I-5 North Coast Corridor
San Elijo Lagoon Bridge Replacement

2015 WESTERN BRIDGE ENGINEERS' SEMINAR

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Introductions

I-5 NCC

Highway Phase 1 (2015-2018)

1. Lomas Santa Fe to Birmingham Drive
2. Birmingham Drive to Leucadia Boulevard
3. Leucadia Boulevard to Palomar Airport Road
4. Palomar Airport Road to SR-78

Railroad Phase 1 (2015-2018)

5. Batiquitos Lagoon Double Track
6. San Elijo Lagoon Double Track Platform

Environment Phase 1 (2015-2018)

7. San Elijo Lagoon Restoration

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Project Overview

Owner – Caltrans District 11

- Oversight by Caltrans DES

Delivery Method – CMGC

- Construction Manager/General Contractor

San Elijo Bridge Replacement and DAR Scope

- Replace San Elijo Lagoon Bridge
- Construct DAR and Multi-use Facility
- Construct Bike/Pedestrian Path Including Lagoon Pedestrian Bridge

Why CM/GC?

Fosters Collaboration

Increases Owner Control and Involvement

Manages Risk

Accelerates Delivery

Increases Flexibility

Focuses on Cost, Value, and Problem Solving

CM/GC Key Notes

CM/GC Contract Executed Post 65% P&Q

Sample Innovations Proposed

- Foundations
- Columns

Innovation Benefits

- Cost Savings
- Schedule Savings
- Risk Reduction

LAGOON BRIDGE

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SE Lagoon Bridge Replacement

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Aesthetics

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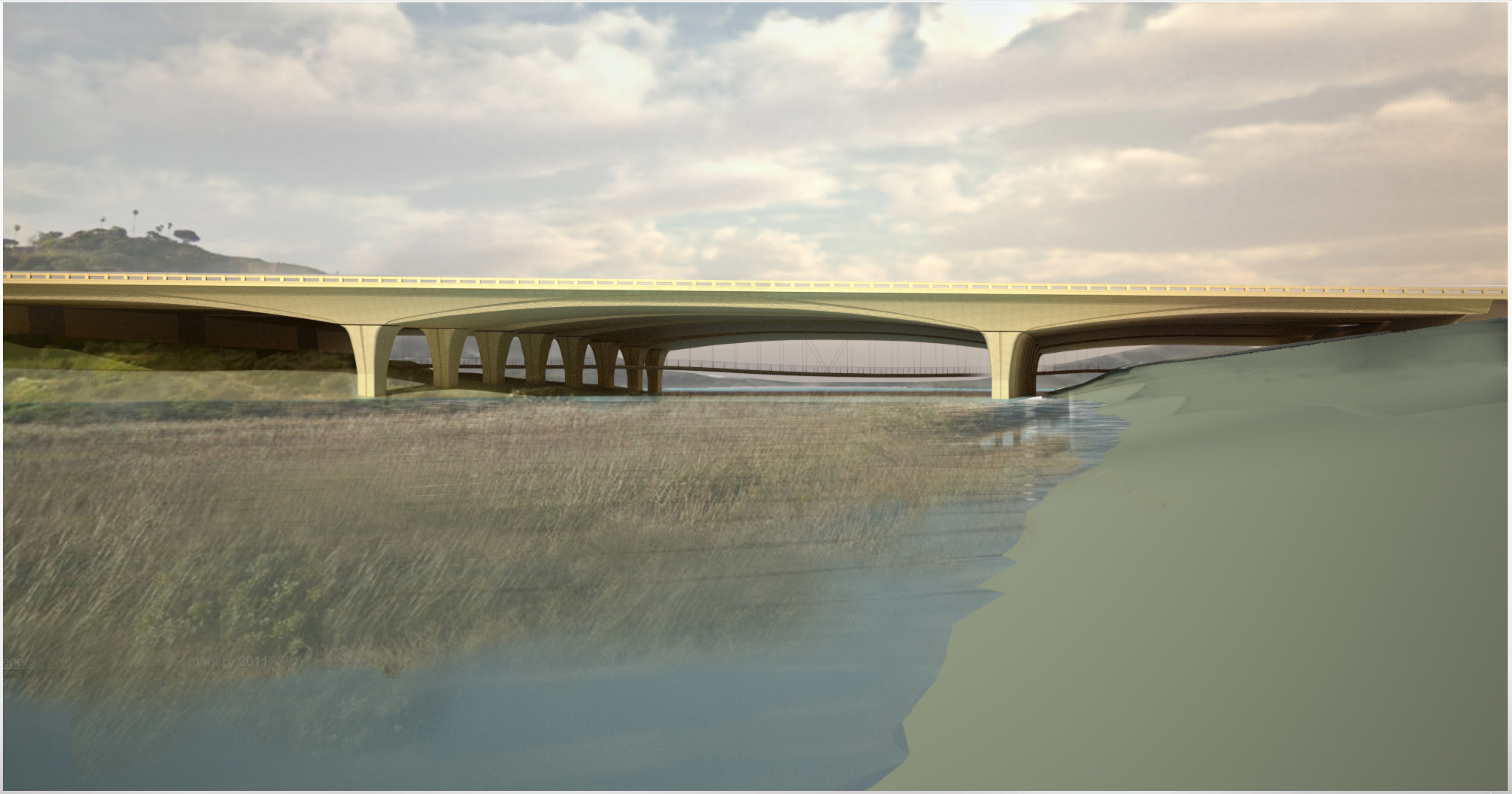
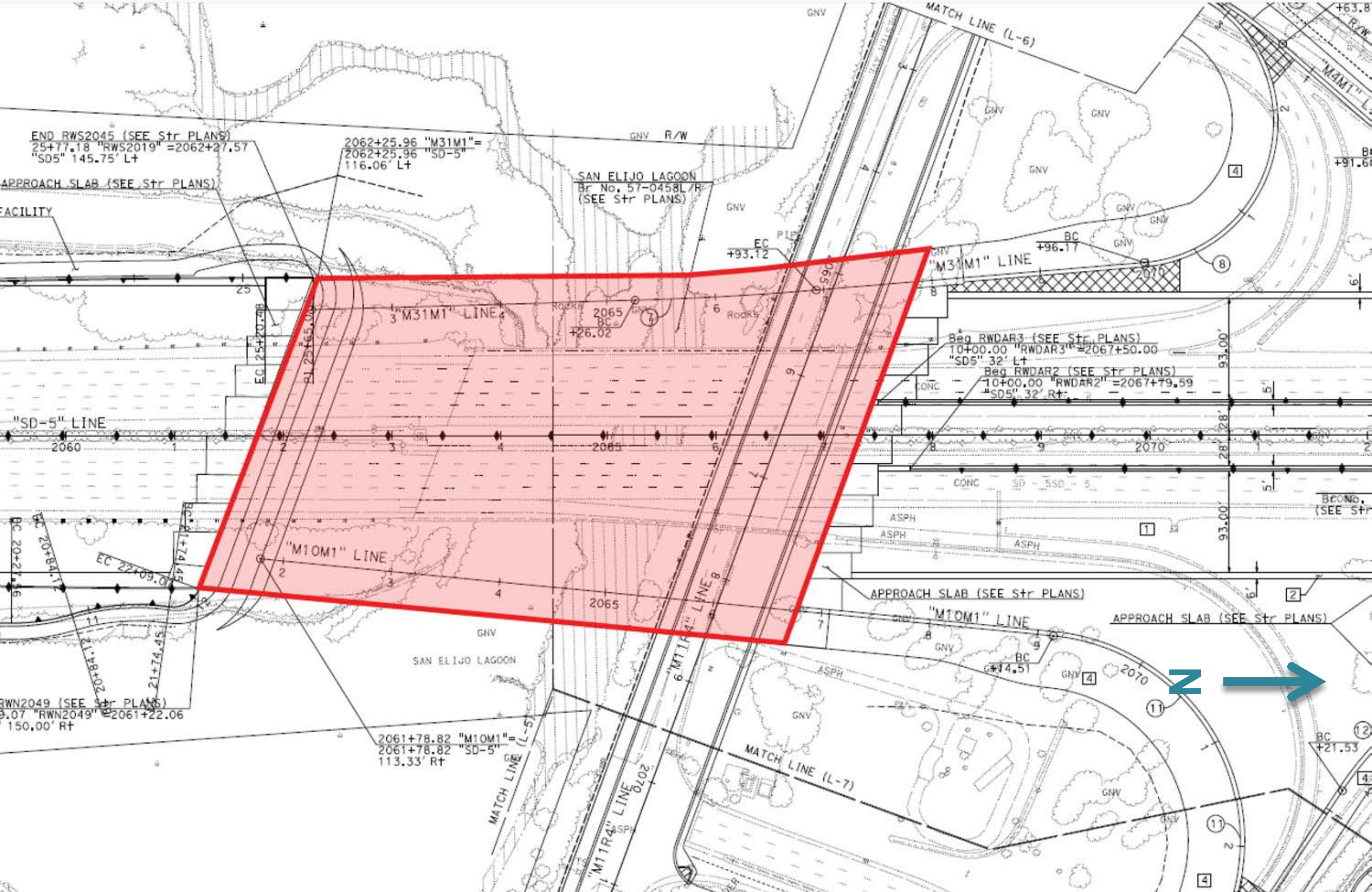
View From Manchester Avenue

