Western Bridge Engineers' Seminar

Port of Long Beach, Ocean Boulevard Coastal Bike Trail Connector Project

Session 8A

September 7, 2023

moffatt & nichol

Port of LONG BEACH THE PORT OF CHOICE

Earth Mechanics, Inc.
Geotechnical and Earthquake Engineering

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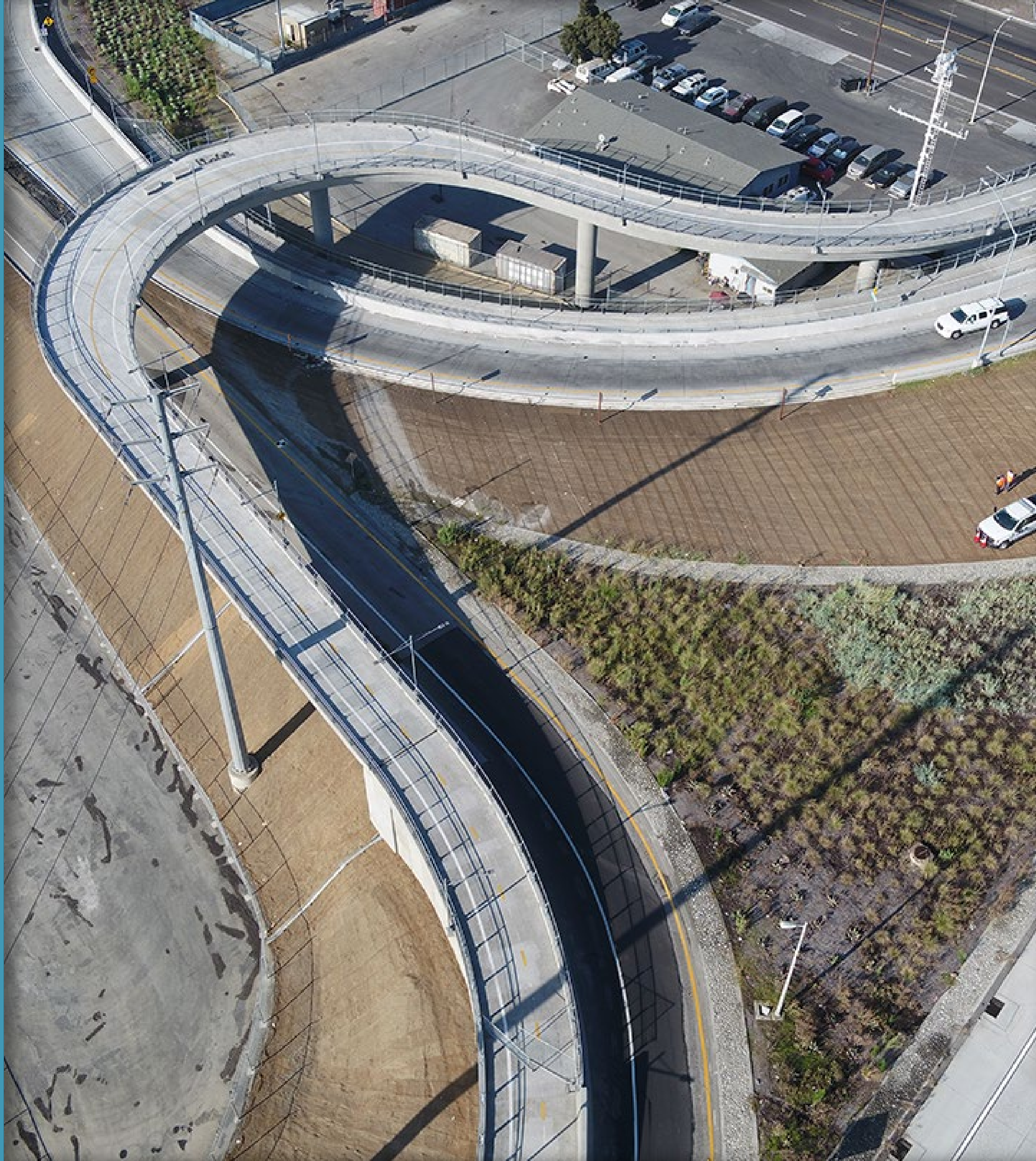
Agenda

1. Overview
2. Constraints
3. Design
4. Construction

1. Overview



Project Overview

- Close a critical gap by building a 3,000-foot bicycle and pedestrian path
- Support recreation and non-motorized commuting to the port area
- Increase safety of walking and bicycle modes
- Connect and increase the use of active transportation facilities

Federal Grants

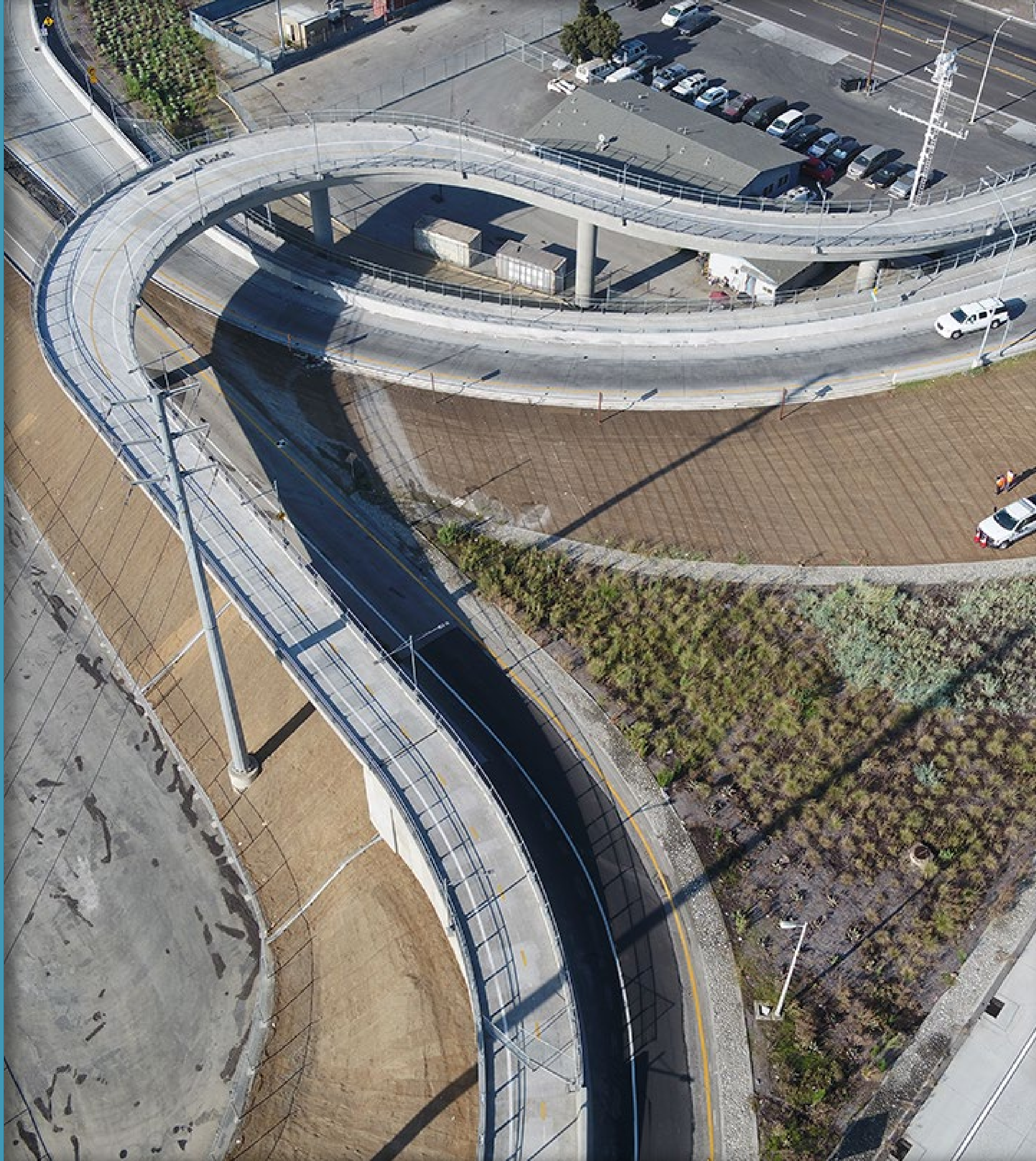
POLB Obtained Two Federal Grants to Supplement the Cost of Construction:

