47TH SOUTHWEST GEOTECHNICAL ENGINEERING CONFERENCE

Evaluation of Soil Plug Geotechnical Resistance in the Design of CISS Piles

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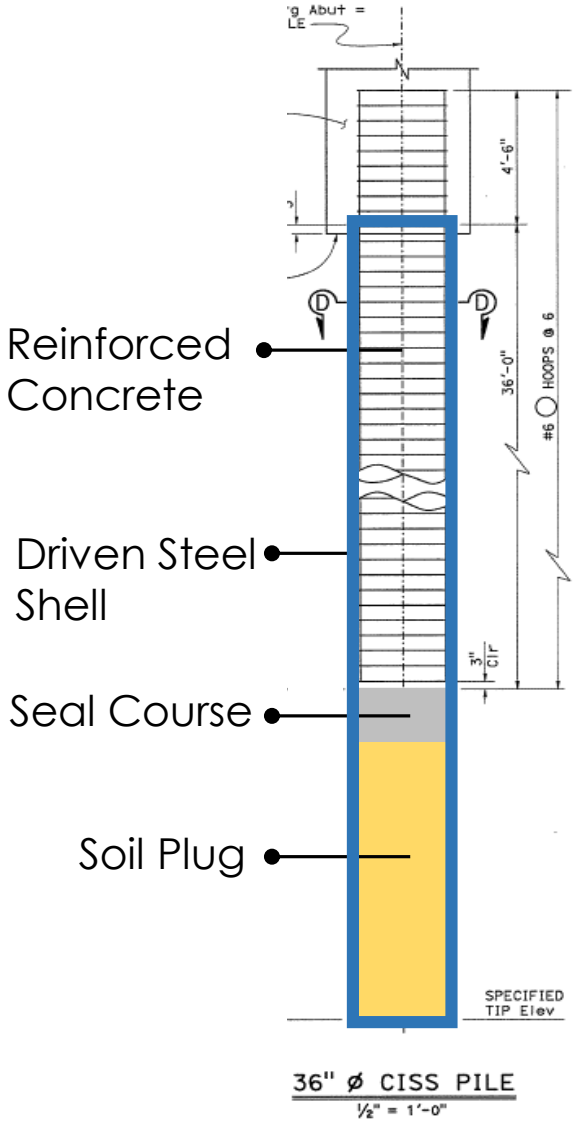
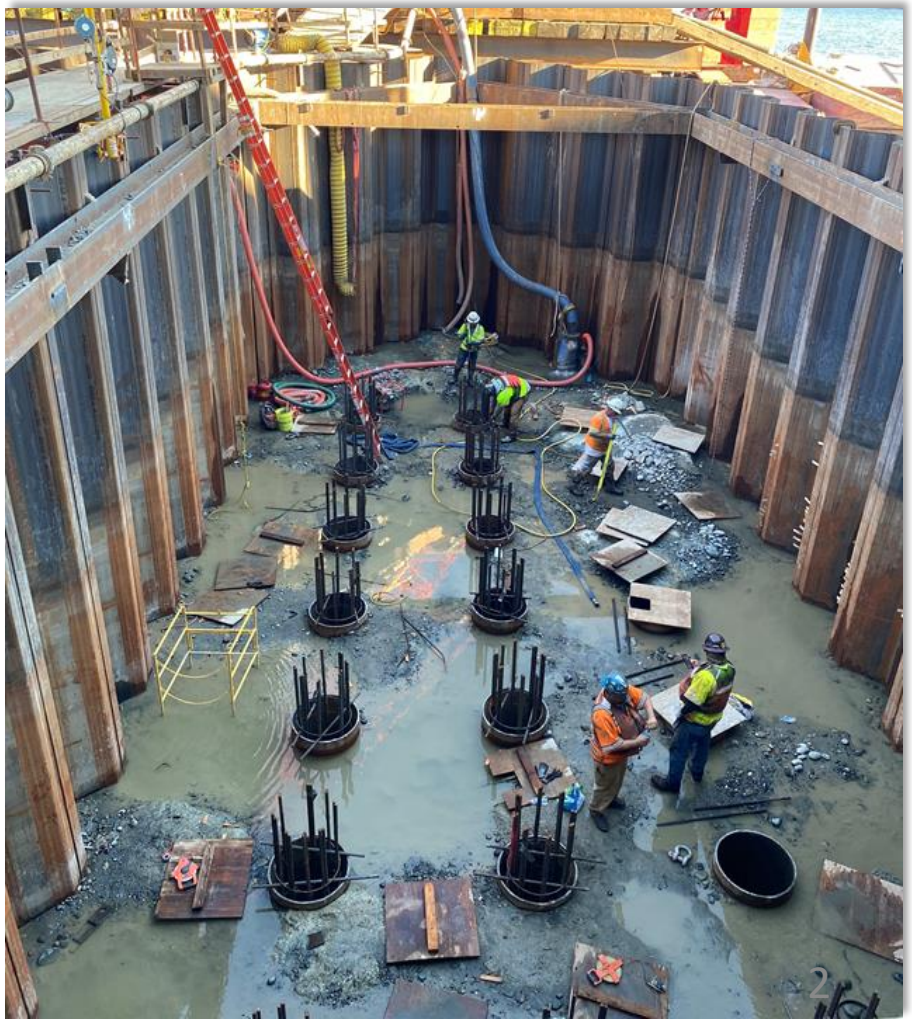
TRANSFORMING IDEAS INTO SOLUTIONS

What is a Cast-in-Steel Shell (CISS) Concrete Pile?

Consists of Driven Steel Shell, Reinforced Concrete, Seal Course and Soil Plug





SF-Oakland Bay Bridge (Skyway) CISS Pile Foundation

The Problem:

There have been a numerous Caltrans projects where the calculated geotechnical resistance was not met (from PDA and/or pile load testing results) due to uncertainty in the design method. As a result, costly change orders during construction were required.

A Caltrans Research (From 2021 to 2025) with UC Berkeley & Foundation Constructors, Inc. to evaluate the soil plug geotechnical resistance for Design of CISS Piles.

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D. Riddle

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J. Wang

The Specific Objectives of This Research

Evaluate geotechnical resistance of soil plug thickness.

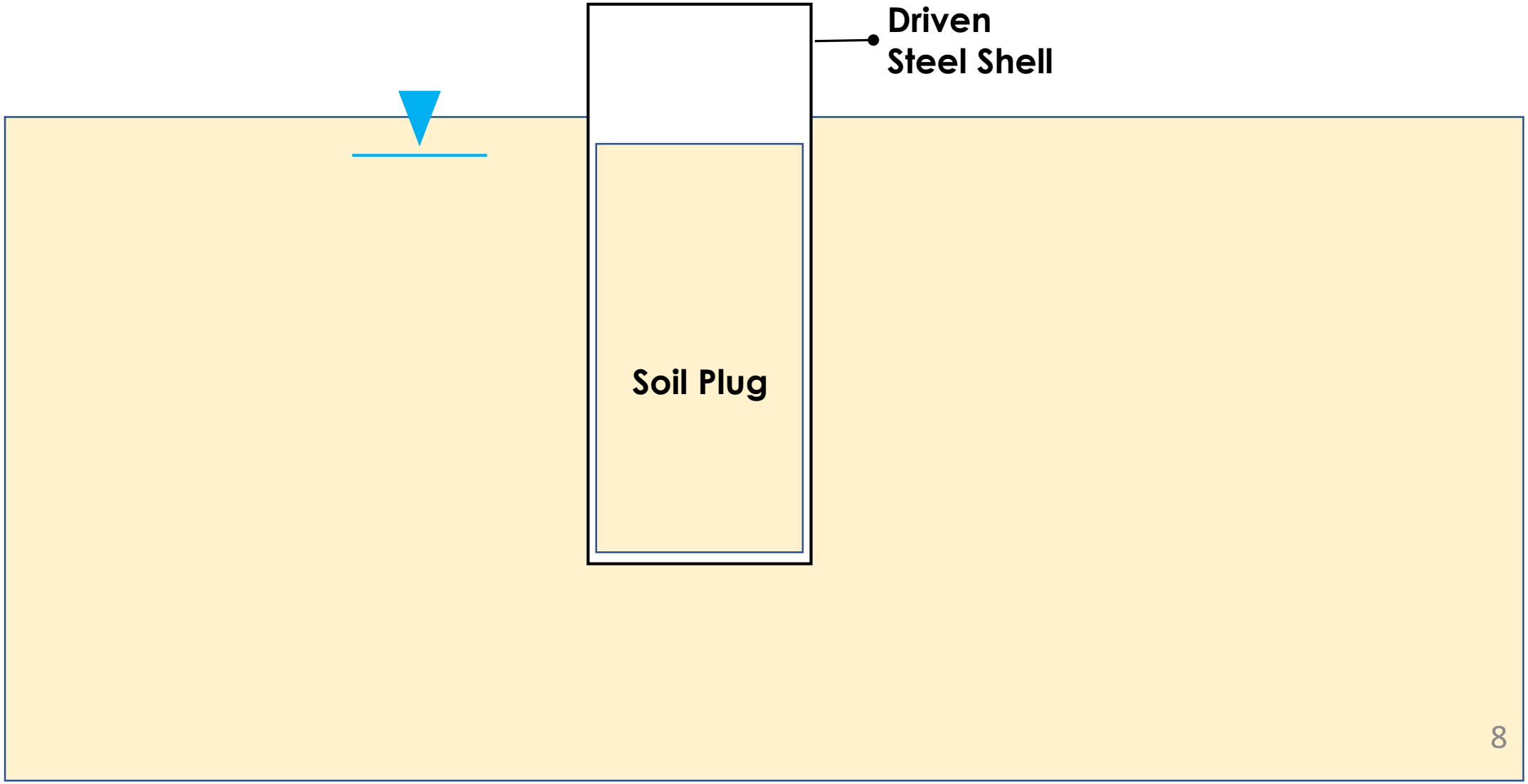
Evaluate the Caltrans construction practice on the impact of soil plug geotechnical resistance.

Evaluate the design procedure for the geotechnical capacity of the CISS pile.