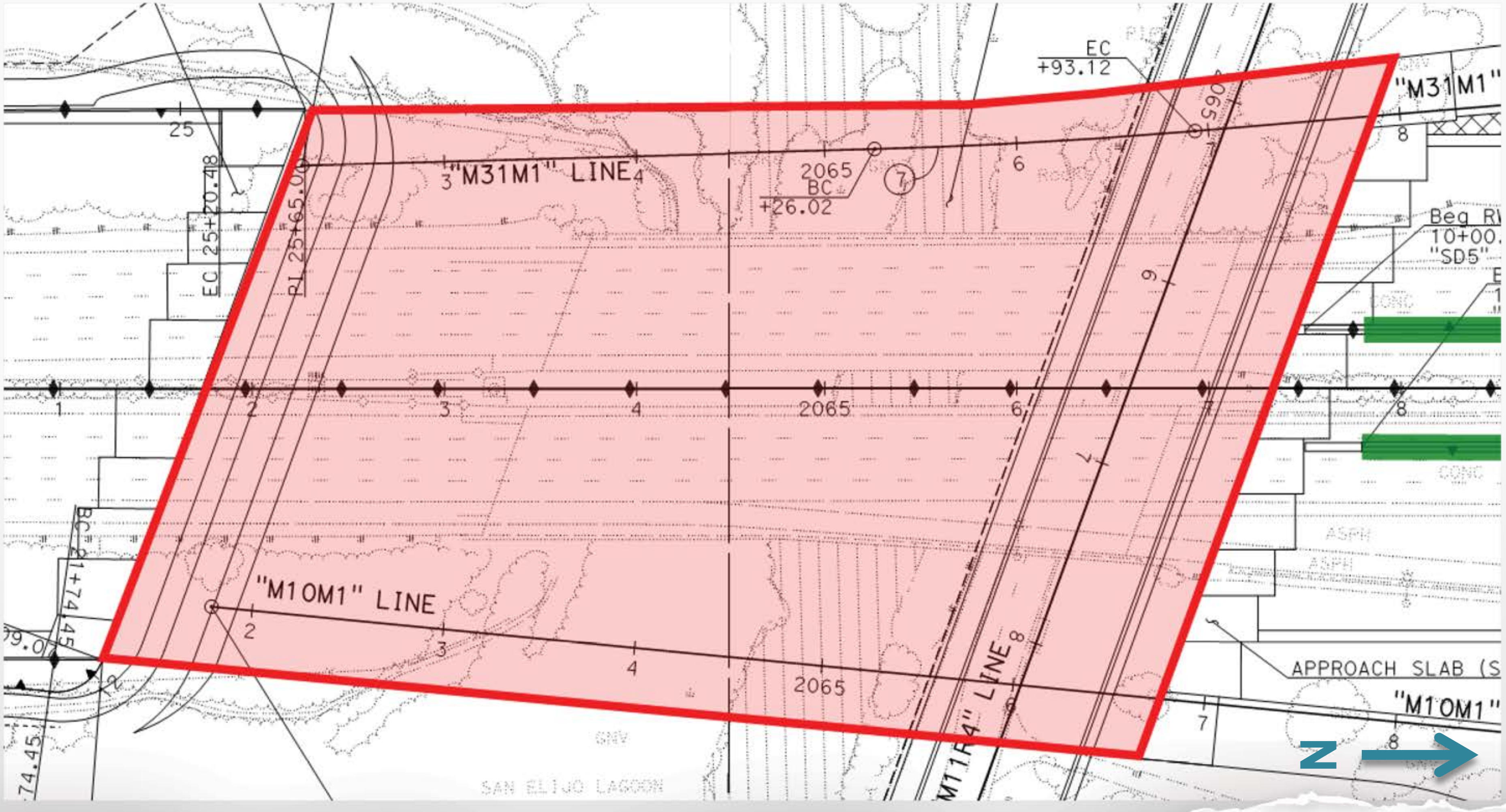


Geometrics

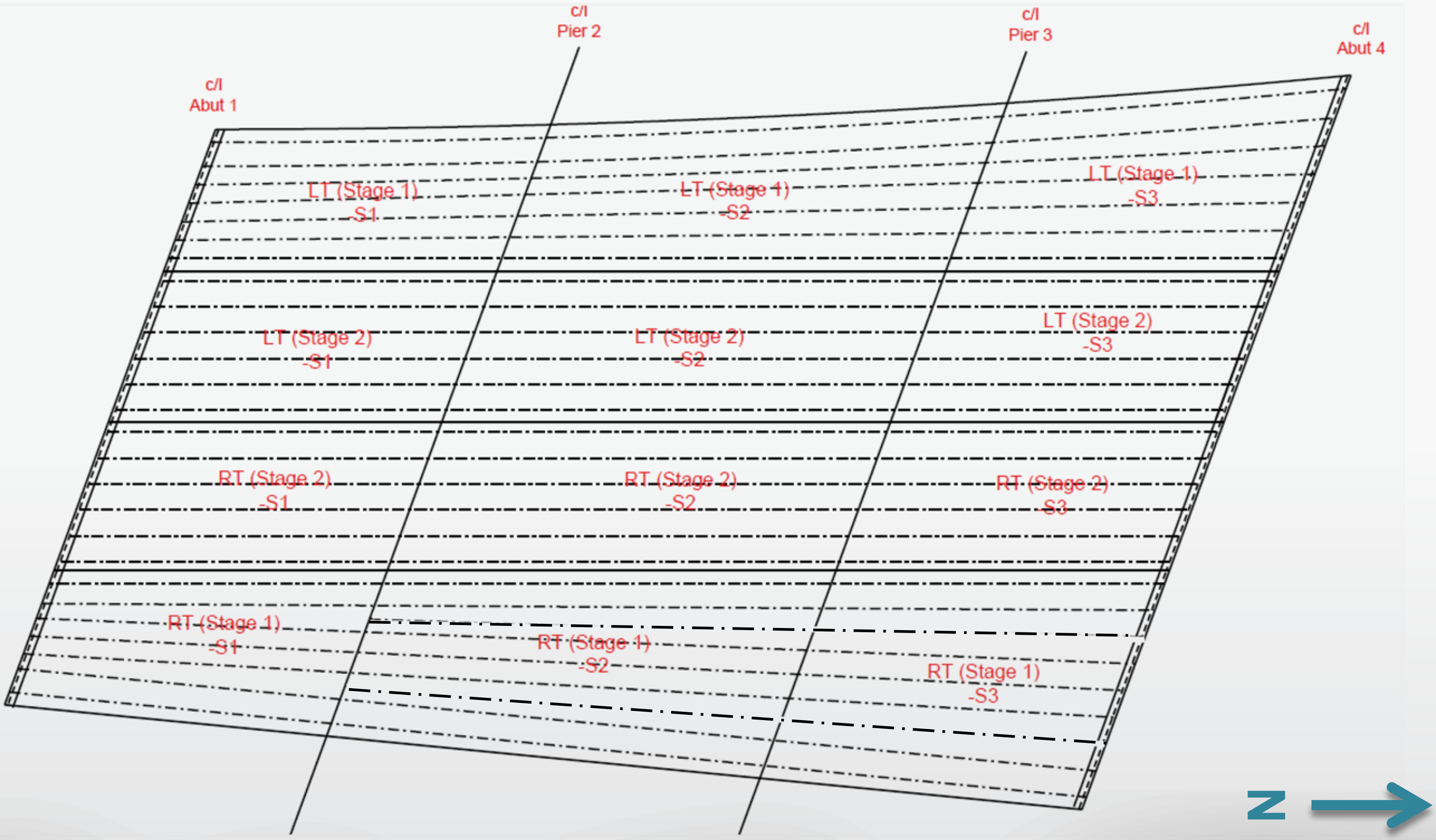


END RWS2045 (SEE Str PLANS)
APPROACH SLAB (SEE Str PLANS)
2062+25.96 "M31M1"=
2062+25.96 "SD-5"
116.06' Lt
SAN ELIJO LAGOON
Br No. 57-0458L/R
(SEE Str PLANS)
MATCH LINE (L-6)
"M31M1" LINE
"SD-5" LINE
"M1OM1" LINE
Beg RWDAR3 (SEE Str PLANS)
10+00.00 "RWDAR3"=2067+50.00
"SD5" 32' Lt
Beg RWDAR2 (SEE Str PLANS)
10+00.00 "RWDAR2" =2067+79.59
"SD5" 32' Rt
APPROACH SLAB (SEE Str PLANS)
SAN ELIJO LAGOON
2061+78.82 "M1OM1"=
2061+78.82 "SD-5"
113.33' Rt
MATCH LINE (L-7)
"M11R4" LINE
N

Bridge Layout



Bridge Layout



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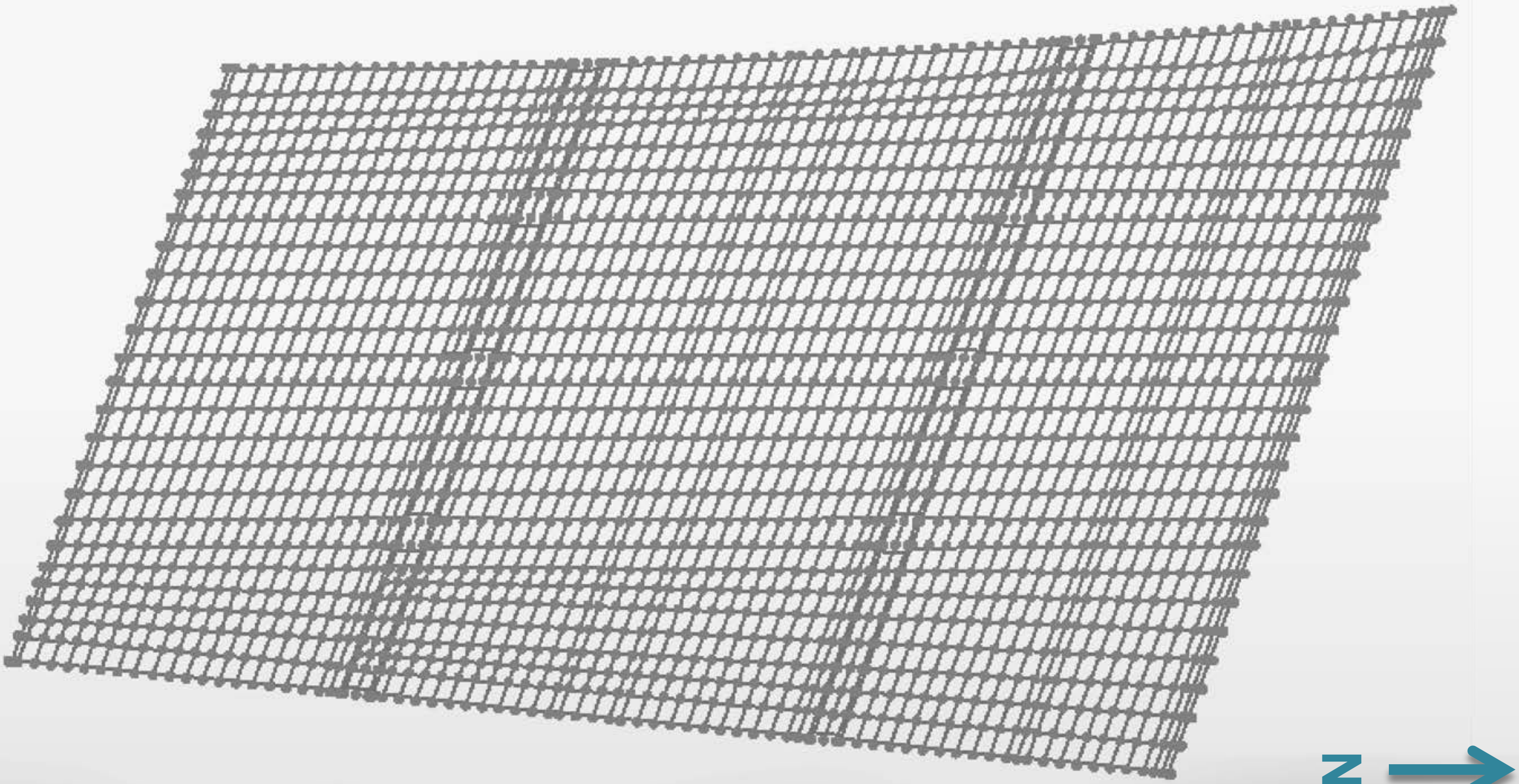
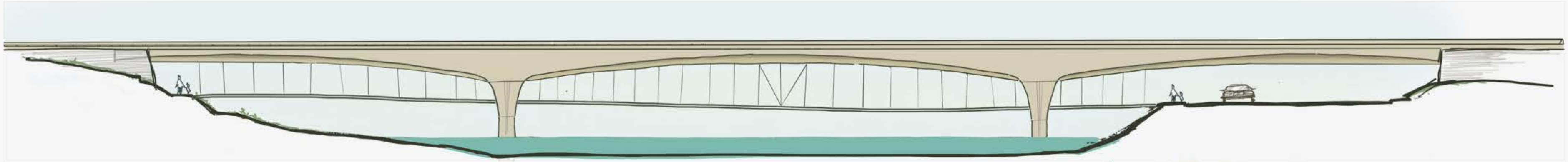
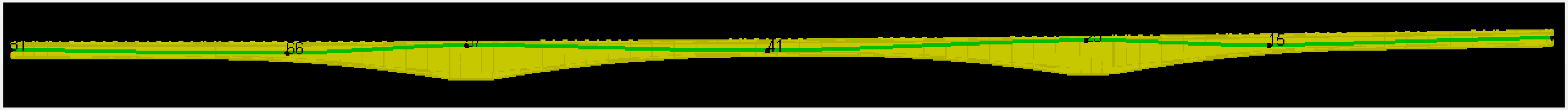
Bridge Layout

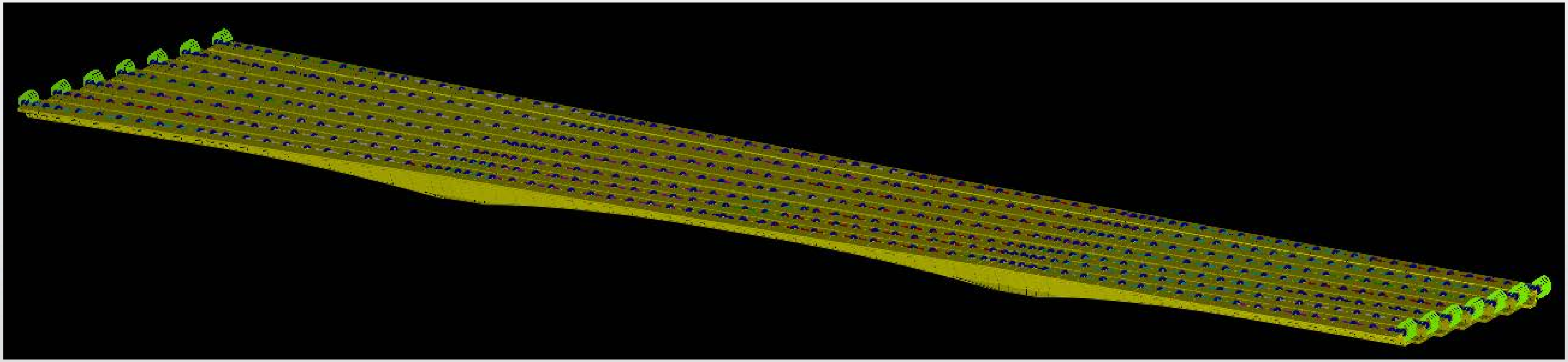


Geometry – Parametric Variation

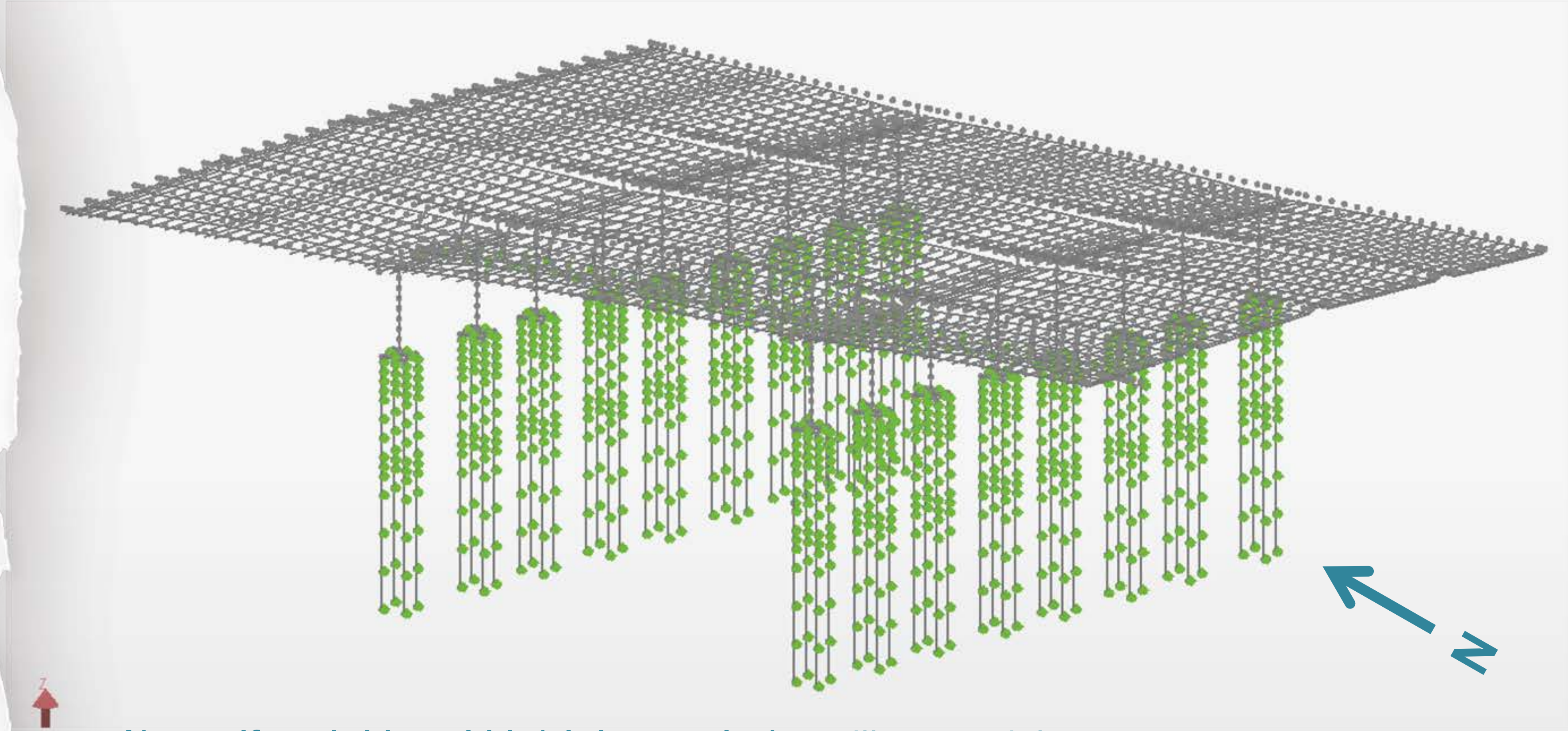


- 15 ft min temporary vertical clearance and 16 ft min permanent clearance
- Max. allowable structure depth = 5’–6” (depth/span = 0.024)
- Balanced spans of 225’ and 167’ for positive flexure
- 13 ft structure depth at piers varying to 5’-6” at midspan



