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Restore | Repurpose | Renew

2025 SPRING CONVENTION

AUSTIN, TEXAS • APRIL 13 – 16, 2025

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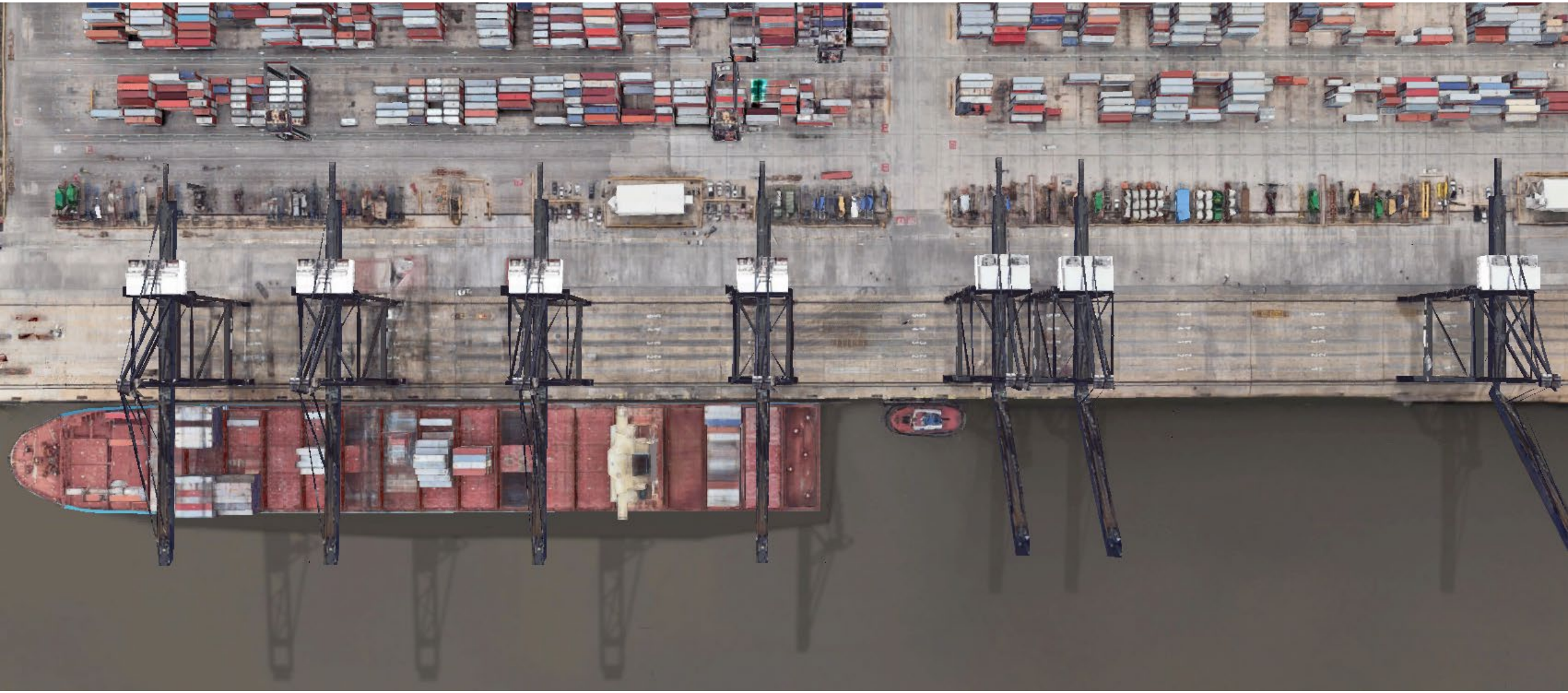
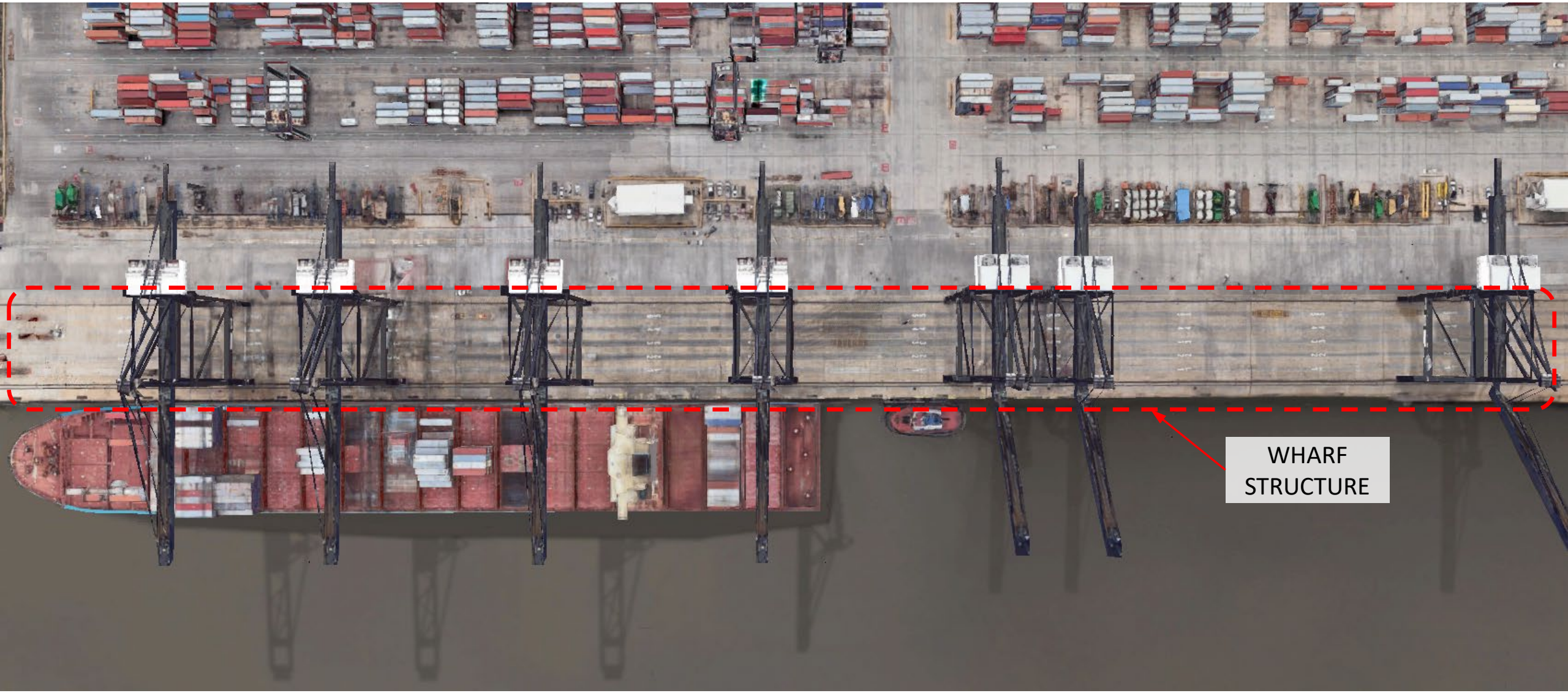
NAVIGATING CHALLENGES IN WHARF PILE REHABILITATION

Esteban Zecchin, PhD, EIT
Staff Engineer
Pivot Engineers

The Project




WHARF
STRUCTURE

TEXAS
LONGHORNS
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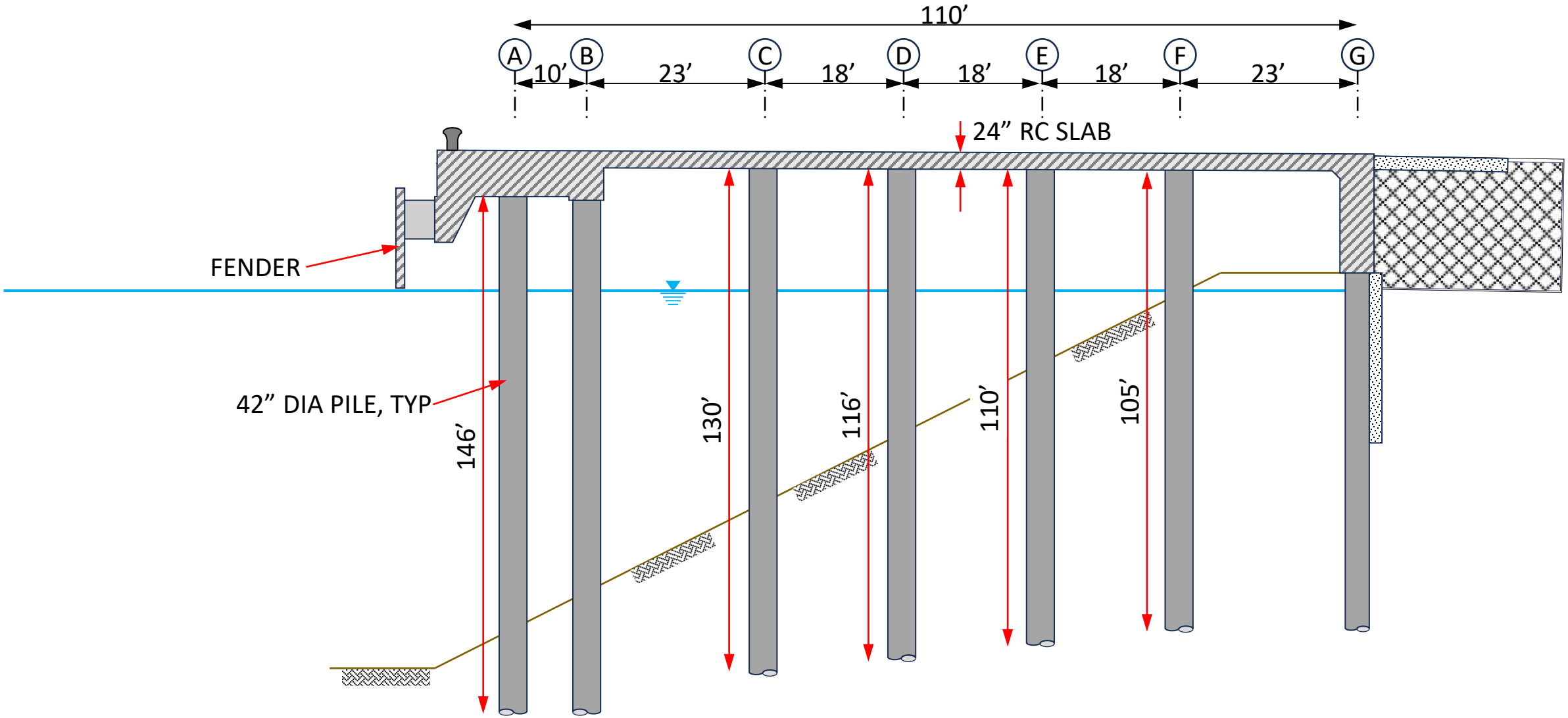
LONGHORNS
TEXAS
LONGHORNS

