Seismic Design of Adjacent Rail Bridges in Deep Liquefiable Soils

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Project Purposes

-LOSSAN Project-

- Carries Commuter, Amtrak and BNSF Freight rail lines
- Construct 0.9-mile segment of second main track

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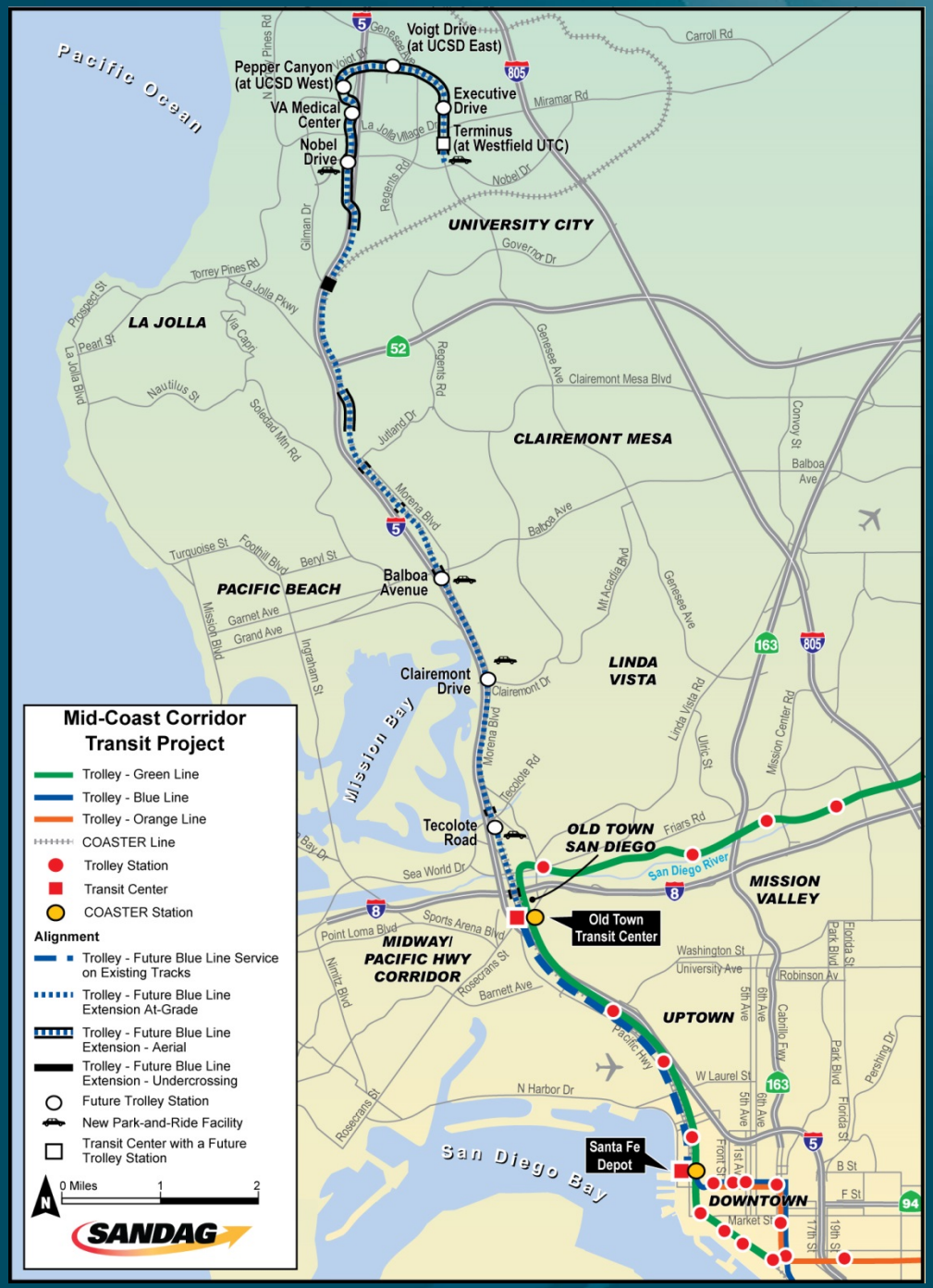
Project Purposes

-Mid-Coast Lightrail Extension Project-

- 11 mile Extension
- 9 new stations



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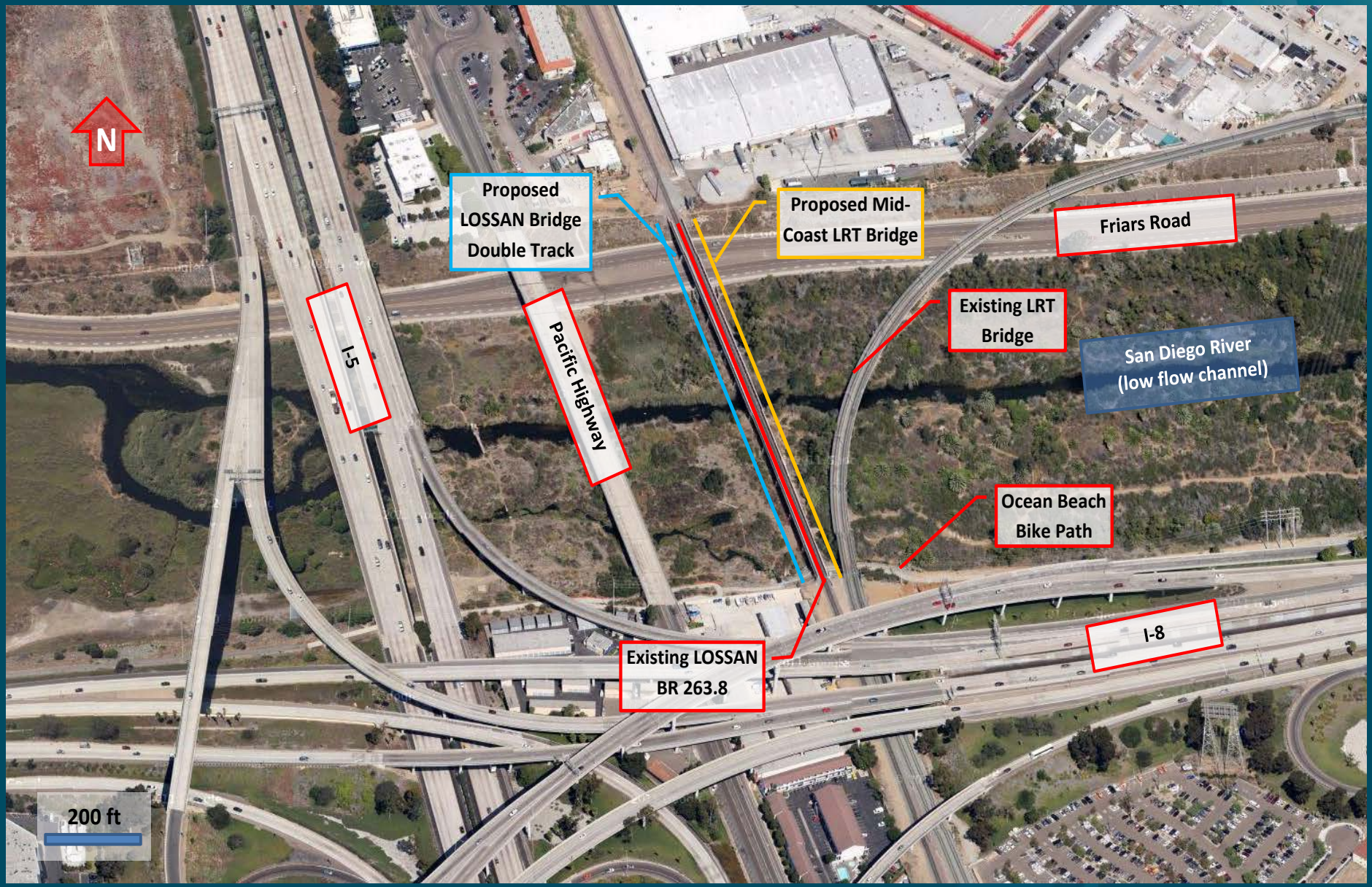
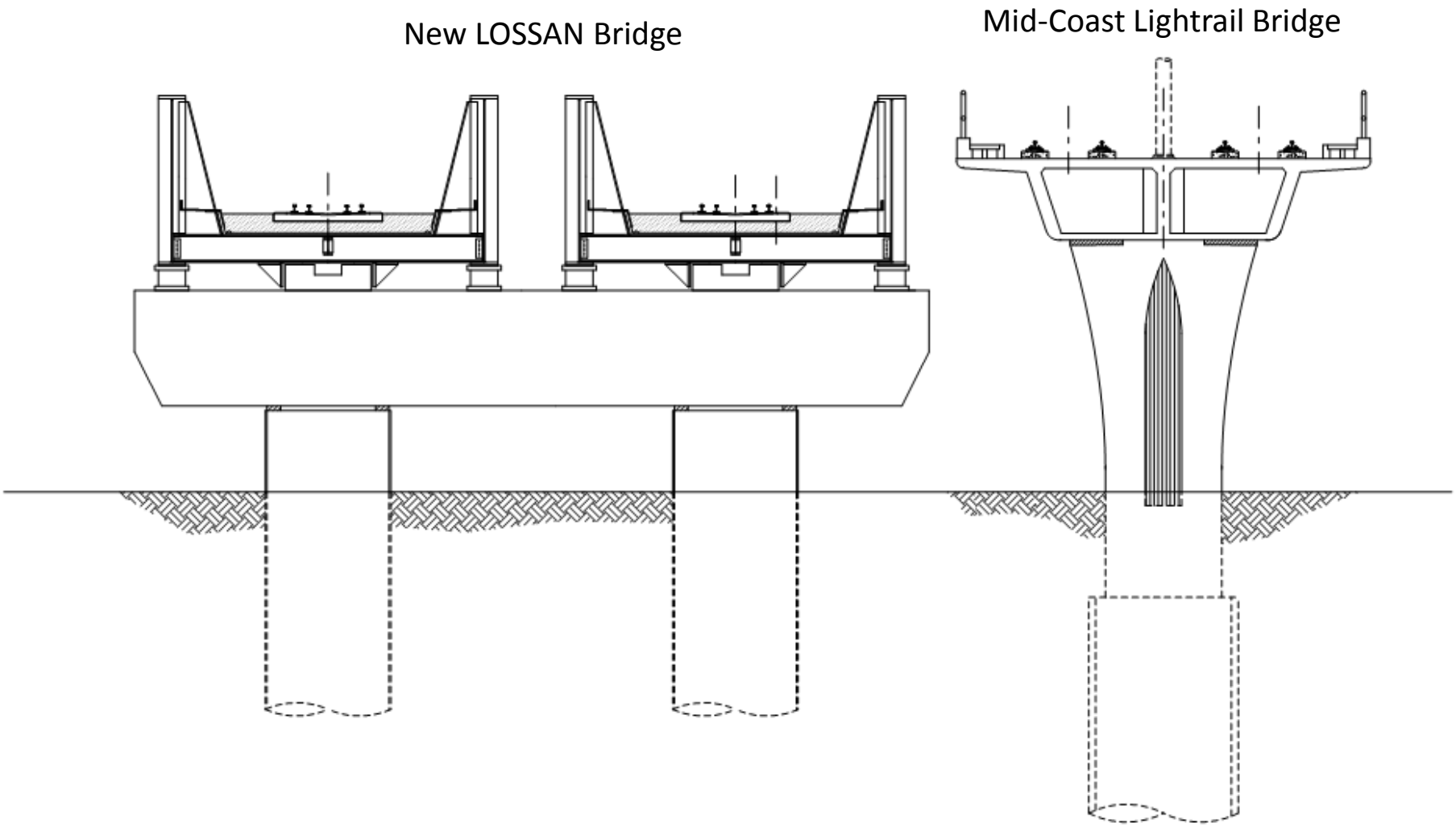
San Diego River Bridge



