

Case Study of a 100-foot Tall MSE Wall for the Sofi Stadium

#### Overview

#### Project Description

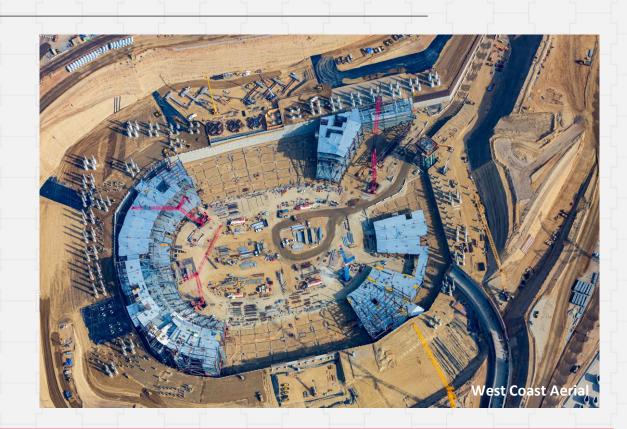
- Why Mechanically Stabilized Earth (MSE)?
- Geotechnical Conditions

#### Design Considerations

- Trapezoidal Strip Design
- Special Wall Components
- North Canyon Aesthetics
- Seismic Detailing
- Obstructions

#### Construction Challenges

- Stockpiling
- Access
- Backfill



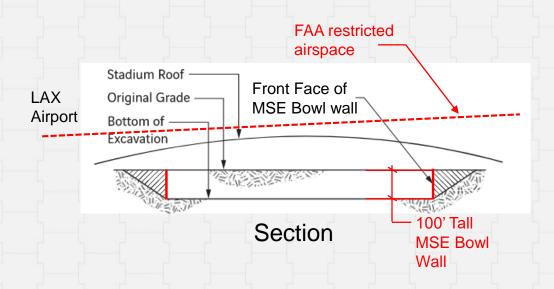
### **Project Description**

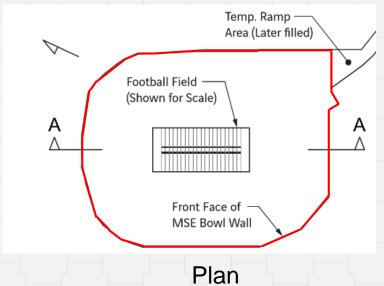
- NFL Sofi Stadium for Rams and Chargers approximately 2 miles east of LAX airport
- Project site was previously home to the Hollywood Park racetrack



### **Project Description**

Field level set ~100 feet below original grade to avoid FAA restricted airspace





#### Project Description: Why MSE?

- Perimeter wall needed for the field/stands:
  - Maximum Wall Height = 109.7 feet
  - Wall Length = 3,018 feet
  - Peak Ground Acceleration = 0.63g
- Secant pile wall was originally considered due to top-down construction
- However, Kiewit chose MSE walls:
  - Superior performance of MSE walls have been historically proven in high seismic areas
  - RECo has experience with building tall MSE walls, especially with cruciform panels
  - Accelerated construction with standardized prefabricated materials
    - Timetable was critical to meet a schedule where the new stadium could host the Super Bowl in 2022

#### Project Description: Geotechnical Conditions

#### Subsurface profile

- Up to 25 feet of manmade fill
- Underlain by alluvial gravel, sand, and clay down to ~80ft below existing grade
- Marine/non-marine deposits of fluvial sand and silt below ~80ft
- Bedrock was not encountered in the borings (boring depths up to ~200ft)

