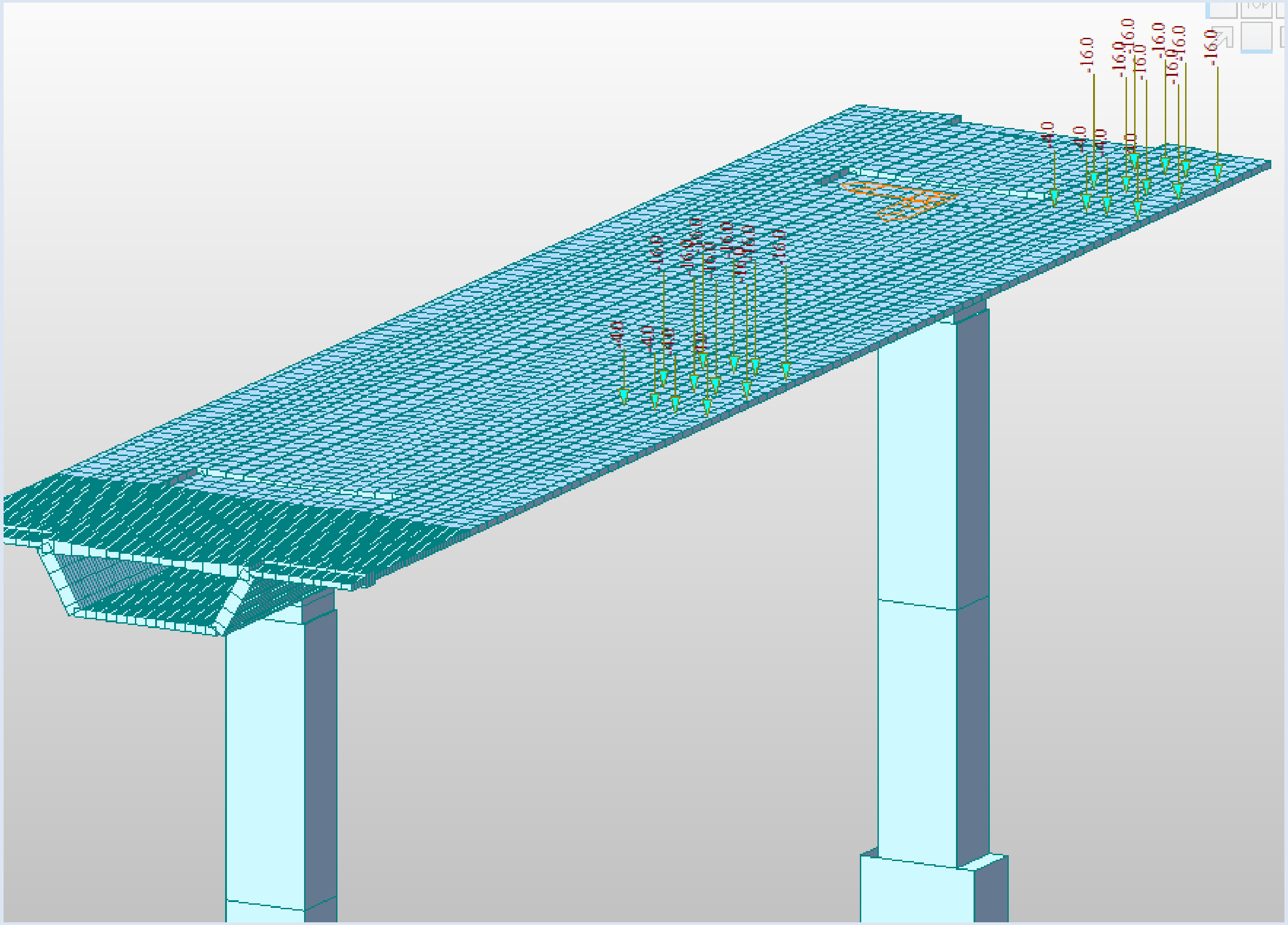
Elastic 3D Analysis



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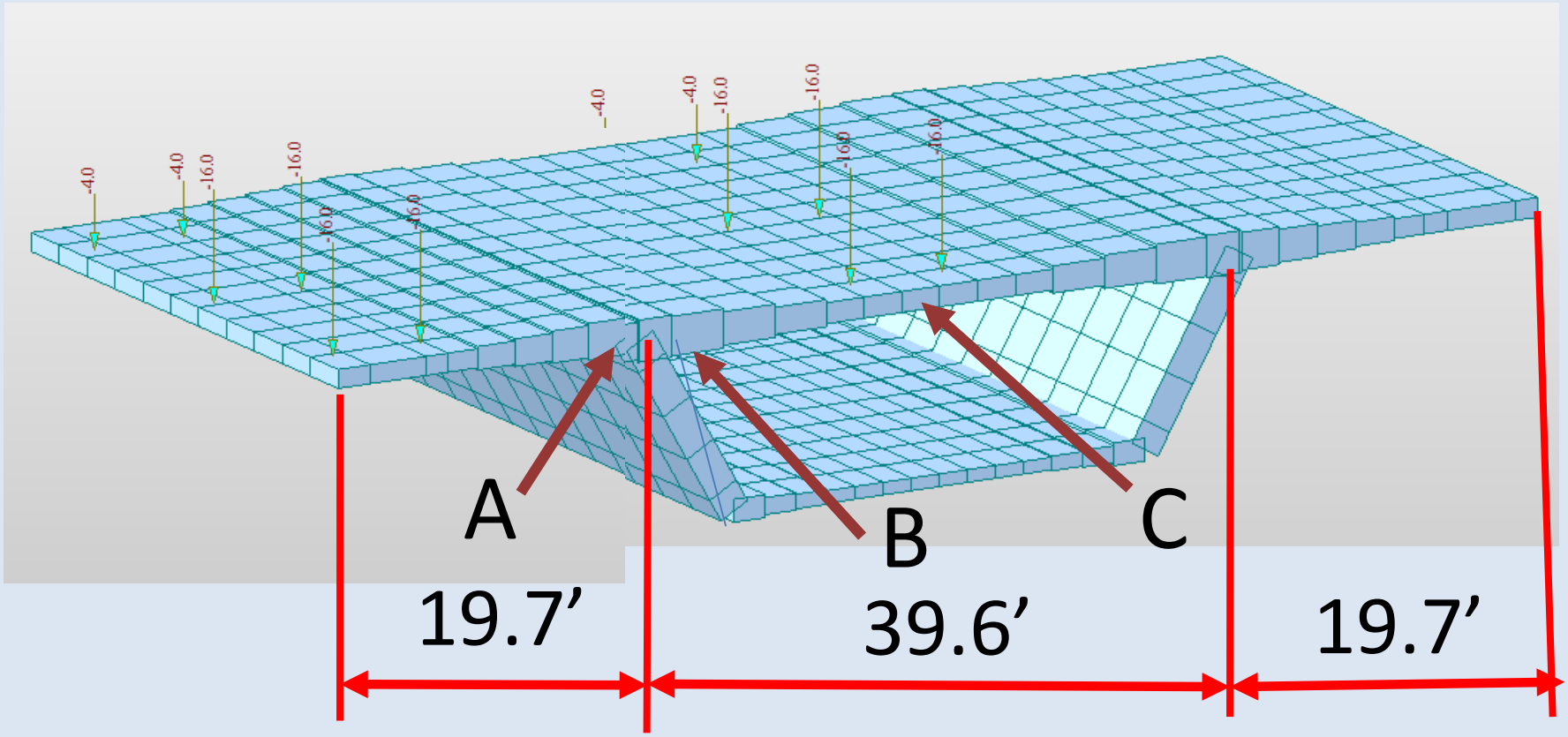
Comparison of Three Method



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Comparison of Three Method

Method	A @Roof of Canti	B@ Support Near Web	C @ Mid of Cell
Simplified Method	-28 (1.17)	-14 (1.27)	5.0 (1.06)
Influence Surface	-25 (1.04)	-11. (1.0)	4.3 (0.90)
3D Finite	-24 (1.0)	-11 (1.0)	4.7 (1.0)

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2D Frame Action Vs 3D Finite