Typical Section



Design Criteria for Different Structures

- AREMA
  - 3 Level Seismic Performance Criteria
  - Site Specific RSA

	PGA (g)	Return Period (years)	Performance
Serviceability	0.13	100	Minor Damage, Structure useable
Ultimate	0.27	500	Inspectable Damage
Survivability	0.53	2400	Collapse Prevention

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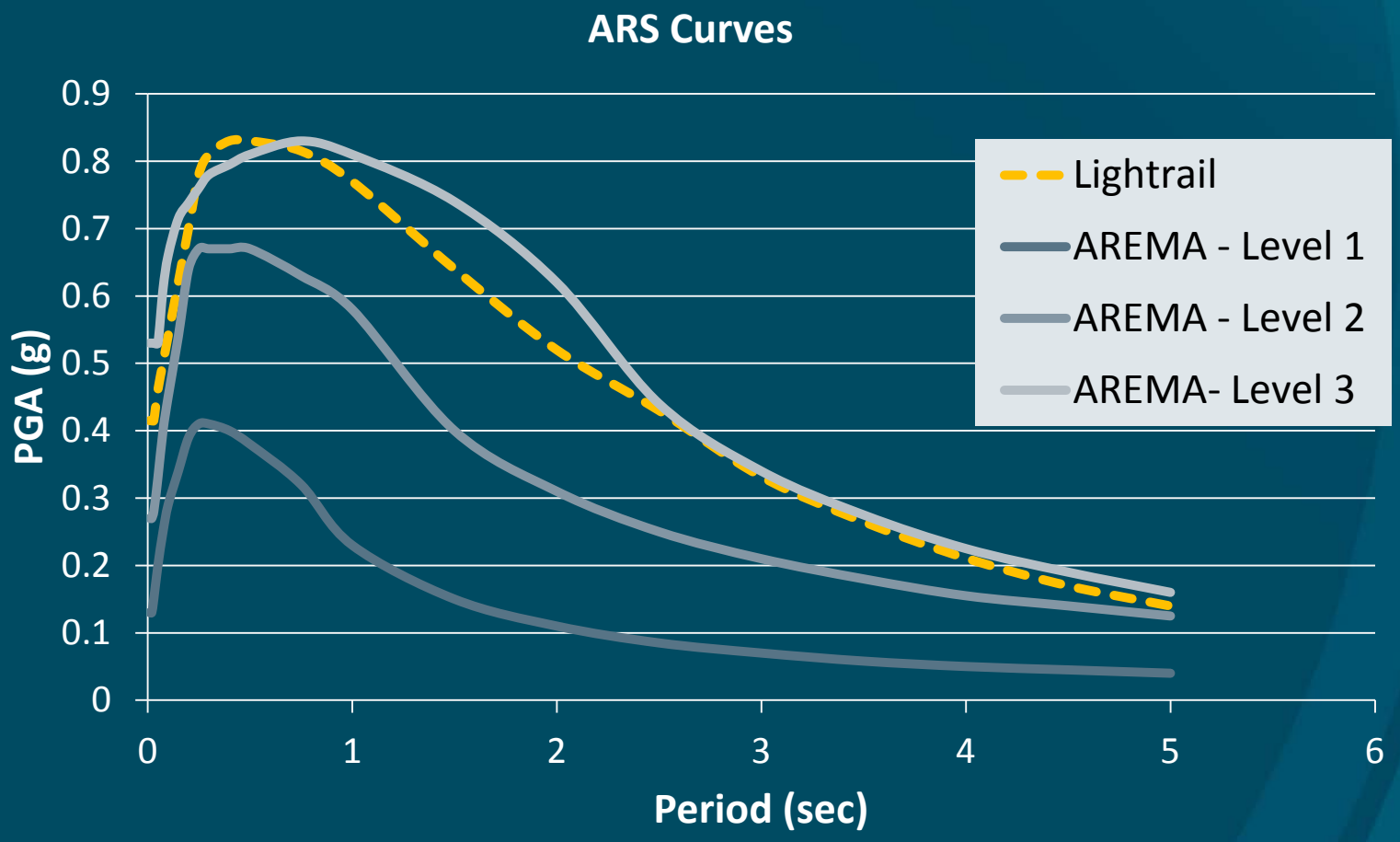
- Mid-Coast Lightrail
  - Caltrans Seismic Design Criteria
    - 1000-yr Return Period
    - PGA – 0.42g
    - Collapse Prevention