- **Active Transportation Program (ATP) - $4 Million**
  - Funded by Southern California Association of Governments (SCAG)
  - Administered through Caltrans
    - Compliance with Caltrans E-76 Authorization
    - Preliminary Environmental Study and NEPA Categorical Exclusion
- **Congestion Management and Air Quality Improvement (CMAQ) - $3.1 Million**
  - Funded by LA Metro
    - Sustainable Design Plan

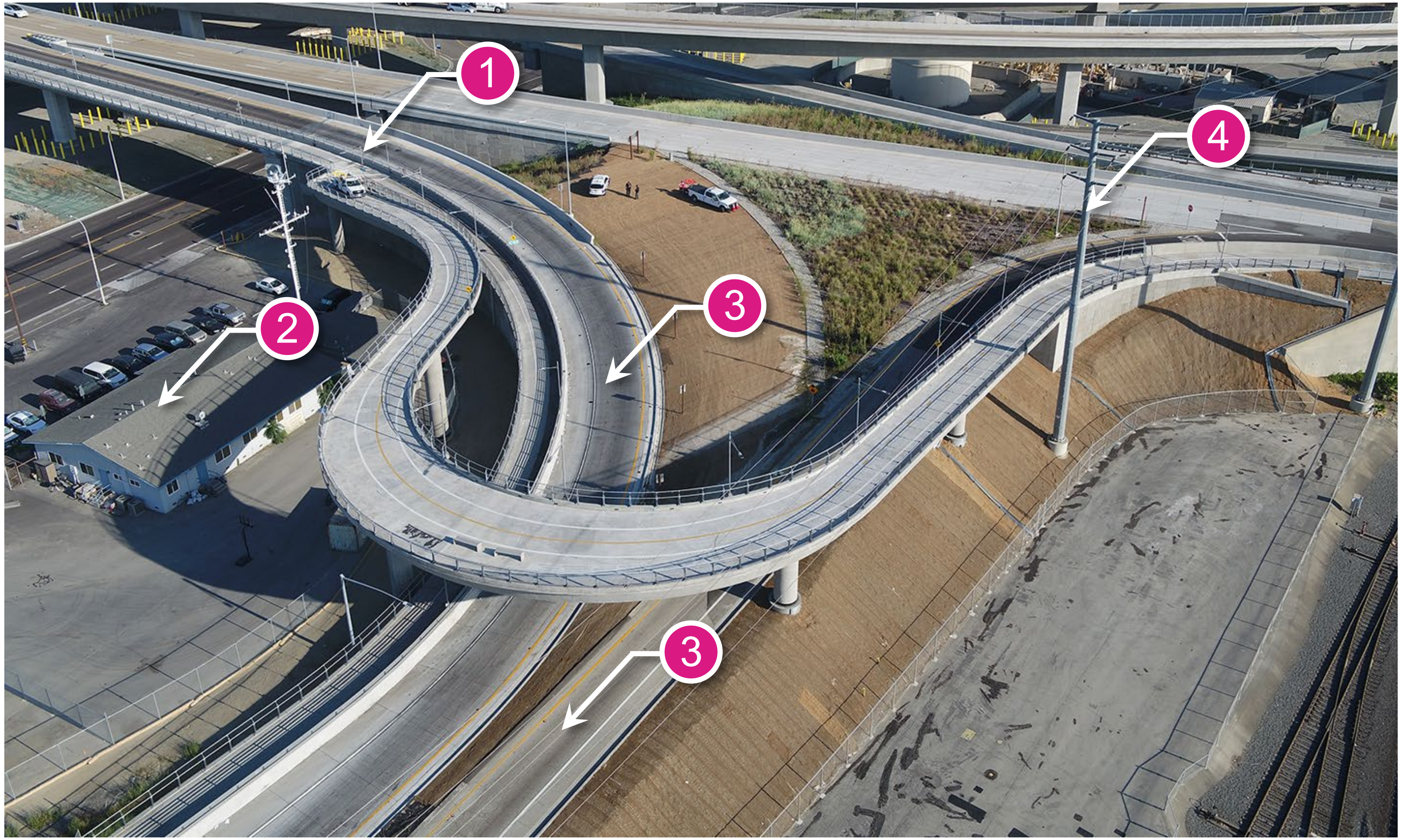
Project Scope

- **Phase 1: Bike and Pedestrian Bridge**
  - Cast-in-place concrete bridge and MSE walls with CIDH foundation
  - Deck drains, traffic signs, pavement striping and railing
  - Wayfinding signs and benches
- **Phase 2: Ocean Blvd & Golden Shore**
  - Convert an existing vehicle lane into a two-way bicycle lane by restriping and installing barriers, pavement markings, and traffic signs

2. Constraints



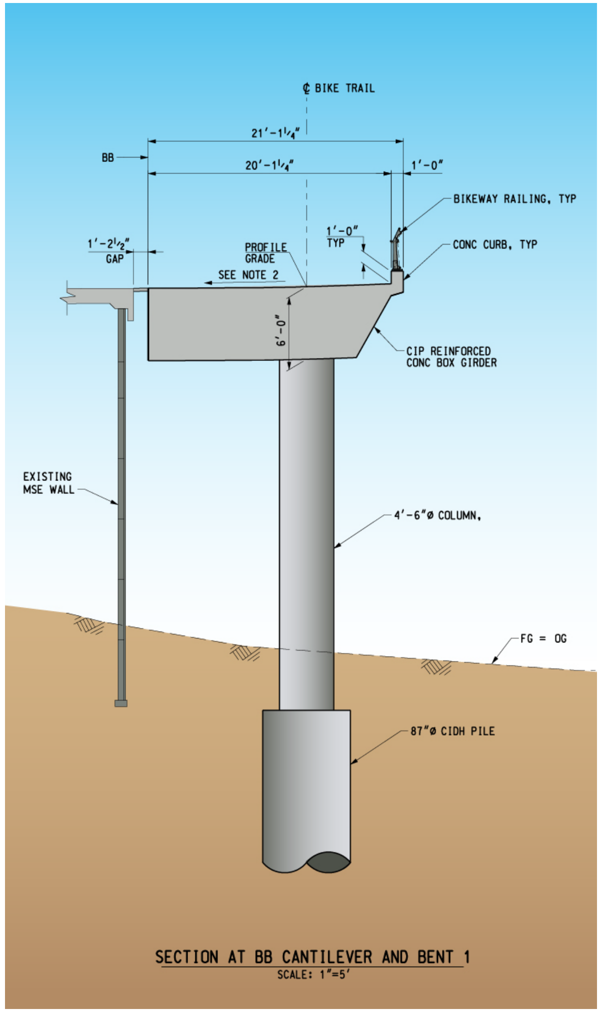
Constraints



1. Transition to LBIGB bike path
2. Seafarer's Center
3. Pico/Ocean Ramps
4. Overhead Power Lines

1. Transition to LBIGB Bike Path

- Transition to the under-construction LBIGB bike path without as-builts
- The new bike bridge was designed with a gap to the LBIGB
- Install steel joint to transition from the new bridge to the LBIGB to accommodate traffic and seismic deformations
- The new bike bridge top of deck elevation to match the top of newly constructed MSE wall without as-builts



2. International Seafarer's Center Building

- Avoid building the new bike bridge over the exiting building

- The new bike bridge columns and foundation to stay outside the existing building site fence to keep the building operational