Wharf Structure Overview



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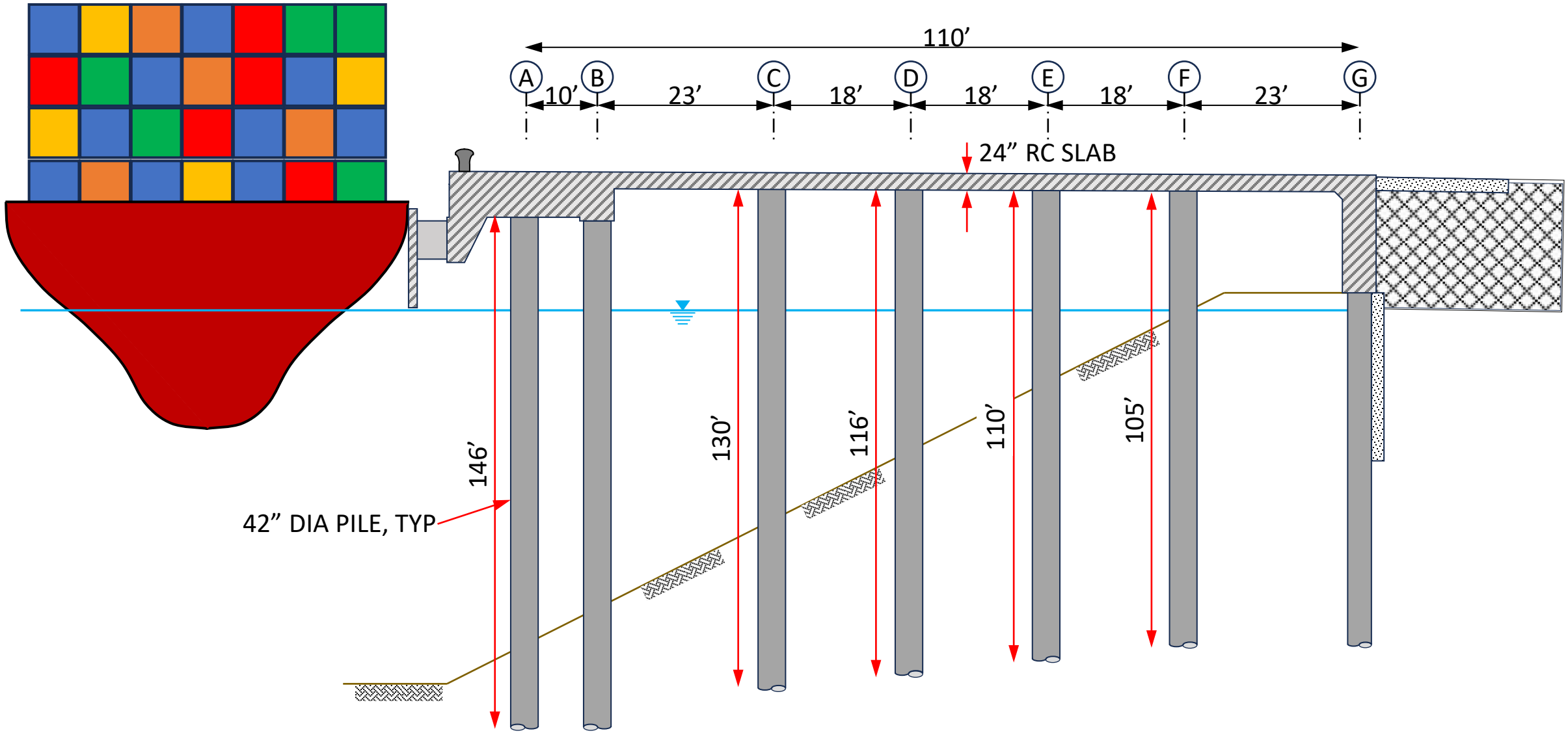
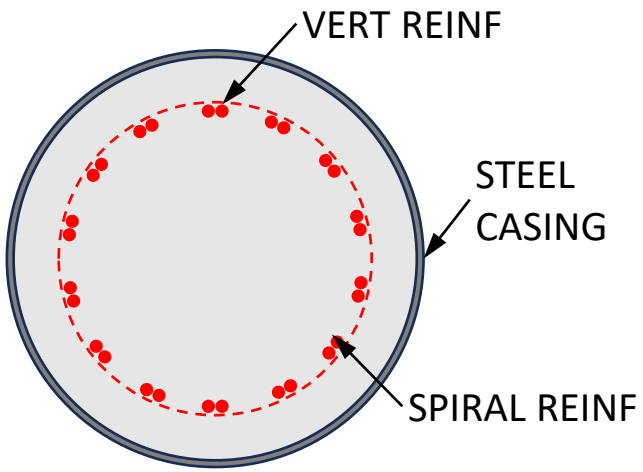
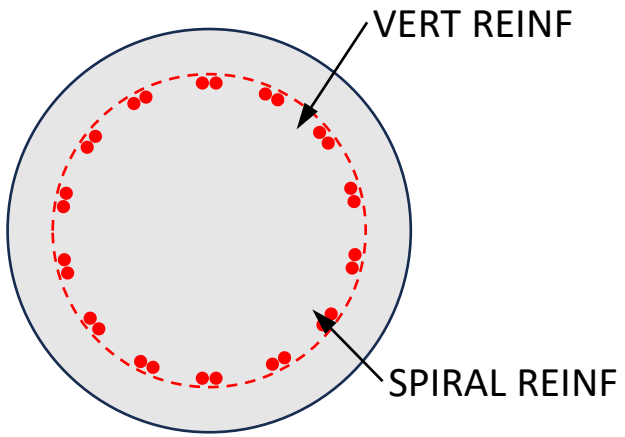