Response Spectra



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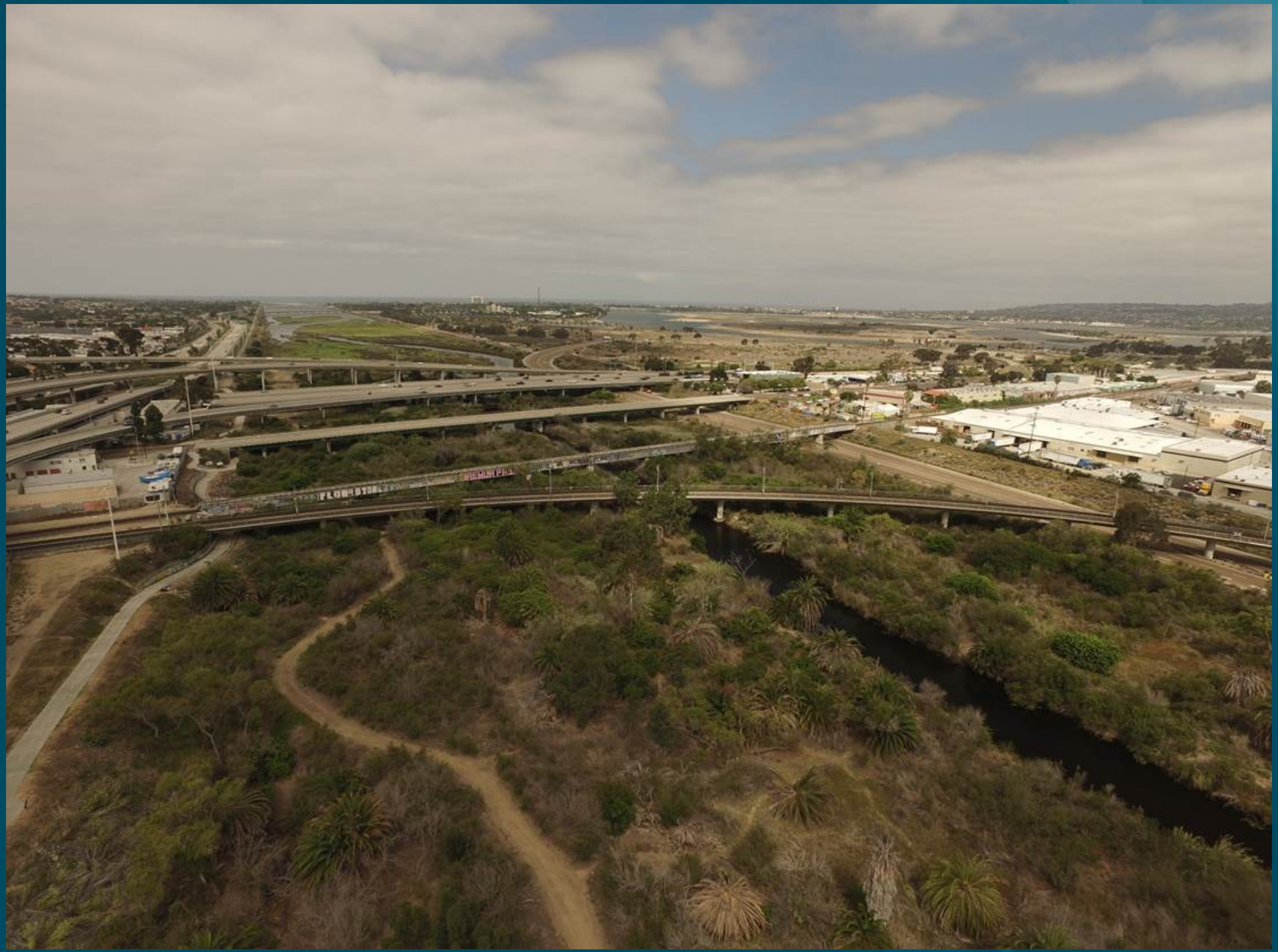
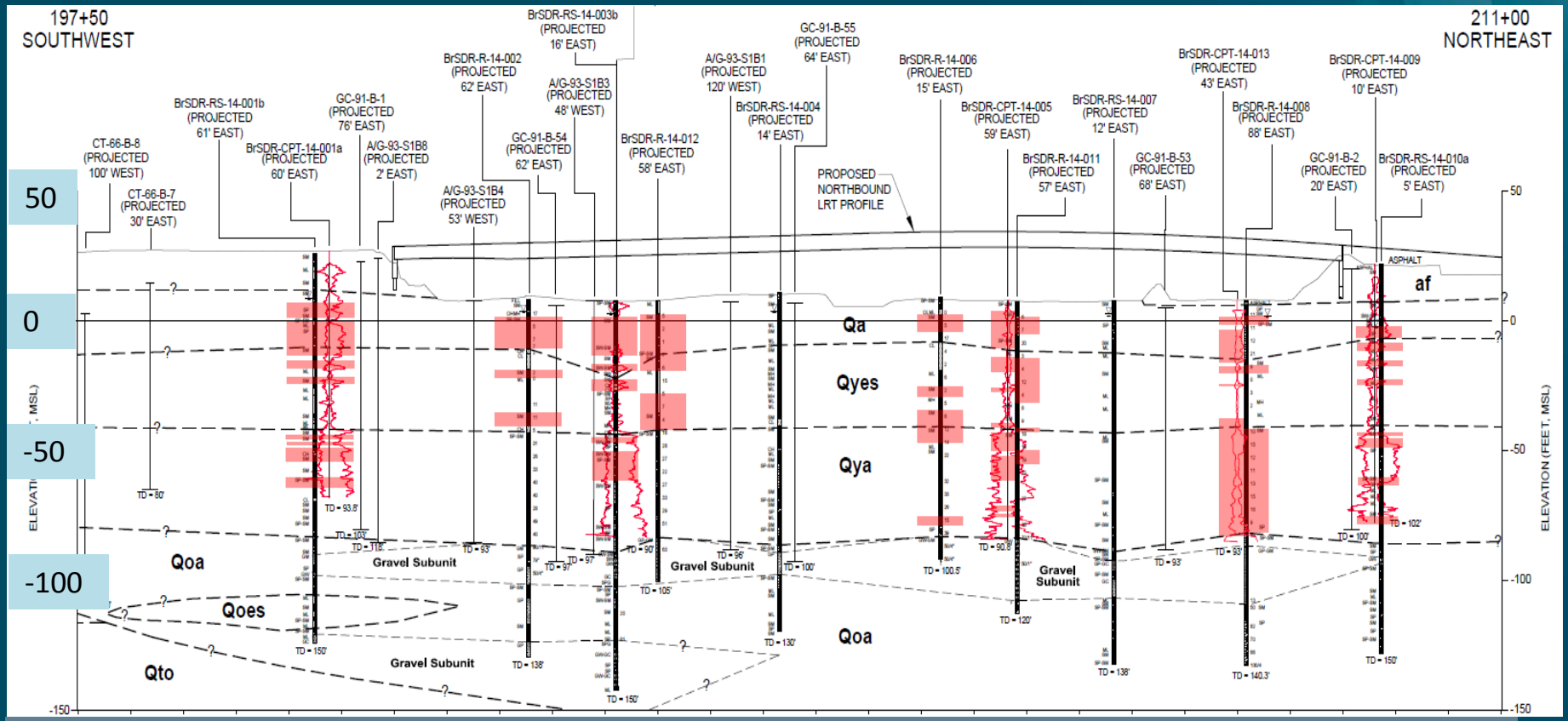
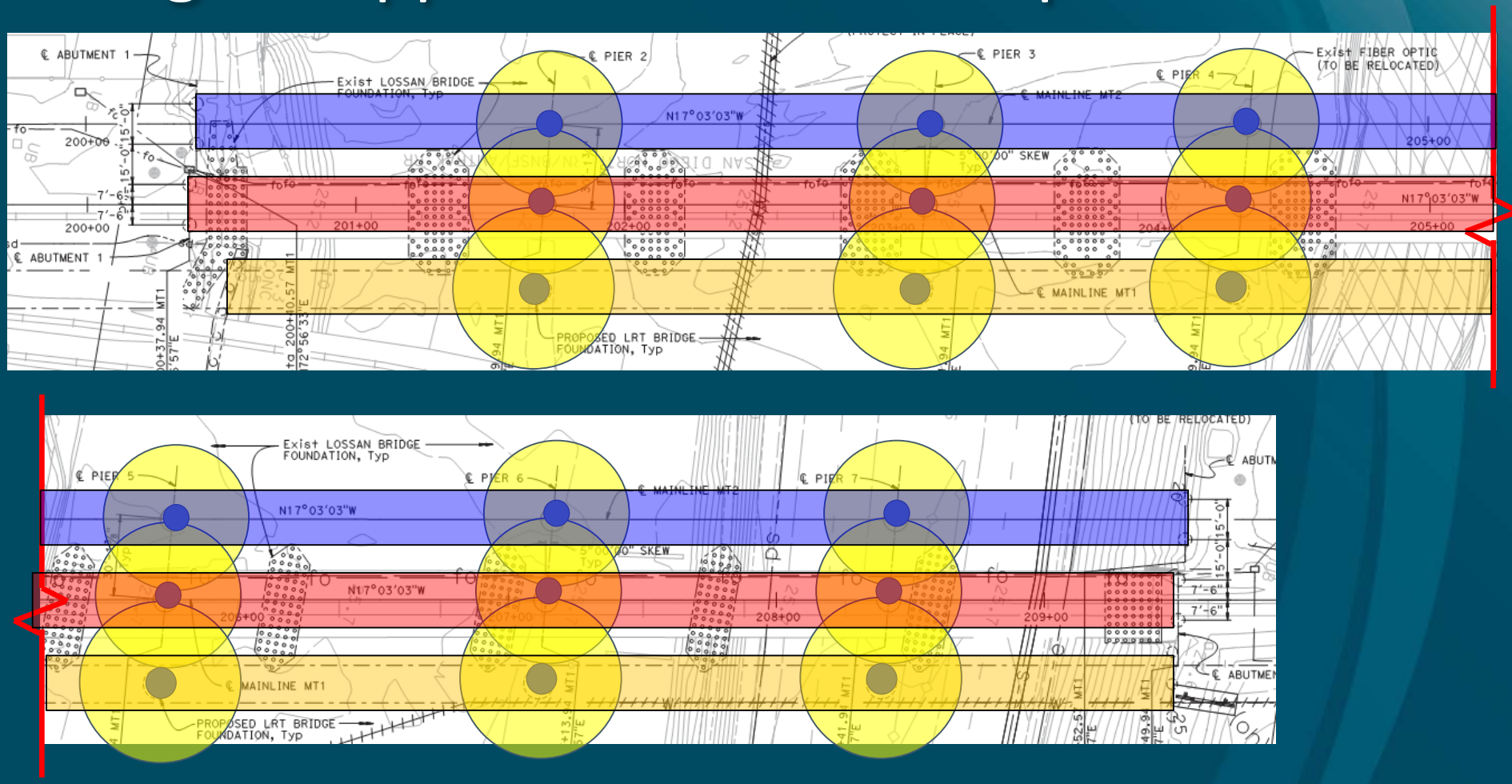