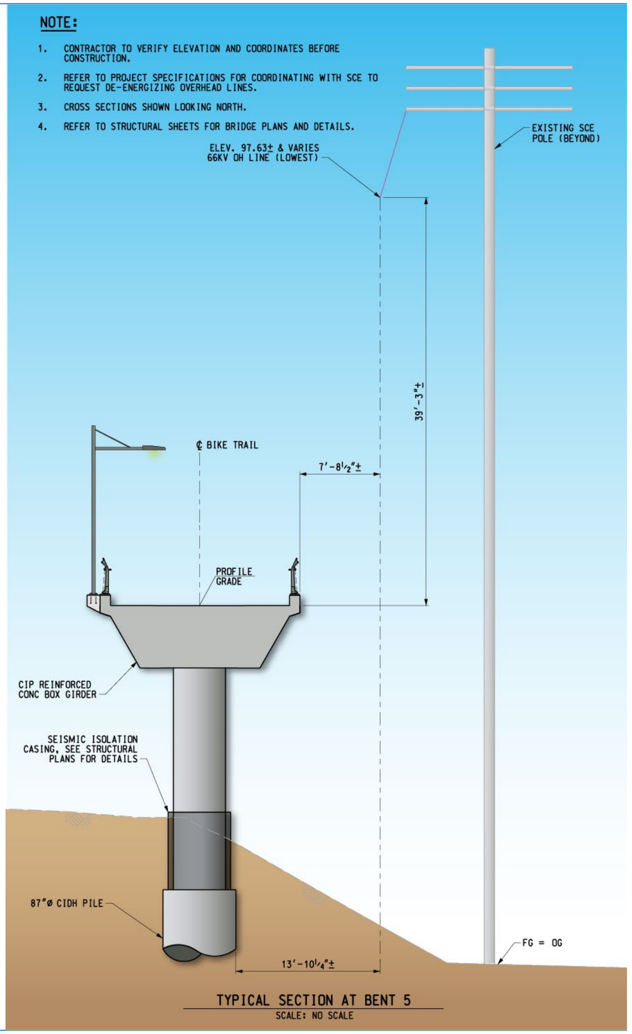
- Avoid existing historical features at the building site

3. Pico/Ocean Ramps

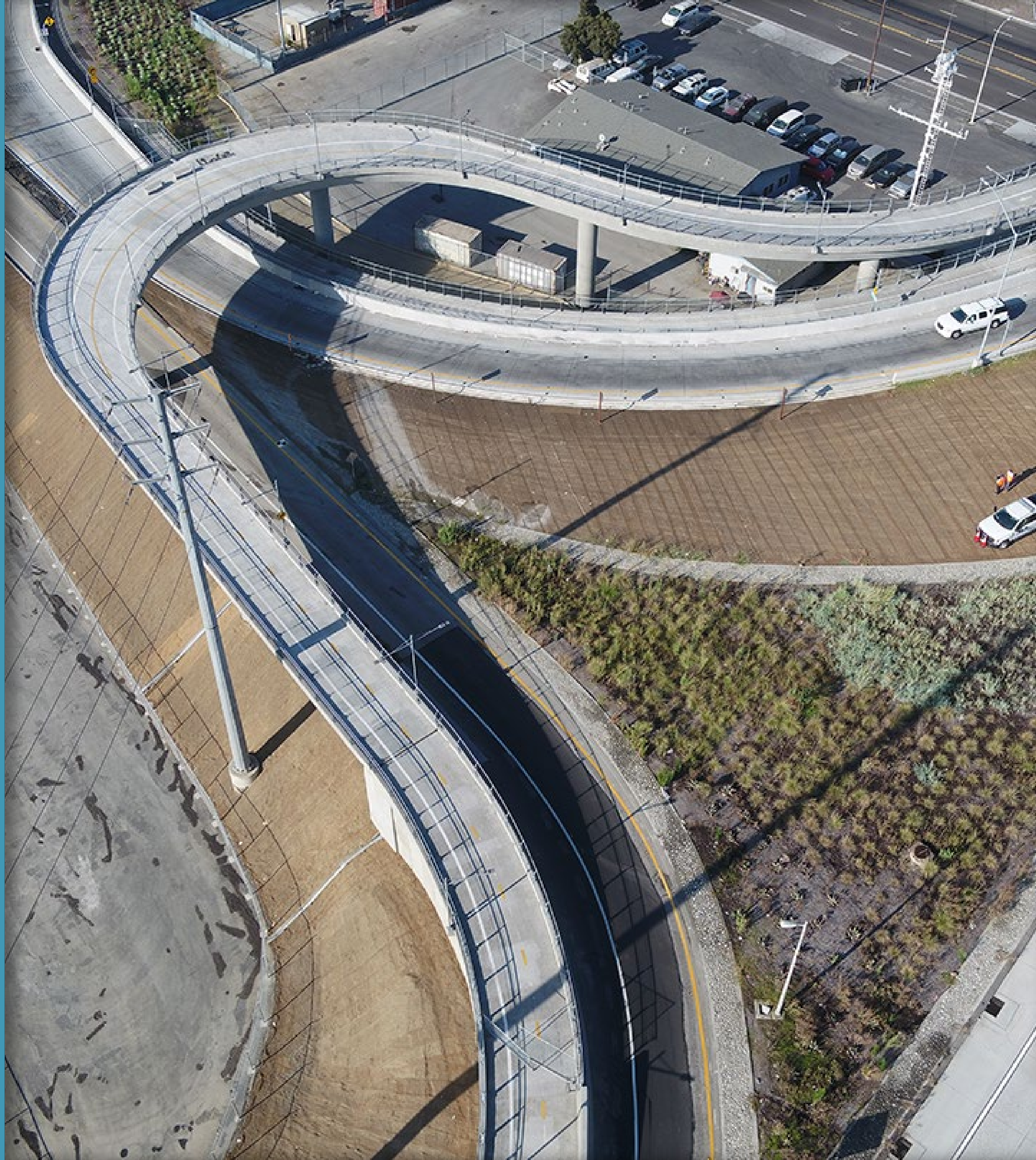
- Maintain vehicle clearance on the on/ off ramps during construction
- Maintain maximum allowable ADA slope of 5% to clear the ramps and connect to the exiting Ocean Blvd bridge approach
- Relocate exiting electrical light poles

4. Overhead Power Lines

- Bridge alignment to fit between the existing onramp and the overhead power line
- Maintain 20ft radial clearance from the overhead power line during construction without de-energizing the power line
- Coordinated with SCE for de-energizing requests for the CIDH installation and the superstructure concrete pour