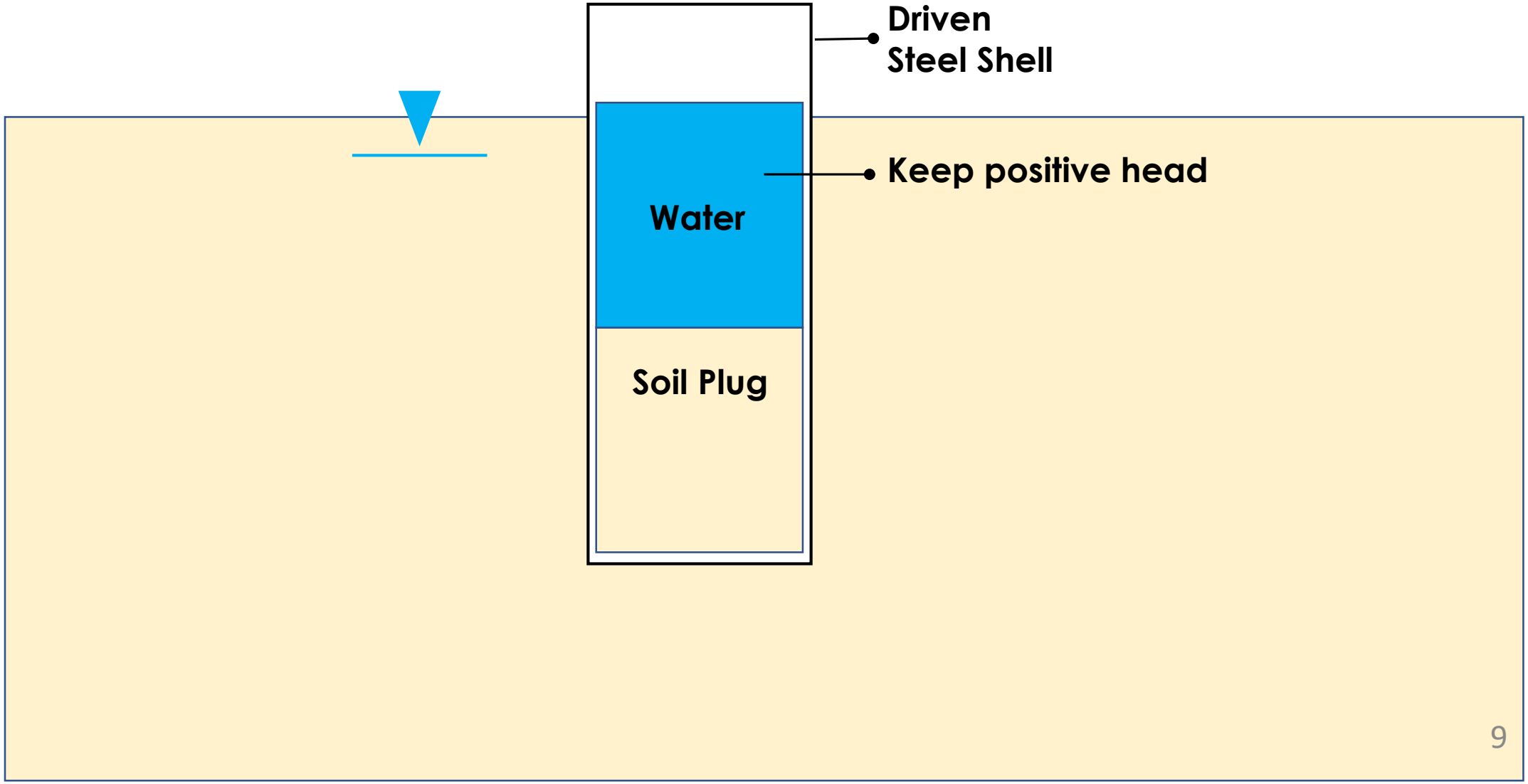
The Goal:

This project will help refine and better predict the geotechnical resistance of the soil plug and therefore yield more cost-effective designs with less risk.

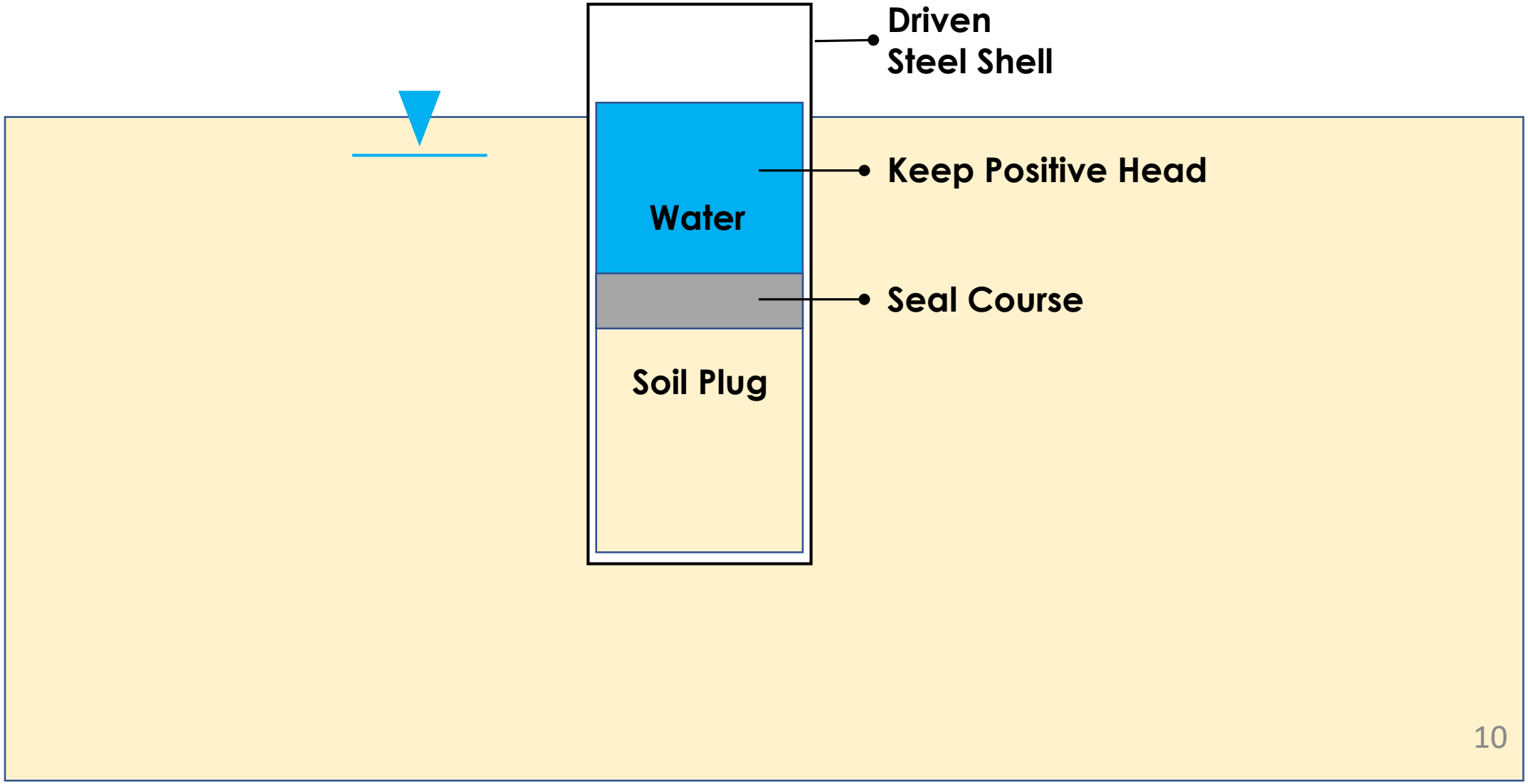
CISS Pile Construction
Step 1 : Drive Steel Shell



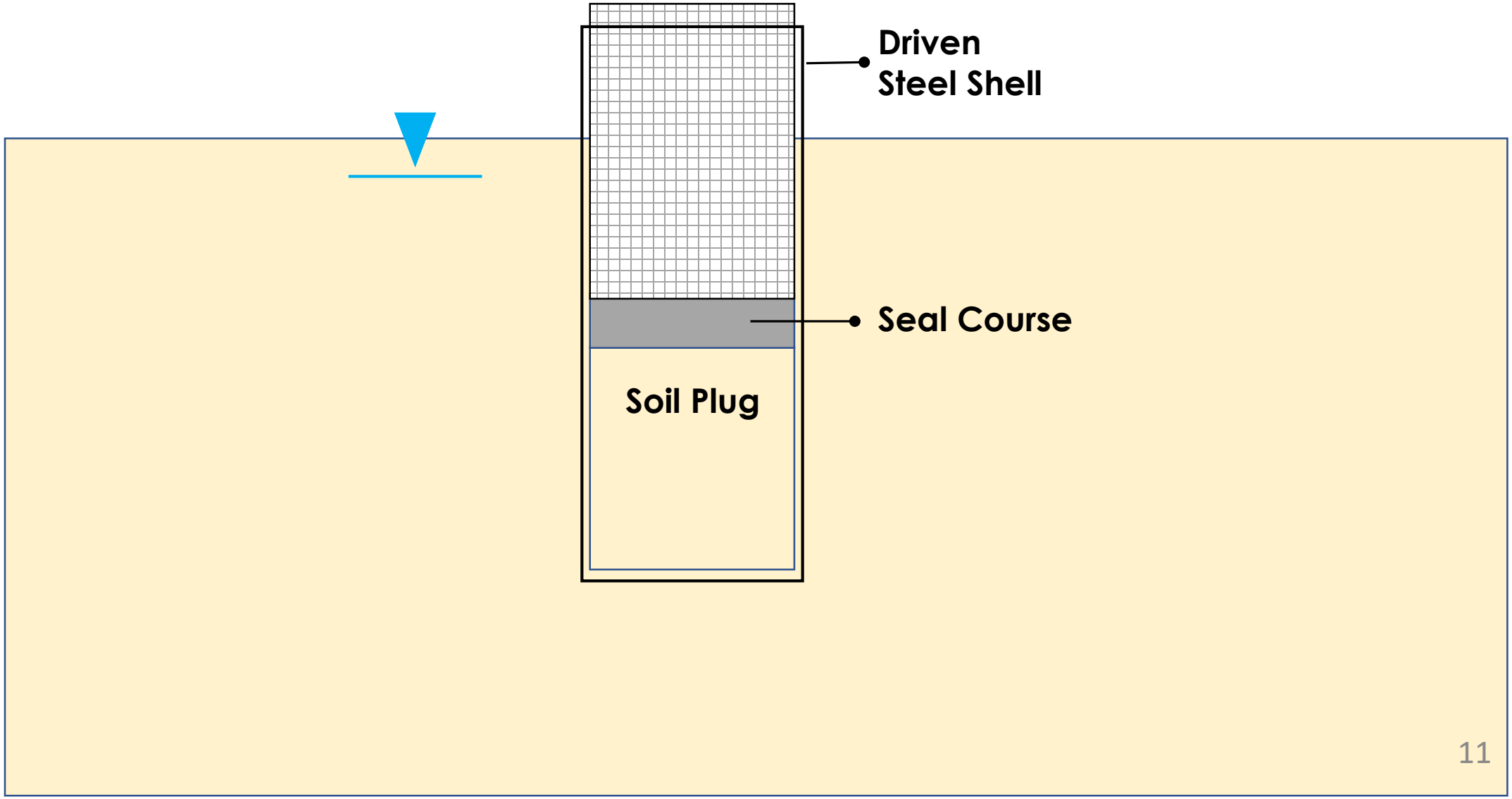
Step 2: Excavate to Design Top of Soil Plug Elevation