River Soil Conditions During Earthquake

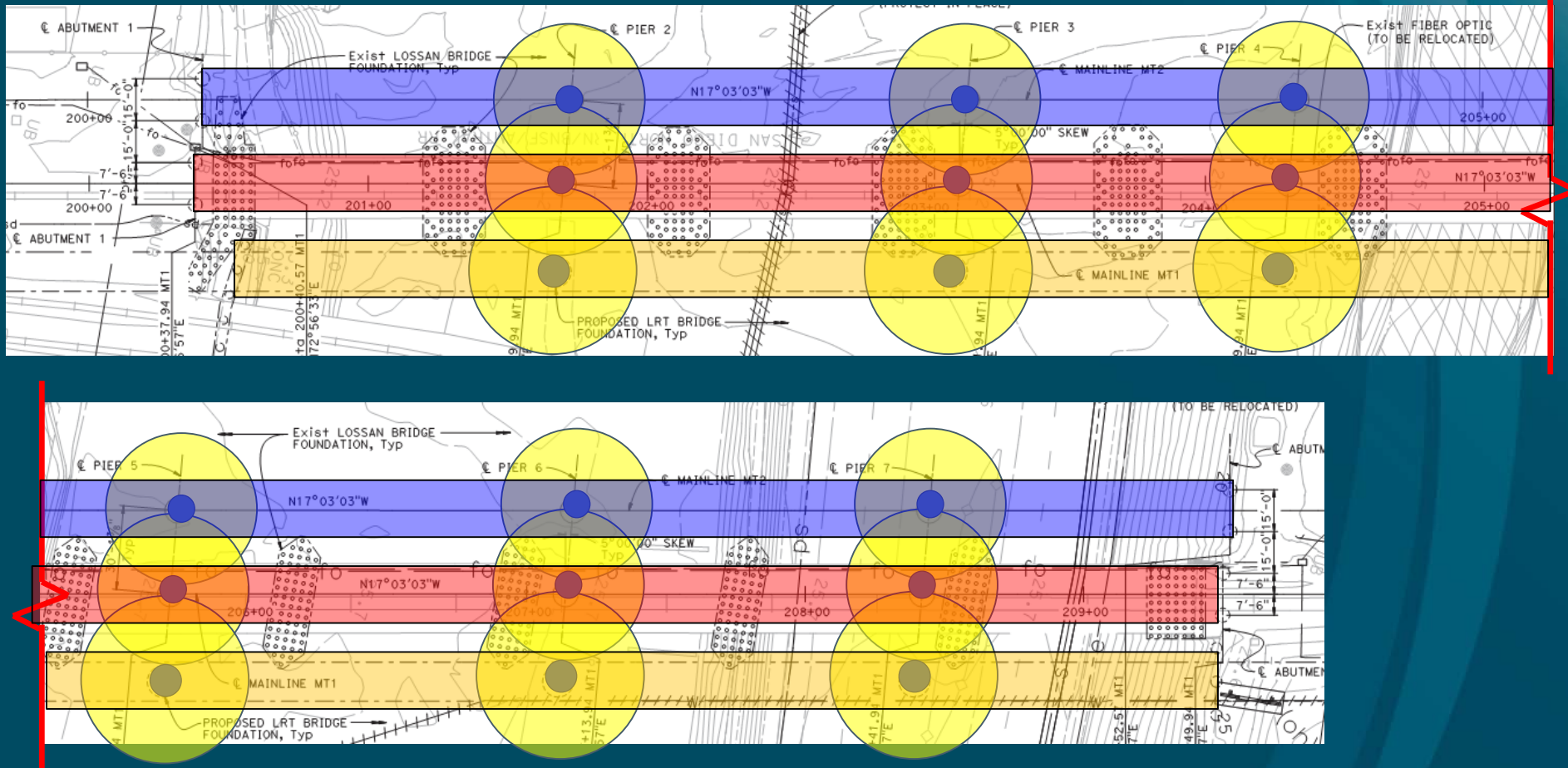


- Ultimate and Survivability Events – Liquefaction up to 80’ deep
- Scour is up to 20 feet
- Slope Stability and Lateral Spreading

Original Approach – Ground Improvement



Original Approach – Ground Improvement



- Ground improvement 90 feet deep
- Conflicts with existing foundations
- Staging of ground improvement