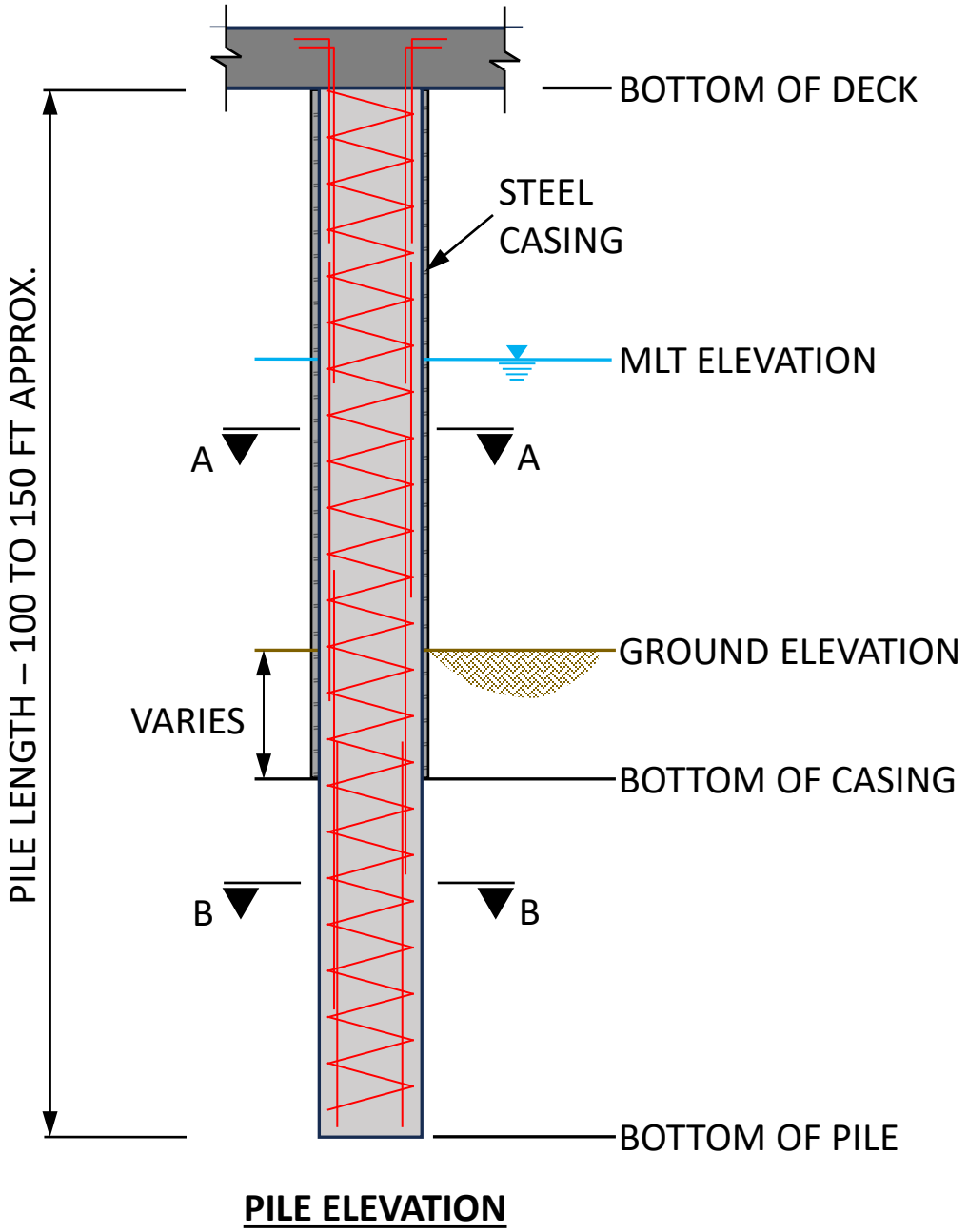
Pile Details



SECTION A-A



SECTION B-B



PILE ELEVATION

Pile Construction – Tremie Method

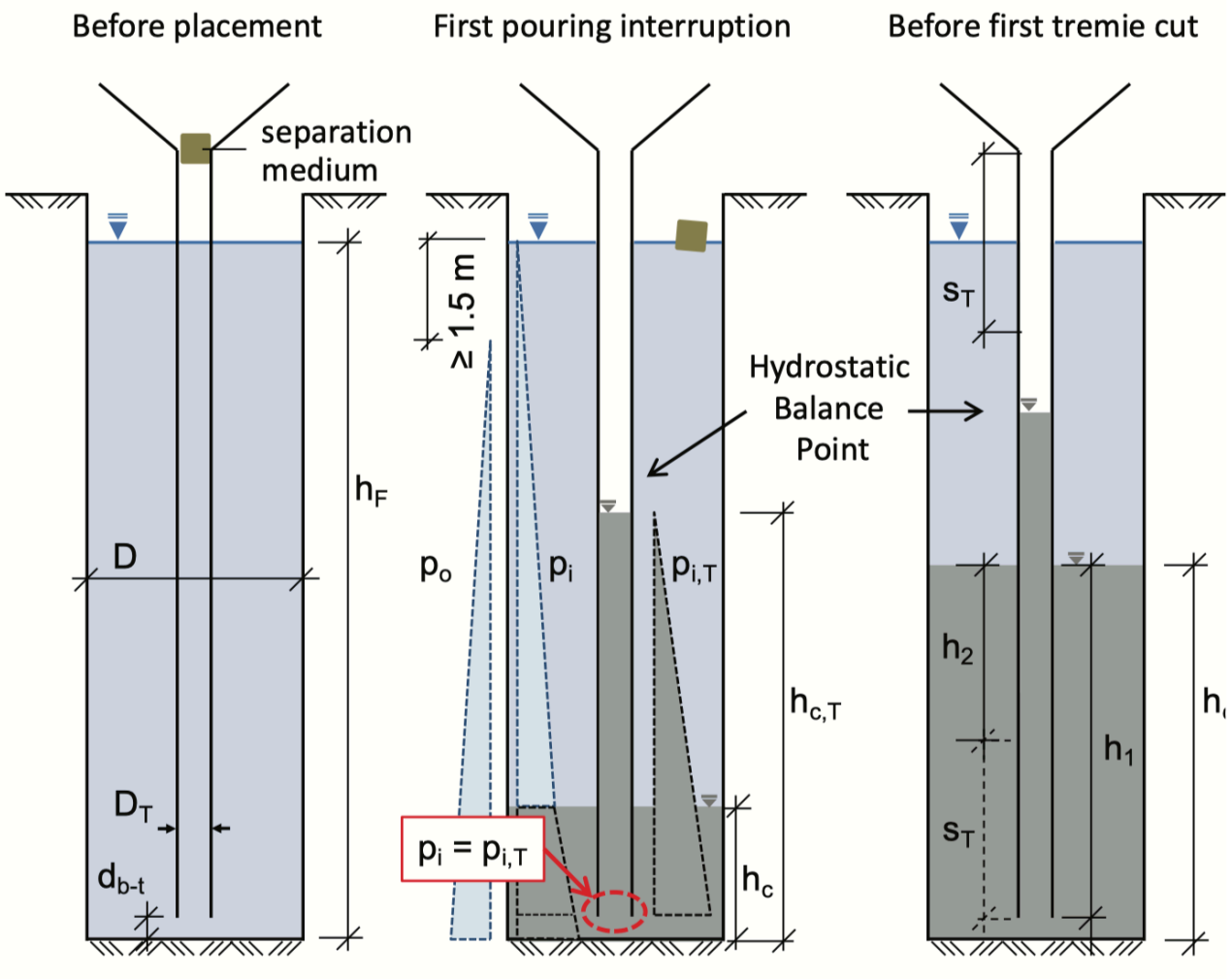


Figure from Guide to Tremie Concrete for Deep Foundations, 2nd Edition, EFFC[1]/DFI[2] Concrete Task Group (2018)
[1]European Federation of Foundation Contractors, [2]Deep Foundations Institute

Pile Construction – Tremie Method

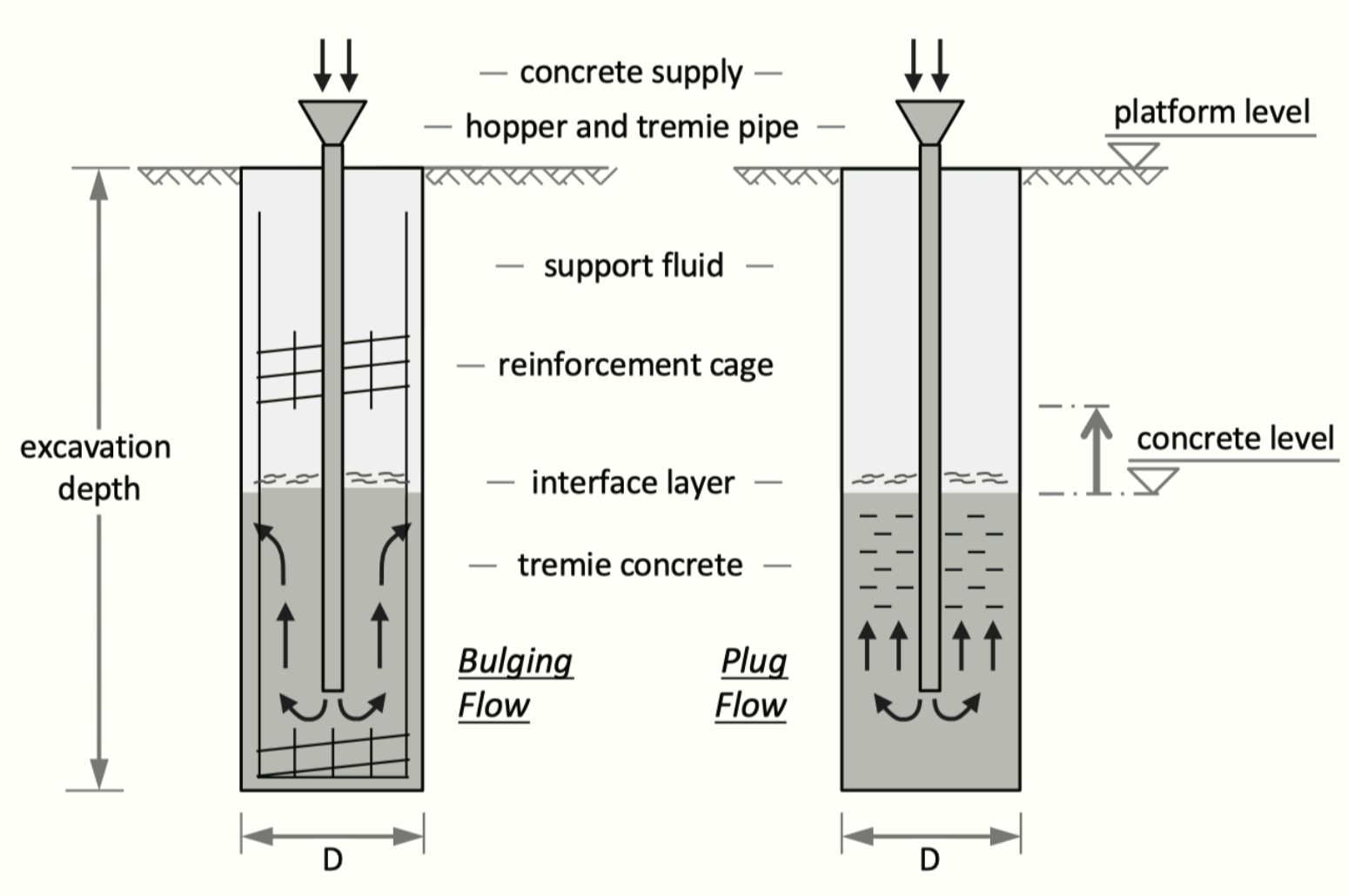


Figure from Guide to Tremie Concrete for Deep Foundations, 2nd Edition, EFFC[1]/DFI[2] Concrete Task Group (2018)
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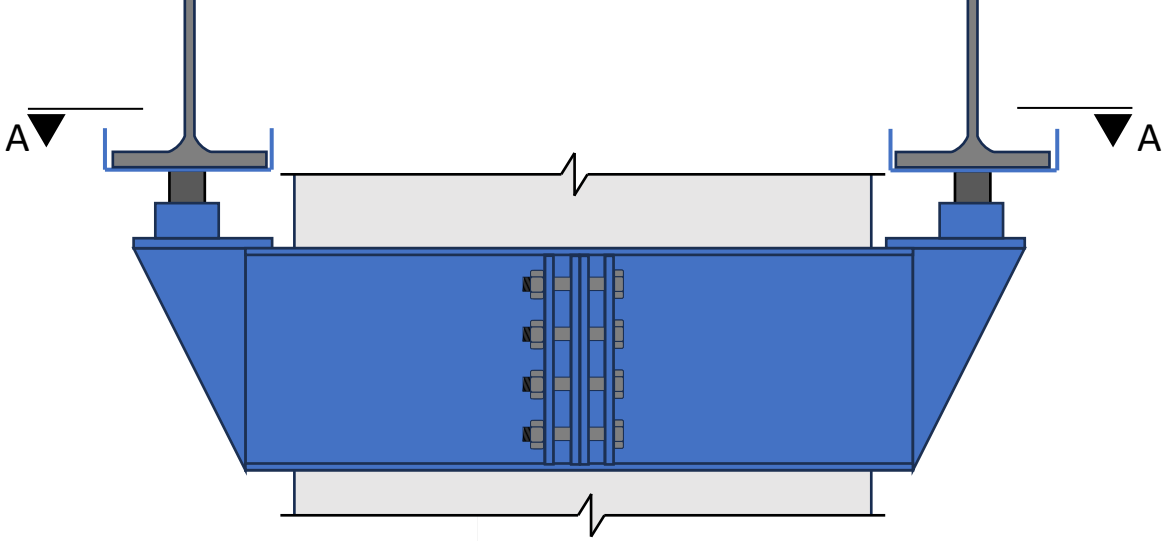
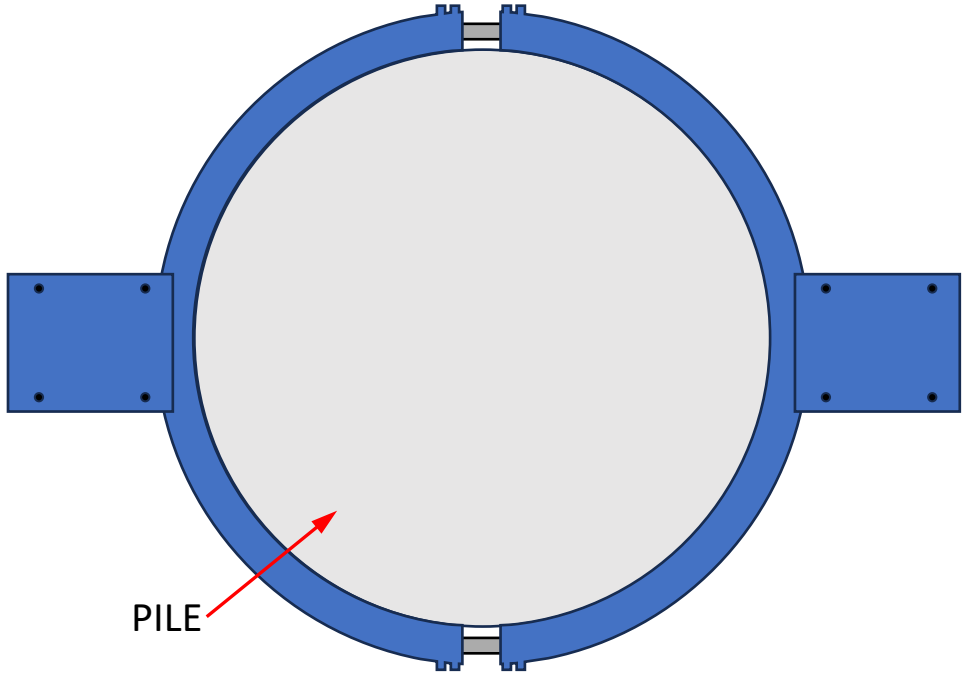
Deck Construction



ELEVATION



SECTION A-A

Deck Construction

The Issues


“SOFT” CONCRETE


F4.