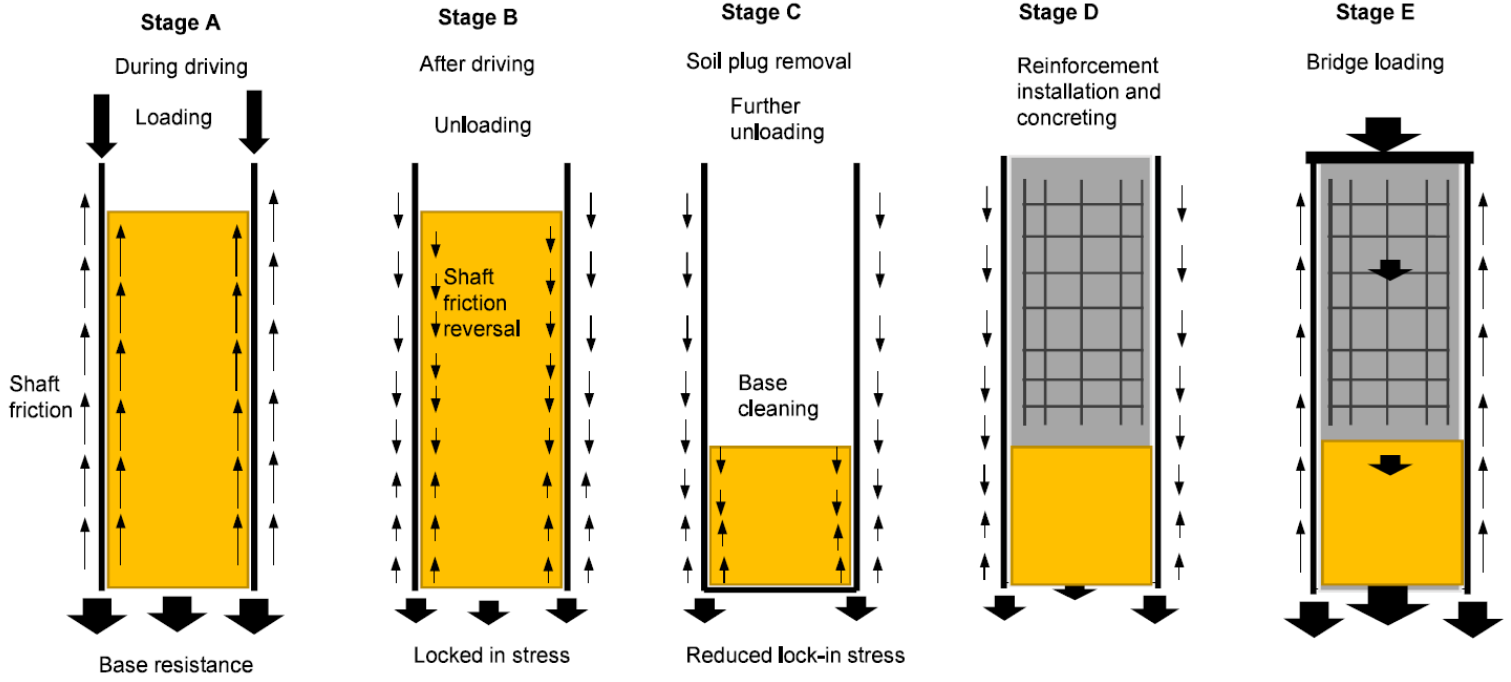
Step 3: Place Seal Course Concrete



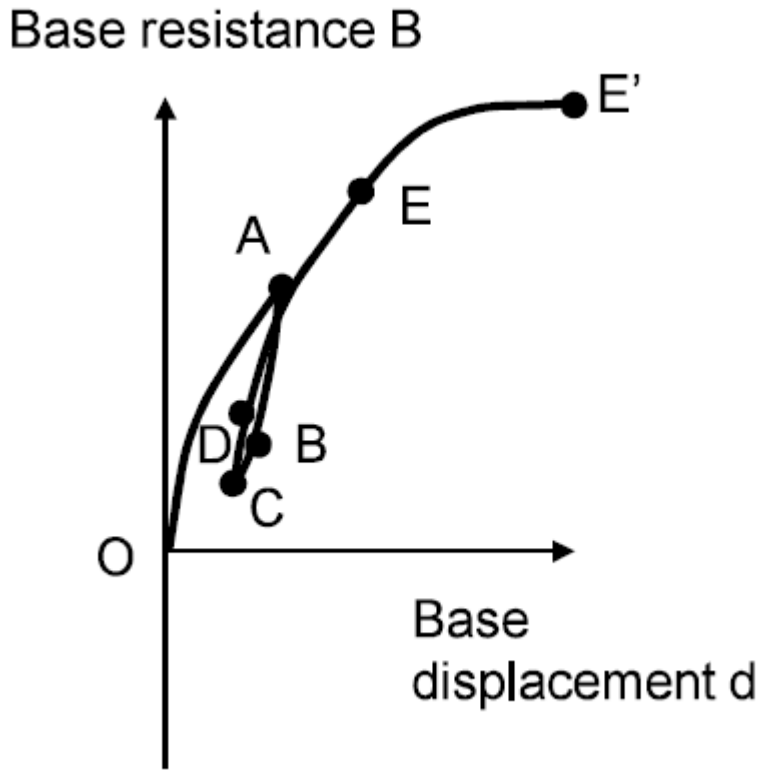
Step 4 : Dewater and Place Reinforced Concrete



Loading and Unloading of Soil Plug

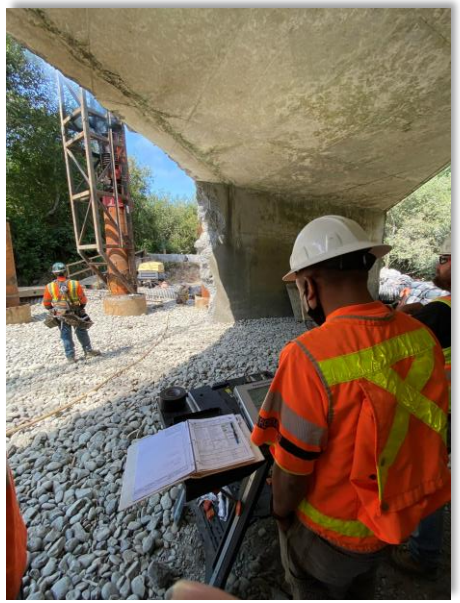


Soga, 2022



Caltrans Acceptance Criteria

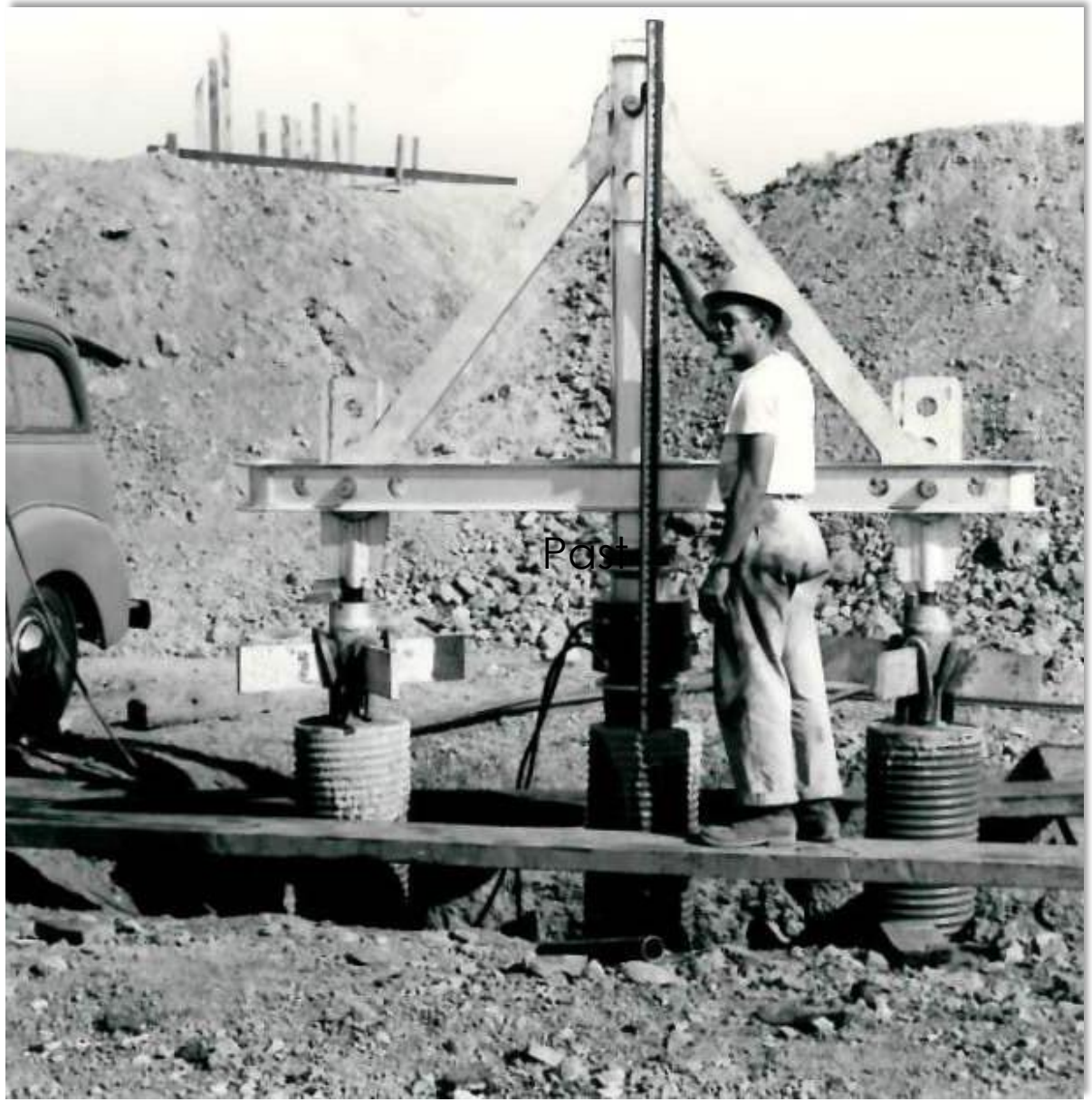
- Pile diameter <18" Mod. Gates Equation.
- Pile diameter ≥ 18" requires dynamic testing.
- Pile diameter > 36" requires dynamic testing and static pile load testing.