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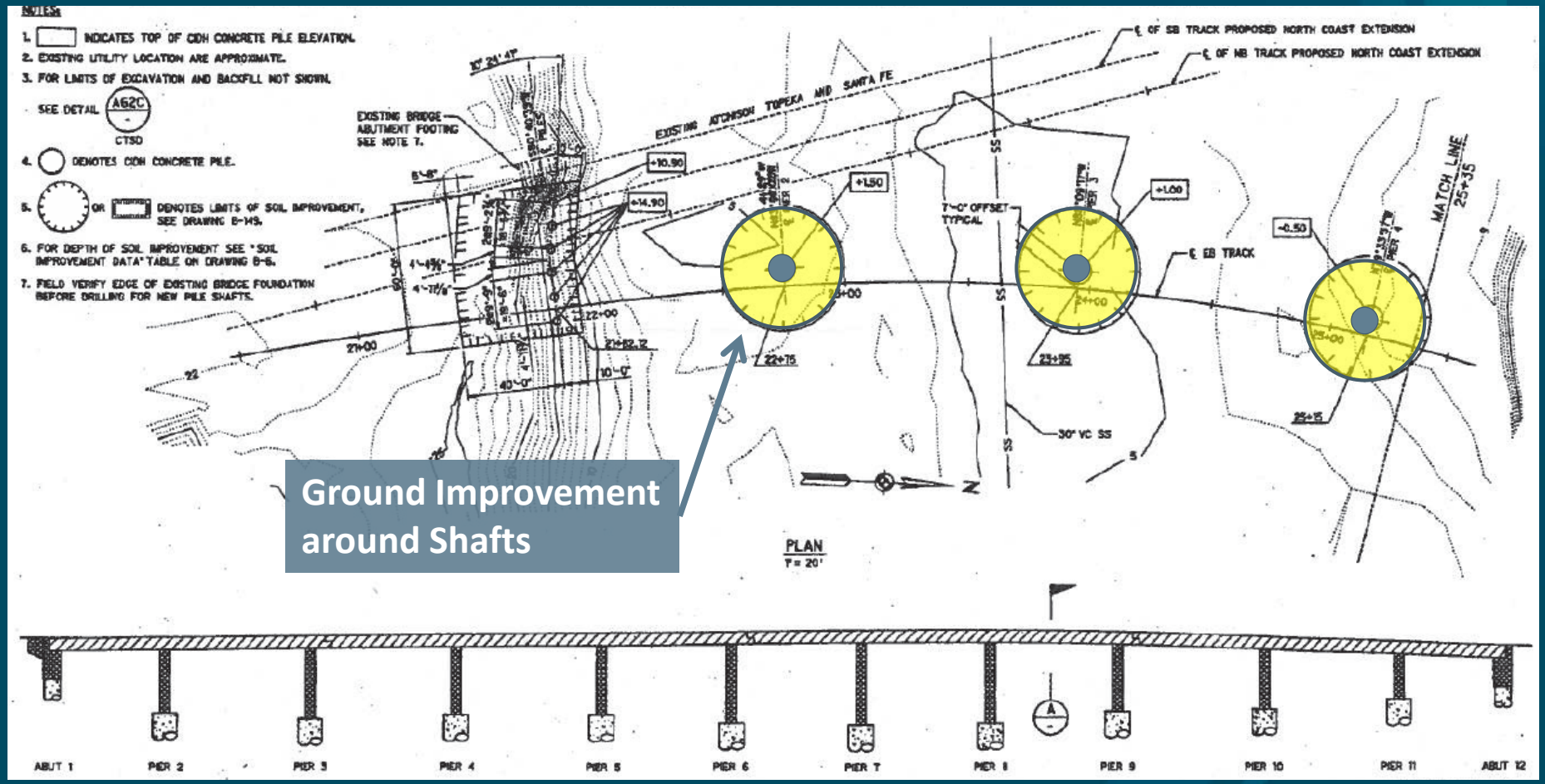
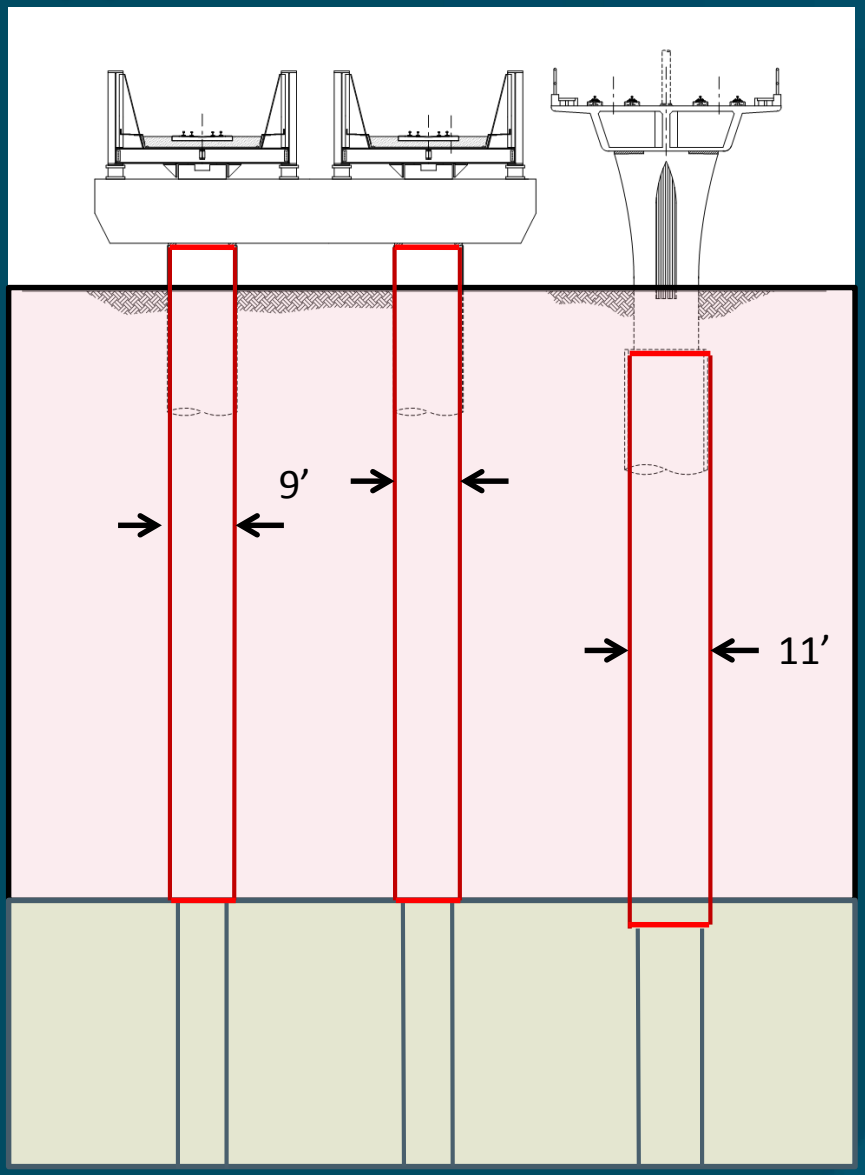
Existing Trolley Bridge Approach– Ground Improvement



Alternative Approach – Permanent Steel Casings



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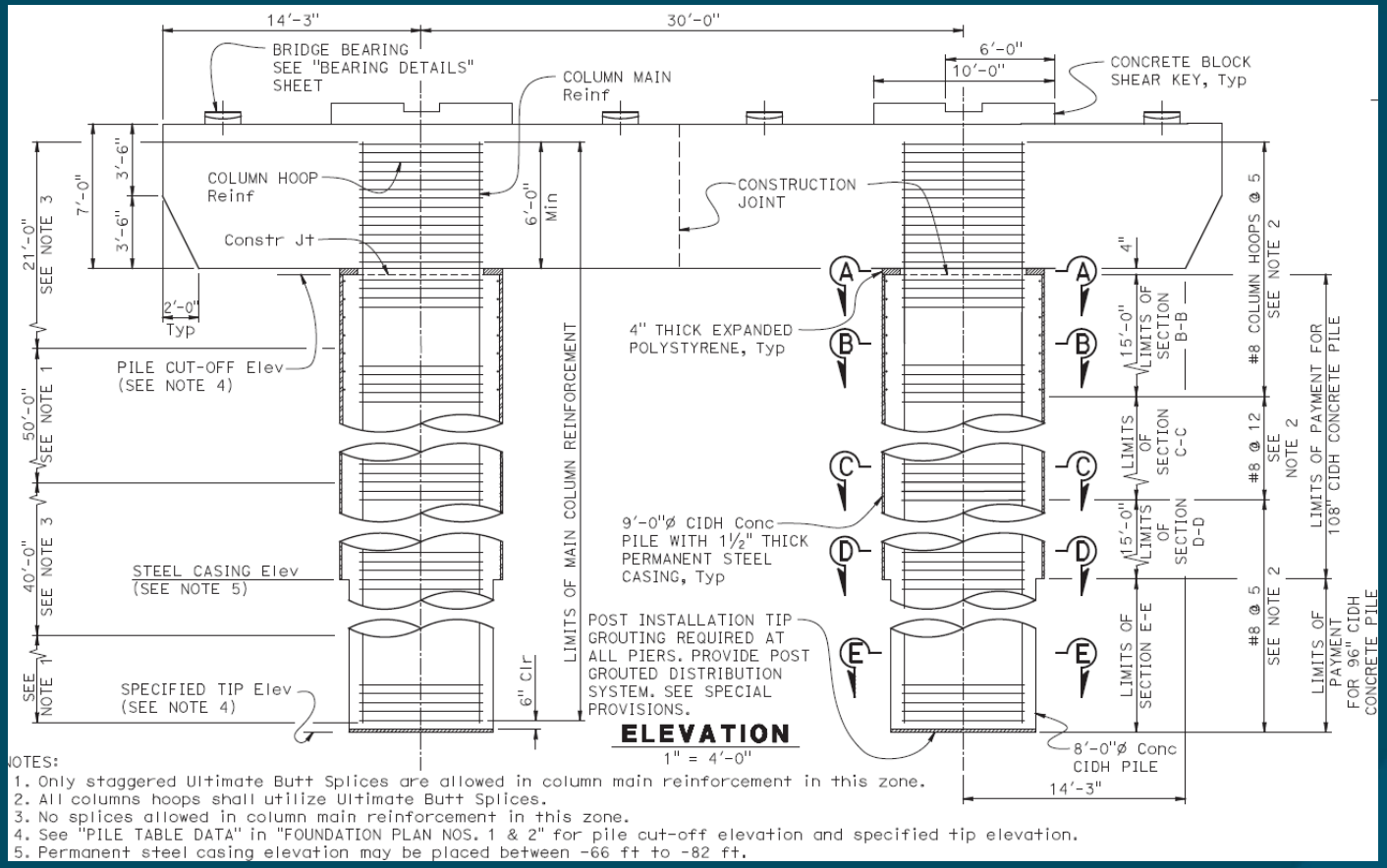
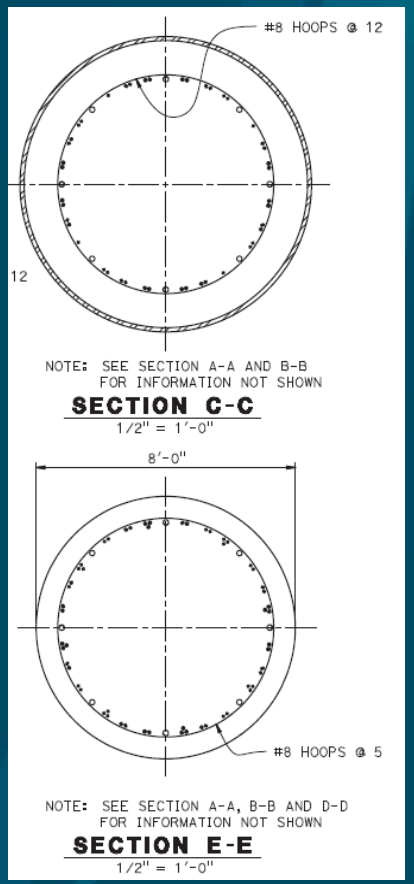
San Diego River

- Approx. $4M Cost Savings





Alternative Approach

- Why not just use larger diameter conventional shafts?