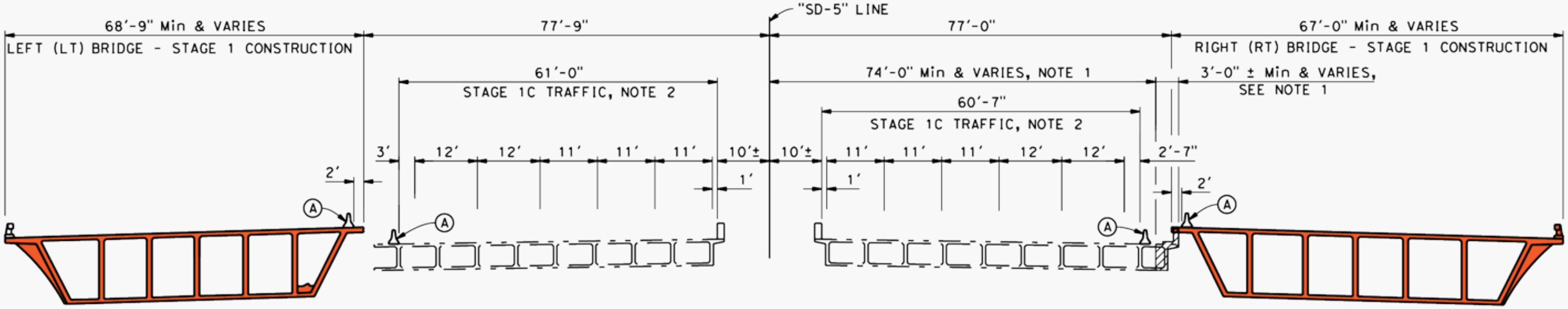


LARSA FEM Summary

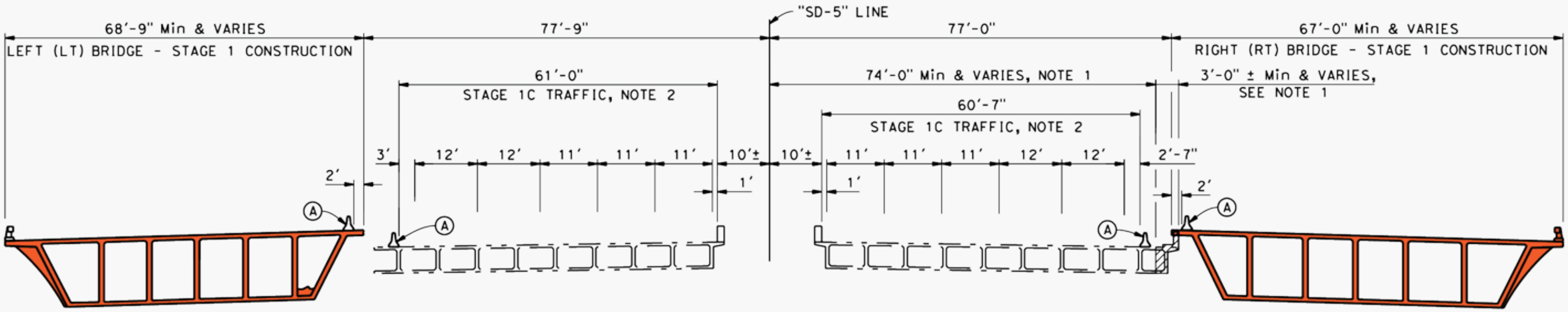


- **Non-uniform bridge width (girder spacing)** – grillage model
- **Haunch section** – parametric variation
- **Torsional effects and resal shear effects** – full 3-D model
- **Effect of highway bridge on pedestrian bridge** – integrated model
- **Foundation issues** – non-linear soil springs

Time Dependent Construction Staging



Time Dependent Construction Staging



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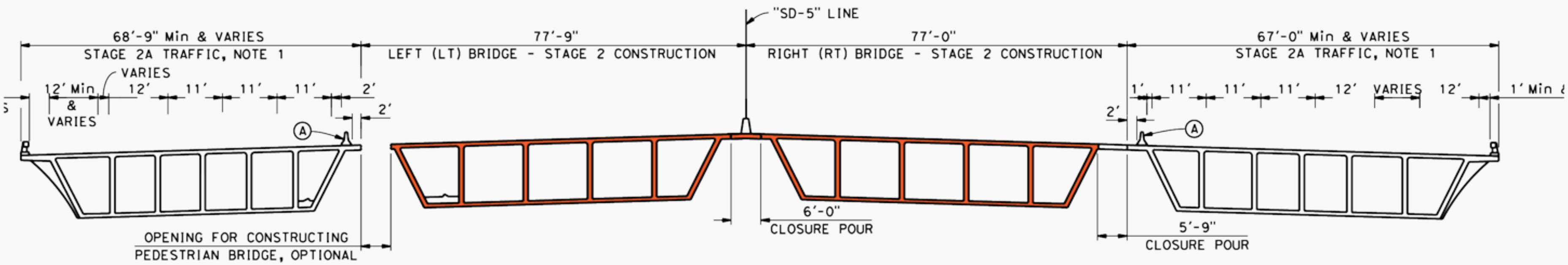
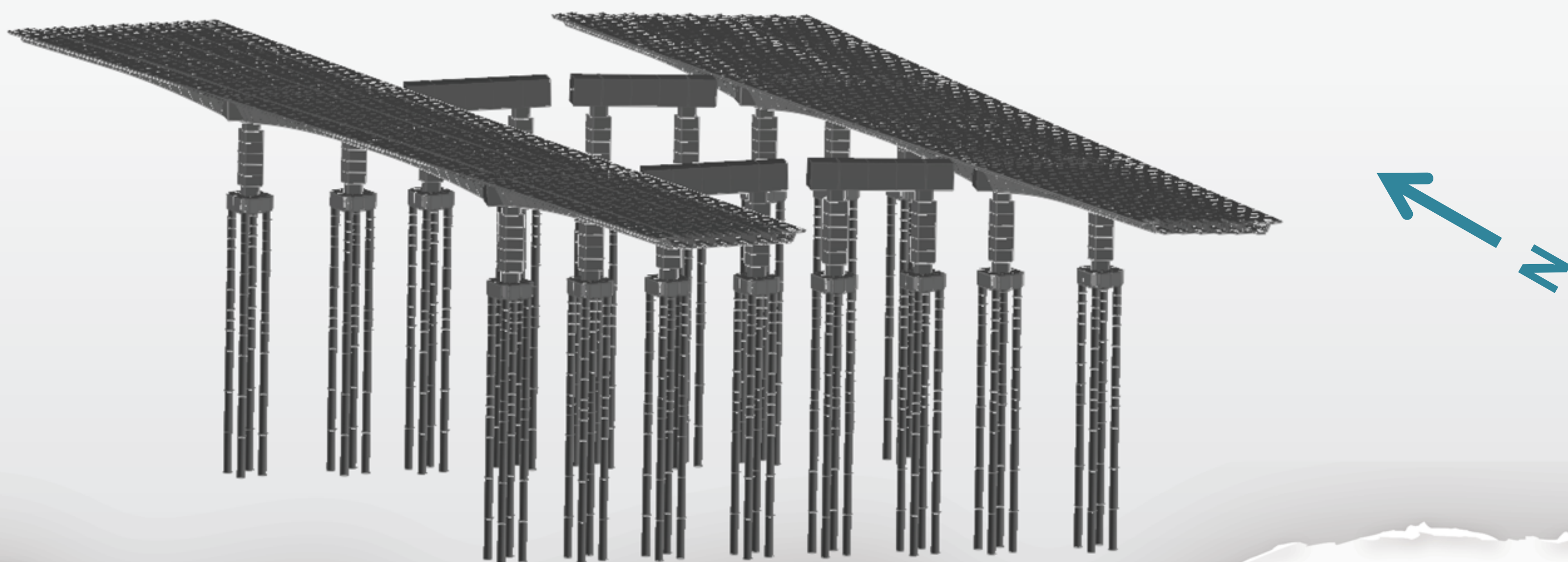
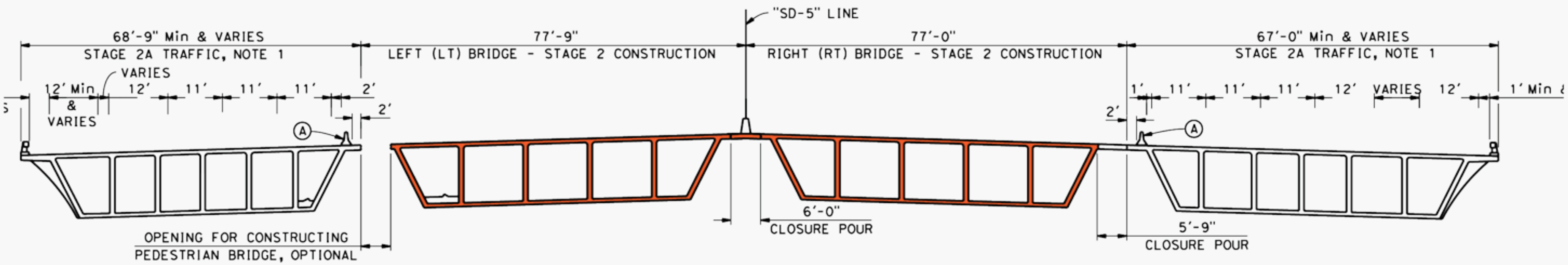
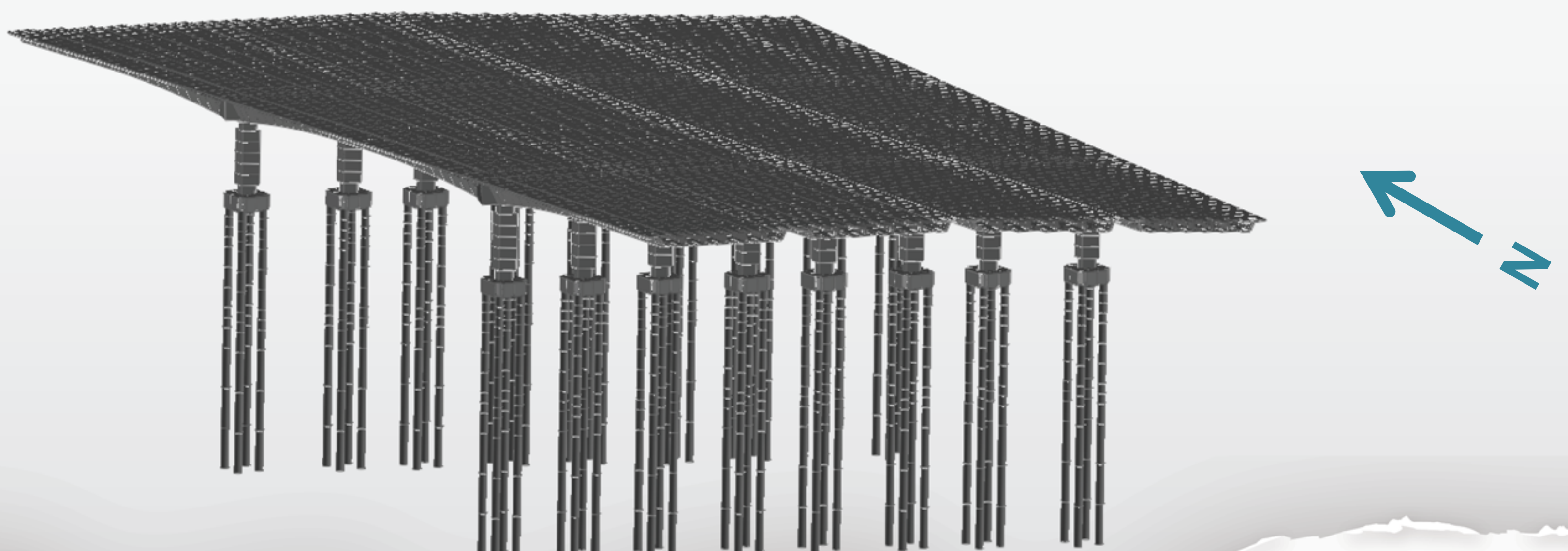
Time Dependent Construction Staging





Time Dependent Construction Staging





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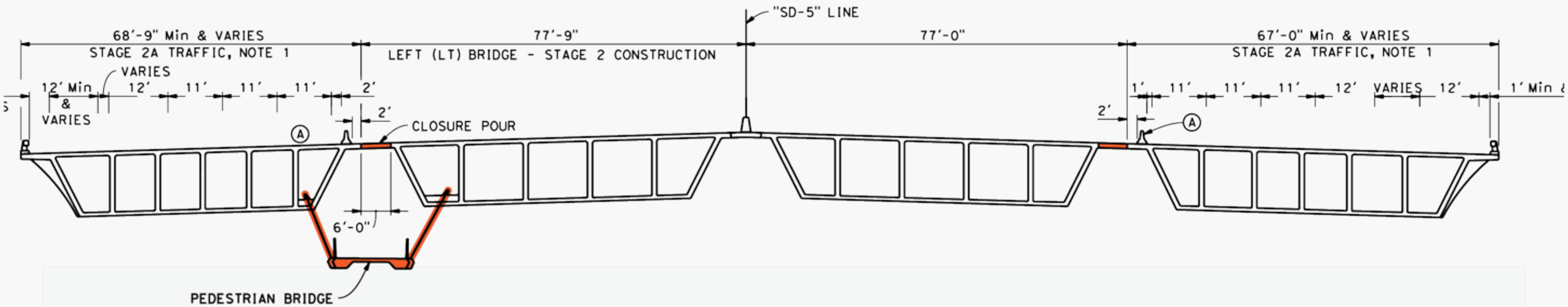
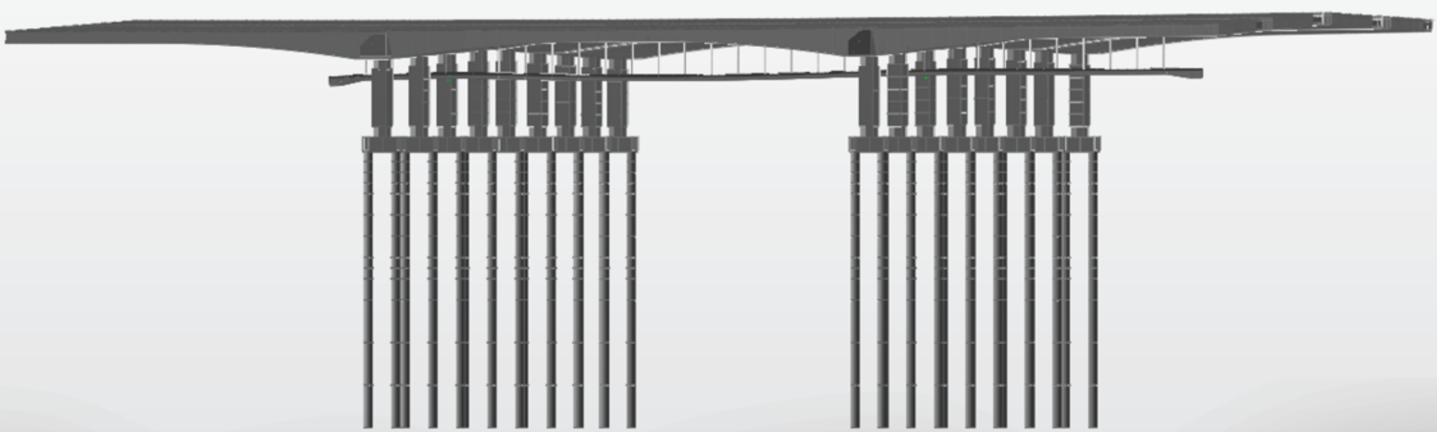
Time Dependent Construction Staging