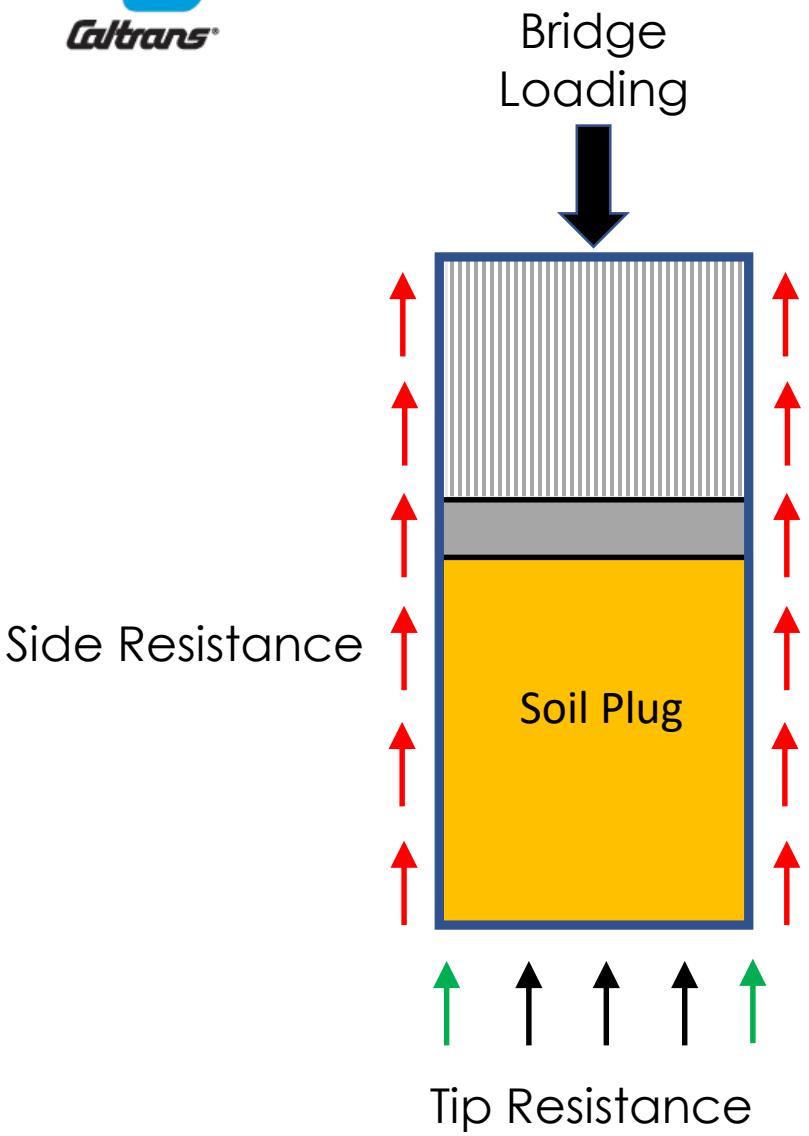

65
PDA


Strain Transducer
&
Accelerometer for
PDA Monitoring

Past



Present



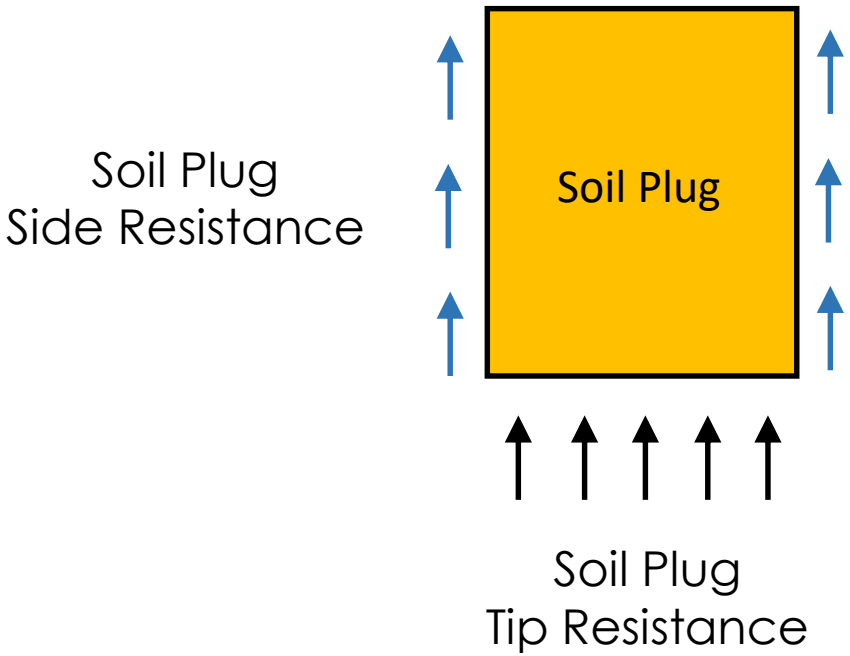
Geotechnical Design of CISS Pile (Caltrans Uses API, 2000 Publication RP 2A)

- Driven steel shell side resistance (↑).
- Tip resistance of steel shell (↑).
- Soil plug tip resistance (↑):

Use the smaller of soil plug tip resistance and Soil plug side resistance.

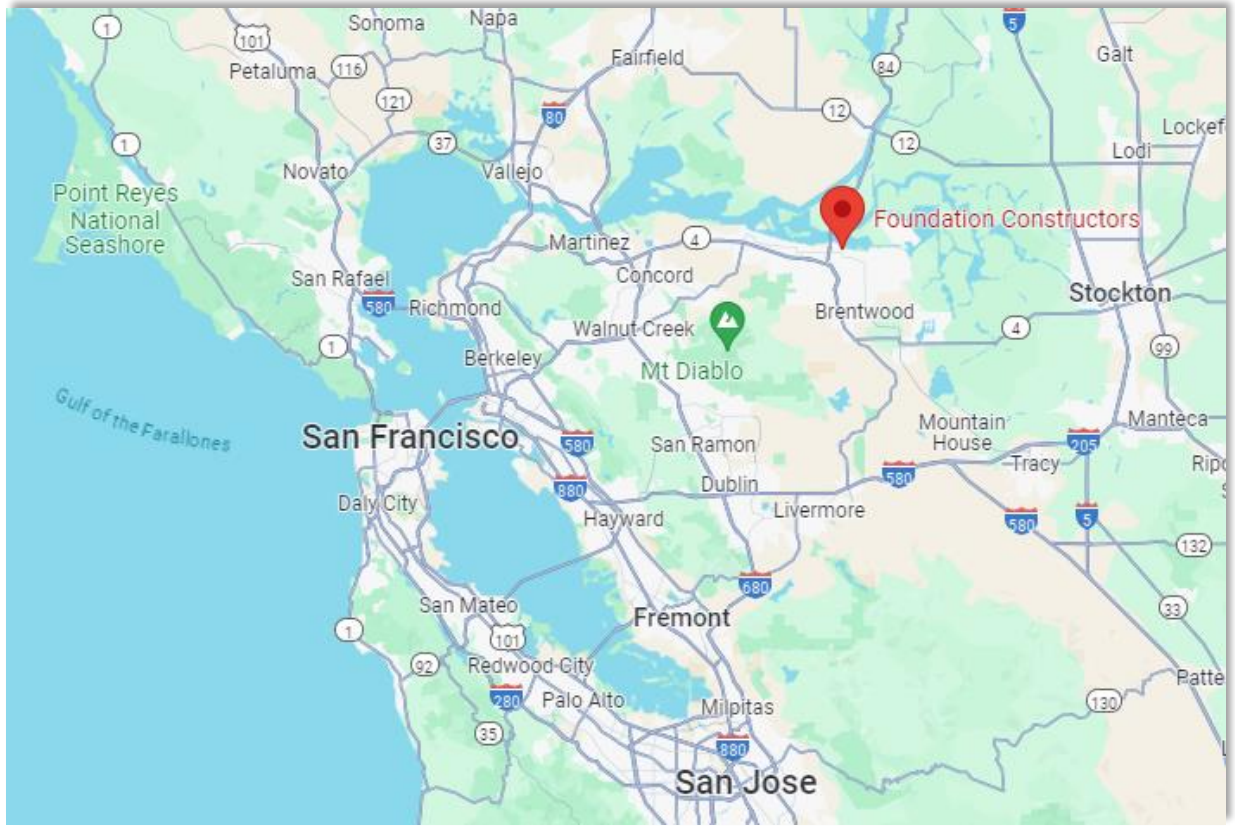
Soil Plug Tip Resistance:

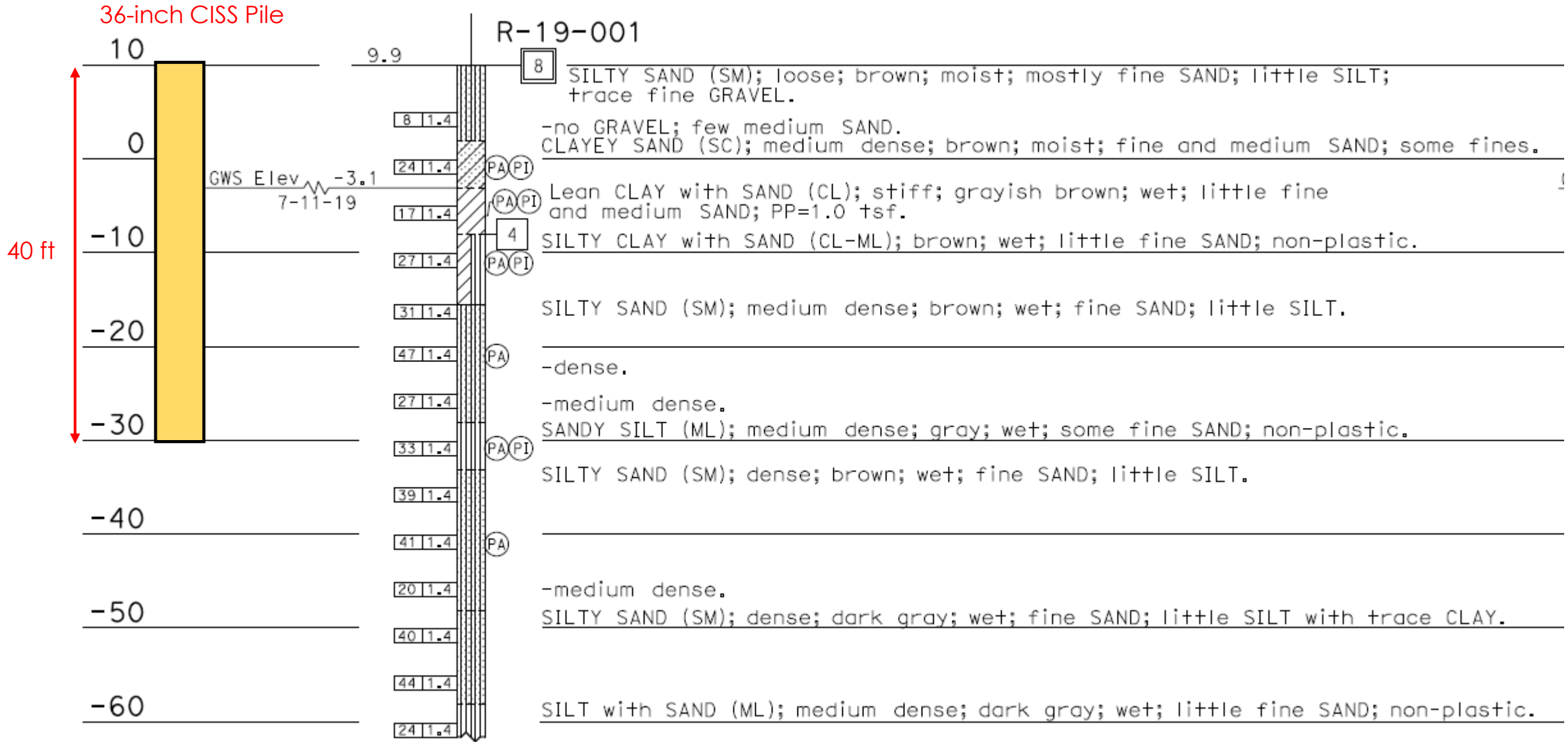
Use the smaller of soil plug tip resistance and Soil plug side resistance.