F14

The Process

The Process

1. Identify potential causes for the soft concrete
2. Determine extents of soft concrete
3. Define need for repairs for each pile

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1. Identify potential causes for the soft concrete
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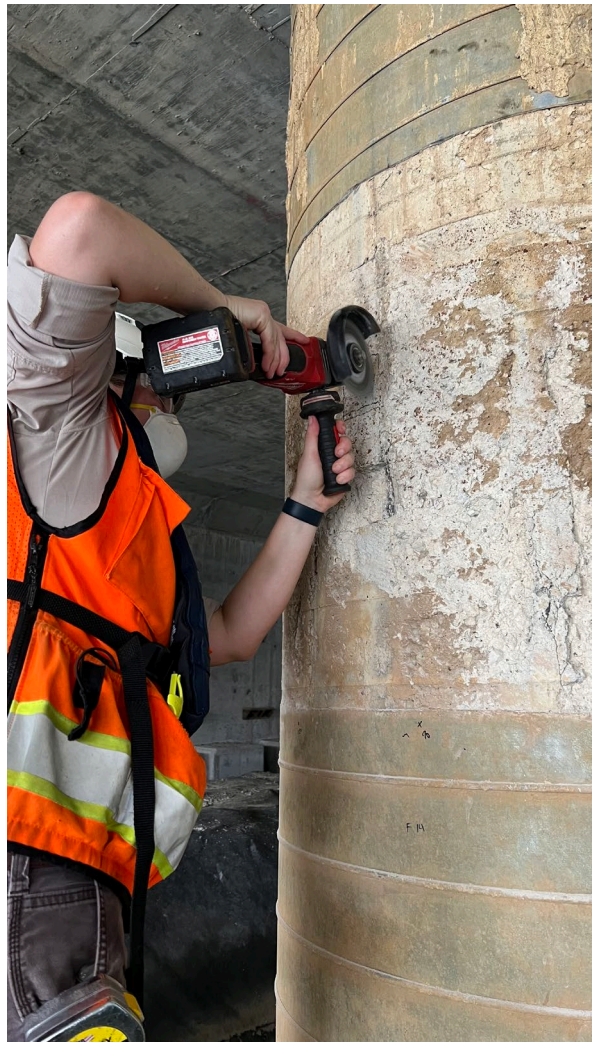
Potential Causes

- Petrographic Testing (X-Ray Diffraction)

"…a trace amount of montmorillonite (smectite) and fly ash pozzolan were documented in the samples which suggests a minor presence of both bentonite and concrete components, respectively, in the samples. Smectite is the main component of the bentonite product and not otherwise expected in the concrete."

Petrographic Test Report



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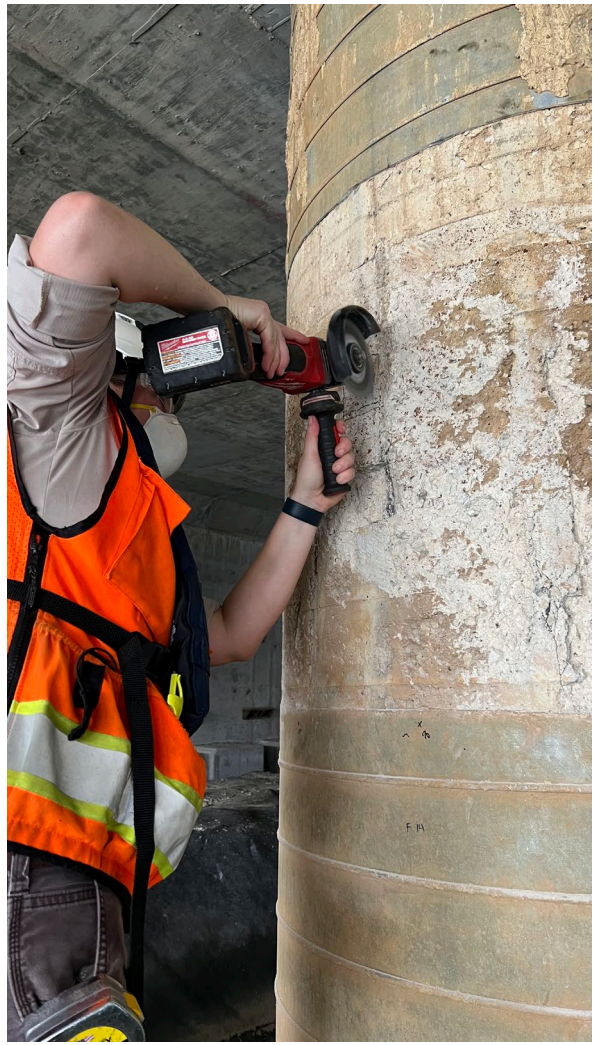

The Process

1. Identify potential causes for the soft concrete

2. Determine extents of soft concrete

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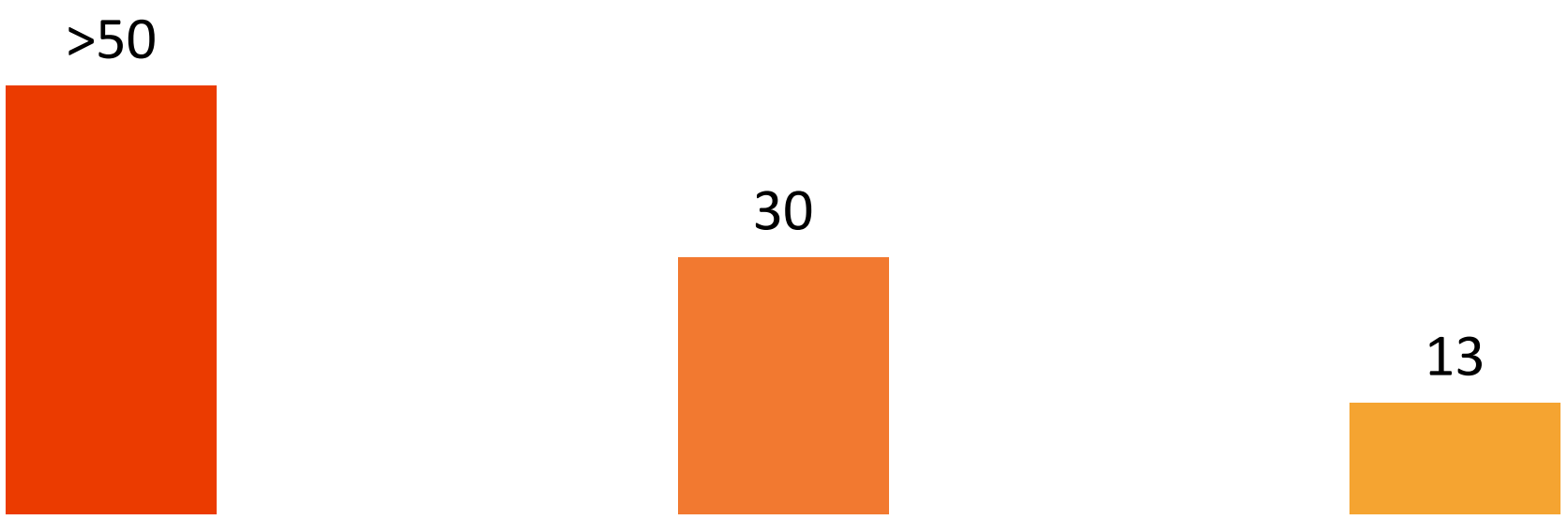
Rebound Hammer Test (ASTM C805)

- Spring-loaded hammer impacts the concrete surface with a predetermined amount of energy
- Assess in-place concrete uniformity, delineate regions of poorer quality, and estimate in-place strength
- Correlated with core strengths at corresponding locations


>50
30
13
Rebound Numbers

Ultrasonic Pulse-Velocity – UPV (ASTM C597)

- Evaluate quality and integrity of concrete, and identify defects
- Sends sound waves through the material being tested

$$Wave\ Velocity = \frac{Distance\ Traveled}{Travel\ Time}$$

- Velocity is related to the modulus of elasticity (E), the Poisson's ratio (ν), and the density (δ)