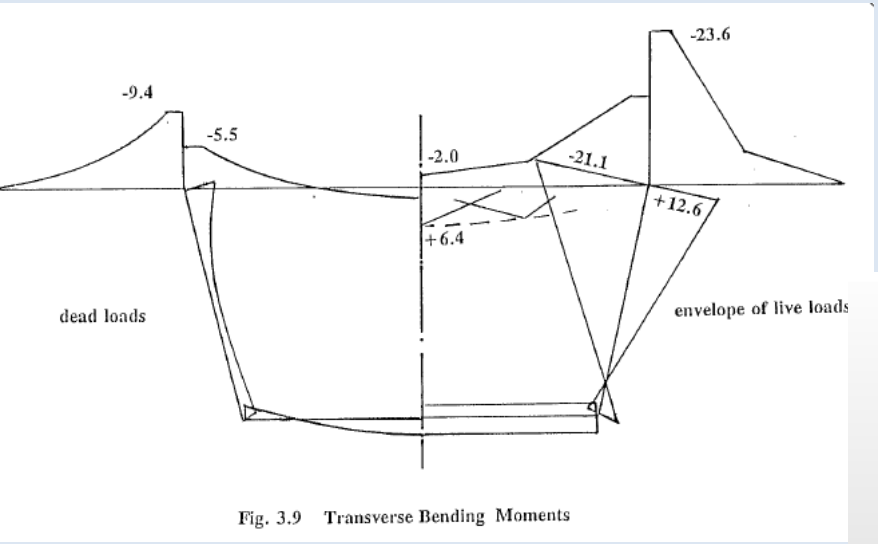
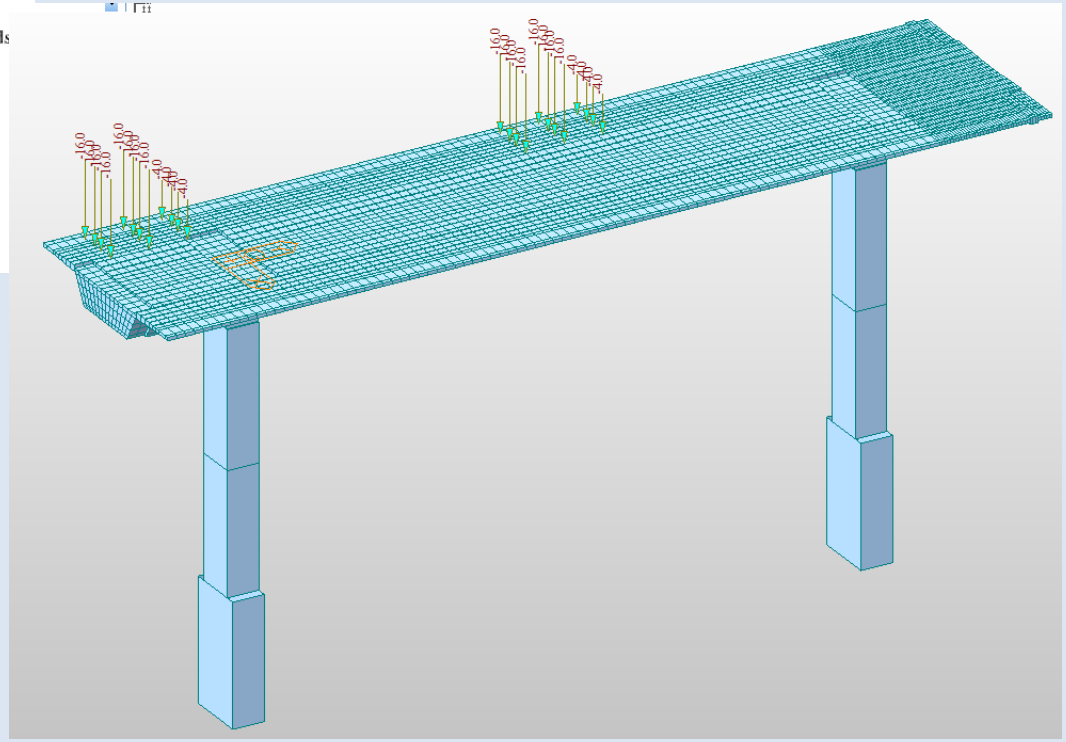