#### Water

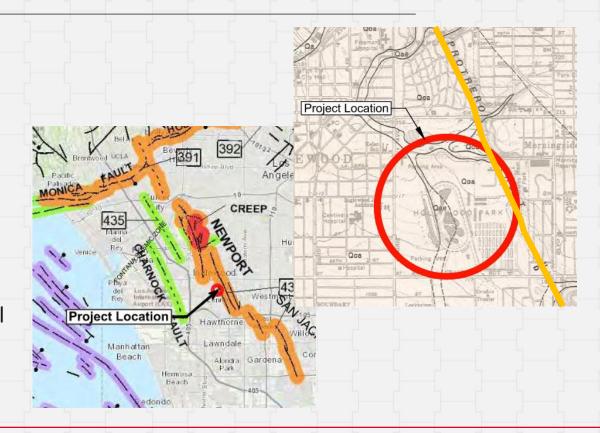
- Design groundwater below bottom of wall
- Flooding did occur during construction due to heavy rains
- Foundation strength >50 blow counts



### Project Description: Geotechnical Conditions

#### Seismicity

- Many fault lines in the vicinity
- No fault line crossing the site
- Potrero fault line ~1,000 feet to the east of the proposed site
- Low liquefaction potential
- PGA = 0.63g for design



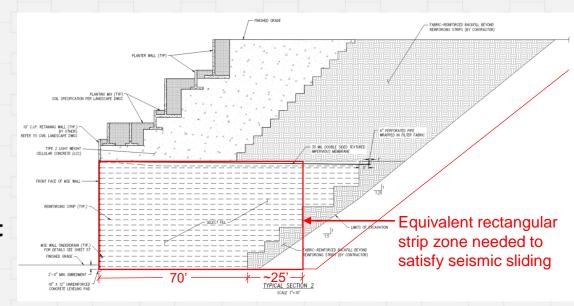
# Design Considerations: Trapezoidal Strip Design

Contractor planned excavation for 70% of the maximum wall height

• Unfortunately, this did not account for seismic sliding with slopes on top of

the wall and strip lengths greater than 70% of the wall height were needed in some locations

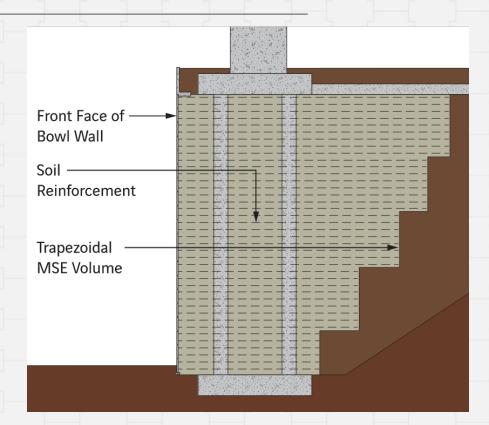
 RECo proposed a trapezoidal strip design to decrease strip lengths on the bottom of the wall, but not the overall weight of the mass to resist sliding



# Design Considerations: Trapezoidal Strip Design

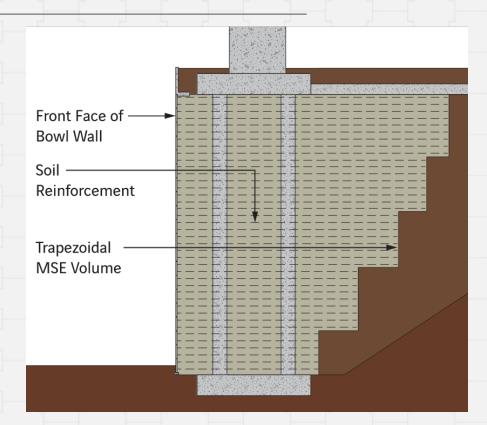
#### Per FHWA guidelines for trapezoidal walls:

- Very competent foundation (>50 blow count)
- Strips as short as 40% of the wall height at the bottom of the wall stepping to longer strips on top
- Equivalent cross-sectional area to an MSE with uniform strip lengths 70% of the wall height



# Design Considerations: Trapezoidal Strip Design

- For final design, bottom strip lengths ranged from ~45% to 70% of the wall height
- The trapezoidal design was also used in areas without a slope on top of the wall (no issue with seismic sliding) to save the contractor even more excavation
- Reduced excavation by almost 100,000 cubic yards