4100 m/s

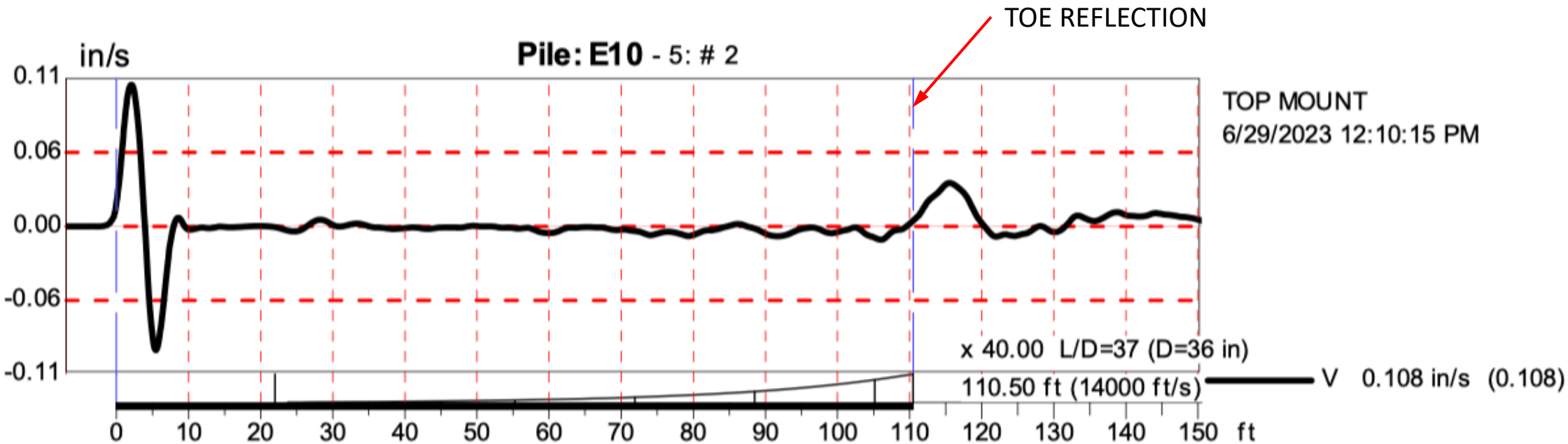
3800 m/s

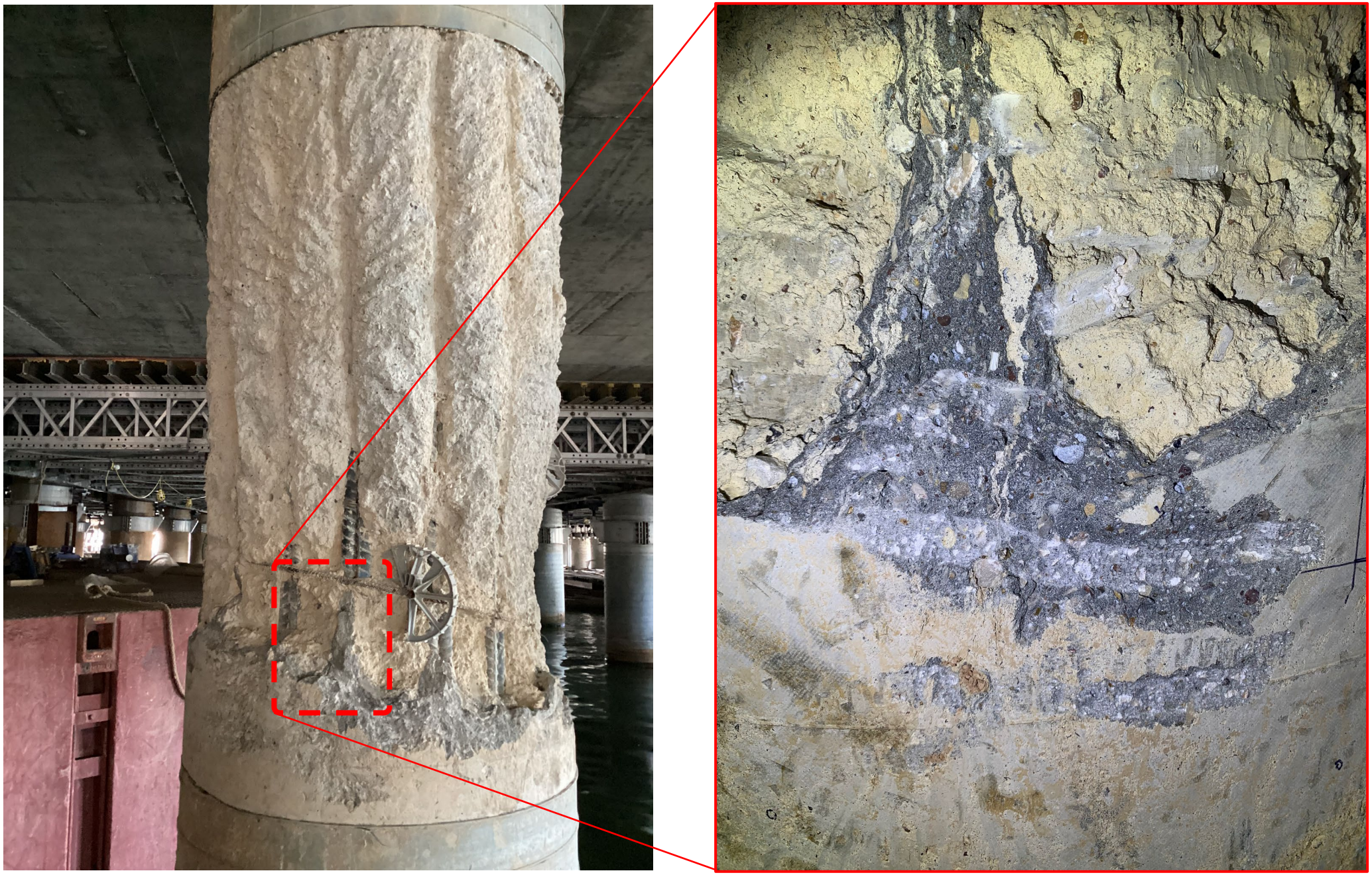
Wave Velocity

PILE INTEGRITY TESTING

PILE INTEGRITY TESTING

PILE INTEGRITY TESTING


TOE REFLECTION
in/s
Pile: E10 - 5: # 2
0.11
0.06
0.00
-0.06
-0.11
TOP MOUNT
6/29/2023 12:10:15 PM
x 40.00 L/D=37 (D=36 in)
110.50 ft (14000 ft/s)
V 0.108 in/s (0.108)
0 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 ft




FLEXIFLOAT


F14


F40

Live Content Slide

When playing as a slideshow, this slide will display live content

Poll: What non-destructive test methods were used to investigate the extent of unsound concrete?