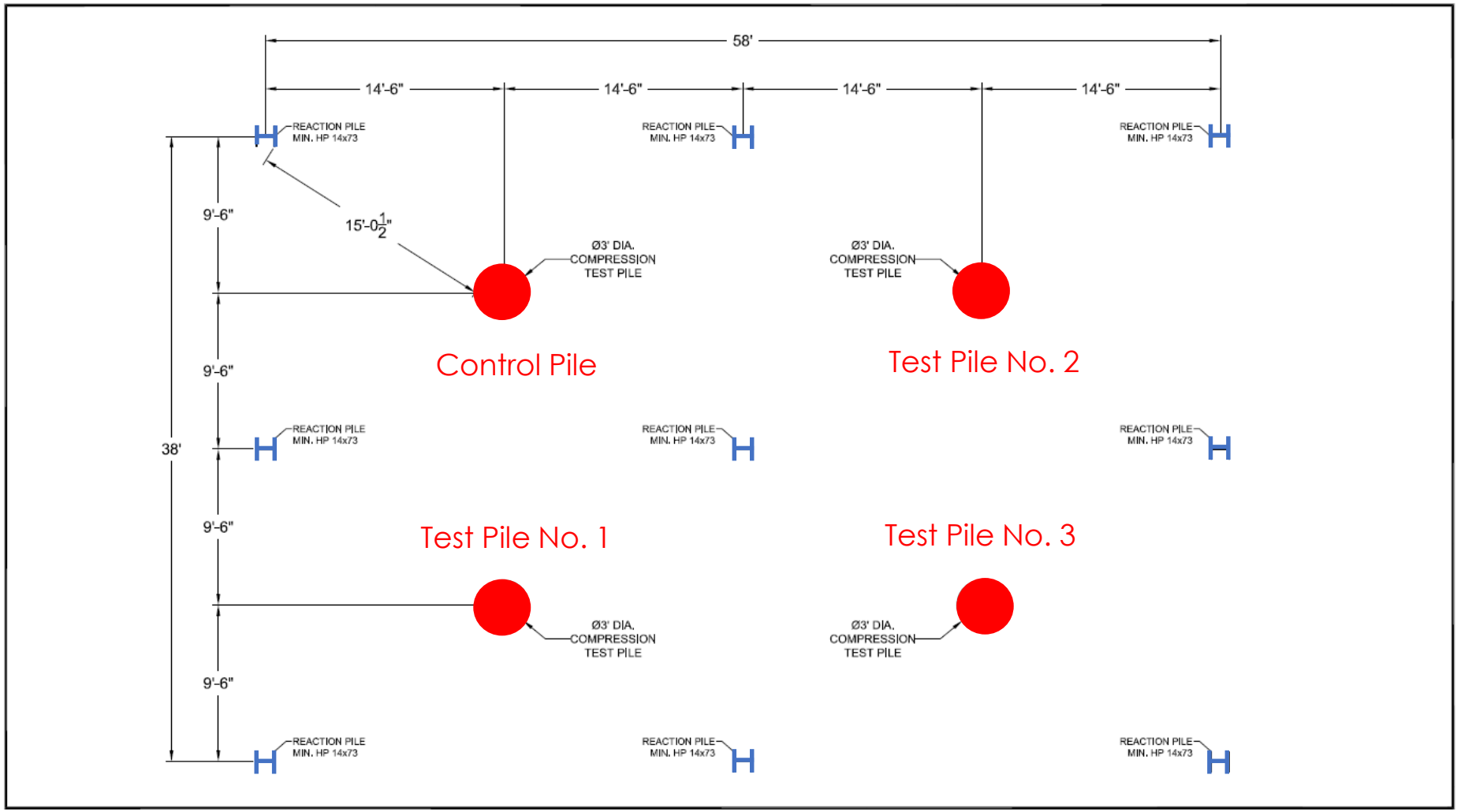
Research: Full Scale Pile Load Testing (8 Total)
36-inch Dia. CISS Piles, 40 ft Long

Test Site: Oakley, CA
At Foundation Constructors, Inc. Facility

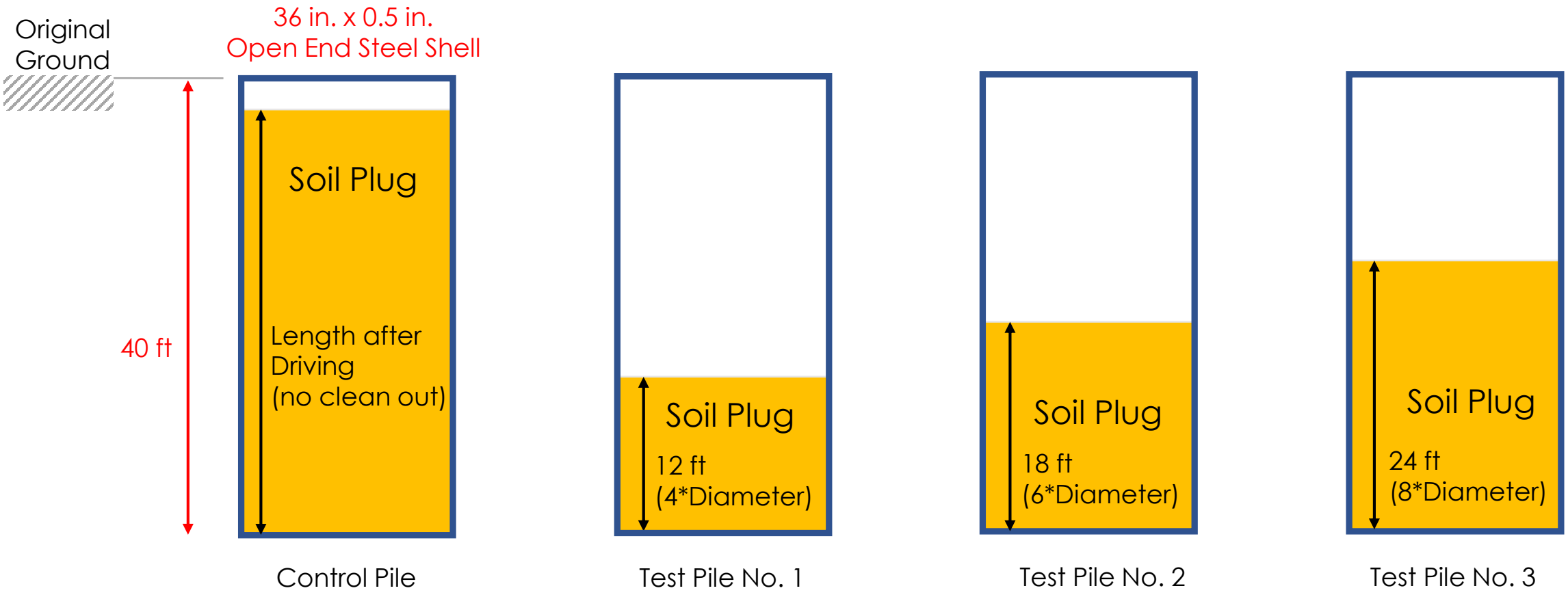



36-inch CISS Pile
40 ft
R-19-001
9.9
10
0
-10
-20
-30
-40
-50
-60
GWS Elev -3.1
7-11-19
8 1.4
24 1.4
17 1.4
27 1.4
31 1.4
47 1.4
27 1.4
33 1.4
39 1.4
41 1.4
20 1.4
40 1.4
44 1.4
24 1.4
PA PI
PA PI
PA PI
PA
PA PI
PA
8
4
SILTY SAND (SM); loose; brown; moist; mostly fine SAND; little SILT; trace fine GRAVEL.
-no GRAVEL; few medium SAND.
CLAYEY SAND (SC); medium dense; brown; moist; fine and medium SAND; some fines.
Lean CLAY with SAND (CL); stiff; grayish brown; wet; little fine and medium SAND; PP=1.0 tsf.
SILTY CLAY with SAND (CL-ML); brown; wet; little fine SAND; non-plastic.
SILTY SAND (SM); medium dense; brown; wet; fine SAND; little SILT.
-dense.
-medium dense.
SANDY SILT (ML); medium dense; gray; wet; some fine SAND; non-plastic.
SILTY SAND (SM); dense; brown; wet; fine SAND; little SILT.
-medium dense.
SILTY SAND (SM); dense; dark gray; wet; fine SAND; little SILT with trace CLAY.
SILT with SAND (ML); medium dense; dark gray; wet; little fine SAND; non-plastic.