#### Design Considerations: Special Wall Components

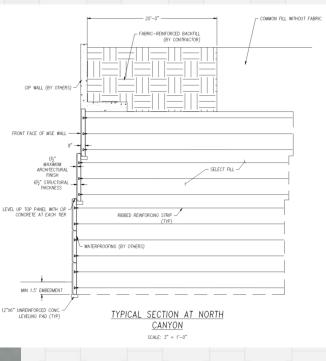
- Due to the tall wall height and seismic loading, specialized wall components had to be used:
  - Panel Thickness: ranged from 5½ inches (standard) to 8 inches
  - Panel Reinforcement: rebar more than tripled from top to bottom of wall
  - Reinforcing Strip Thickness: ranged from 0.16 inches (standard) to 0.24 inches
  - <u>Tie Strip Thickness</u> (panel connection): ranged from 10 gauge (standard) to 7 gauge
  - <u>Bearing pads</u> (between panels): pads were equivalently quadrupled near the bottom of wall compared to a standard design
  - Reinforcing Strip Length: reinforcing strip lengths up to 120 feet were used along the wall (any strip longer than 32 feet long requires splicing)
  - Vertical Strip Spacing: ranged from 2.46' (standard) down to 1.23'



# Design Considerations: North Canyon Aesthetics

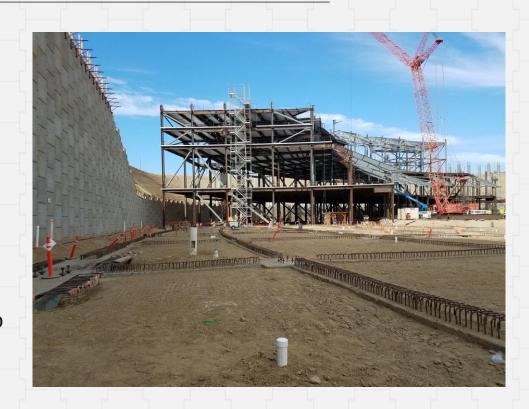
- Only exposed MSE wall that required special aesthetics and waterproofing to prevent staining
- Panels set back every panel course
- Panels are nominally 5'x10' rectangular panels
- Other precast walls are constructed using the nominal 5'x 5' cruciform panels