The Process

1. Identify potential causes for the soft concrete

2. Determine extents of soft concrete

3. Define need for repairs for each pile

Repair implementation

LEVEL 1 REPAIRS

LEVEL 2 REPAIRS

LEVEL 3 REPAIRS

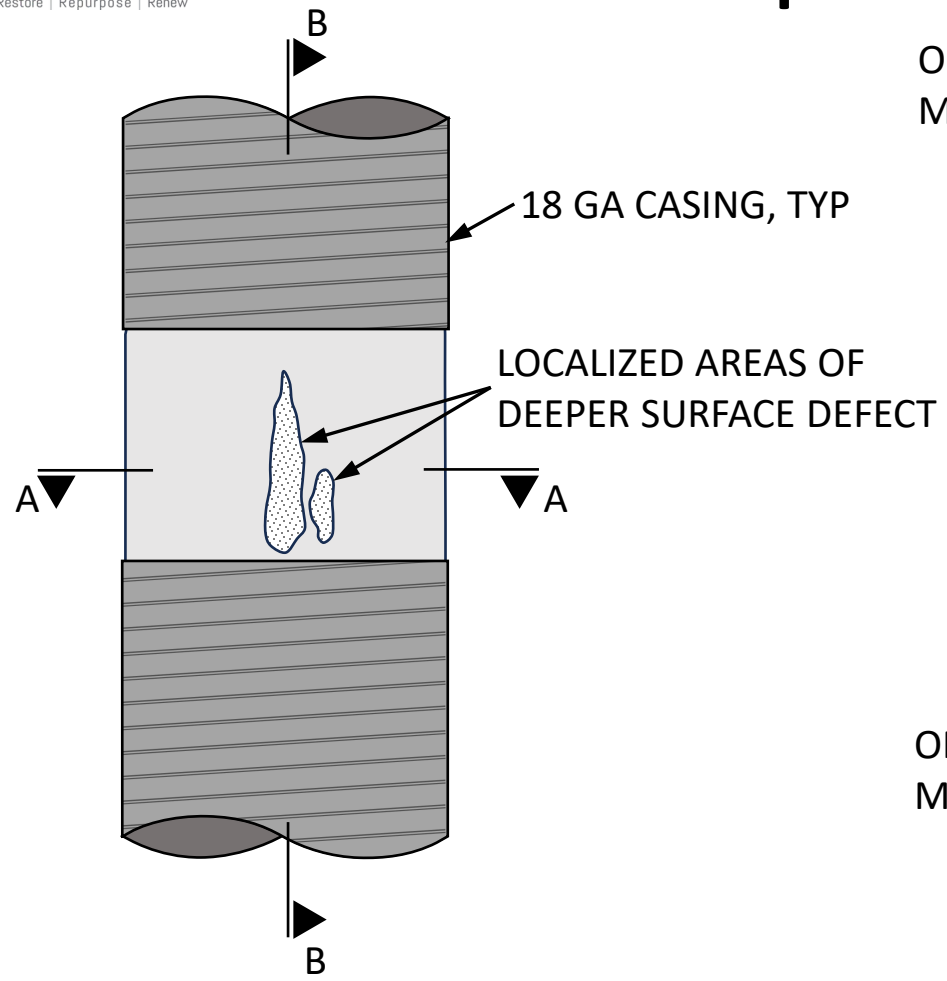
Repair implementation

LEVEL 1 REPAIRS

LEVEL 2 REPAIRS

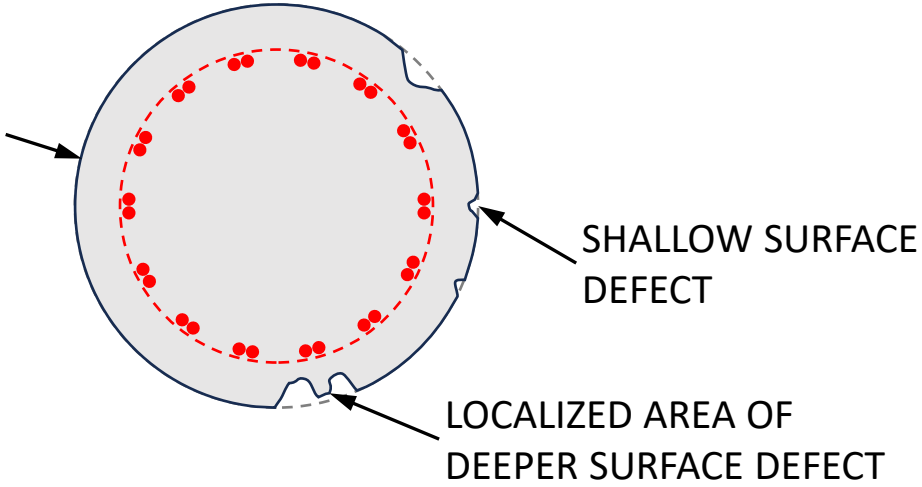
LEVEL 3 REPAIRS

Level 1 Repairs



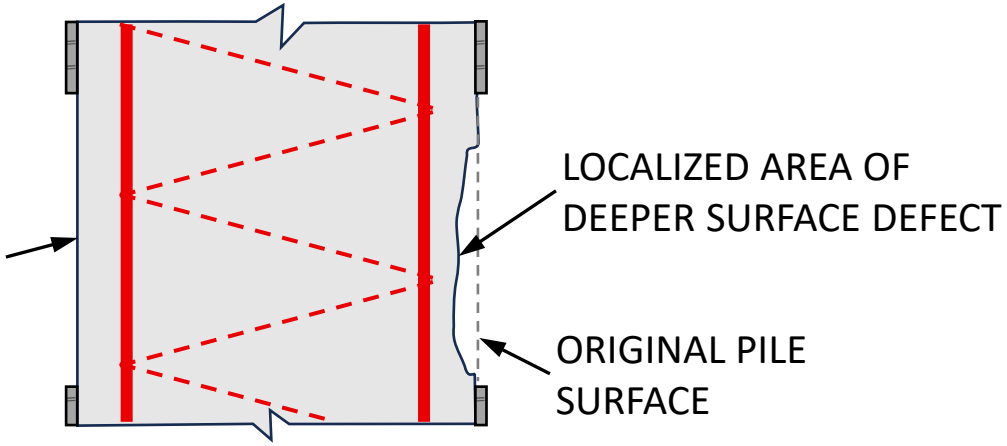
ELEVATION

ORIGINAL PILE SURFACE,
MOSTLY FREE OF DEFECTS



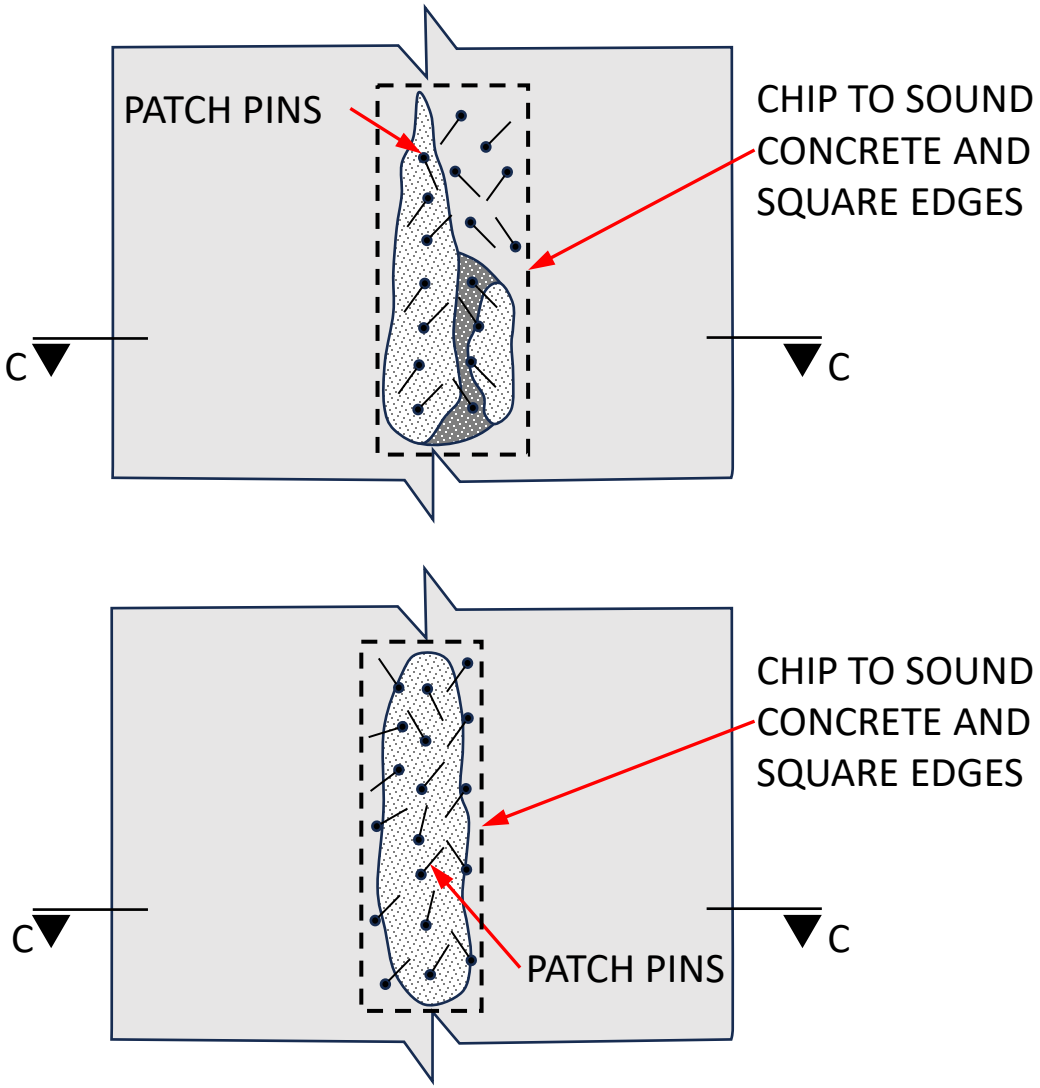
SECTION A-A