Fig. 3.9 Transverse Bending Moments



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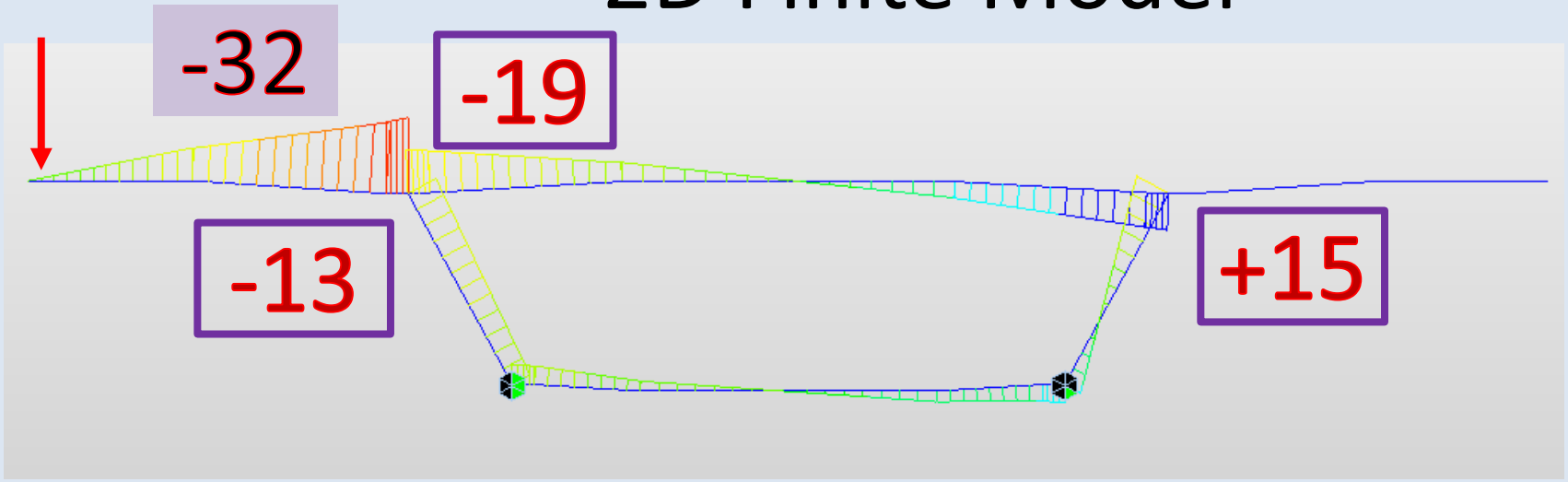
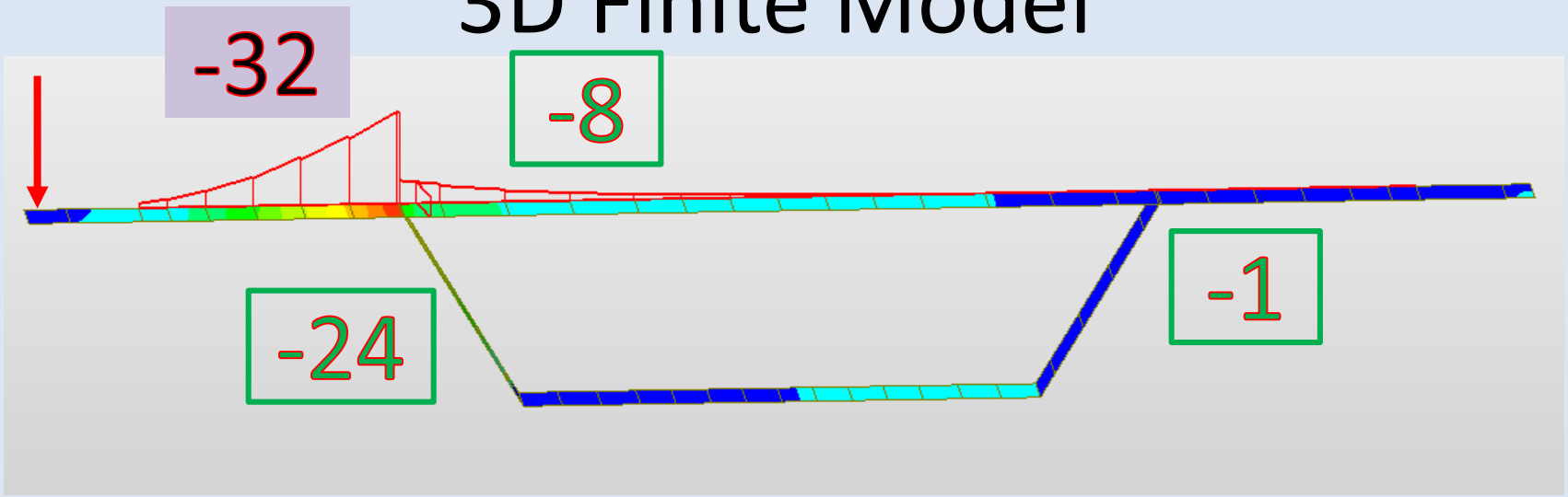
2D Finite Model