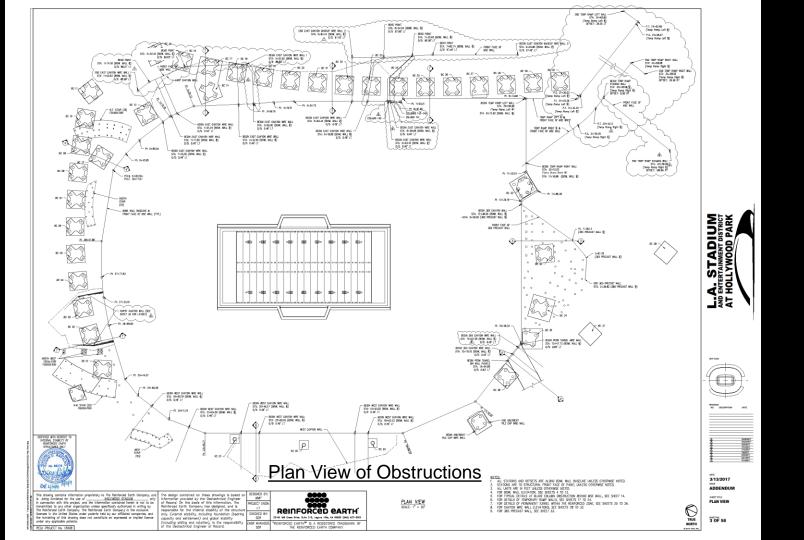


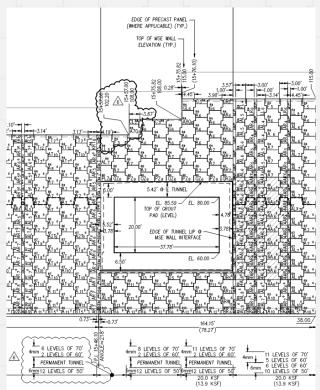


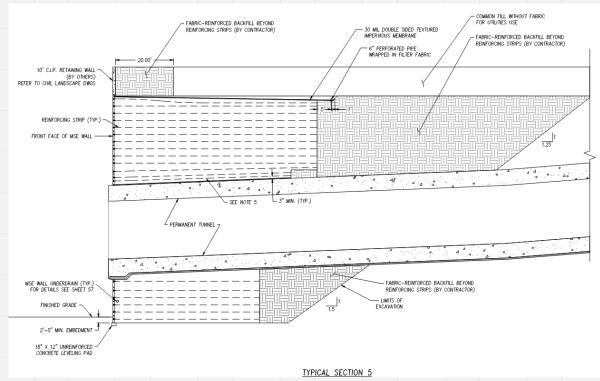
#### Categories for structures:

- Moving with the wall mass
- Isolated from the wall mass
- Stands isolated
  - 5' to 11.5' corridor separates the MSE wall from the stands
- Permanent tunnel isolated
  - Load relief walls and special MSE panels and used at the interface to allow movement
- Piles both

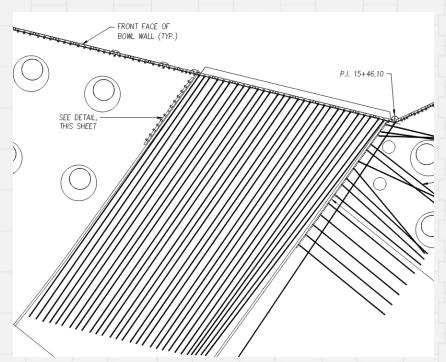


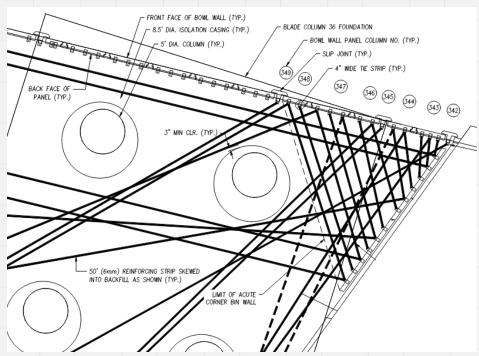




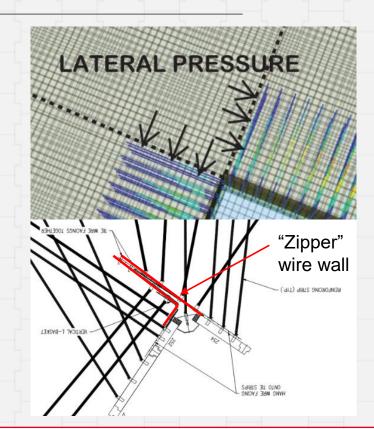






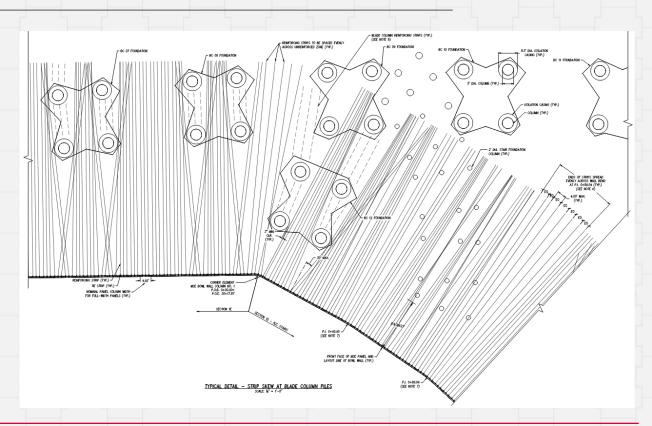


- FLAC3D modeling showed potential for inside corners to open from lateral pressures on the strip zone during a seismic event
- To retain the soil at these corners, a "zipper" design was used
- The "zipper" consisted of wire wall facing and additional reinforcements
- Strips were skewed around the corner to prevent large unreinforced zones