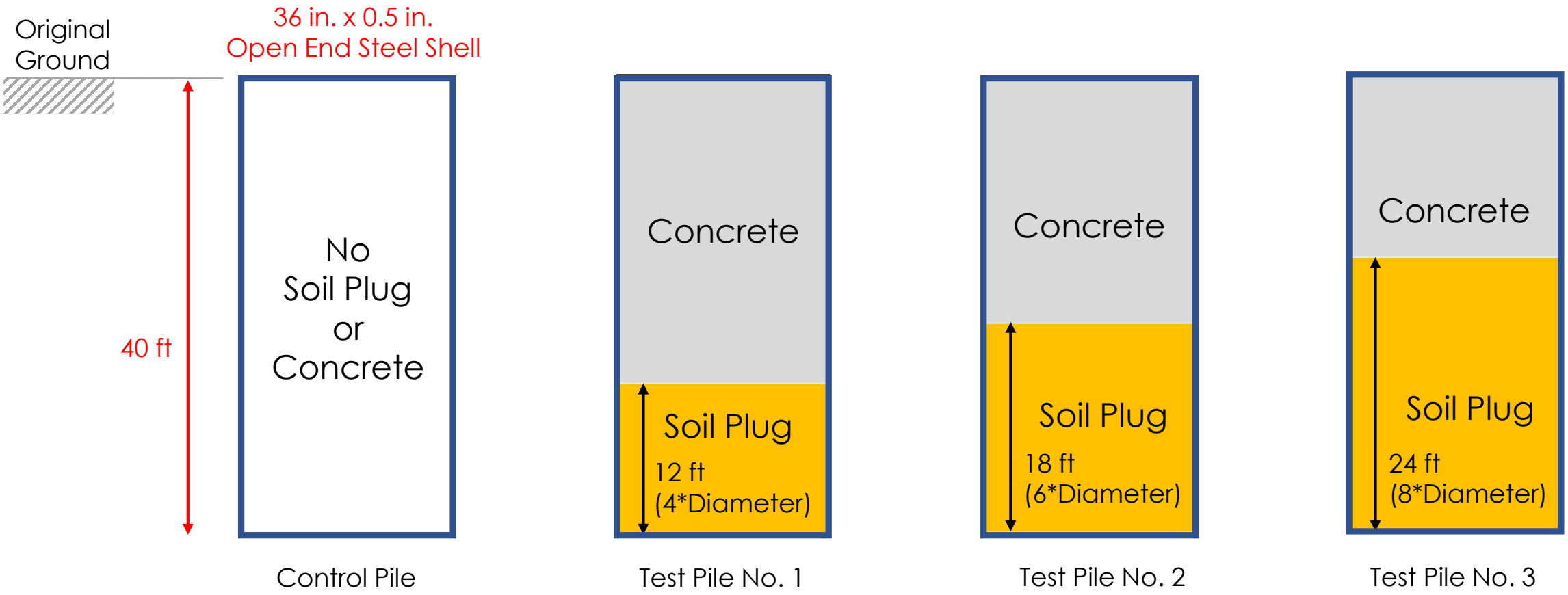
Research: Full Scale Pile Load Testing



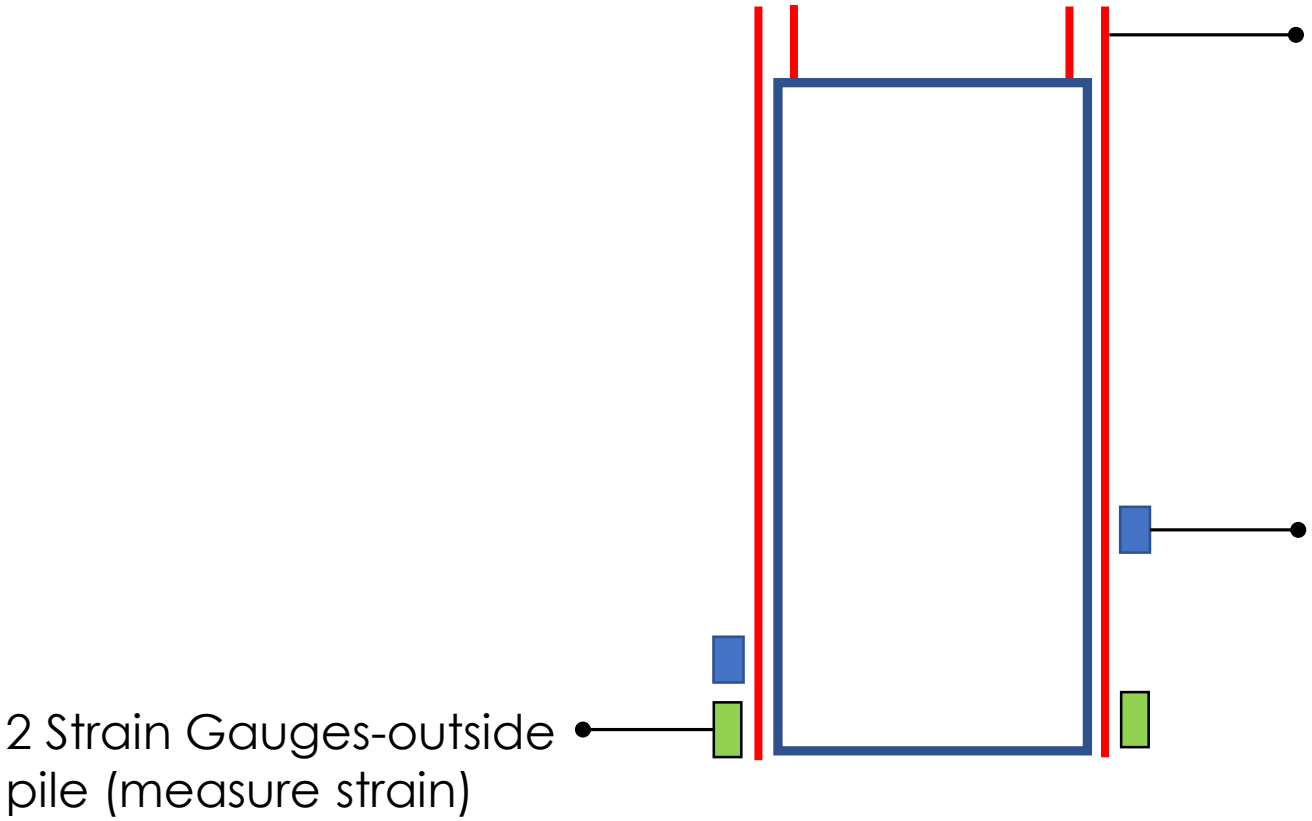
Perform Static Compression Pile Load Testing
Stage-1: with Soil Plug Only



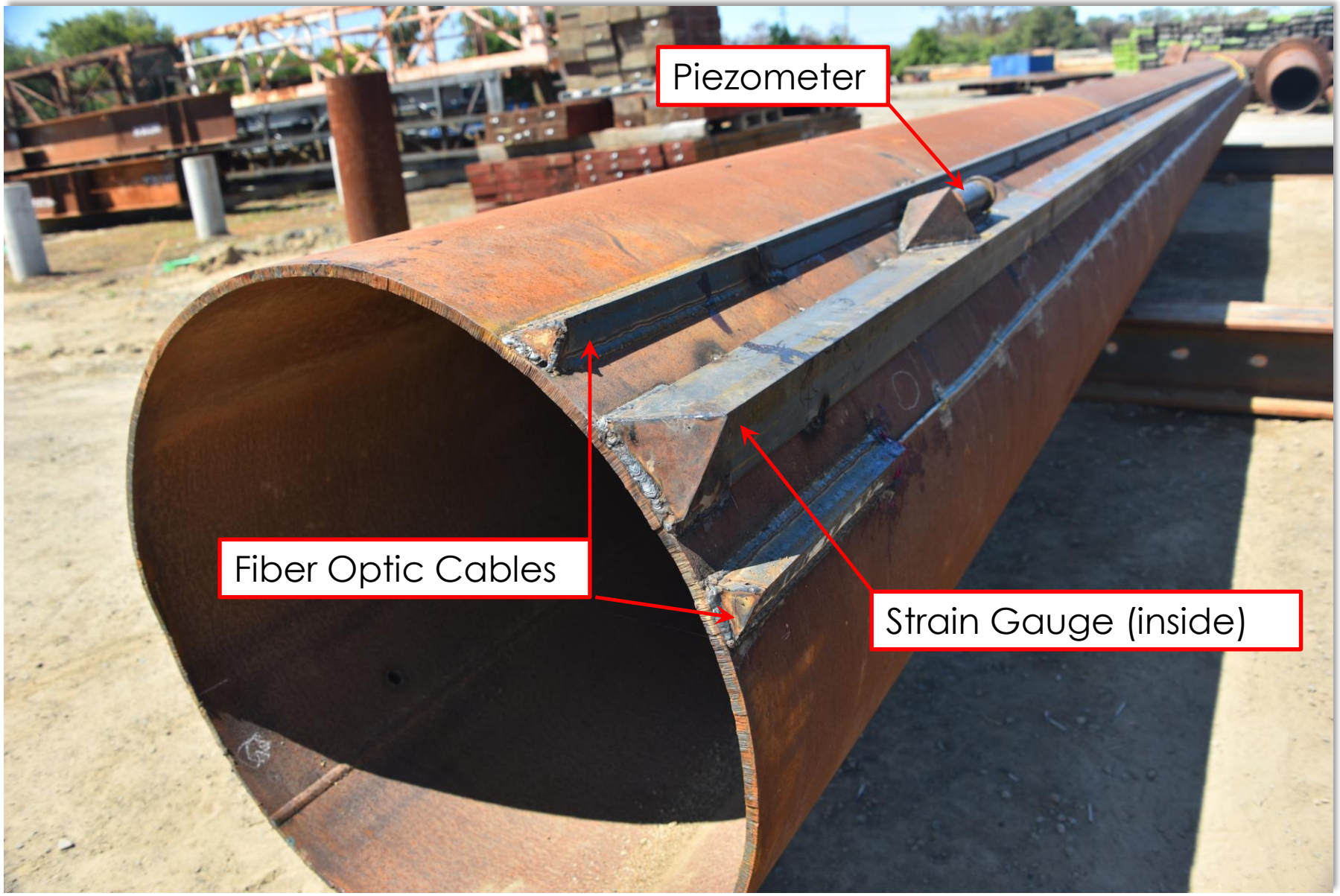
Perform Static Compression Pile Load Testing Stage-2: with Soil Plug and Concrete (Control Pile Has No Soil Plug/Concrete Inside)