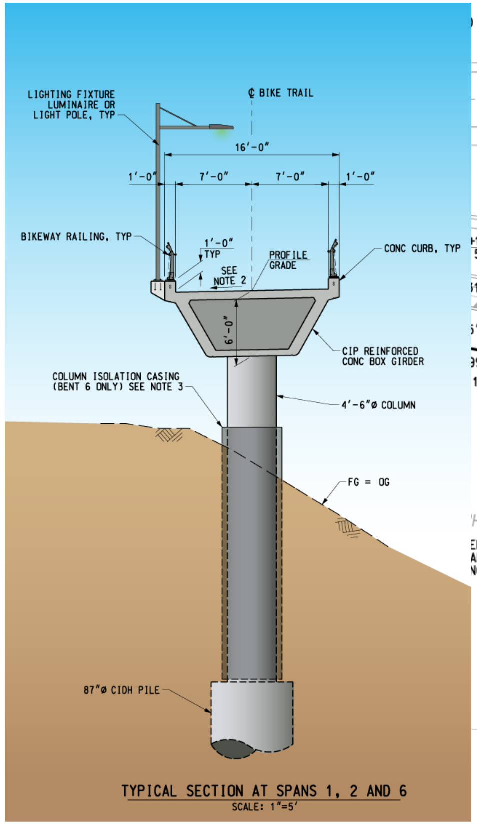


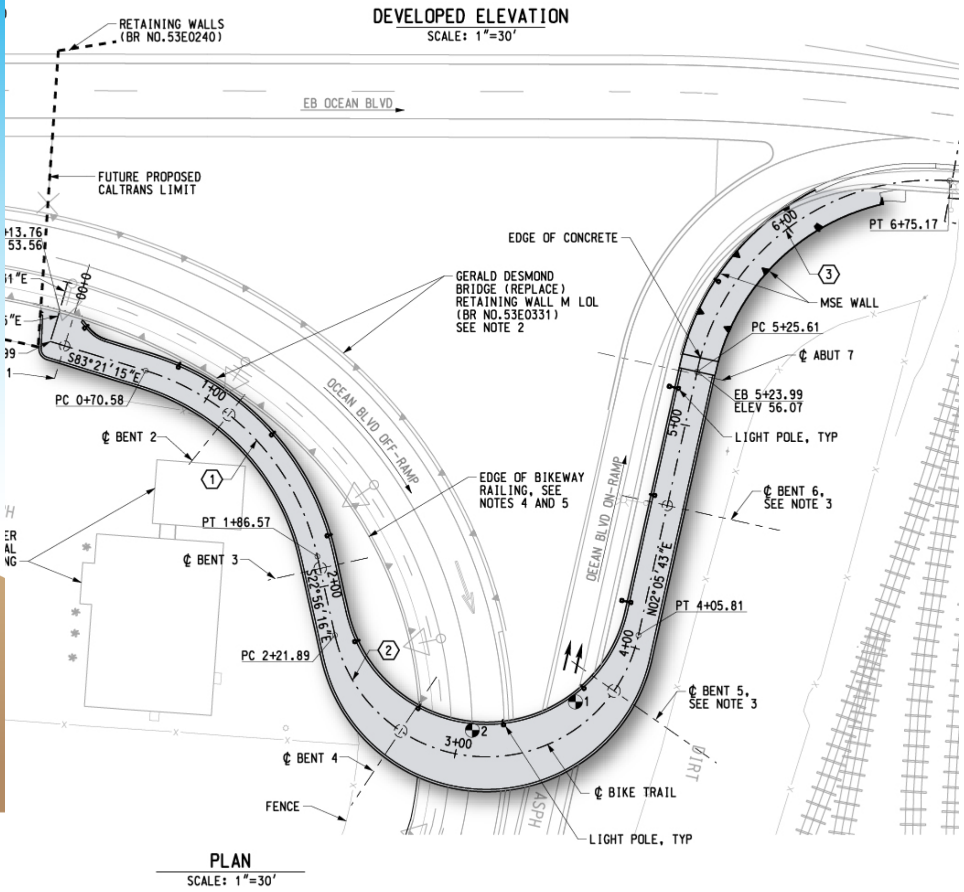
3. Design



Structural System

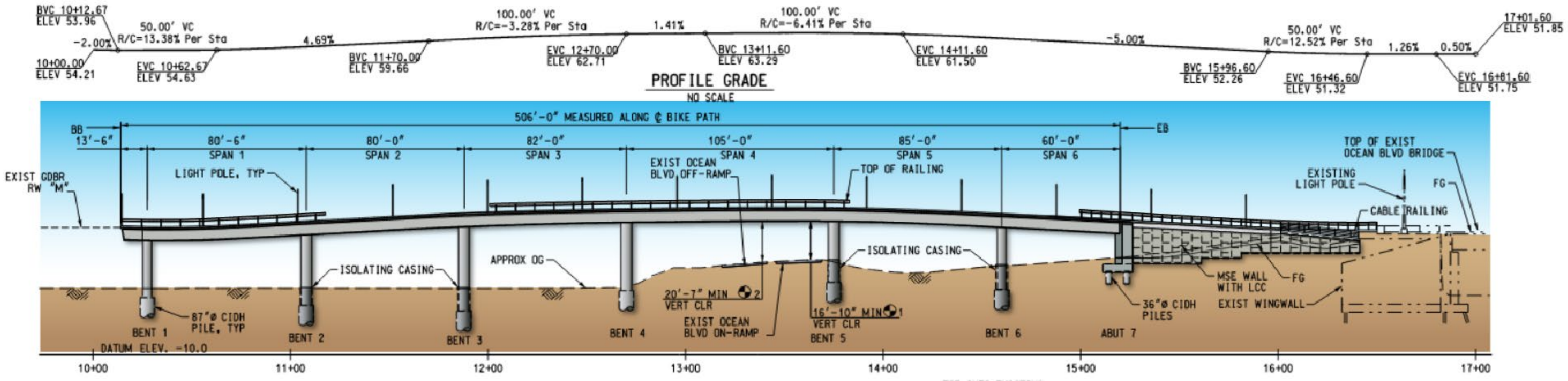
- Bridge has challenging curved geometrical alignment
- Abutment on one end and free end at the LBIGB side
- The bridge structural system is composed of:
  - Curved cast-in-place reinforced concrete box girder bridge
  - Six spans ranging from 60 to 105 feet; total length is 550 feet
  - Superstructure width varies from 16 feet to 30 feet
  - Substructure with six bents supported on 87-inch-diameter CIDH
  - One abutment supported on 36-inch-diameter piles





Bridge Elevation

- Cast-in-place concrete bridge (~500 feet long) with 6 spans
- Width varies from 14 to 30.5 feet
- Cast-in-drilled-hole (CIDH) foundations
- MSE wall