#### Two main pile types:

- 5'Ø blade columns isolated from the surrounding soil by 8.5'Ø casings
- Non-isolated smaller piles supporting various structures
- Strips splayed evenly at geometry changes



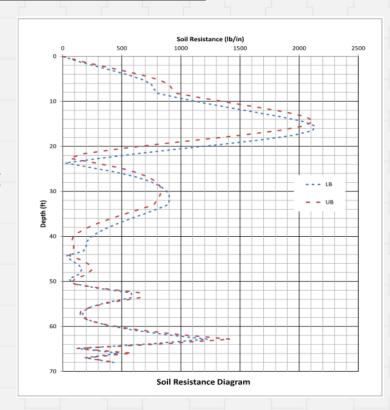
#### Isolated blade columns

- Strips were skewed around these large obstructions
- Large unreinforced zones were created due to the height of the wall and length of strips
- Additional strips, not connected to the panel facing, were installed behind these obstructions
- No additional loading was considered on the wall from these columns

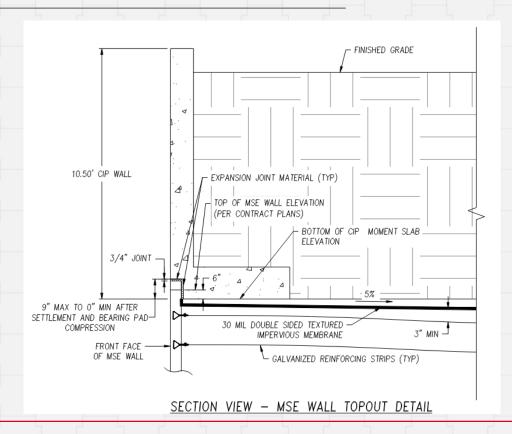


#### Non-Isolated Piles

- Additional unattached strips not required
- Earth Mechanics, Inc. provided soil resistance for the piles
- 2:1 distribution was used to project the loading from the pile to the MSE wall
- External stability Loading included when pile was within 8 pile diameters from the ends of the reinforcing strips
- Internal stability Loading included when the pile was within the MSE wall mass



- For future maintenance of utilities or other structures, a 10.5' CIP cantilever wall was constructed at the top of the MSE wall, so the reinforced zone would not be disturbed
- A horizontal load at the top of the MSE wall was applied to model this 10.5' CIP wall



# Construction Challenges: Stockpiling

- Managing large quantities of material
  - Panels were
     manufactured at Harper
     Precast in Utah
  - After fabrication, panels were mostly stored on the project site (~5 acres)
  - Soil reinforcements were also staged on site in large quantities