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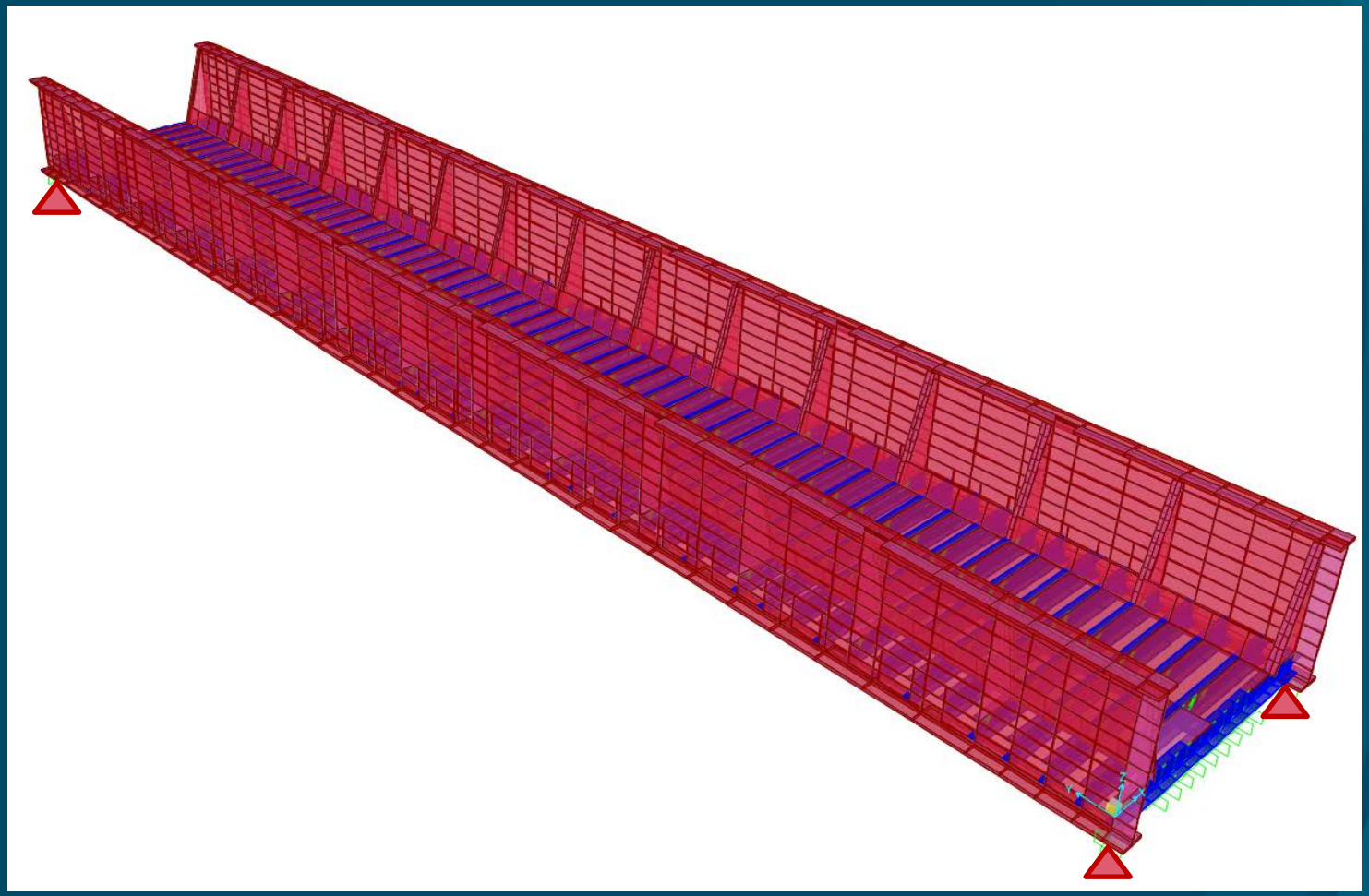
Seismic Design of Superstructure



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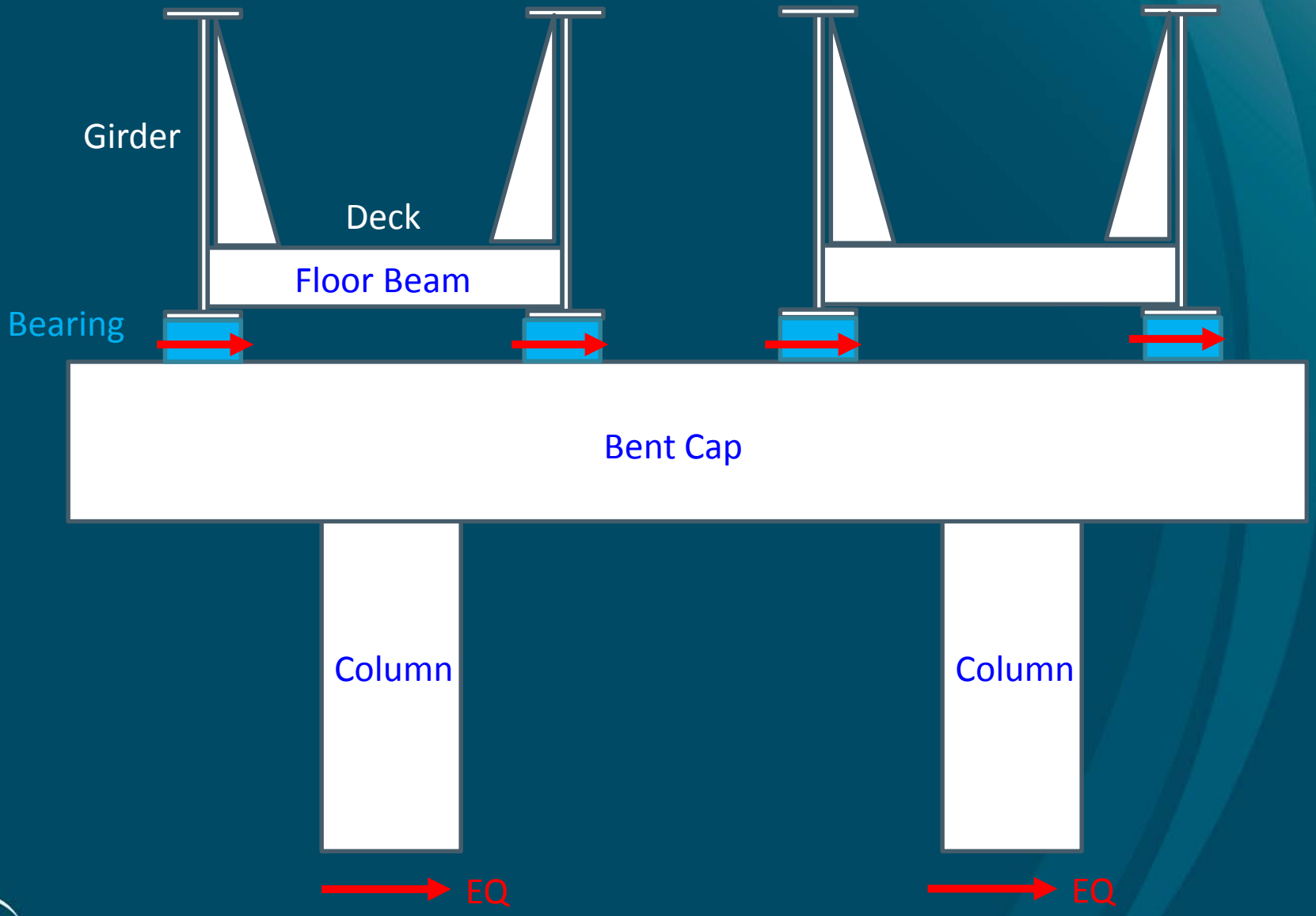