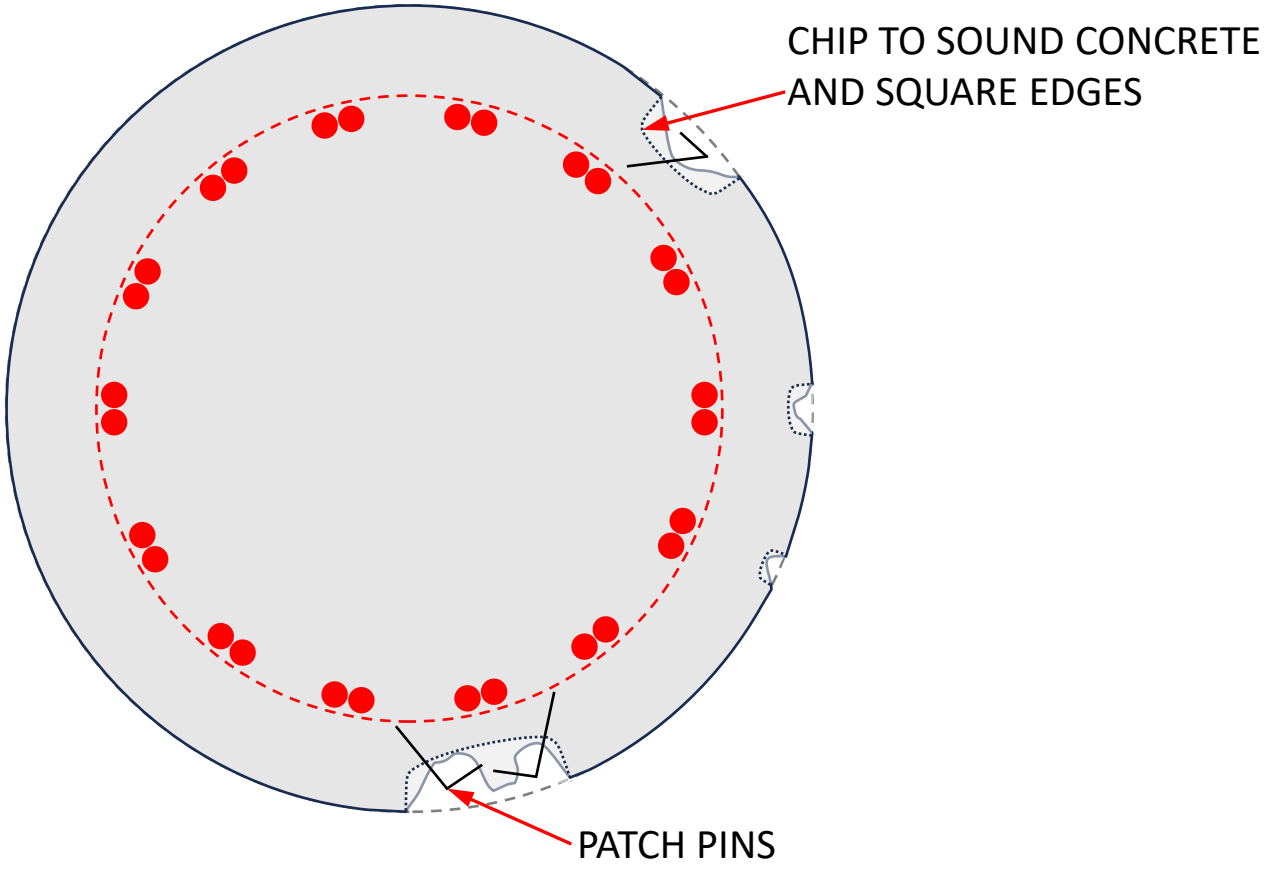
ORIGINAL PILE SURFACE,
MOSTLY FREE OF DEFECTS



SECTION B-B

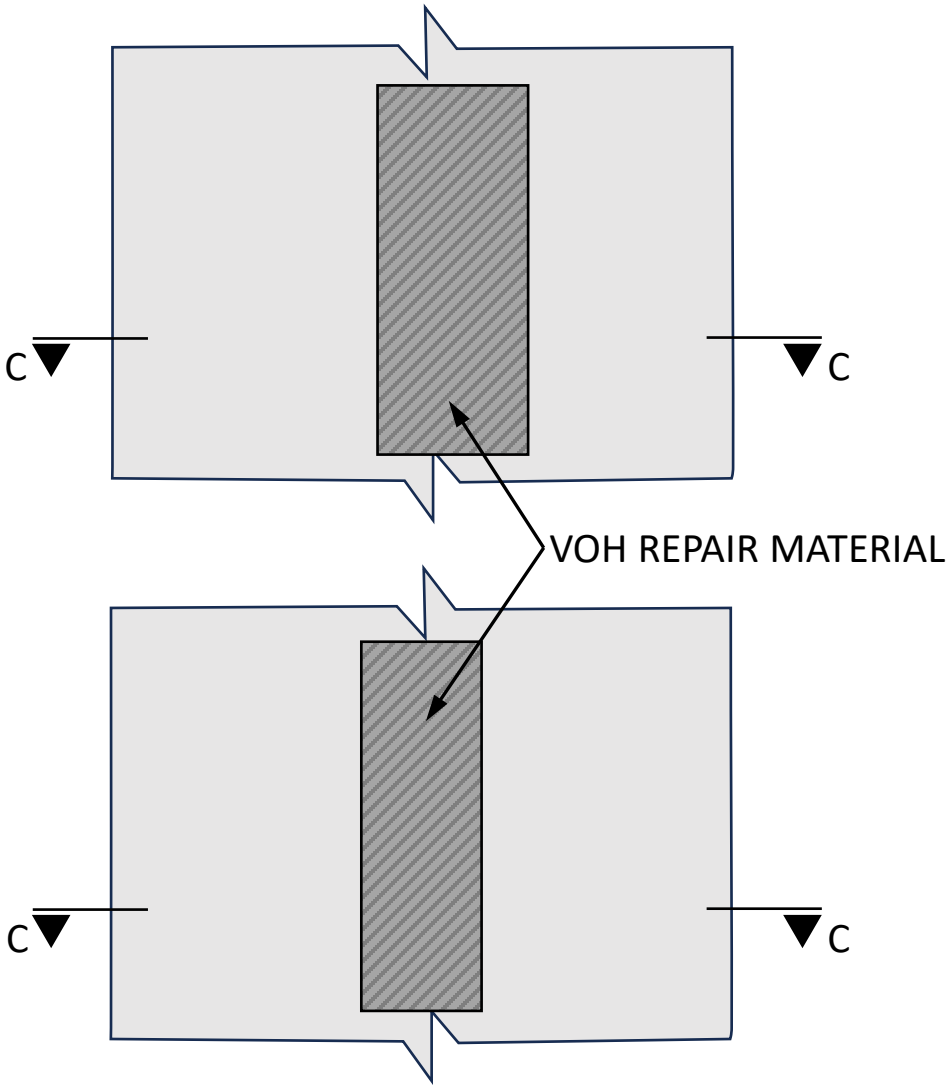
Level 1 Repairs

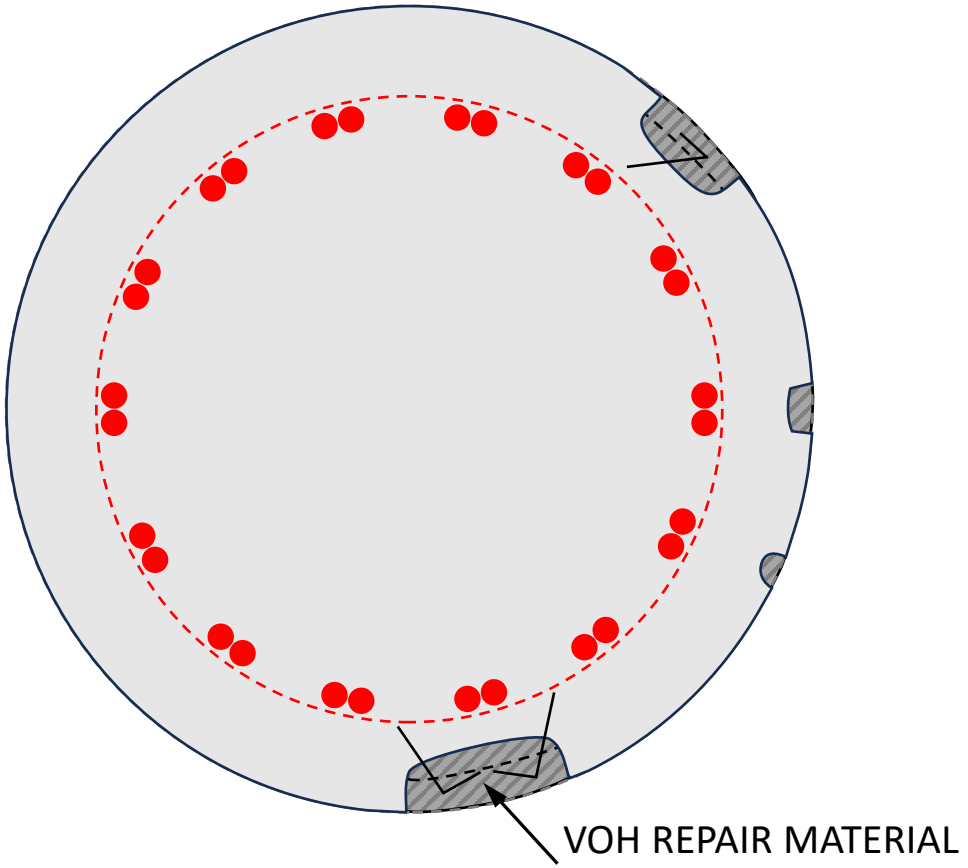




SECTION C-C

Level 1 Repairs





SECTION C-C

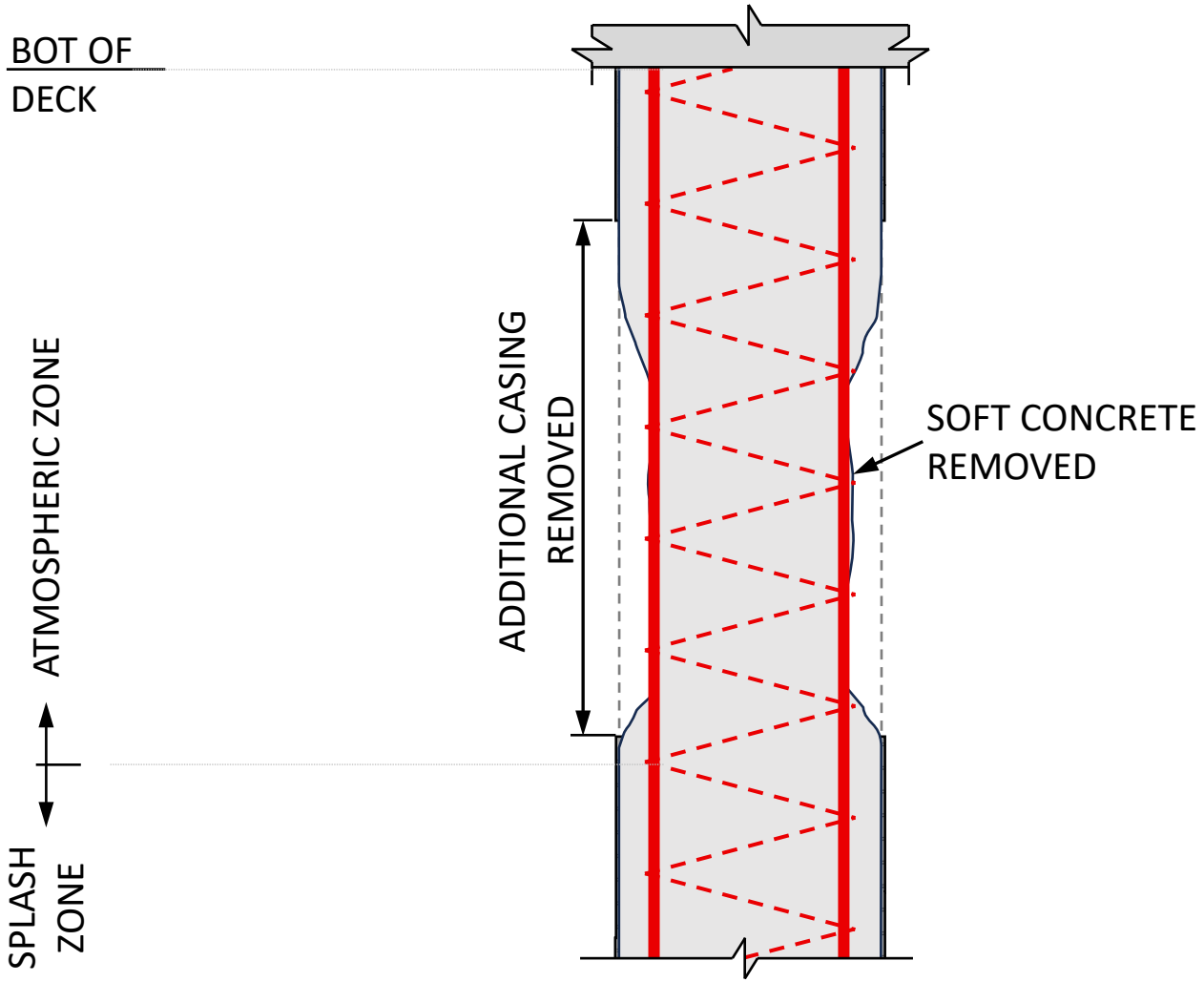
Repair implementation

LEVEL 1 REPAIRS

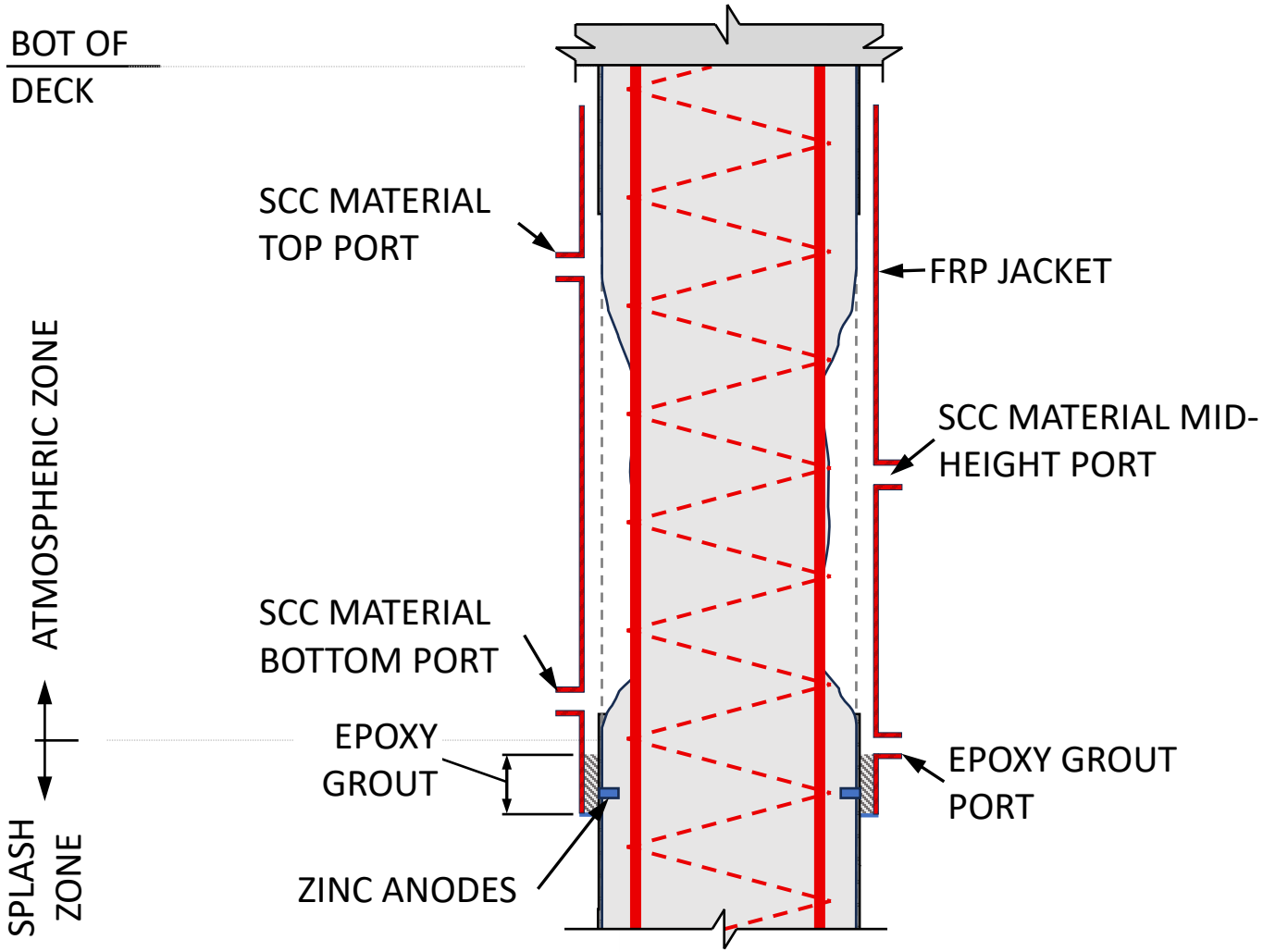
LEVEL 2 REPAIRS

LEVEL 3 REPAIRS

Level 2 Repairs



Level 2 Repairs



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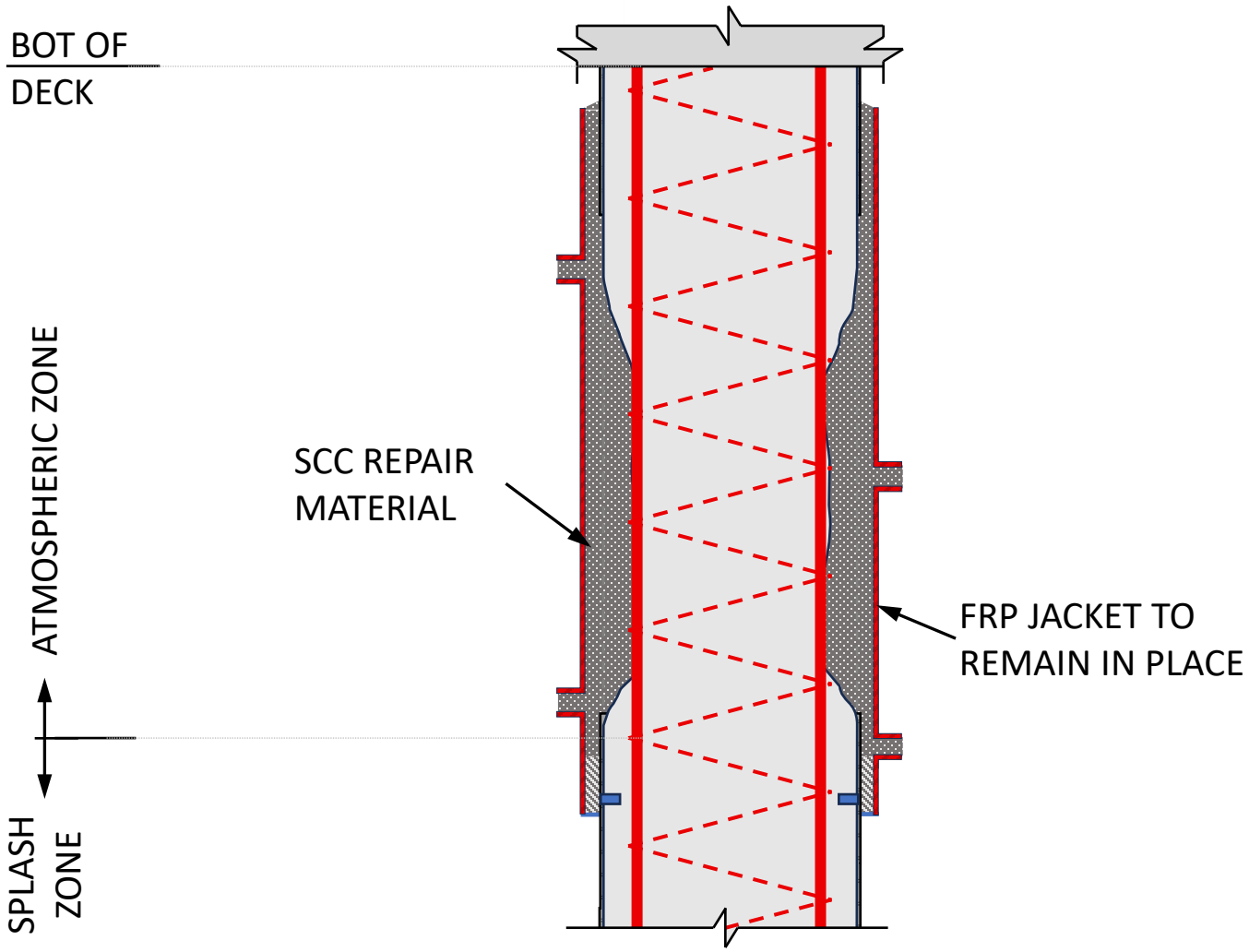