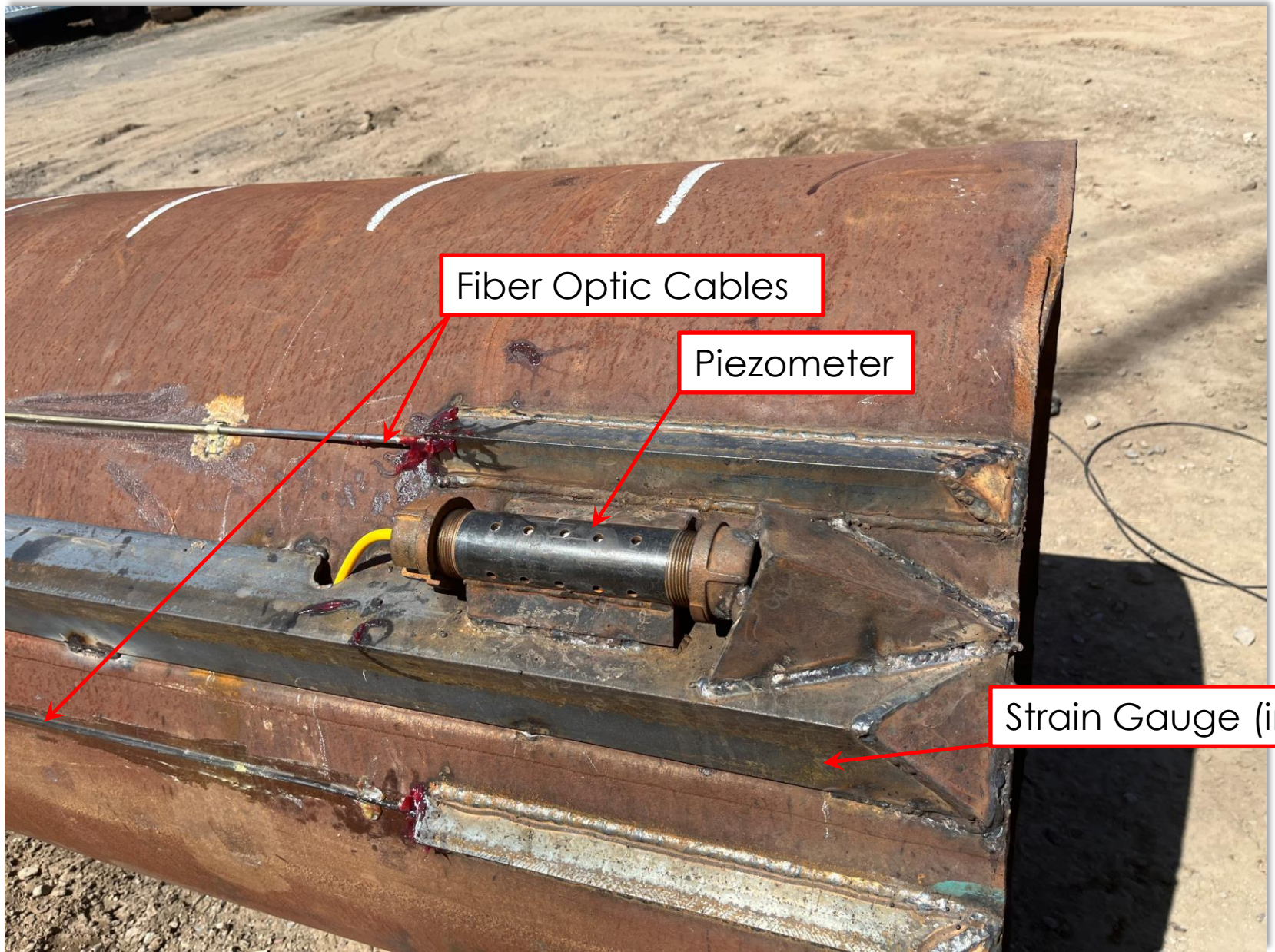
Instrumentation of Control CISS Pile



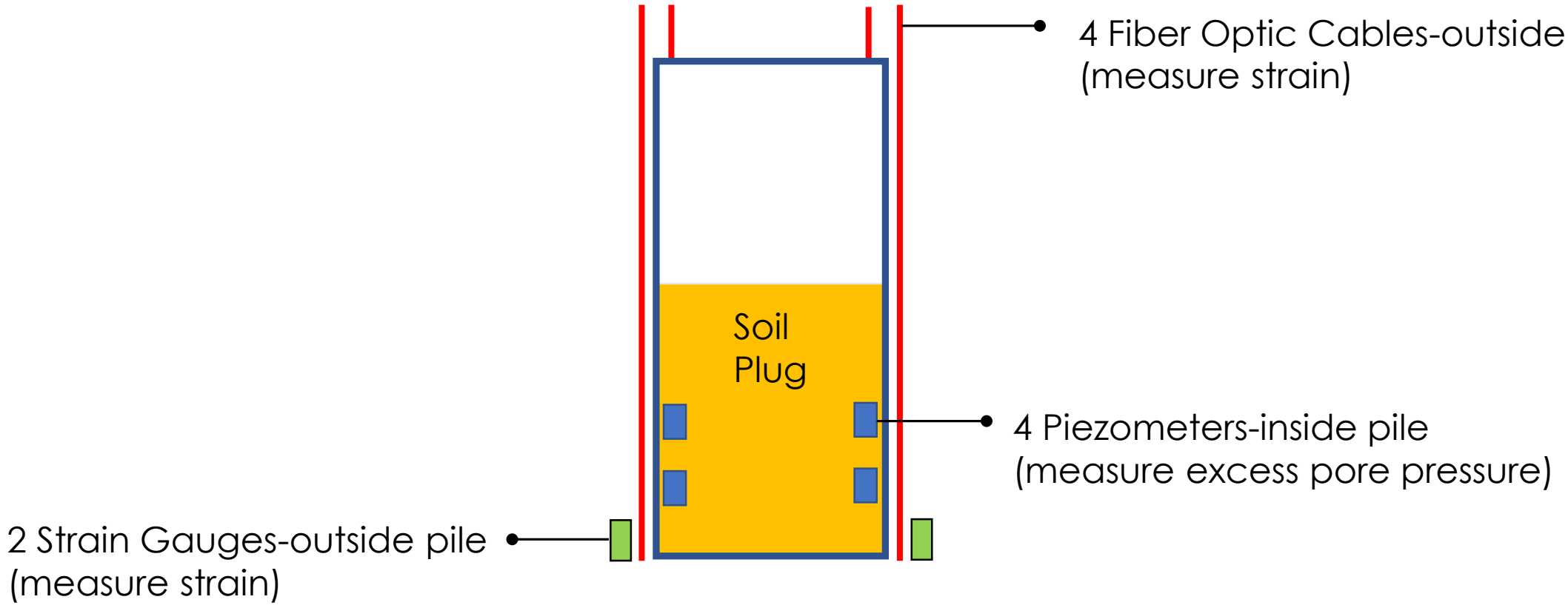
Instrumentation of Control CISS Pile



Instrumentation of Control CISS Pile



Instrumentation of Test CISS Pile



Instrumentation of Test CISS Pile

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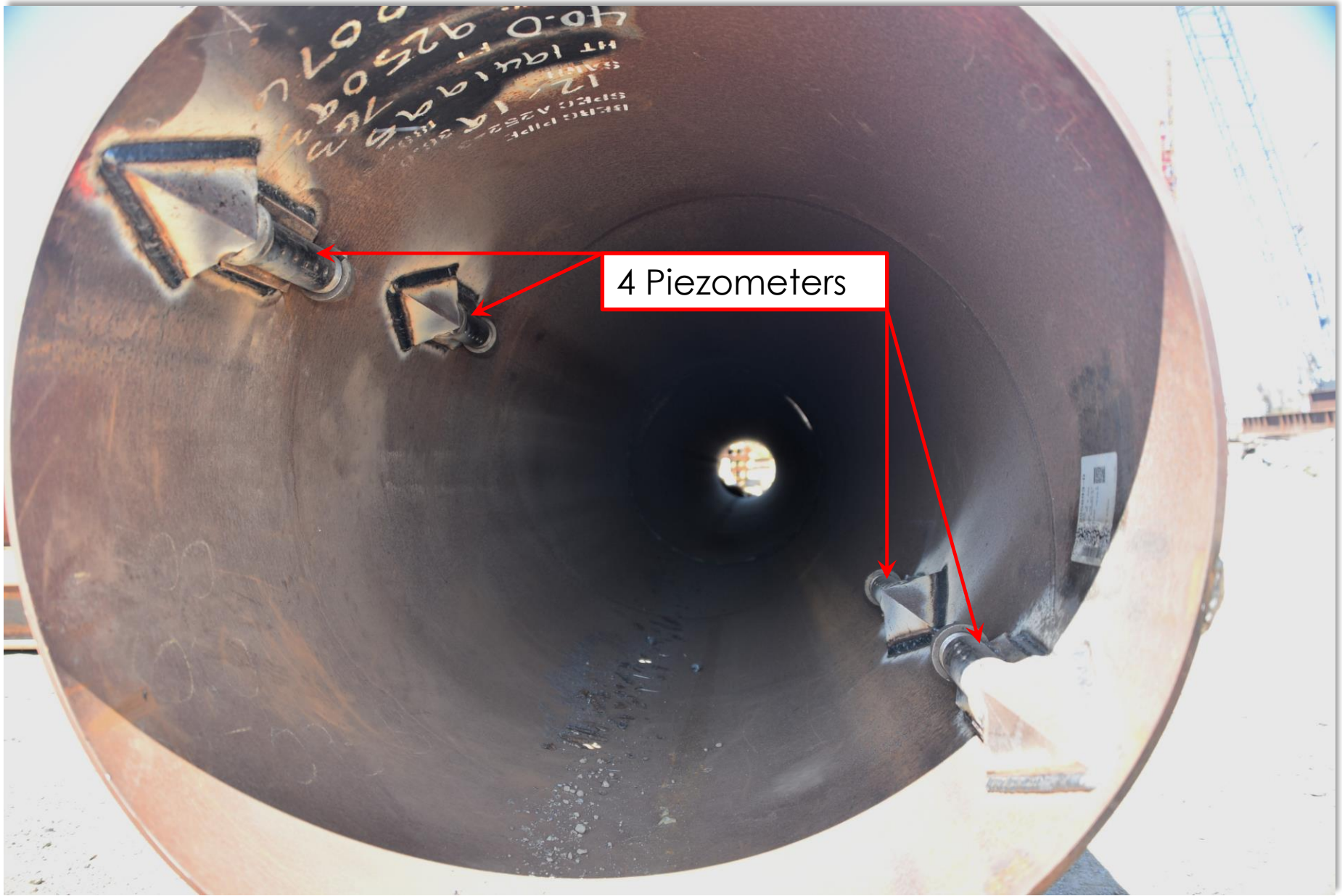
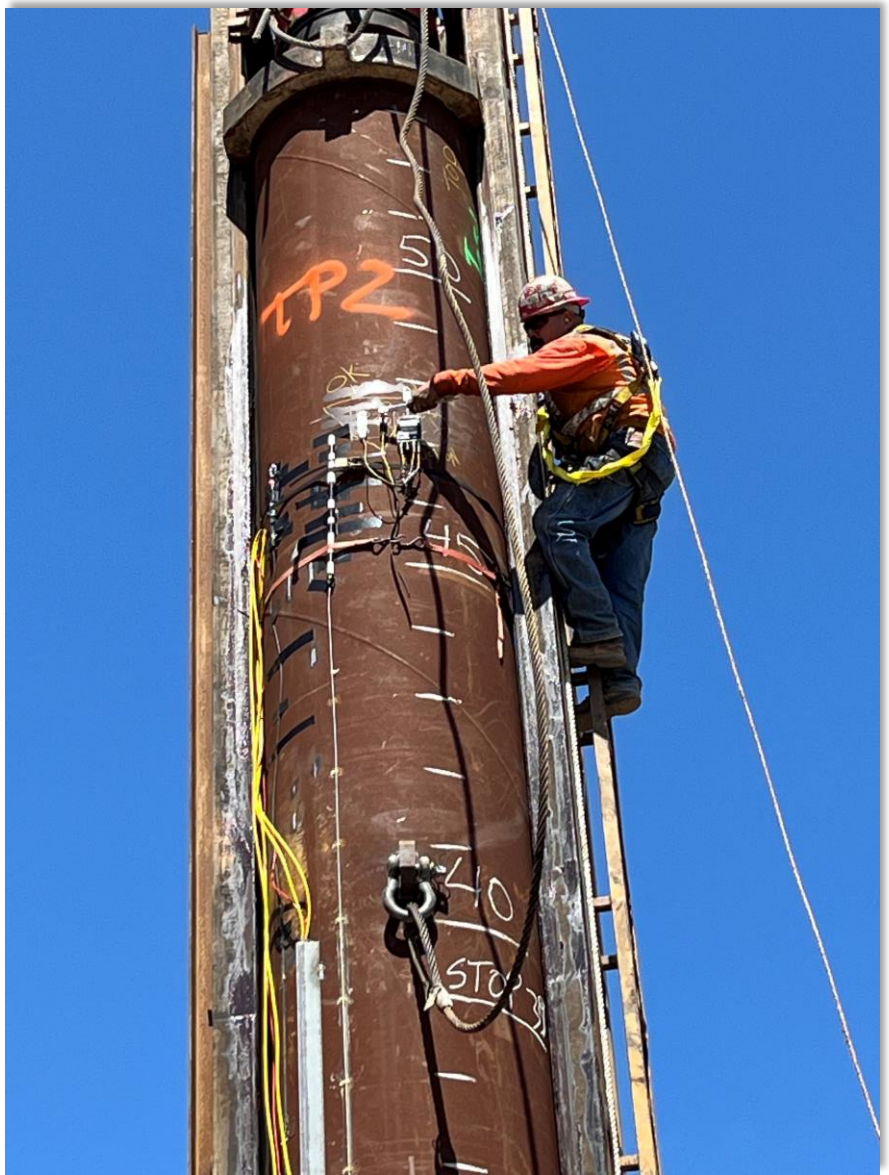
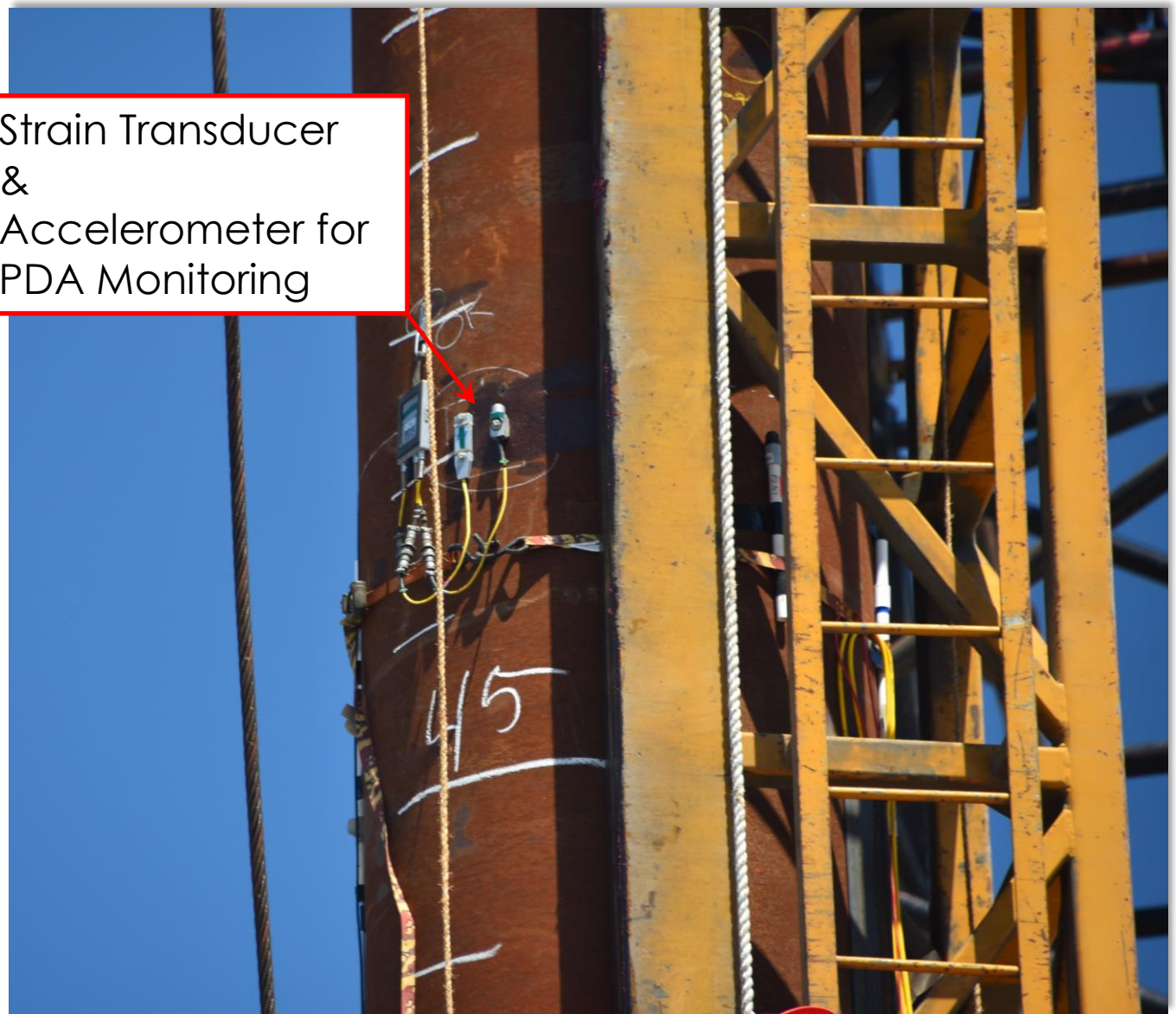