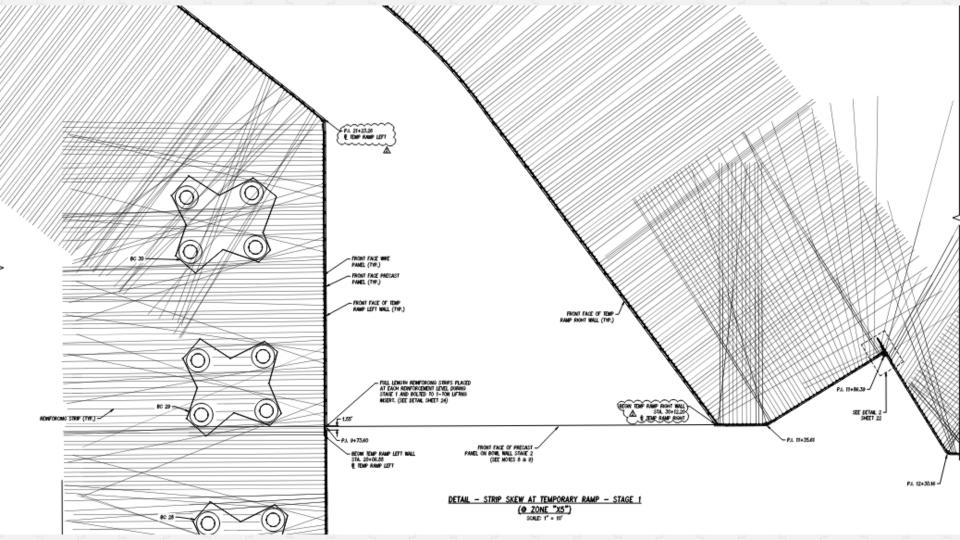


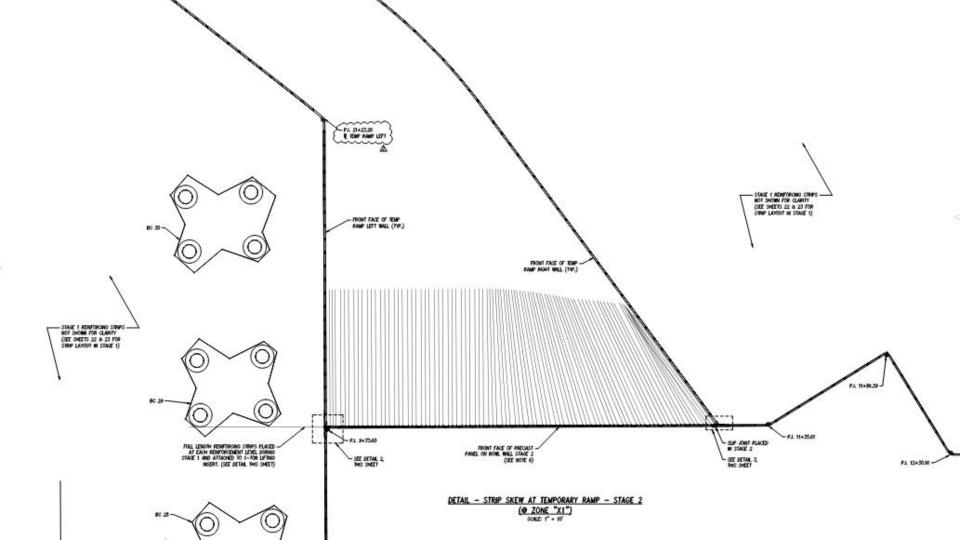


### Construction Challenges: Access

- Temporary ramp was used for the contractor to access the bottom of the bowl
- Majority of the temporary wall was built with wire facing panels to reduce cost
- Precast paneling was still needed at the bottom of the wall for collision protection and very high horizontal earth pressures
- At the end of construction, the temporary ramp was buried and closed off







#### Construction Challenges: Backfill

- Site excavation (~8 million cubic yards) required 1.5:1 slope for the installation of the MSE wall
- Onsite material contained 20% to 50% fines, which is not suitable for MSE wall select backfill in the reinforced zone (15% fines maximum)
- In general, contractor blended 70% of the onsite material with 30% of a small grained gravel called "birdseye" to reduce the final fines content to a maximum of 15%
- Approximately 1 million cubic yards of select backfill for the reinforced zone was needed for the MSE walls
- The contractor was also able to use onsite material in the retained zone (behind the reinforced zone) by reinforcing it with a geotextile

#### Conclusions

#### During Construction:

- MSE walls allowed for an accelerated schedule saving the contractor both time and money
- MSE walls were able to effectively accommodate all the seismic design loading and various obstructions within the MSE wall mass

#### After construction:

An earthquake of a magnitude 5.1 occurred in the LA area during Hurricane
Hilary August 2023 without any apparent affect to any of the structures
(#hurriquake)



# Questions?