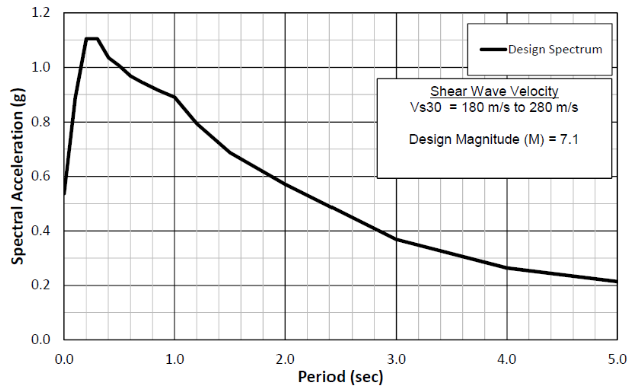


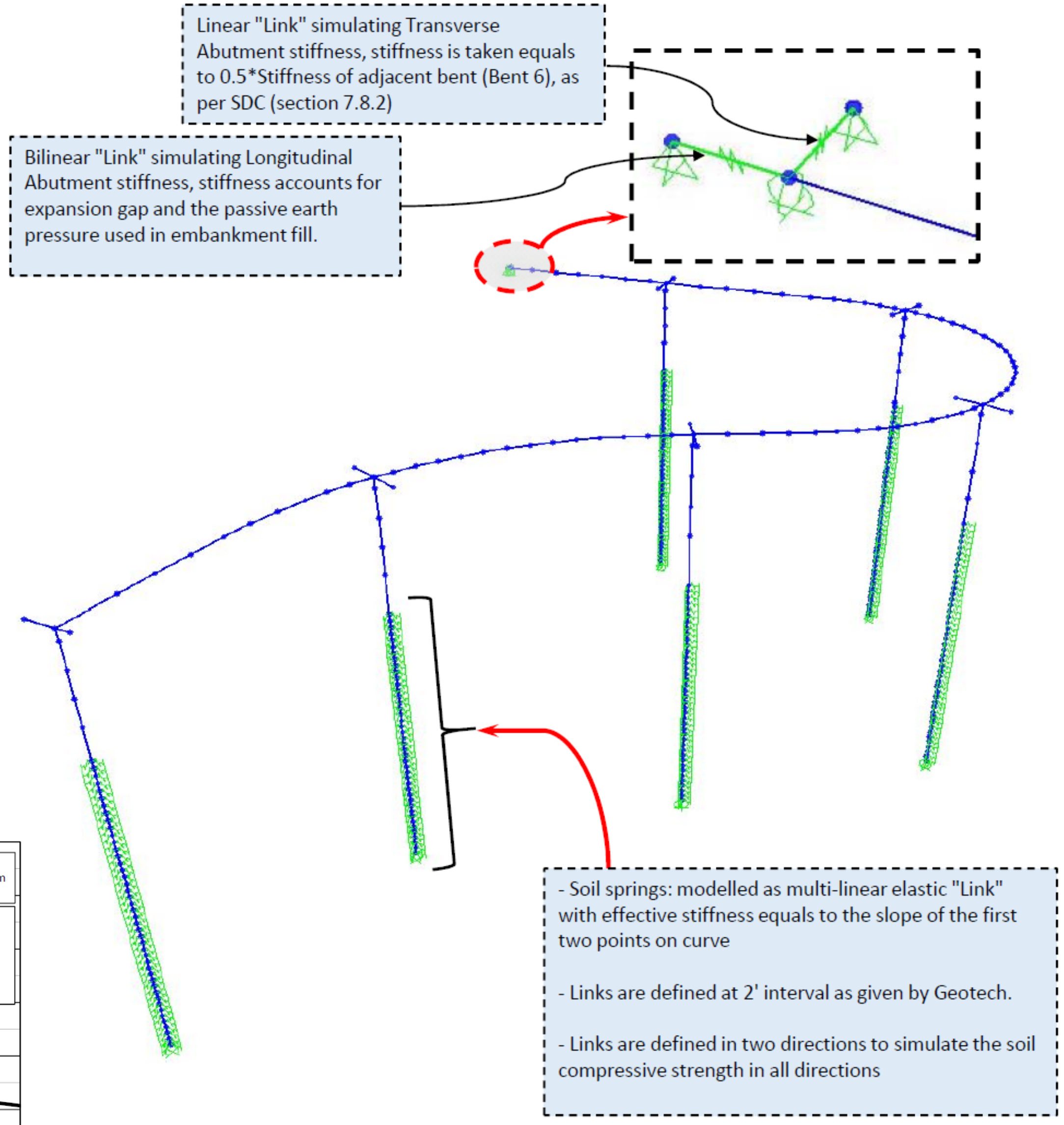
Design Challenges

- Seismic Design
- Connecting to Existing LBIGB
- Existing Ocean Blvd Bridge Load Capacity

Seismic Design

- Global Seismic Model:
  - Curved geometry
  - One abutment
  - Columns with varying stiffness
  - Seismic gap
- Caltrans SDC 2.0 2019
  - Balanced Stiffness Check



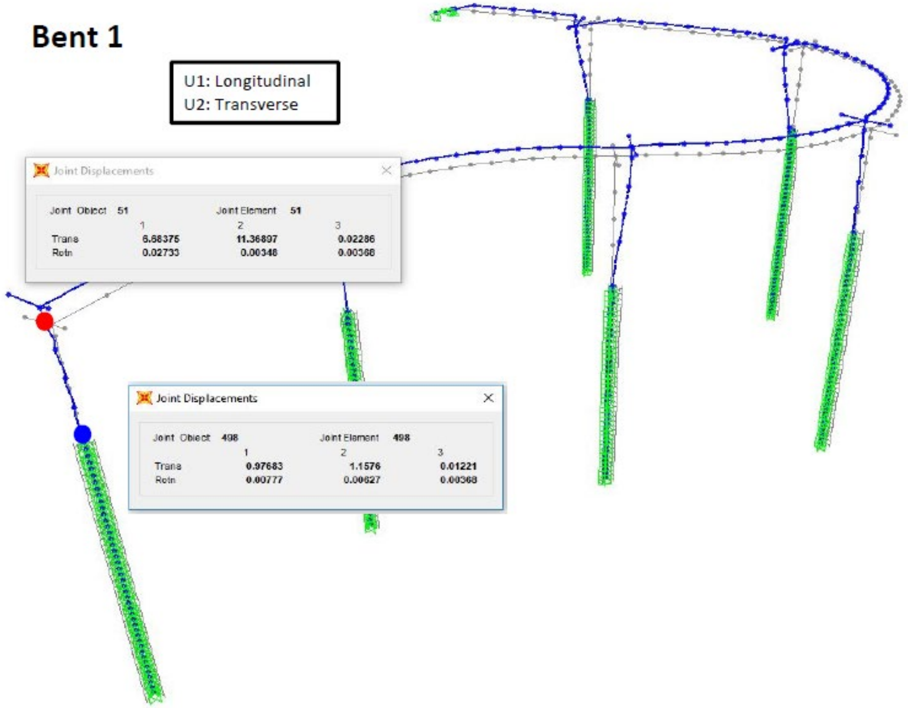


Balanced Stiffness Check per Caltrans SDC

- Balanced Stiffness Check per Caltrans SDC

Table 7.1.2-1 Column/Bent Stiffness-to-Mass Ratios for Bents/Frames

Column/Bent	Stiffness-to-Mass Ratio
For any two bents in a frame or any two columns in a Bent	$0.5 \le \dfrac{\left(\frac{k_i^e}{m_i}\right)}{\left(\frac{k_j^e}{m_j}\right)} \le 2.0$ (7.1.2-1)
For adjacent bents in a frame or adjacent columns in a Bent	$0.75 \le \dfrac{\left(\frac{k_i^e}{m_i}\right)}{\left(\frac{k_j^e}{m_j}\right)} \le 1.33$ (7.1.2-2)

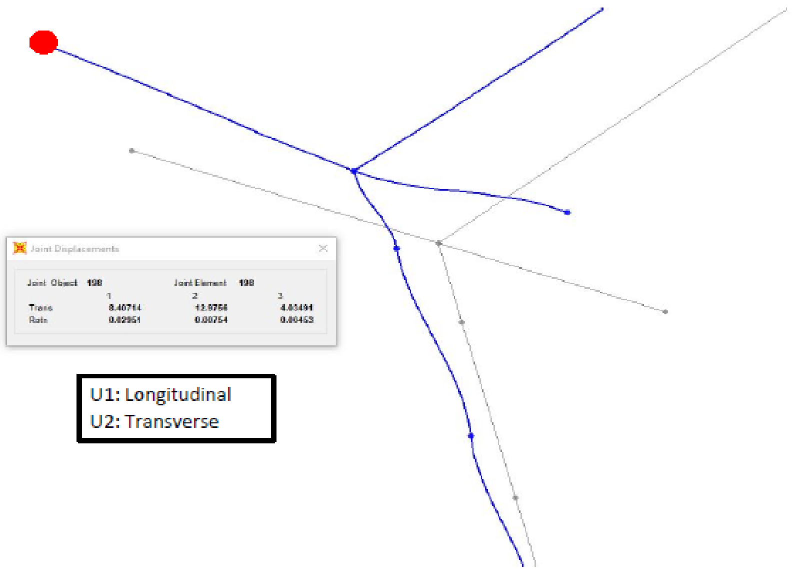


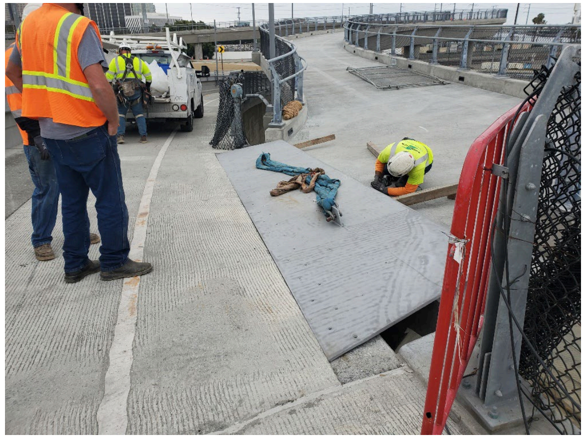
Bent #	Column Length	Column dia.	P (kips)	Δ trans. (in.) From SAP	Δ Long (in.) From SAP	Mass	Ktrans	Ktrans/ mass	Check trans	Check	Klong.	Klong/ mass	Check long	Check	Foundation
Bent 1	29.00	4.5	1000	37.7	10.8	433	319	0.74	0.80	OK > 0.75	1108	2.56	0.81	OK > 0.75	1-87" dia CIDH
Bent 2	35.75	5.5	1000	32.9	9.3	622	365	0.59	0.75	OK ≈ 0.75	1287	2.07	0.78	OK > 0.75	1-87" dia CIDH
Bent 3	42.75	5.5	1000	51.7	14.1	530	232	0.44	0.81	OK > 0.75	851	1.61	0.75	OK ≈ 0.75	1-87" dia CIDH
Bent 4	34.50	5.5	1000	31.6	9.3	1077	380	0.35	0.75	OK > 0.75	1290	1.20	0.80	OK > 0.75	1-87" dia CIDH
Bent 5	31.00	4.5	1000	26.3	8.2	972	457	0.47	0.83	OK > 0.75	1465	1.51	0.75	OK > 0.75	1-87" dia CIDH
Bent 6	31.50	4.5	1000	46.6	13.1	455	257	0.57			913	2.01			1-87" dia CIDH
							min (k/m) =	0.35	0.5	OK ≈ 0.5	min (k/m) =	1.2	0.5	OK ≈ 0.50	
							max (k/m) =	0.74			max (k/m) =	2.6			