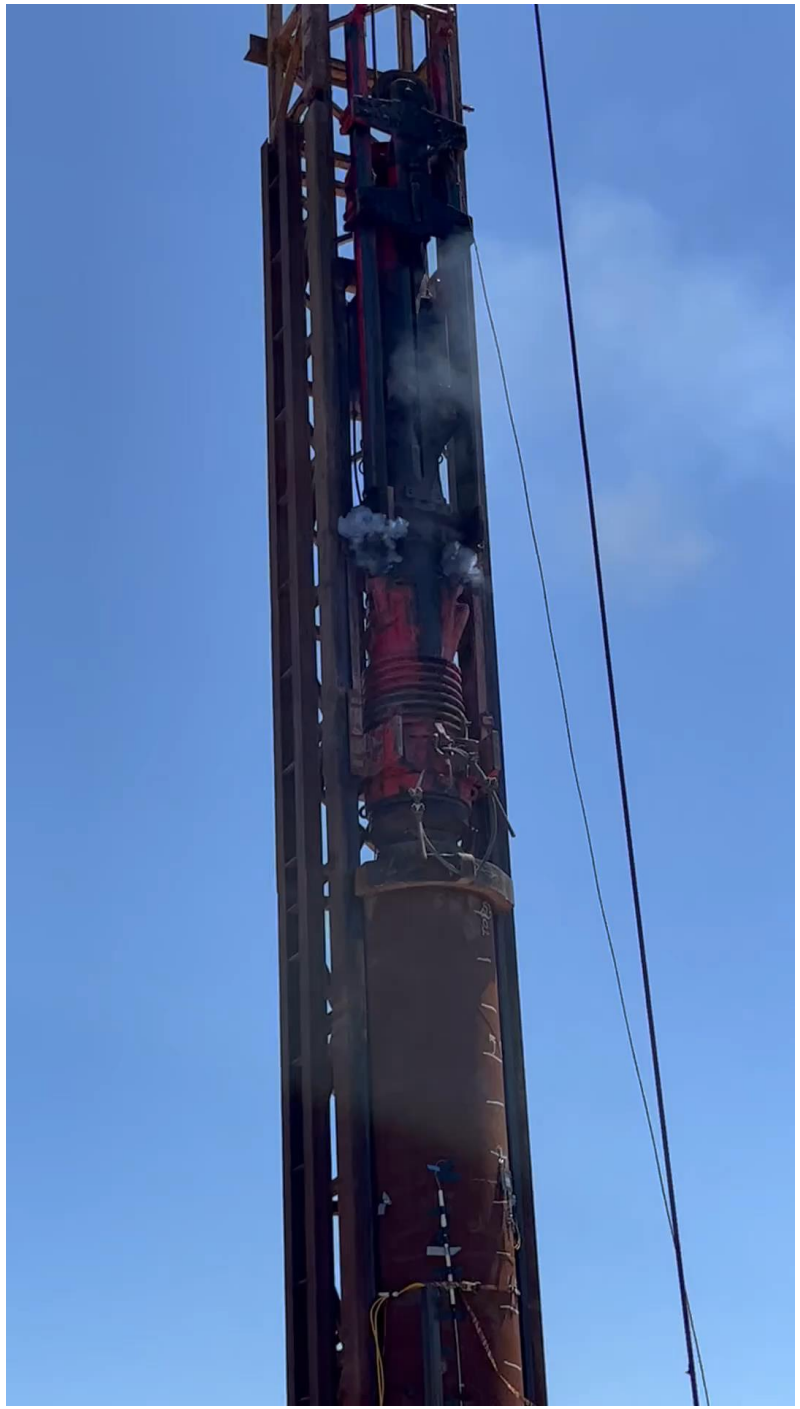
Instrumentation for PDA Monitoring



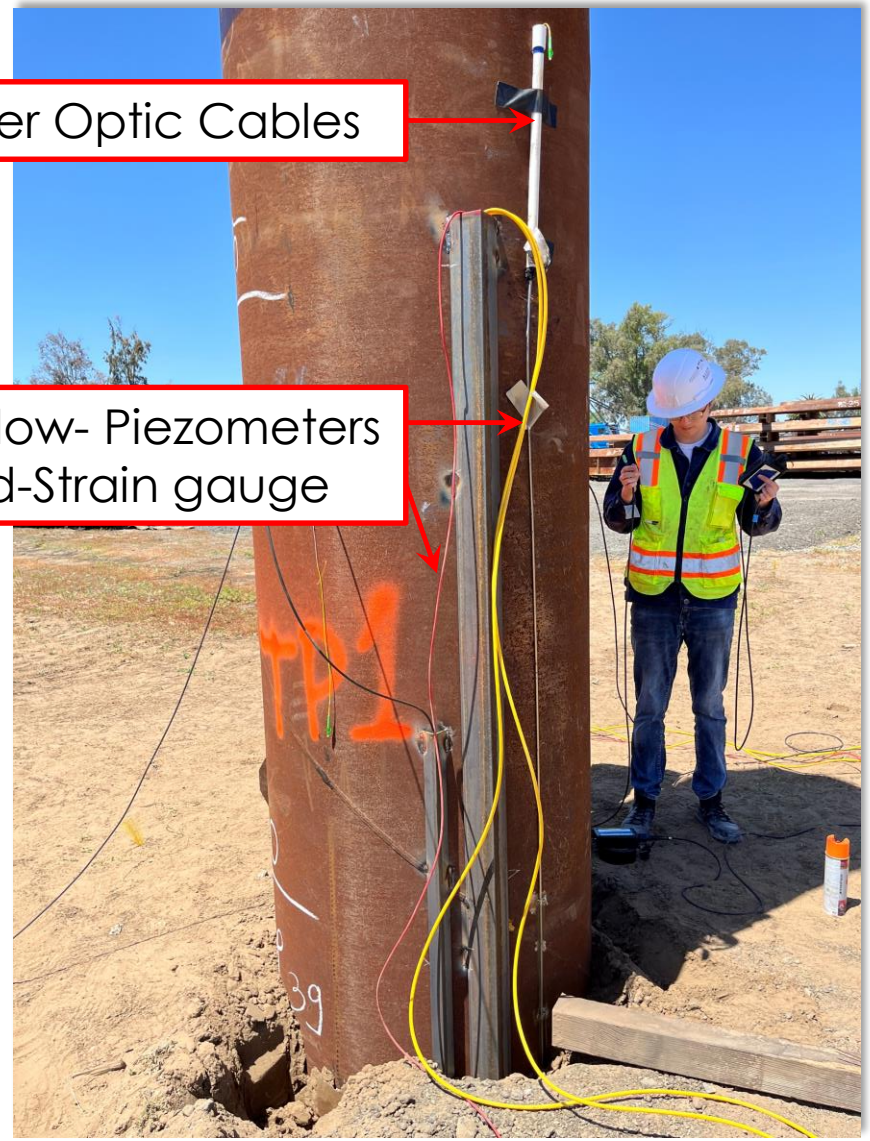


Driving Steel Shells
5/7/2024

Delmag D46-32
Single Acting
Diesel Pile Hammer



Instrumentation Cables



First Pile Load Test on May 20, 2024
Stage-1 Control Pile

For the next 3 weeks:

- Complete Stage-1 pile load tests.
- Excavate out soil plugs for the piles.
- Place concrete inside test piles
- Perform Stage-2 pile load tests.