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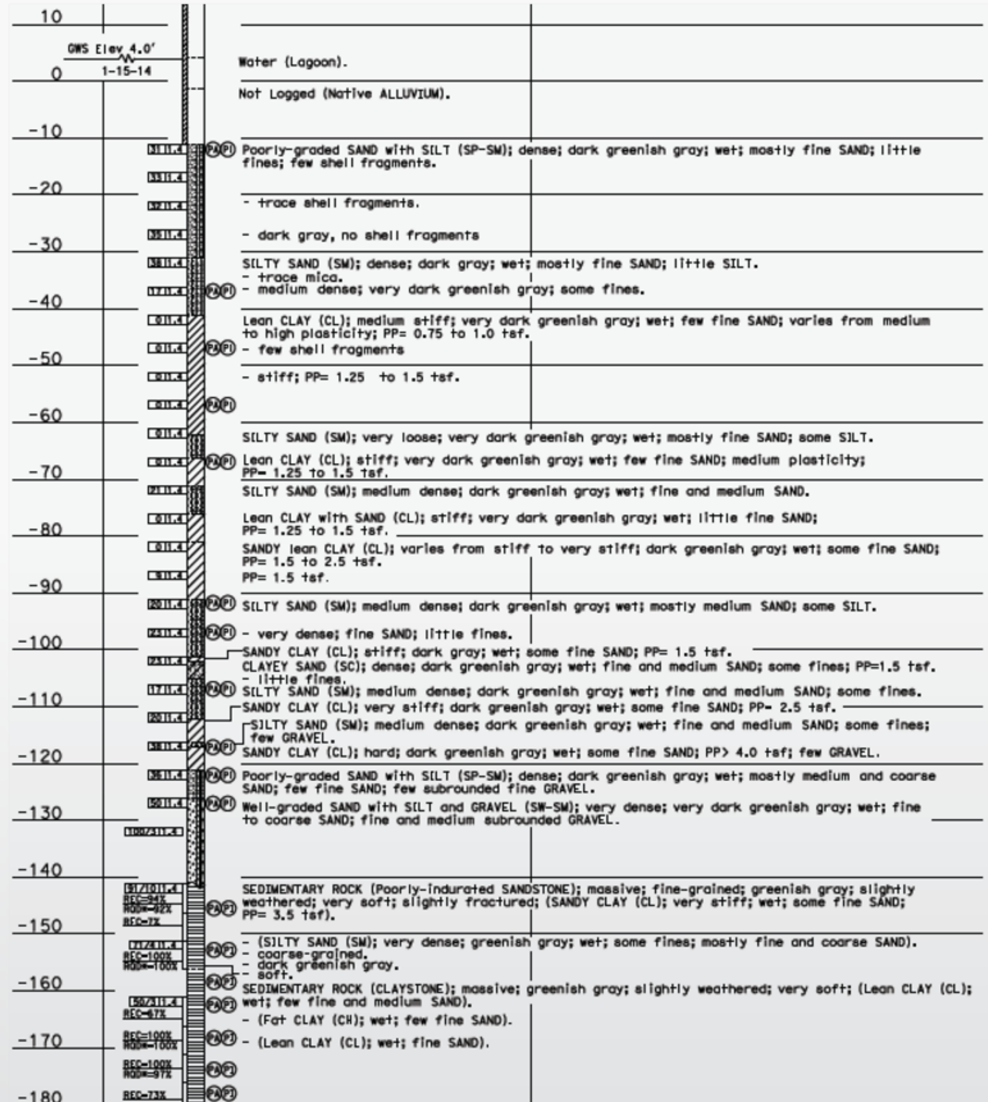
Geotechnical

Typically Alluvial Material

- Silty Sand, Sand with Silt, Sandy Clay, Poorly Graded Sand, and Very Soft to Stiff Lean Clay

Sedimentary Formation

- Elevation – 142’
- Sandstone, Siltstone and Claystone



Foundation Options

- Recommendations from geotechnical engineer
- Contractor preference (schedule/ method/ risk) not known
- Foundation redundancy to complement uncertainties
- Driven piles preferred

4’ CISS Piles (Group of 4) with pile cap - shell driven to -155’

Input from CMGC and Drilling Subcontractor

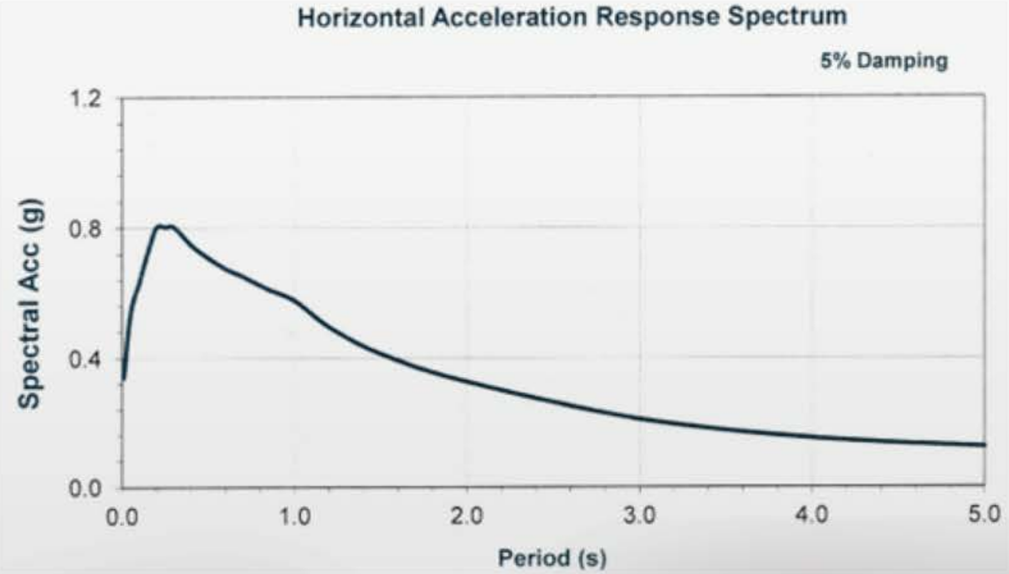
- Large diameter shaft preferred
- Driven piles will affect schedule – oscillate/vibrate shell with noise attenuation
- No need for cofferdams – reduce risk and cost
- Test piles not needed

- Reduce p-y curves for lateral design (vibrated shell)
- Use single cage from CIDH to cased shaft
- Use #18 pile reinforcement
- 6” construction tolerace between cased shaft and CIDH

10.5’ cased shaft (oscillate/ vibrate shell to -115’) and 10’ CIDH below to -270’

Seismic

- Horizontal ARS Based on Caltrans ARS Online
- Vertical ARS Based on Vertical Ground Motion Prediction Equations
- Low Liquefaction Potential
- No Lateral Spreading



Hydraulics

Escondido Creek
East Basin
I-5
I-5 Bridge Replacement
Project Area
La Orilla
Creek
Central Basin
West Basin
I-5
San Elijo Lagoon
Model Boundary
N

Hydraulics

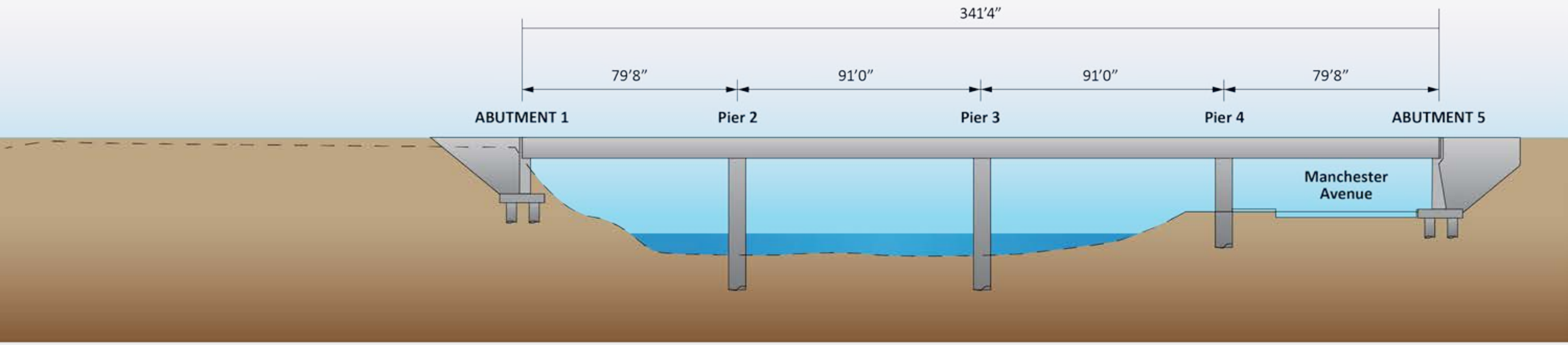
Comprehensive Lagoon Analysis Conducted

Modeling Scenarios:

- 50 – Year *(Design Flood)*: 2' Clearance Required
- 100 – Year *(Base Flood)*
- Tides and Sea Level Rise *(SLR)* Included
  - SLR Projections: 2.0' (2050), 5.5' (2100)
- Pedestrian Bridge Controls High Water Clearances

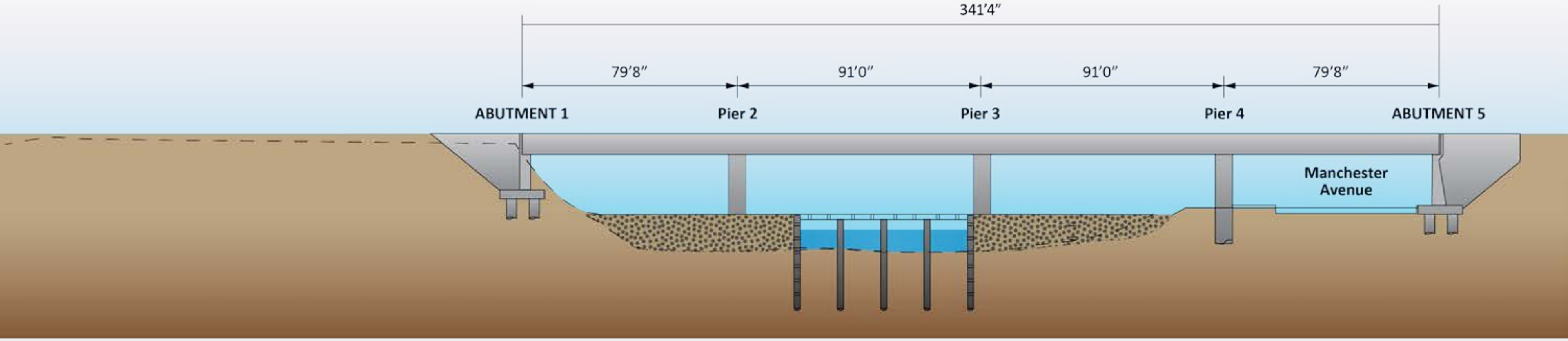
Hydraulic Summary					
Frequency (Years)		50-yr Design Flood	100-yr Base Flood	500-yr
Discharge (cfs)		19,767	23,255	31,311
Water Surface Elevation I-5 Bridge (NAVD 88)	Current	10.34	10.96	12.36
	2050 SLR	11.71	12.28	-
	2100 SLR	14.83	15.31	-