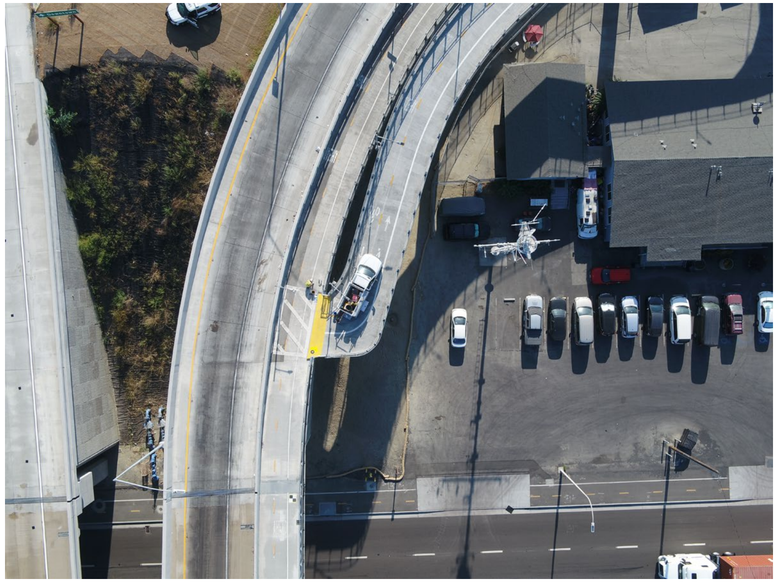
Seismic Gap

	Transverse	Longitudinal	$(\Delta Trans^2 + \Delta Long^2)^{0.5}$
Movement at Bent 1 edge	12.98	8.41	15.46

Provide Gap Size of 1'-4"



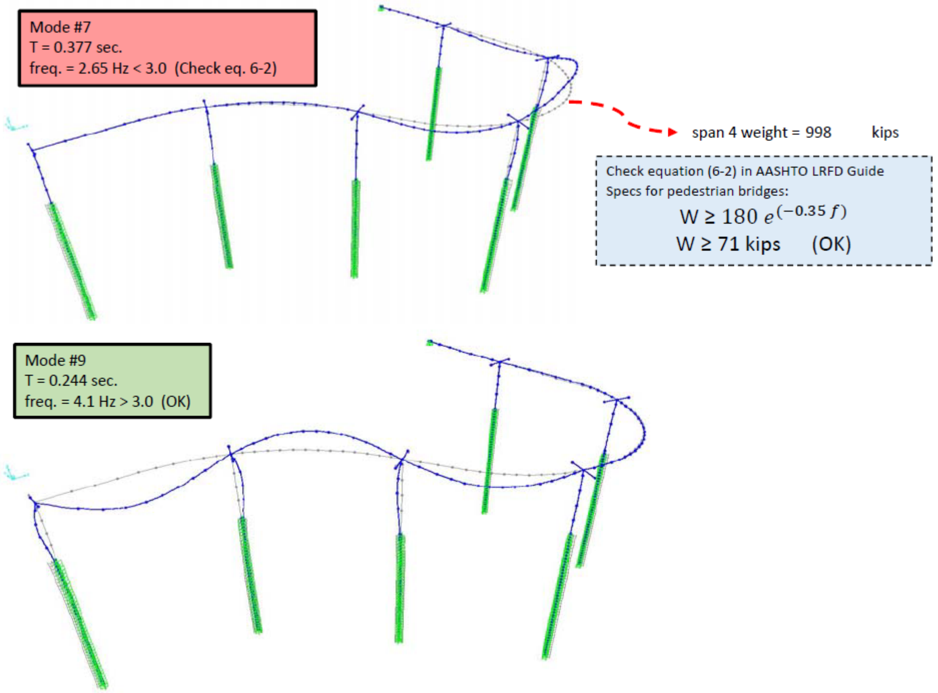




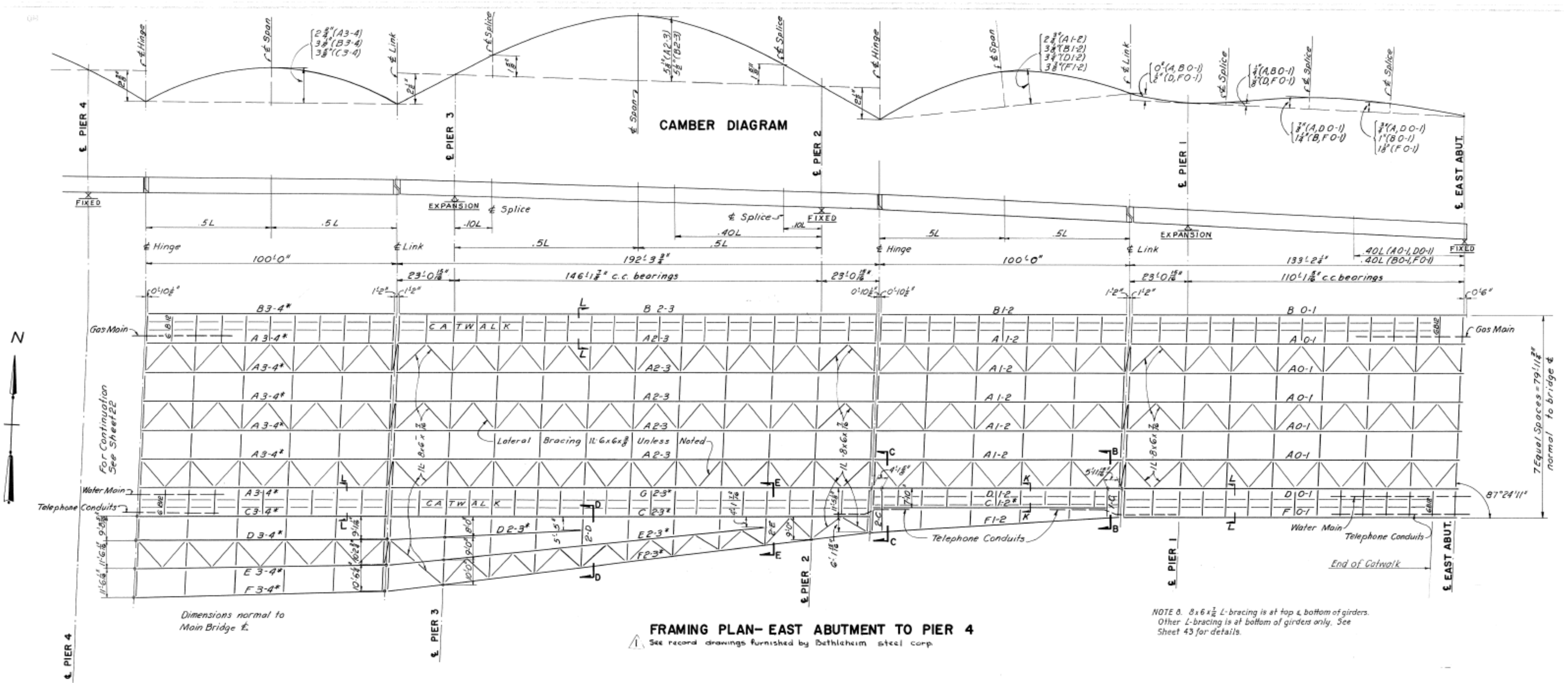
Vibration Check

- LRFD Guide Specifications for the Design of Pedestrian Bridges
- Vibration Check per Section 6
  - The fundamental frequency in a vertical mode of the pedestrian bridge without live load shall be greater than 3.0 Hz to avoid the first harmonic.
  - In the lateral direction, the fundamental frequency of the pedestrian bridge shall be greater than 1.3 Hz.