Bent Elevation

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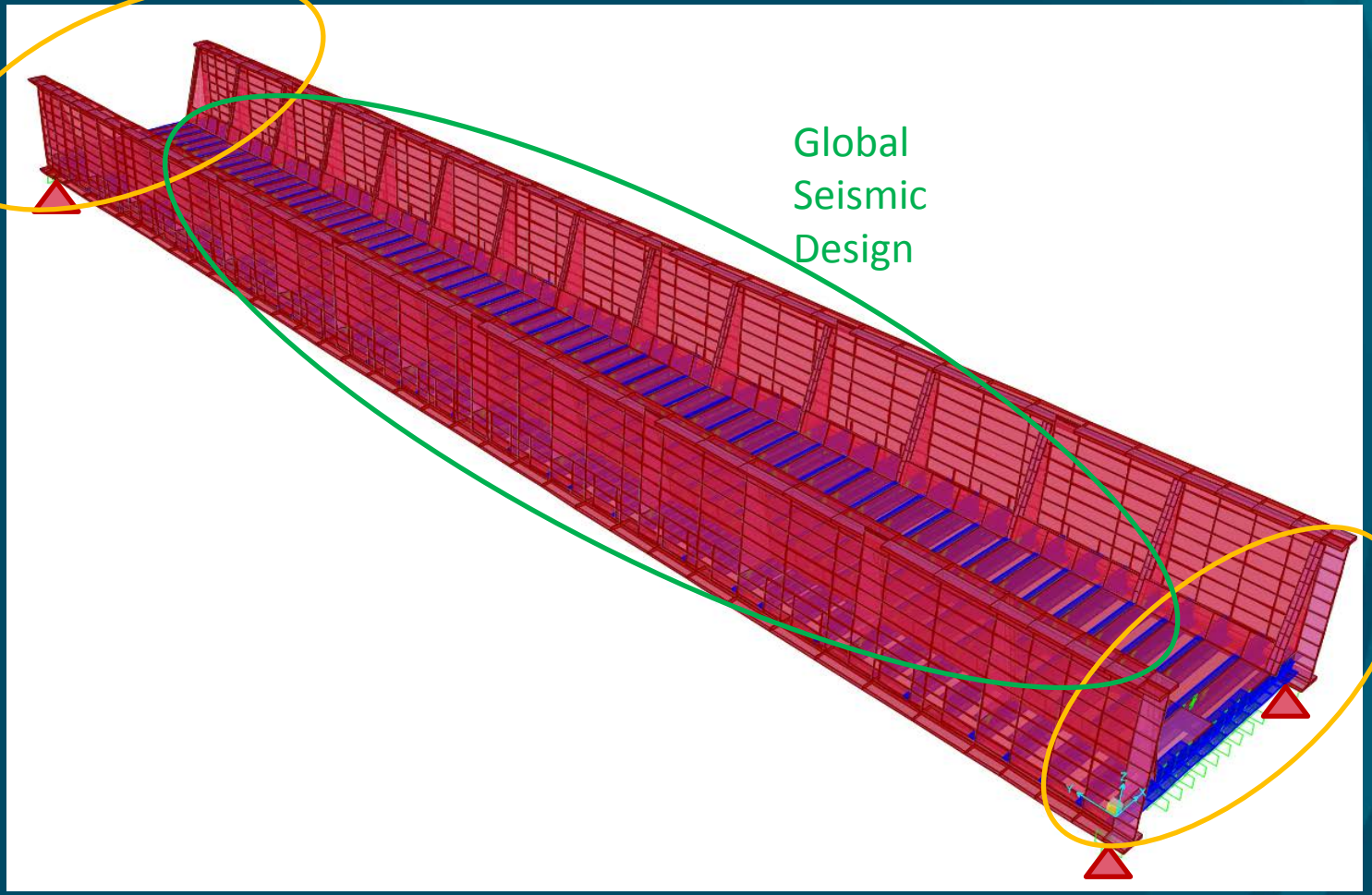

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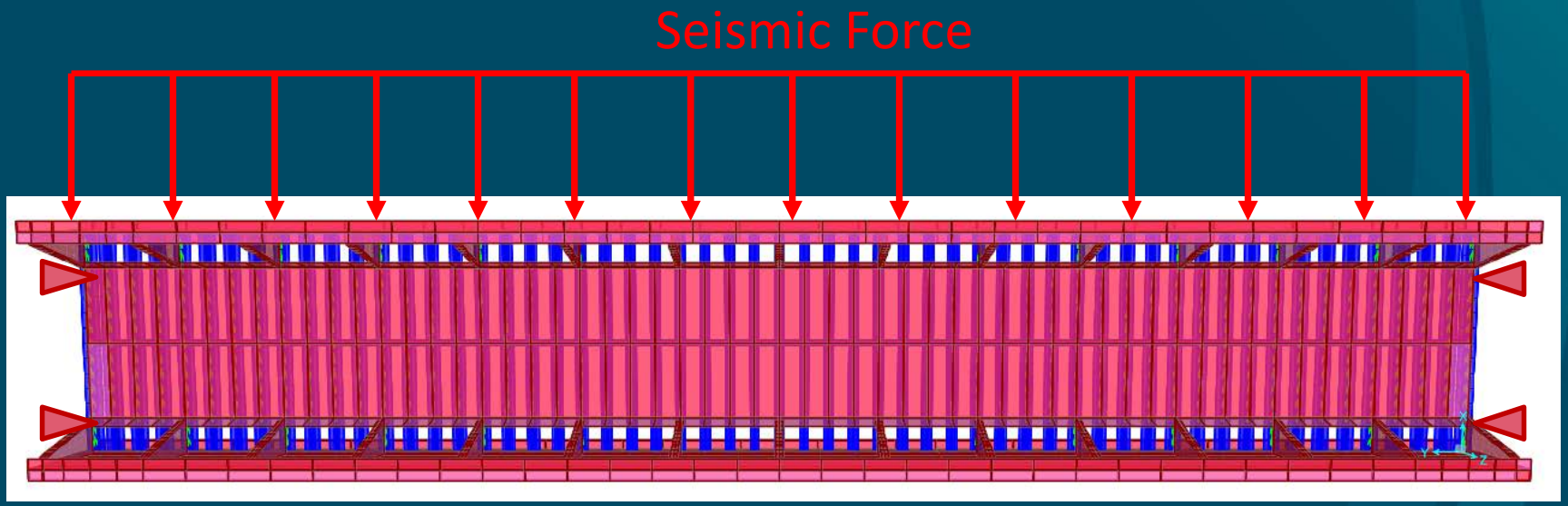

Bridge Plan

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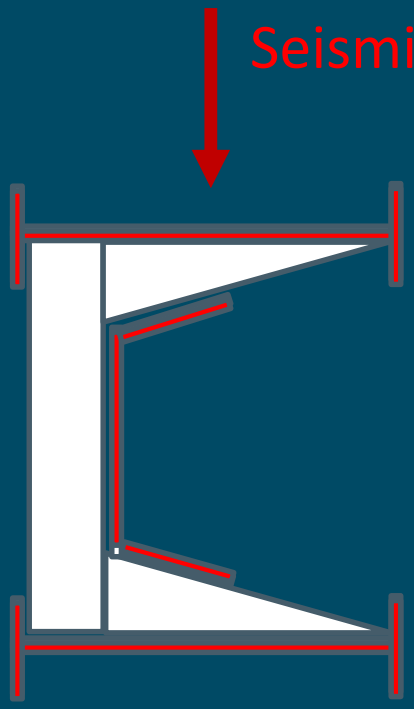
Seismic Design of Superstructure



Resisting Cross Section

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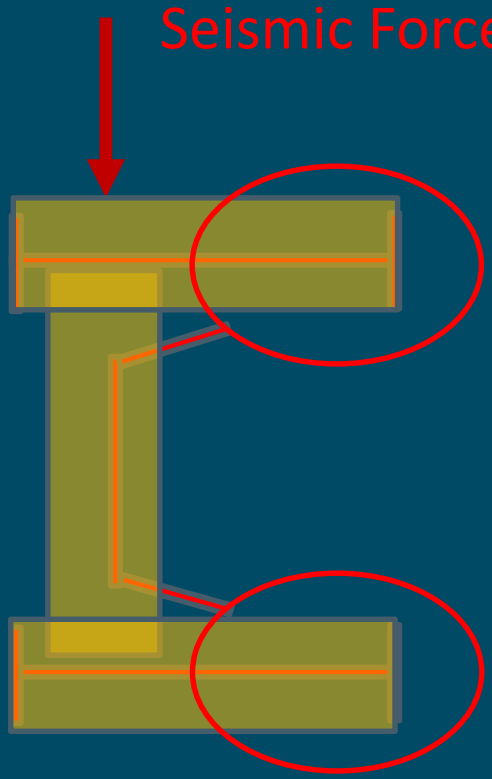