Construction



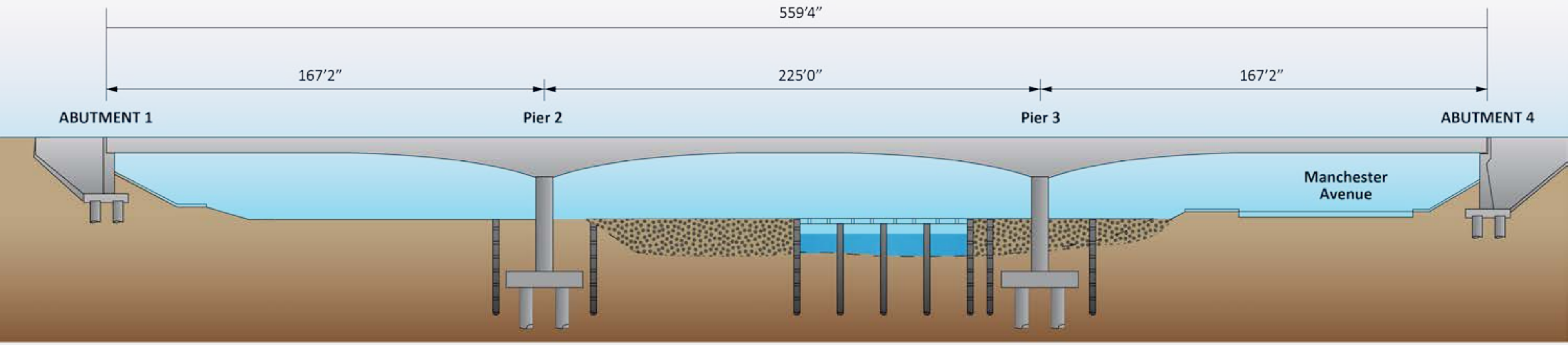
EXISTING BRIDGE

Construction



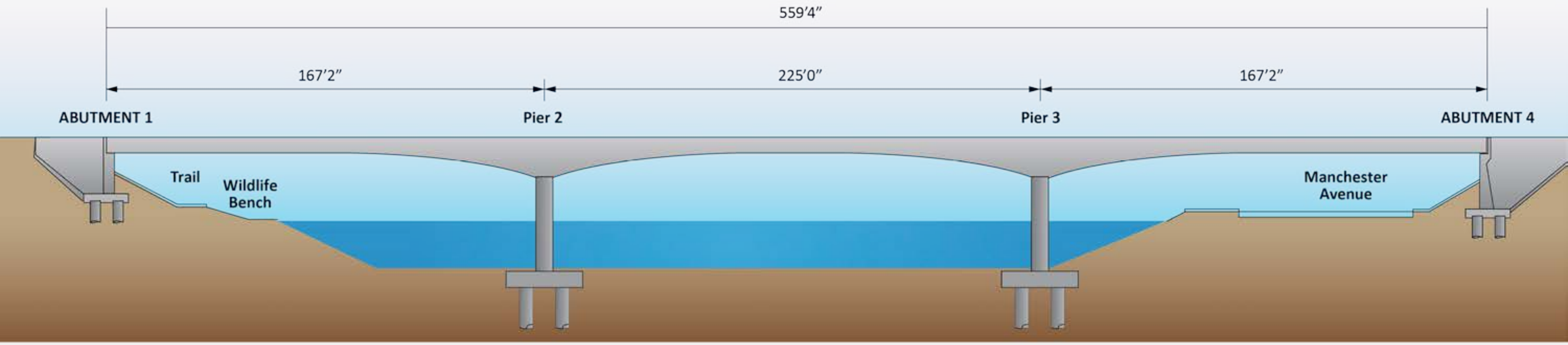
CONSTRUCTION OF WORK PLATFORM

Construction



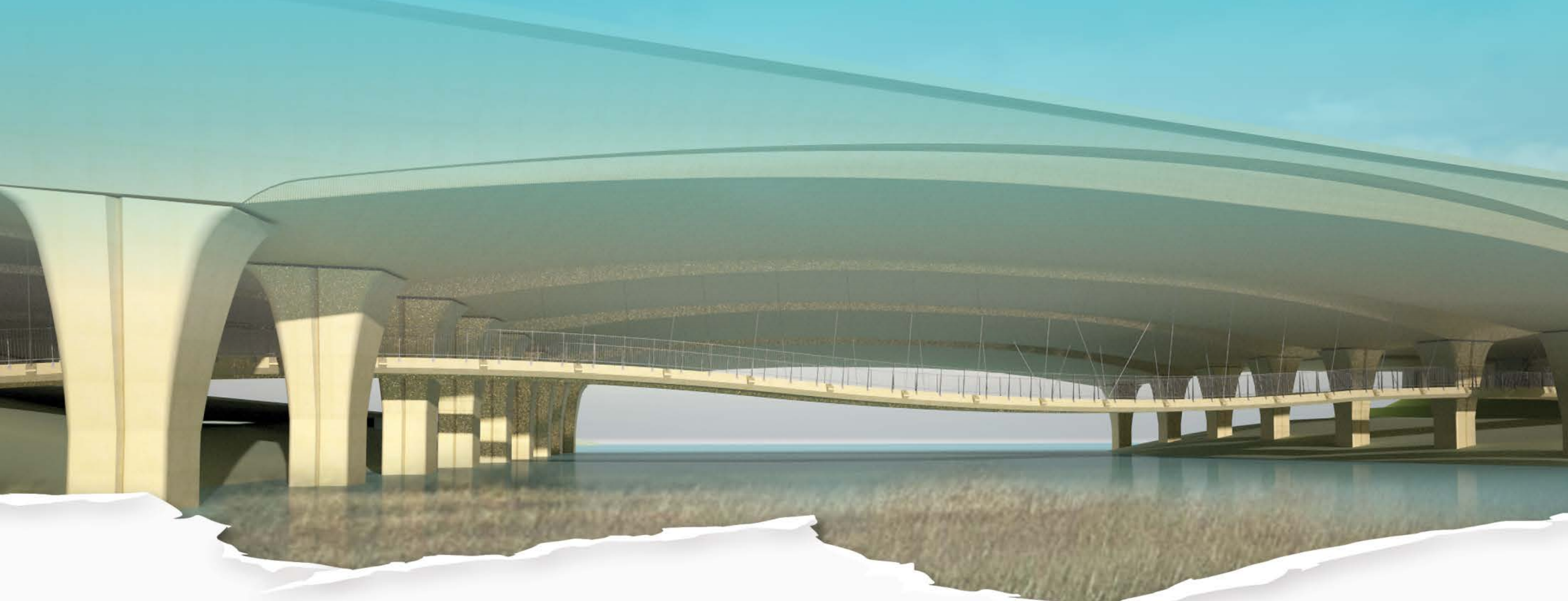
NEW BRIDGE CONSTRUCTION

Construction



NEW BRIDGE

PEDESTRIAN BRIDGE



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Pedestrian Bridge

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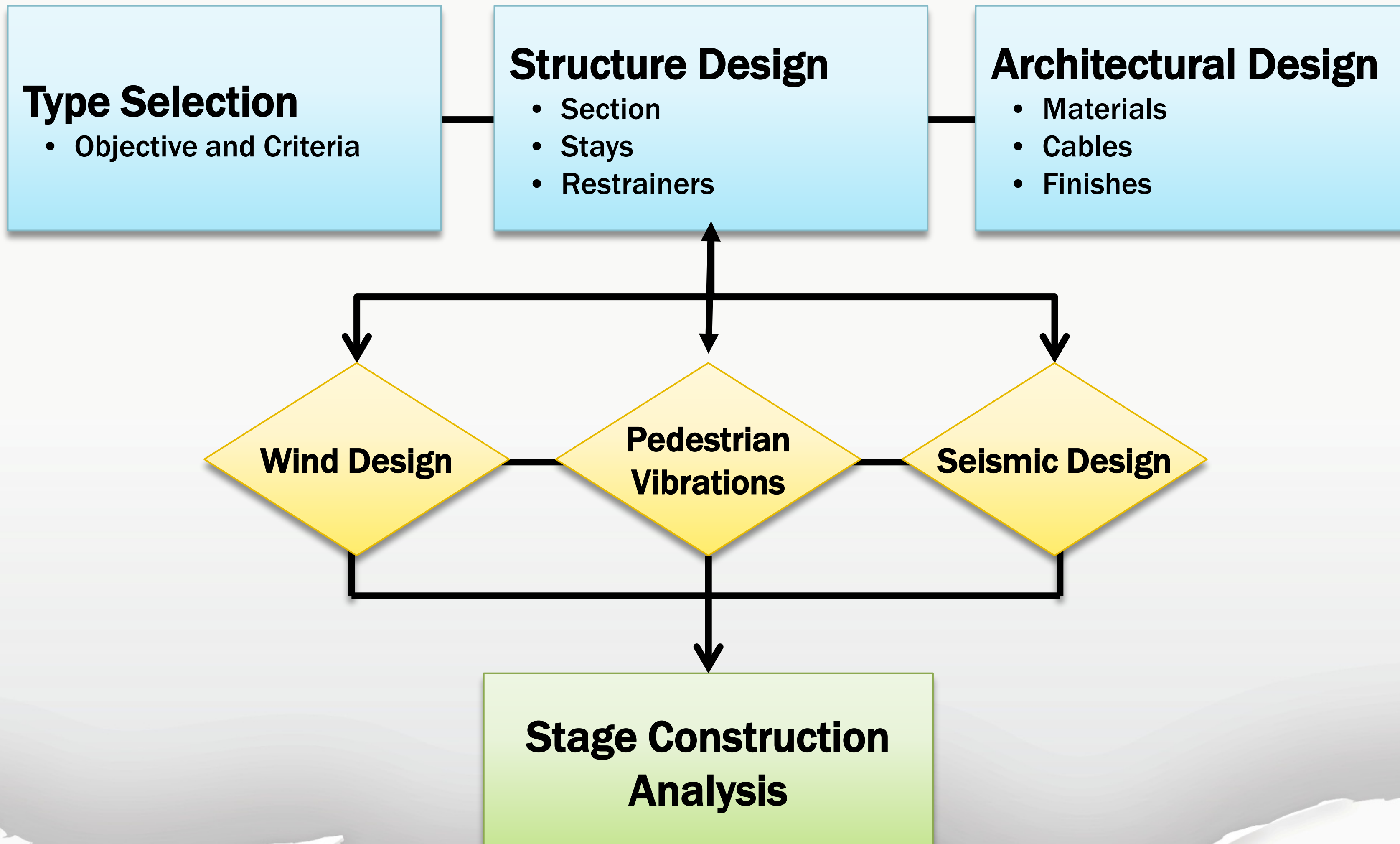
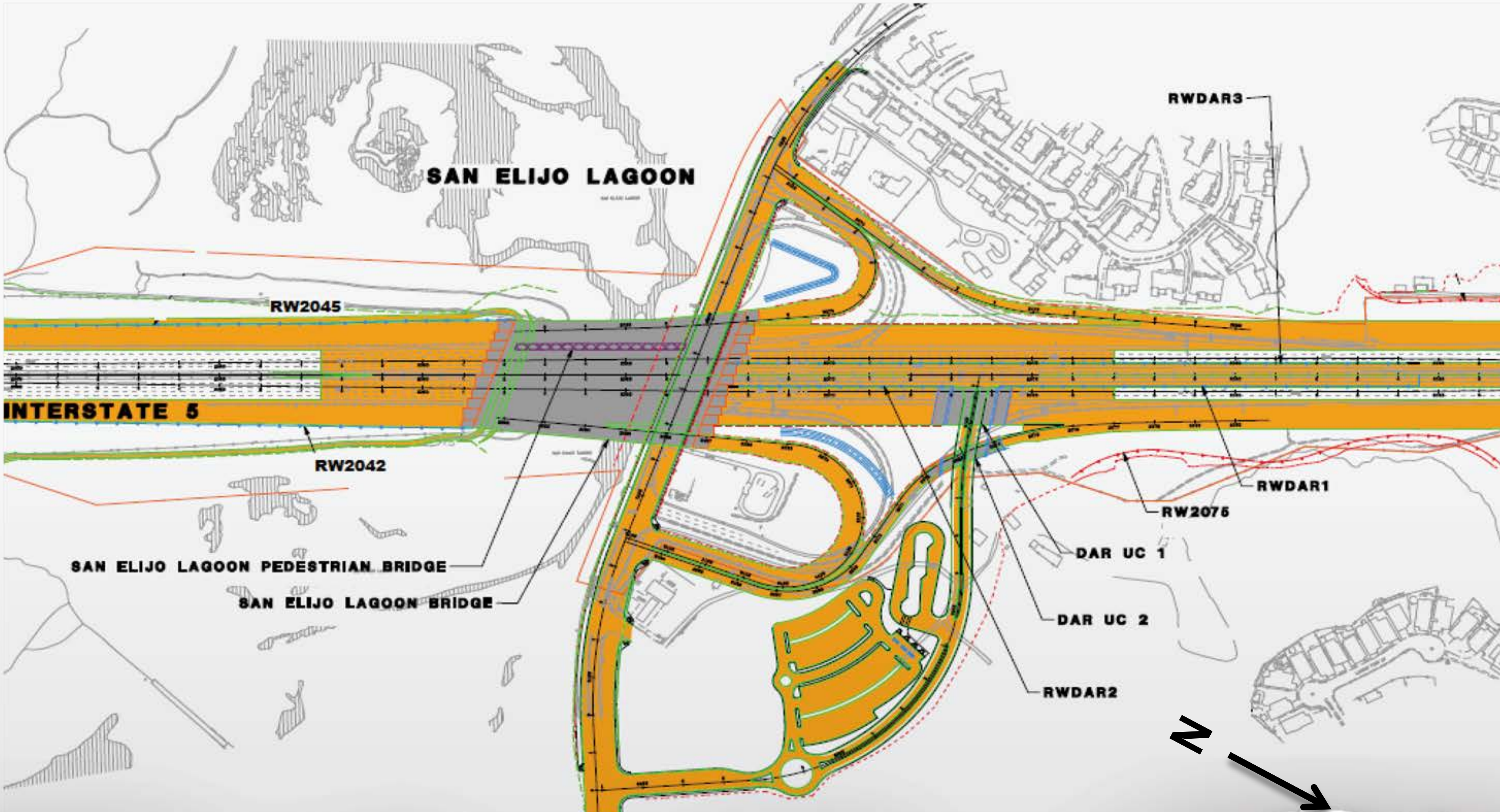
Design Procedure



San Elijo Lagoon Pedestrian Bridge



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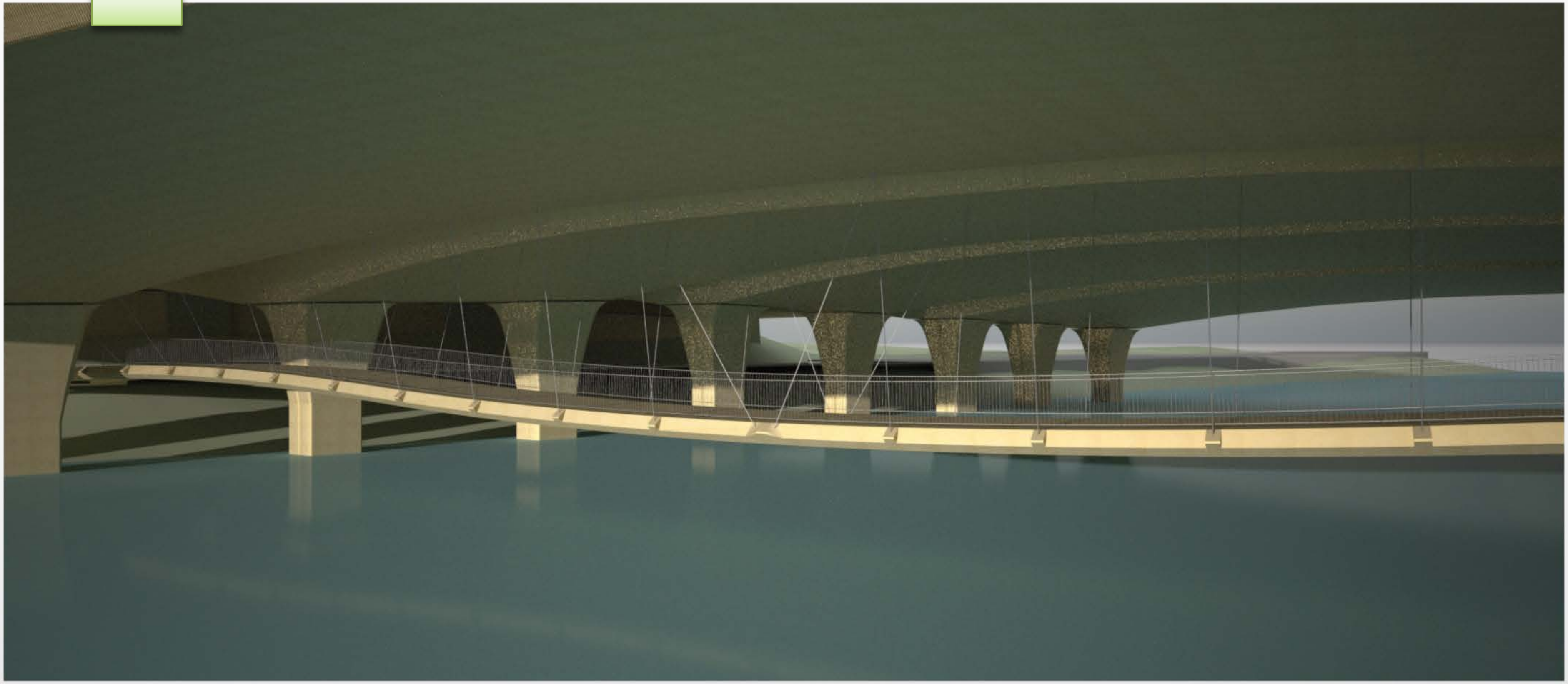
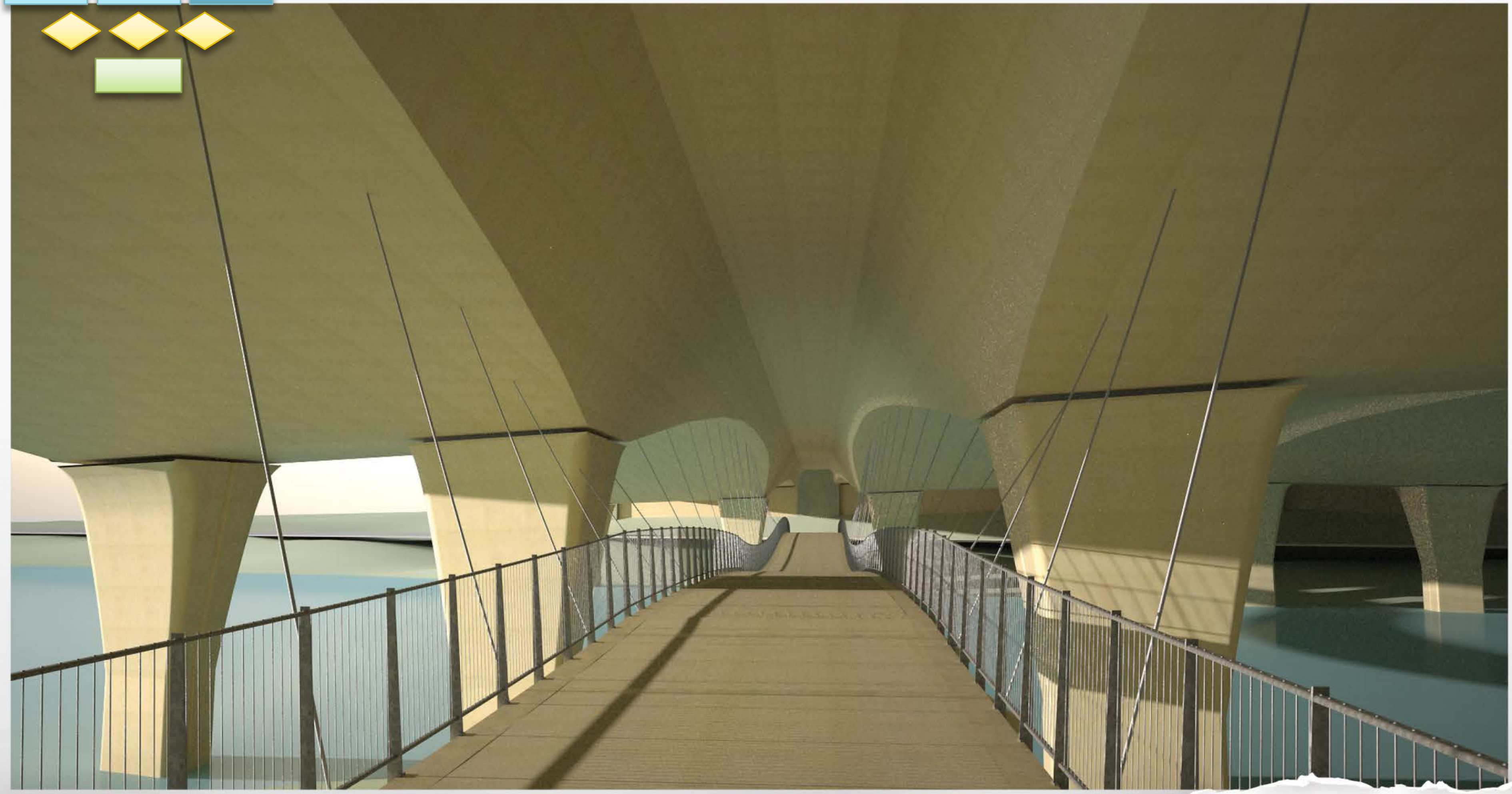
Structure Type