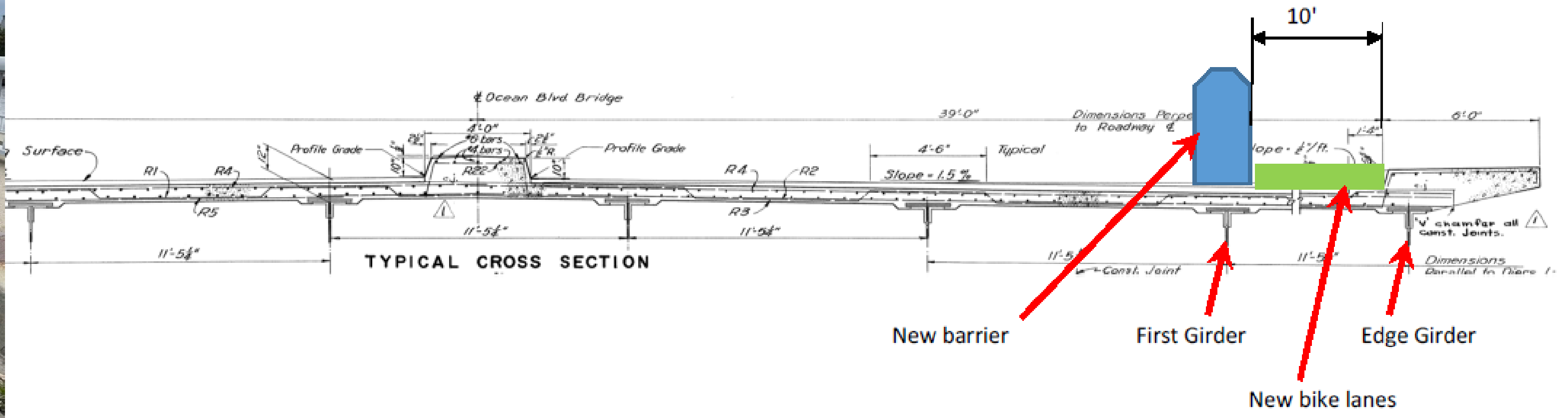
Mode #	Period (sec.)	Freq. (Hz)	UX	UY	UZ	
1	1.044	0.958	0.216	0.469	0.000	
2	0.981	1.019	0.675	0.093	0.000	
3	0.826	1.211	0.019	0.379	0.000	
4	0.793	1.260	0.048	0.004	0.000	
5	0.580	1.724	0.000	0.013	0.000	
6	0.477	2.098	0.003	0.001	0.000	
7	0.377	2.650	0.001	0.002	0.095	→ 1st VL Mode (9.5% of mass)
8	0.305	3.282	0.000	0.000	0.000	
9	0.244	4.101	0.000	0.000	0.061	→ 2nd VL Mode (6.1% of mass)
10	0.240	4.167	0.000	0.000	0.001	
11	0.221	4.521	0.001	0.001	0.003	
12	0.217	4.616	0.000	0.000	0.145	→ 3rd VL Mode (14.5% of mass)
13	0.193	5.191	0.000	0.000	0.000	
14	0.183	5.472	0.000	0.000	0.255	→ 4th VL Mode (25.5% of mass)