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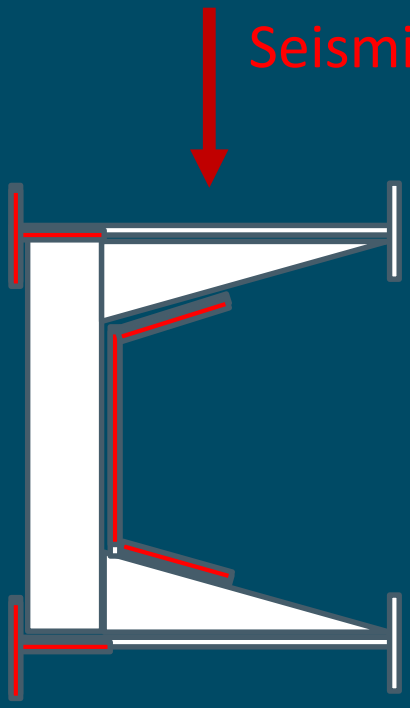

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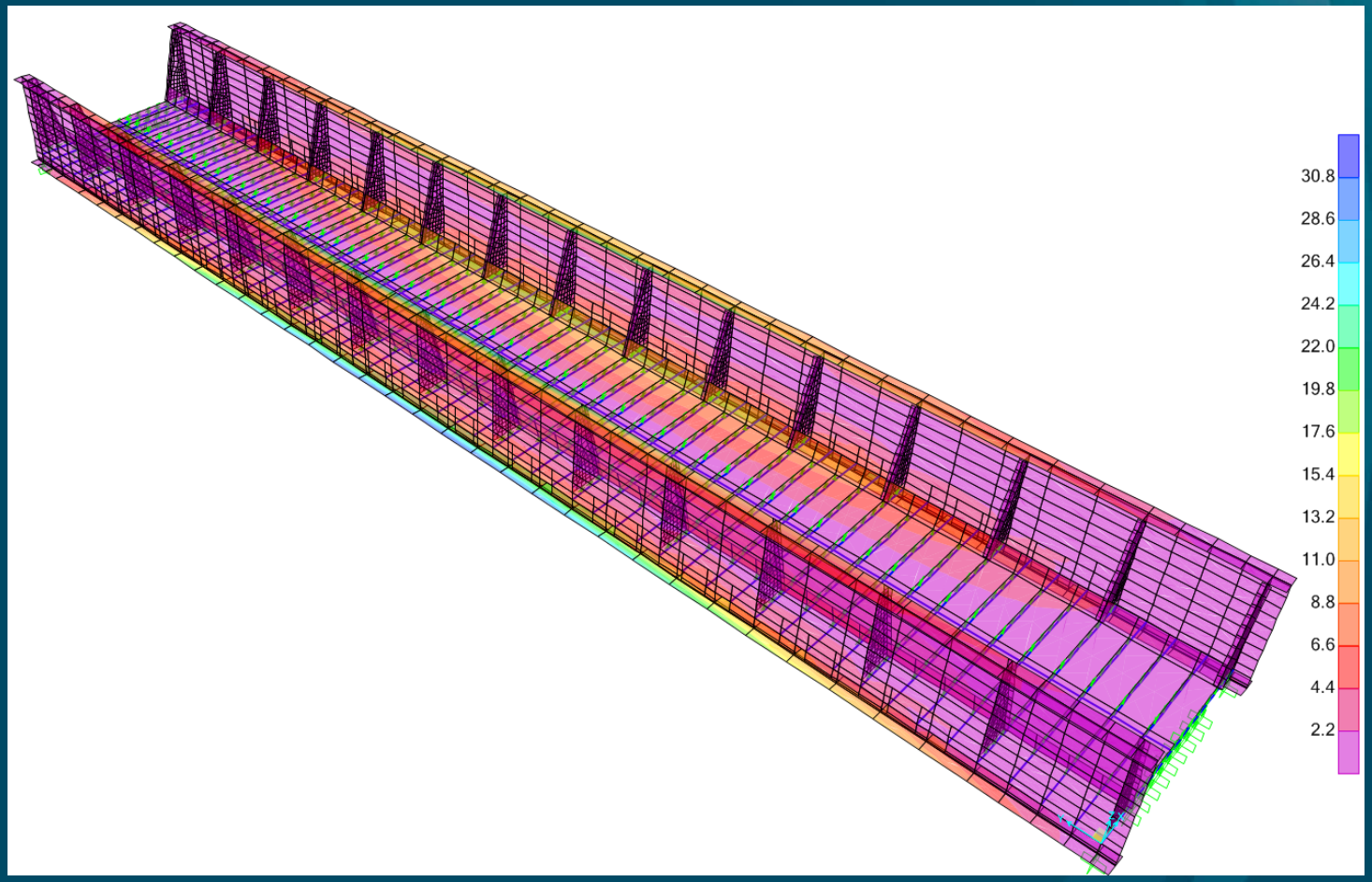

Finite Element Model
(SAP 2000)

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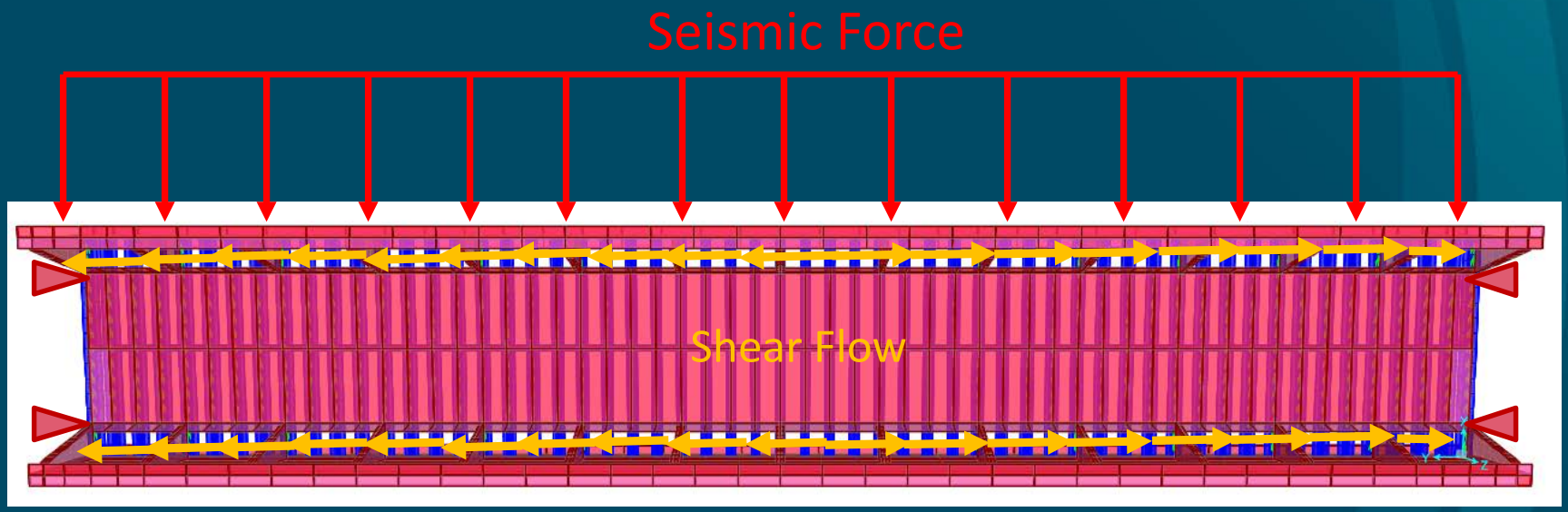
Seismic Design of Superstructure



Bridge Plan

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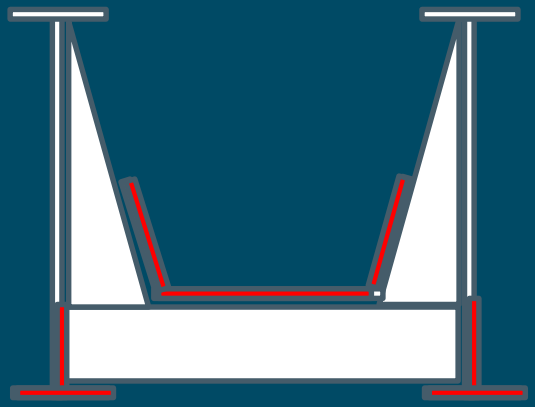
Seismic Design of Superstructure – Key Points

1. Simplified Resisting Cross Section



2. Pay Attention to Shear Flow actions at ends of floor beams

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