Materials



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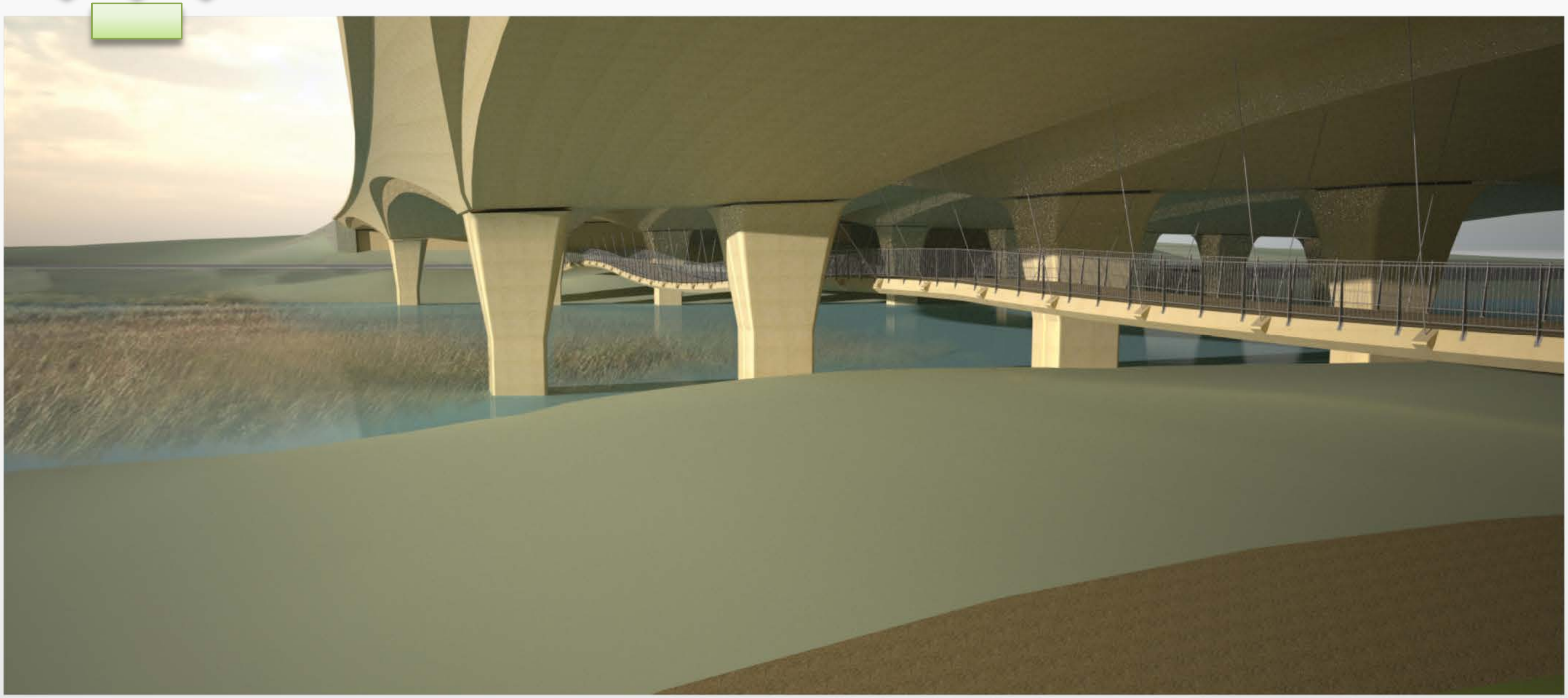
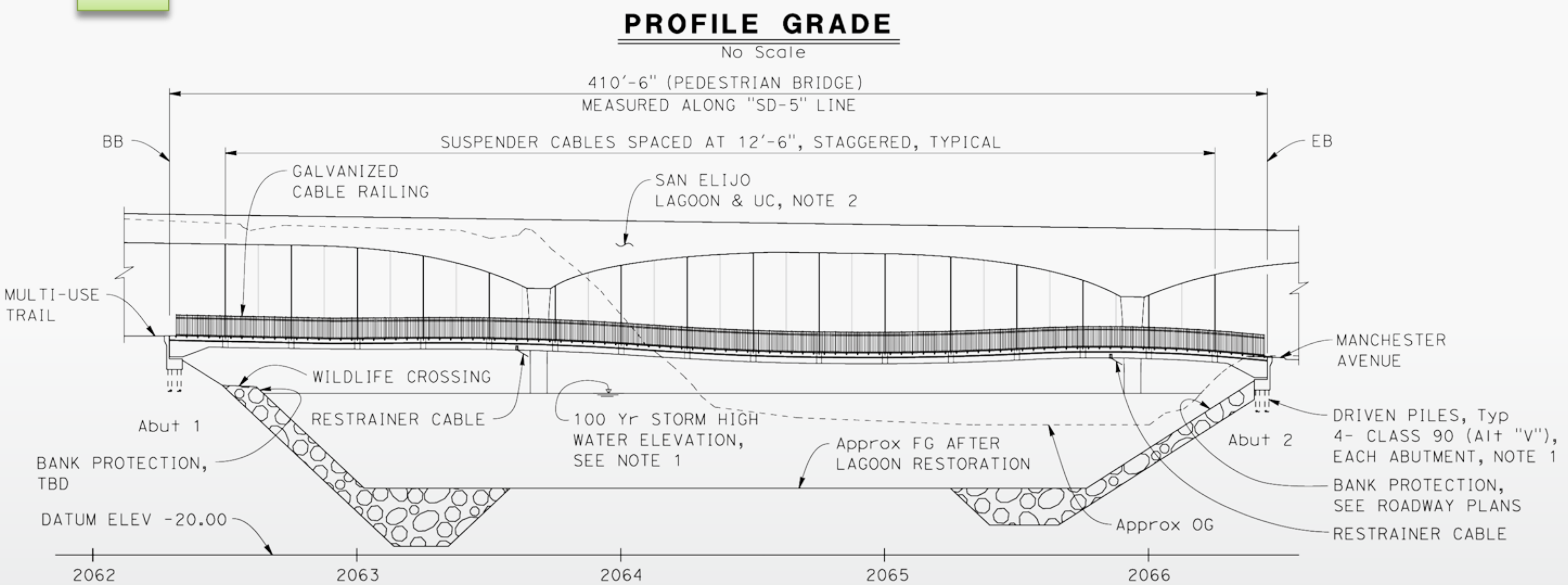
Full Locked Cables