3D Finite Model



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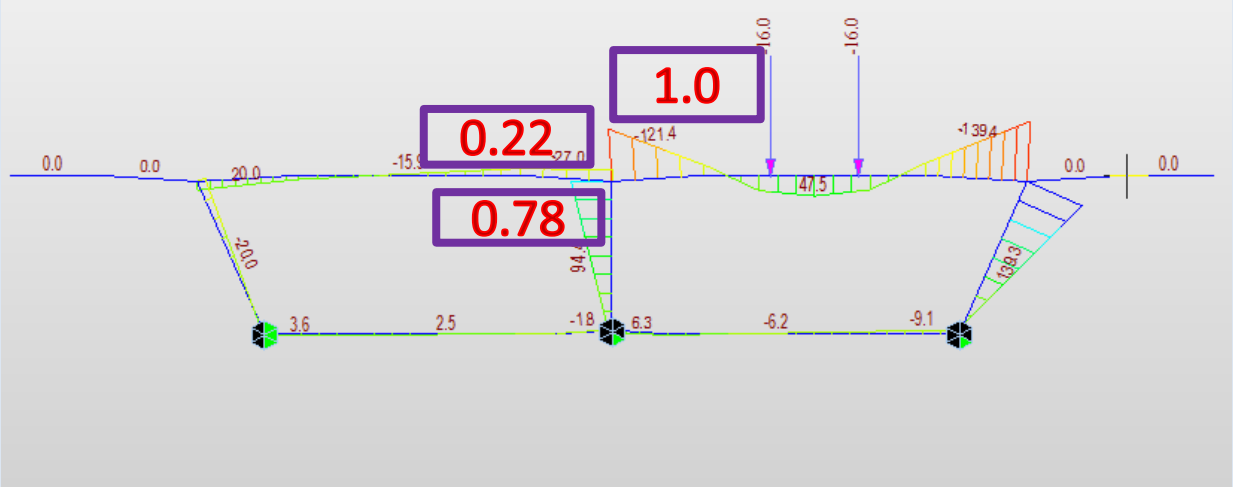
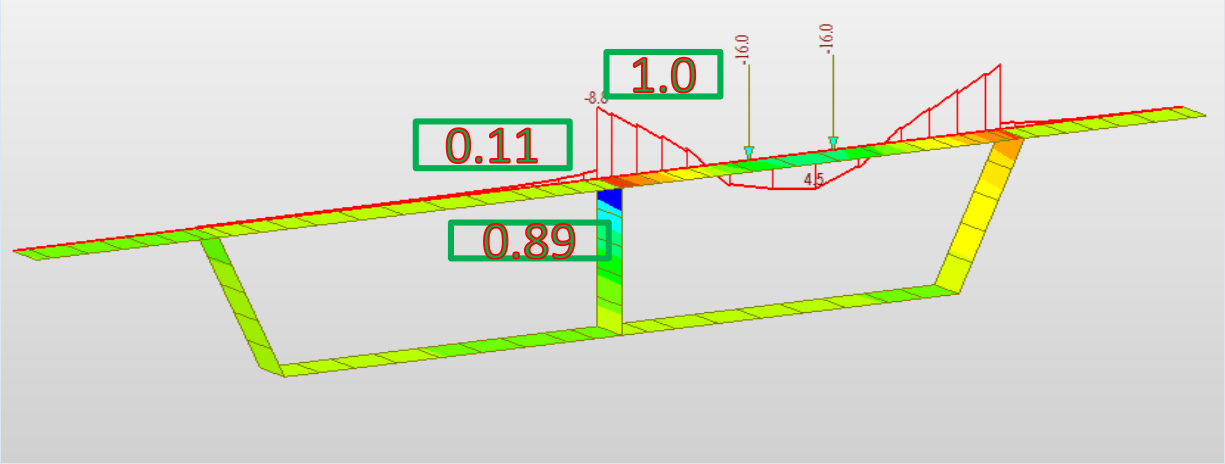


3D Finite Model



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Summary

- Simplified method is conservative and may be good for preliminary design
- Influence surface is adequate for deck transverse design
- Traditional 2D Frame action analysis may not accurately reflect moment distribution.
- 3D Finite is recommended for final design

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Thank you

Questions ?