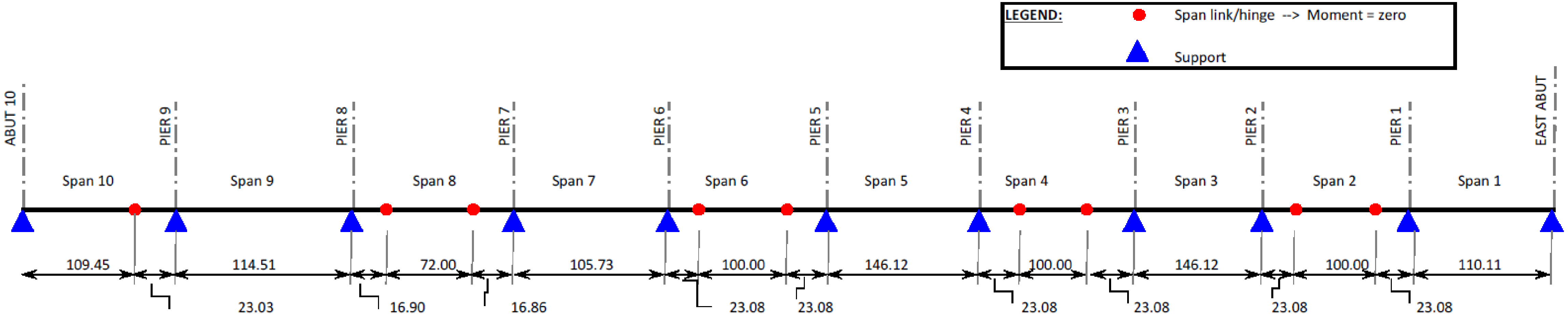


Existing Ocean Blvd Bridge



Existing Ocean Blvd Bridge Load Chack

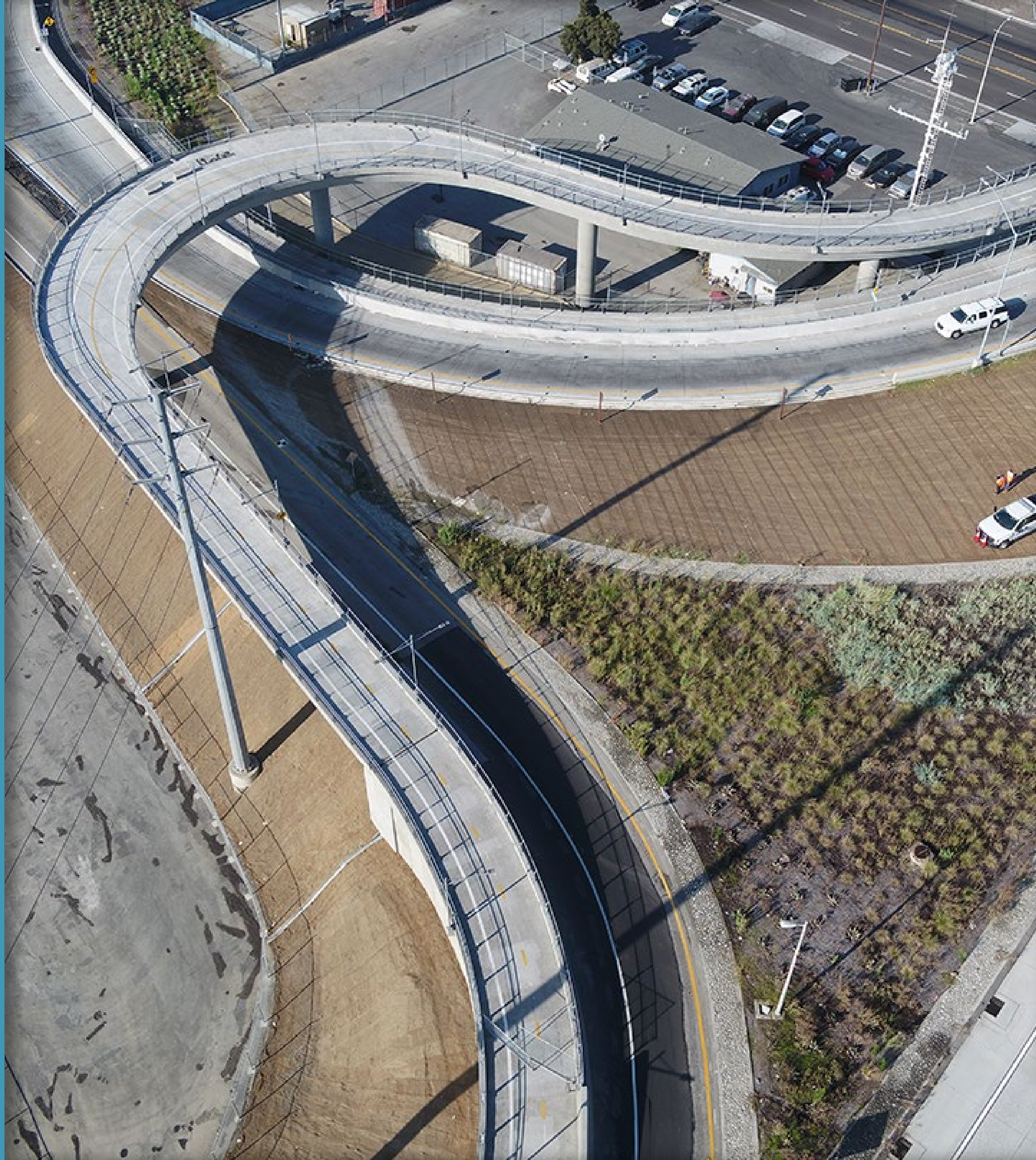




Design Challenges

› Ocean Blvd Reconfiguration for Bike Path Safety

4. Construction



Construction Challenges

- CIDH Pile Installation
  - Existing MSE Walls
  - Overhead Power Lines
  - High Groundwater
  - Full Length Temporary Steel Casing

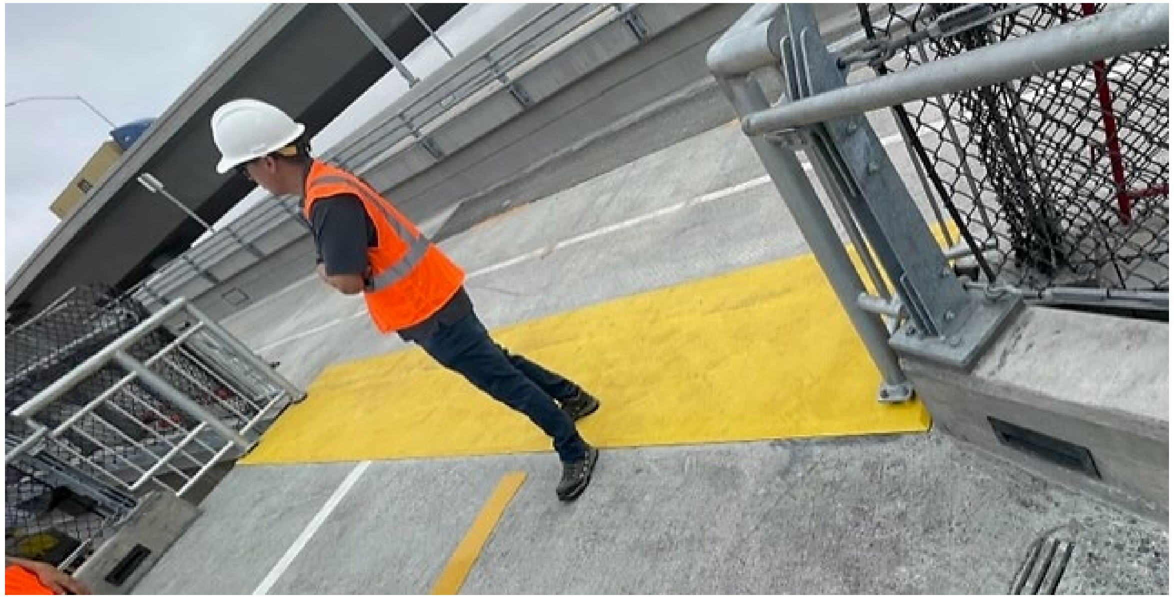
CIDH & Overhead Lines

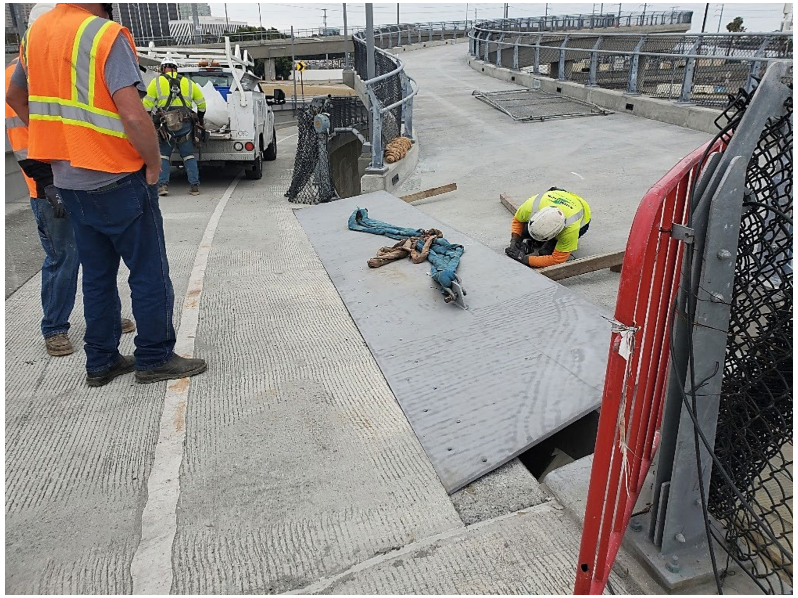
CIDH & Overhead Lines

CIDH & Existing MSE Wall

Construction Challenges

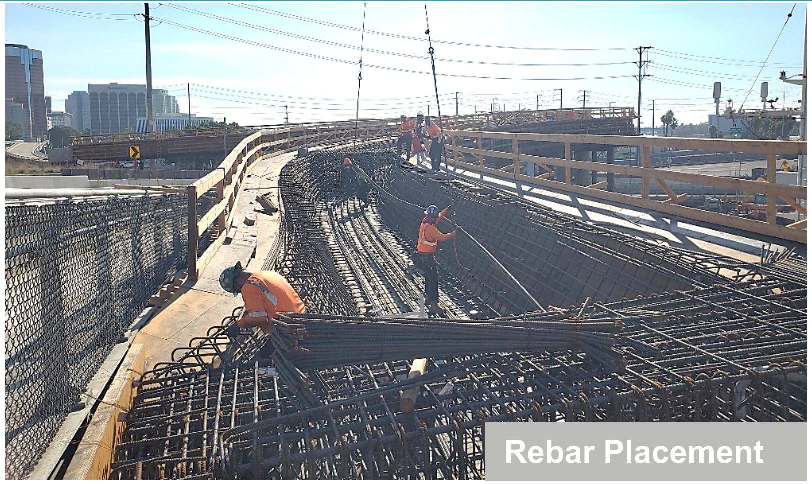
- Steel Plate at Transition to LBIGB
  - No as-built elevations of the LBIGB until construction started
  - All four edges of the plate had different slopes
  - Edges had to be beveled to meet ADA requirements
  - Multiple fit ups required to bend plate and ensure it sits flush on the bridge surface





Construction

CIDH Drilling



Rebar Placement

Railing Installation

- NTP on March 2021
- Substantial Completion on Aug 2022
- Construction Cost = $8.6M
- Engineers Estimate = $8.0M

Awards

2022 American Public Works Association (APWA) BEST Awards

- Traffic, Mobility, and Beautification

2022 American Council of Engineering Council (ACEC) Engineering Excellence Award

- Merit Award

Thank You

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Earth Mechanics, Inc. Geotechnical and Earthquake Engineering