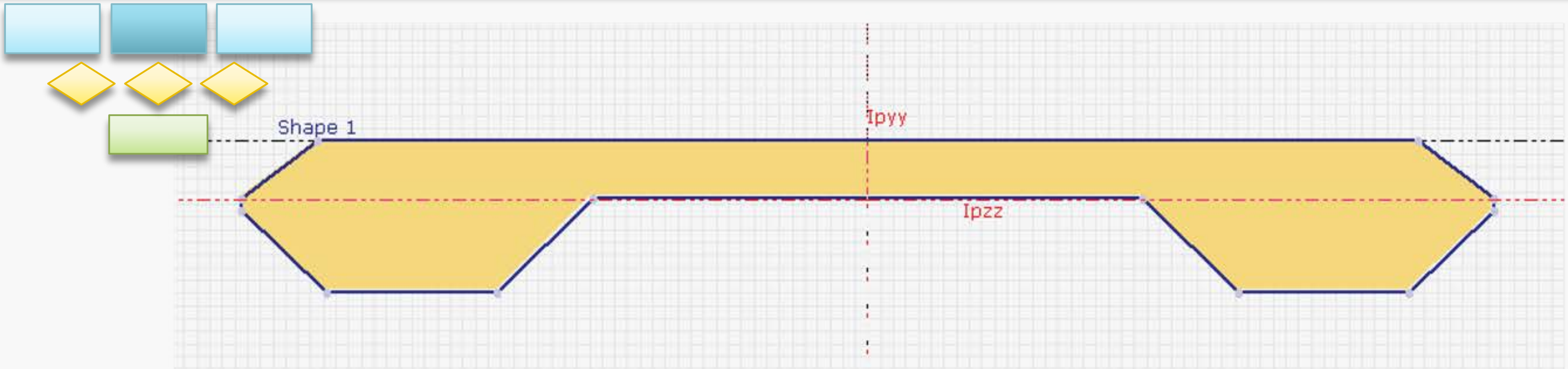
Site and Environmental Constraints

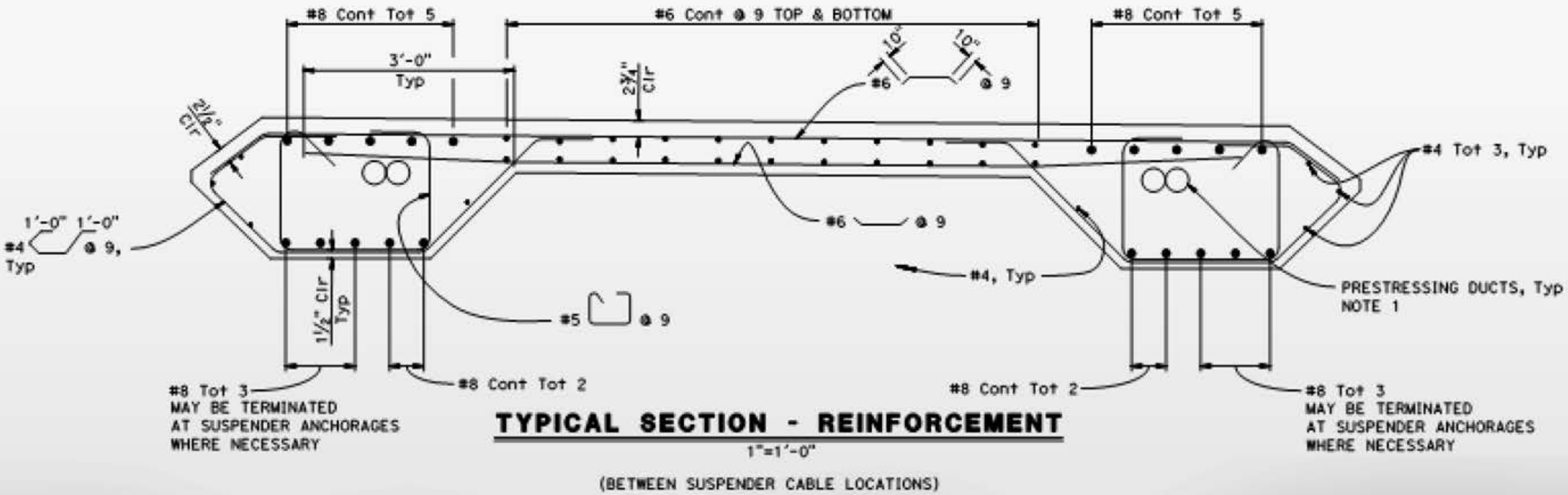


General Elevation

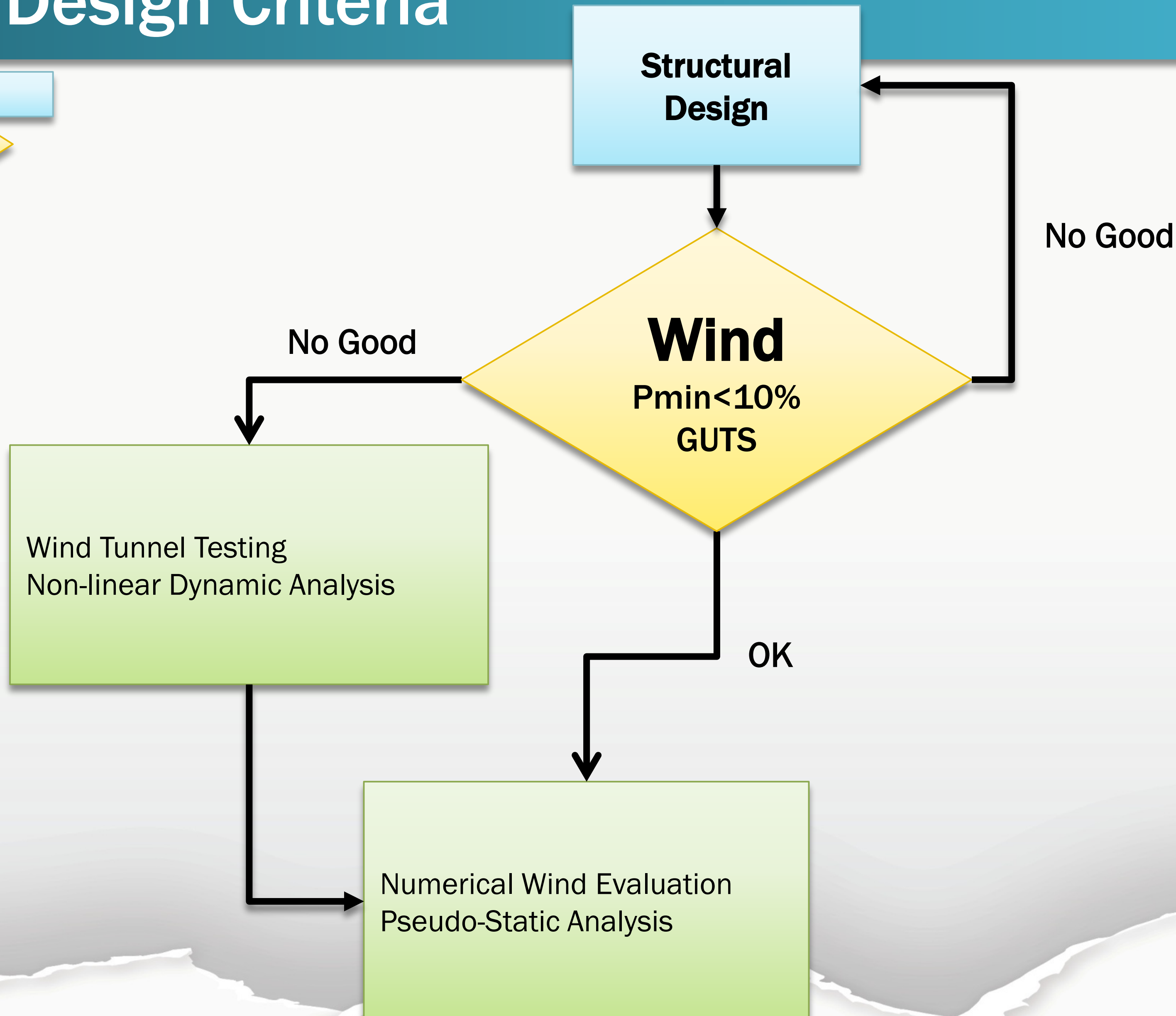


Deck Section

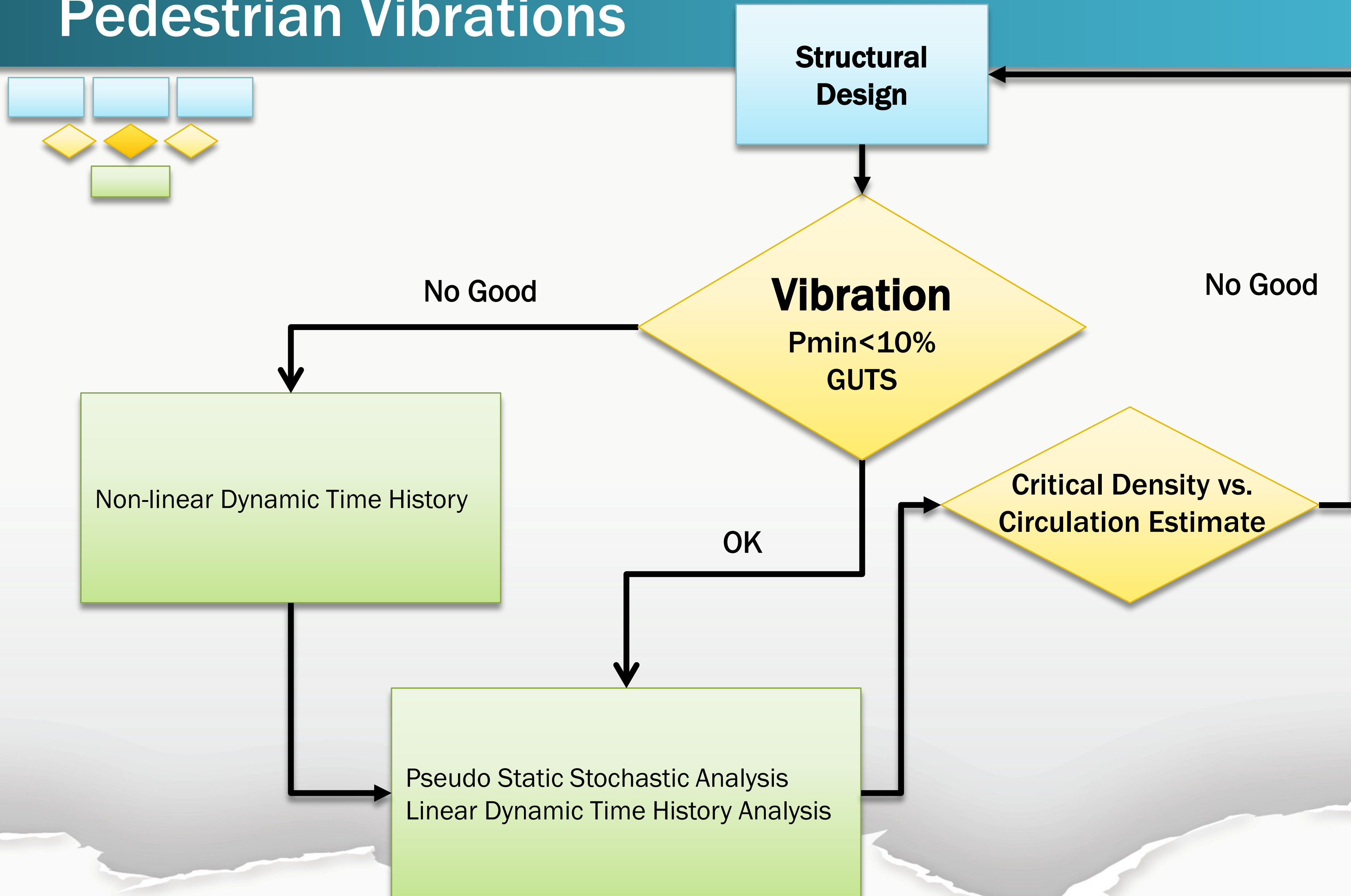




Wind Design Criteria



Pedestrian Vibrations



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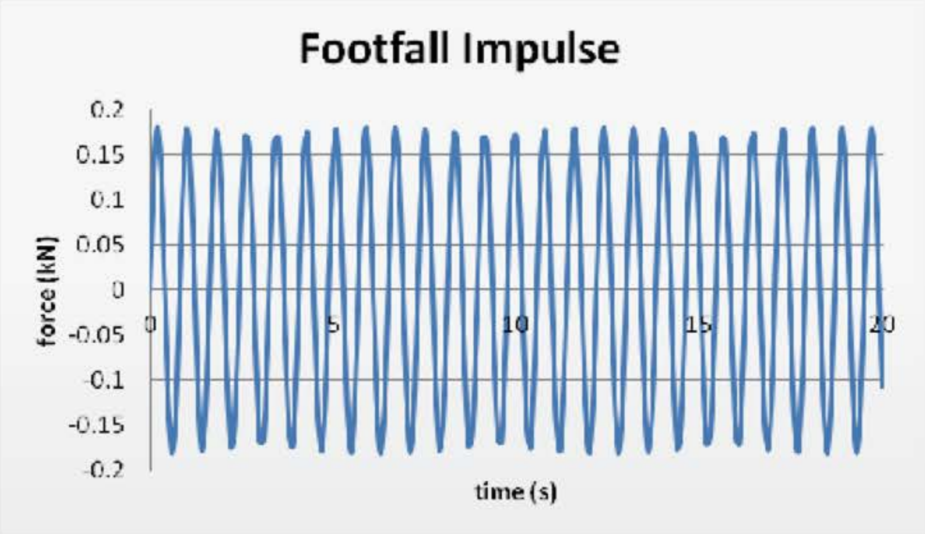
Linear Time History Evaluation

Vibrations from Pedestrian Input

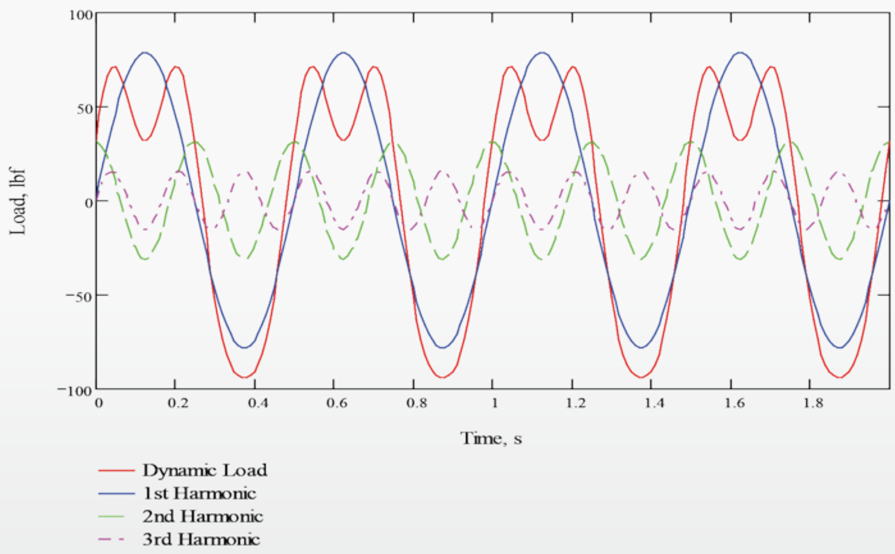
- Vertical and Horizontal Movements

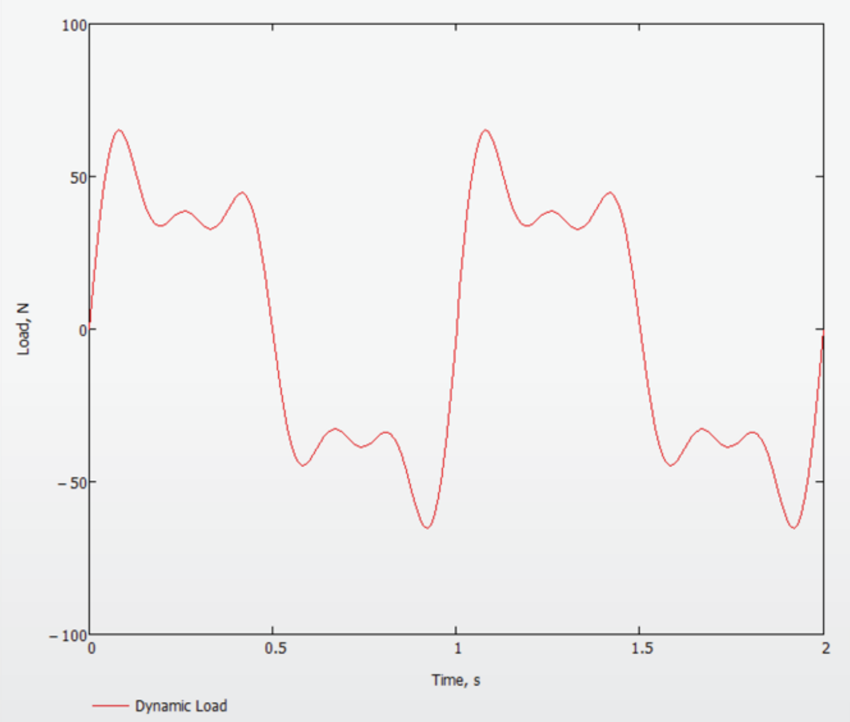
Linear Time-History

Analysis was performed



Frequency Based Stochastic Vibrations





Pedestrian Vibrations Analysis

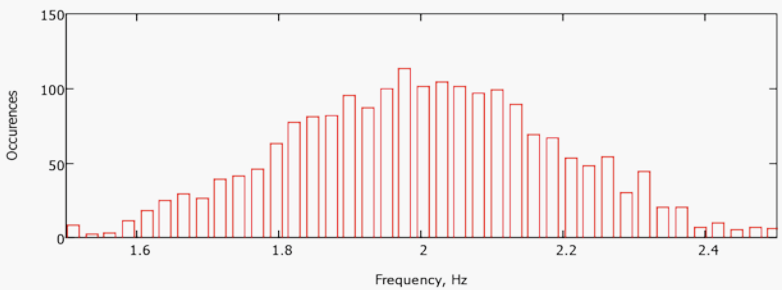


Figure 1, **Histogram of Step Frequency**

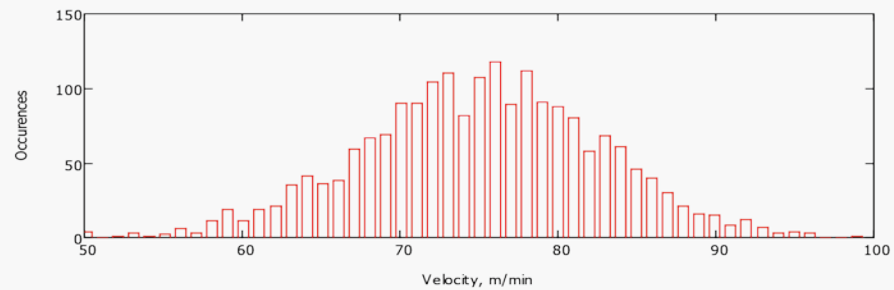


Figure 2, **Histogram of Speed**

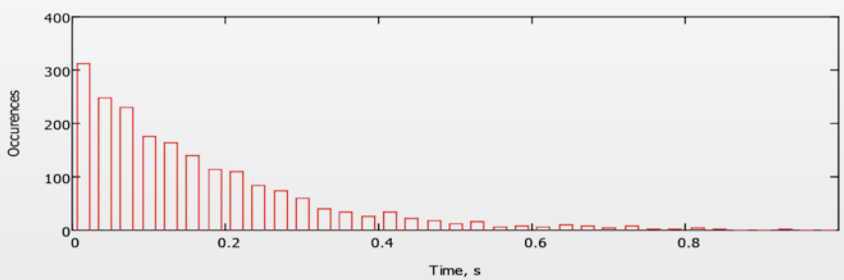


Figure 3, **Histogram of Arrival Interval**

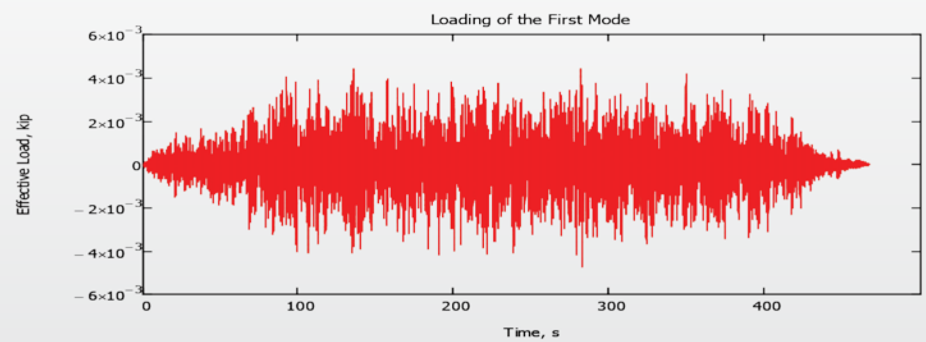


Figure 4, **Modal Loading**

Vibration Response

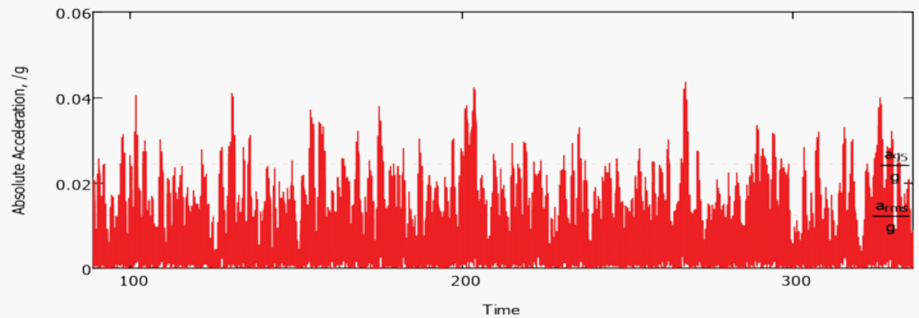


Figure 13, **Normalized, Absolute Acceleration**

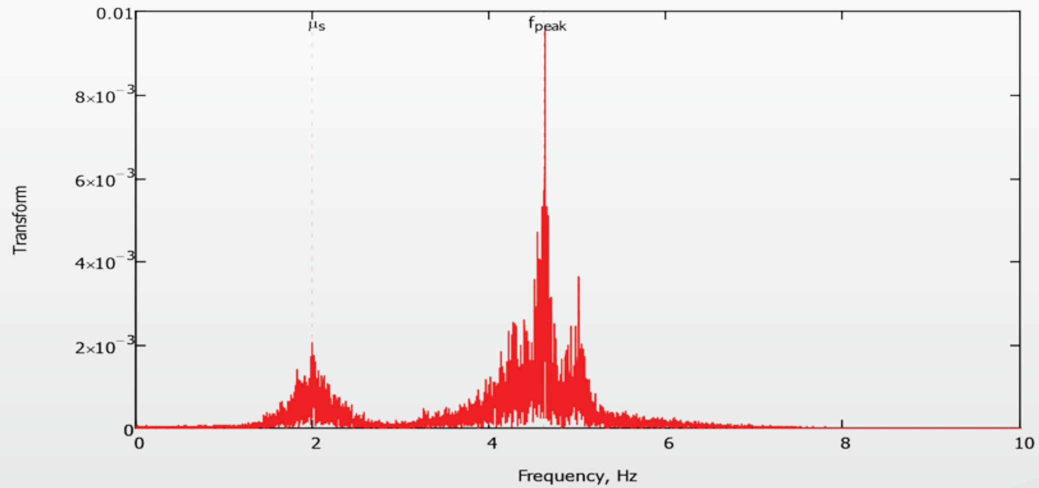
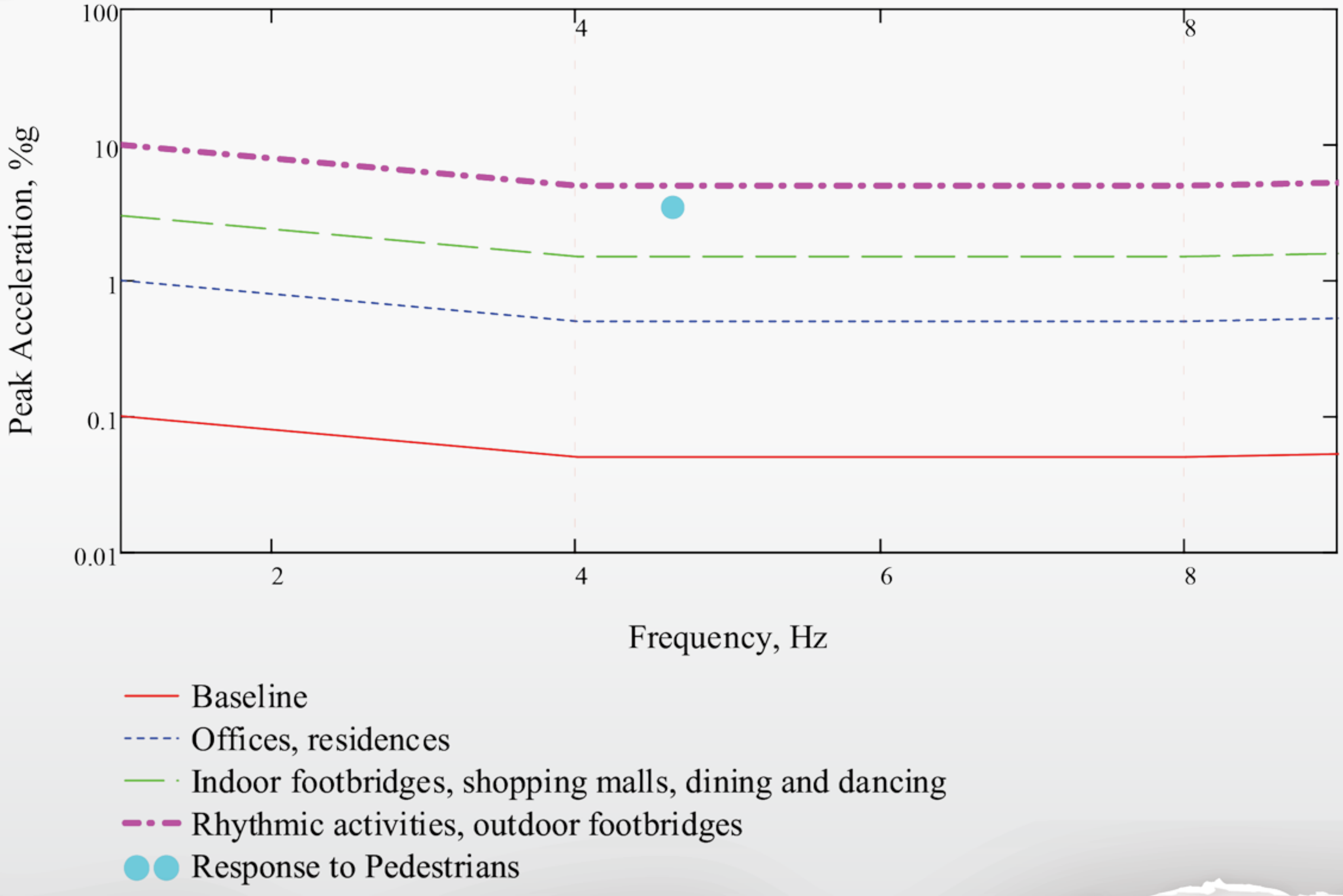


Figure 14, **Fourier Transform of Response**

Vertical Acceleration Acceptance Criteria



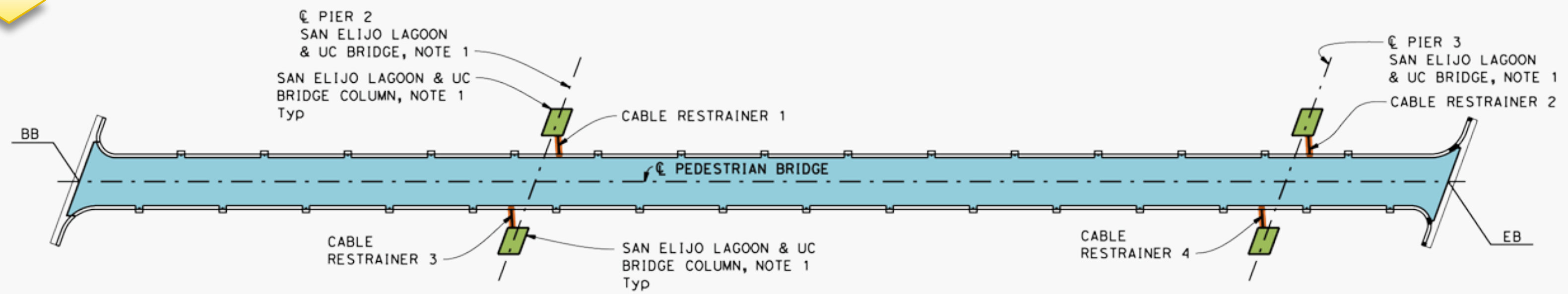
Max Credible Live Load

Figure C3.1-1—Live Load of 50 psf

Figure C3.1-2—Live Load of 100 psf

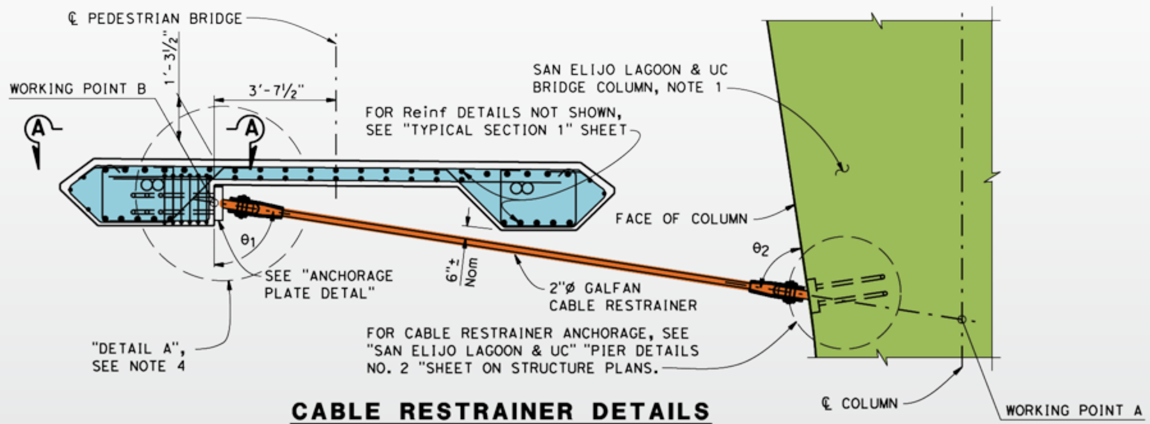
Figure C3.1-3—Live Load of 150 psf

Cable Restrainers



CABLE RESTRAINER - PLAN

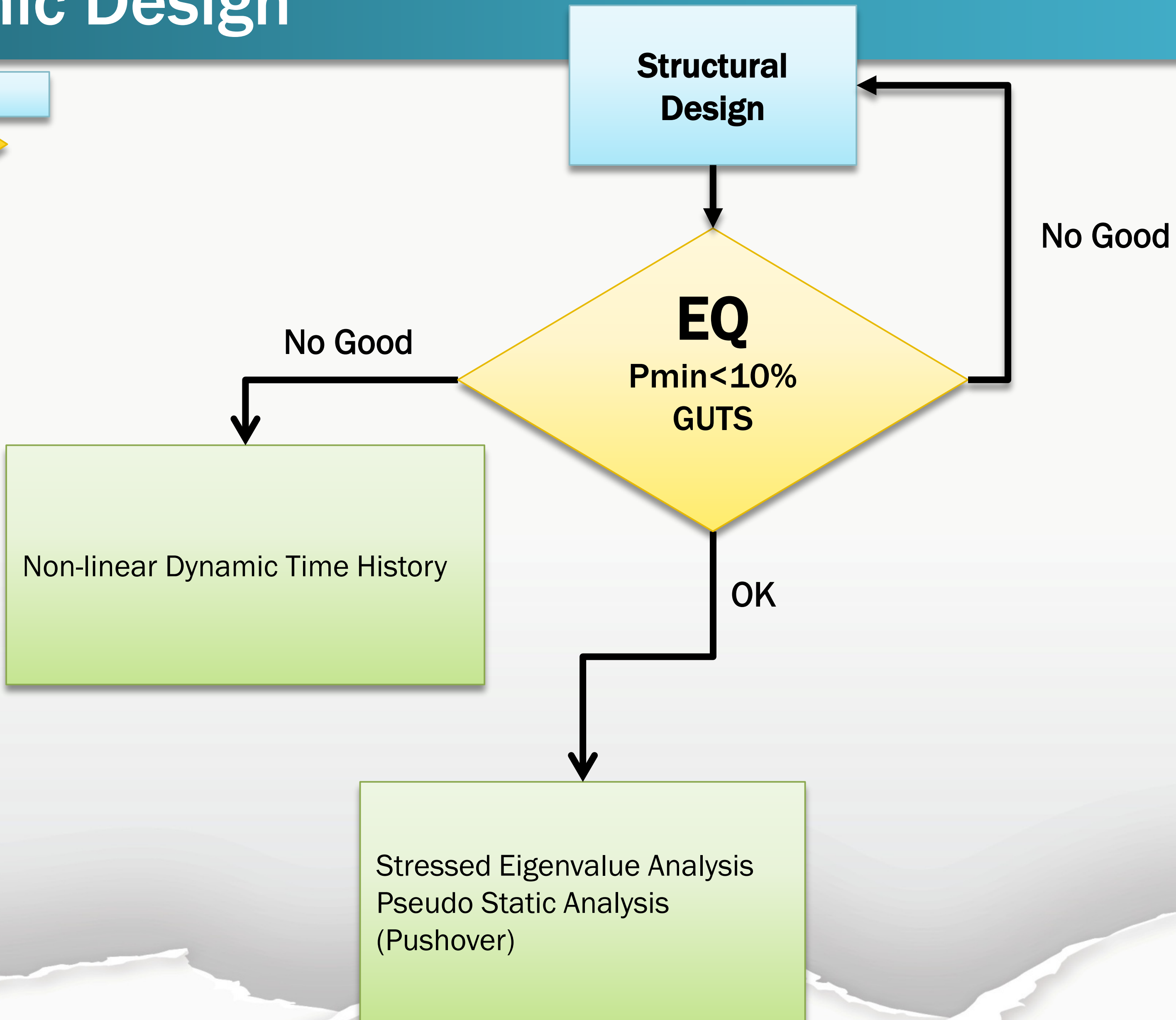
1"=20'



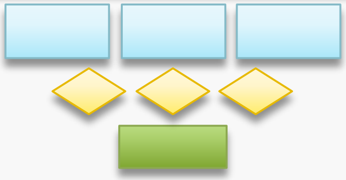
CABLE RESTRAINER DETAILS

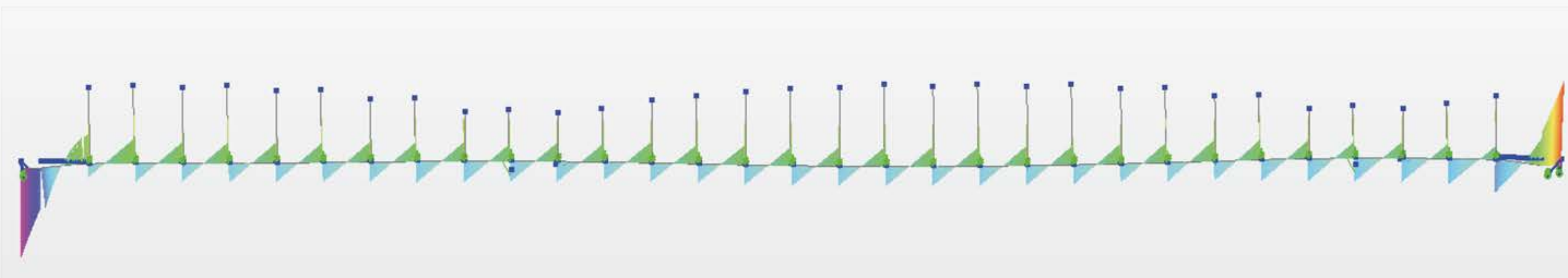
½"=1'-0"

Seismic Design



Stage Construction Analysis





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Acknowledgements

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- Allan Kosup
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California Department of Transportation

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