Repair implementation

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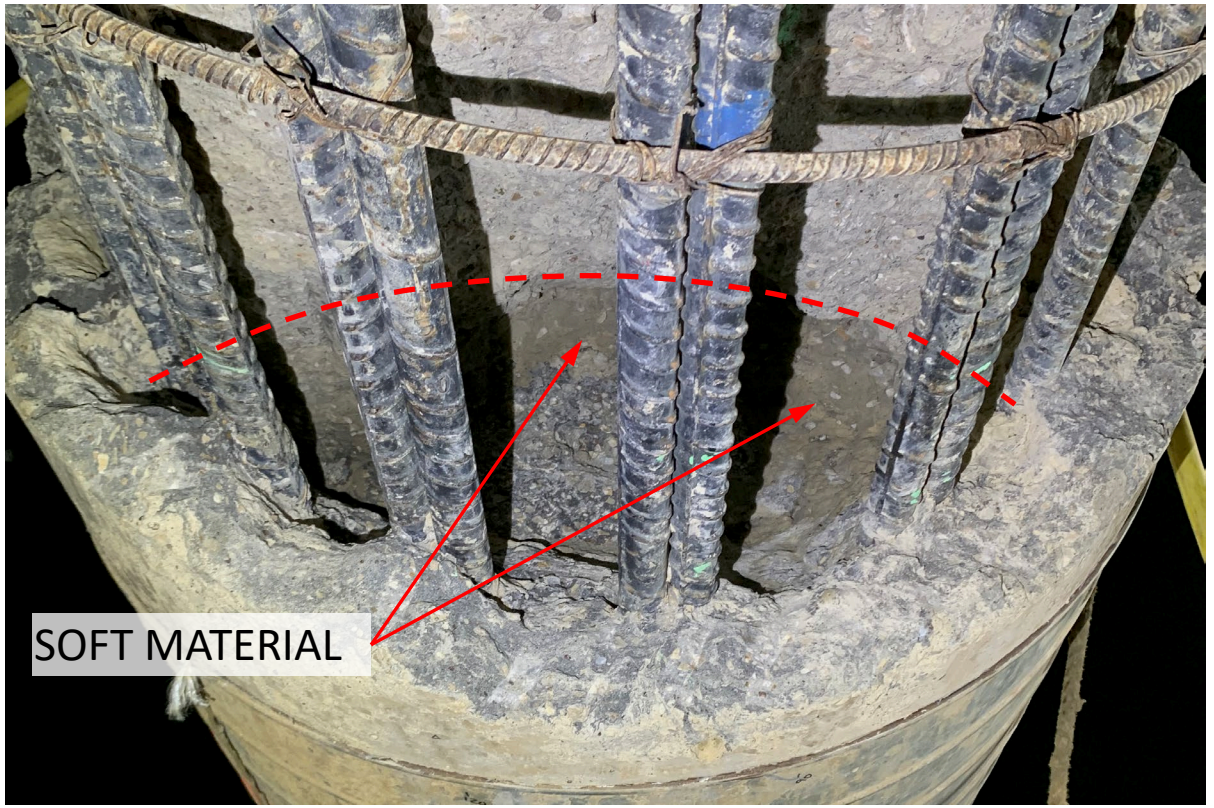

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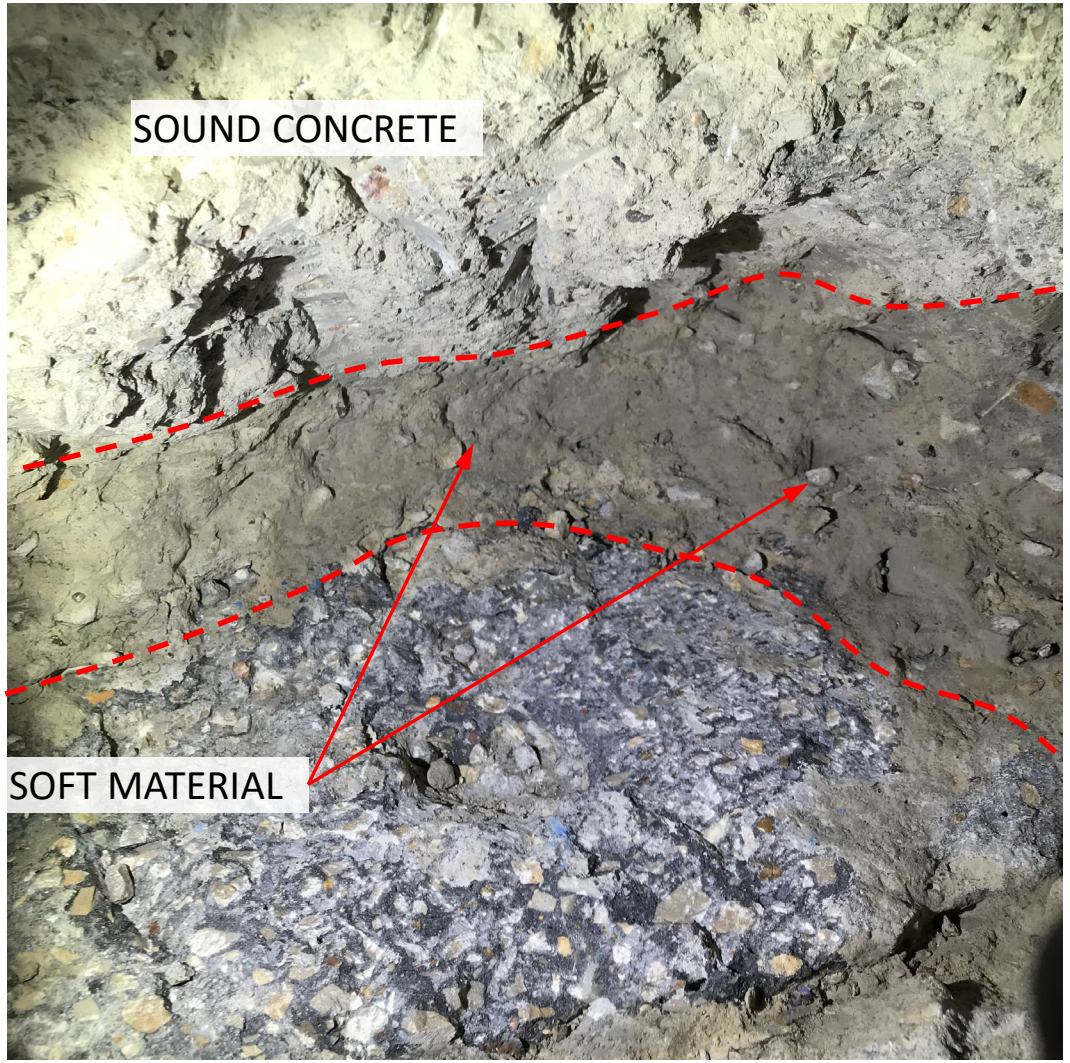

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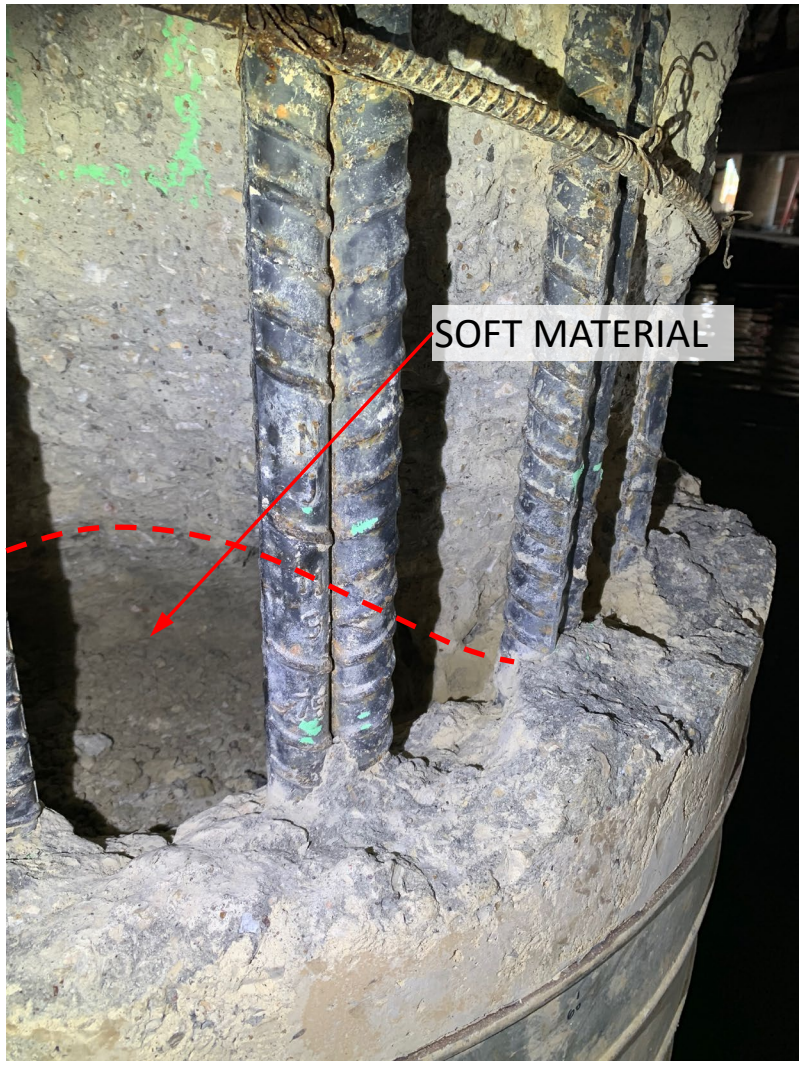

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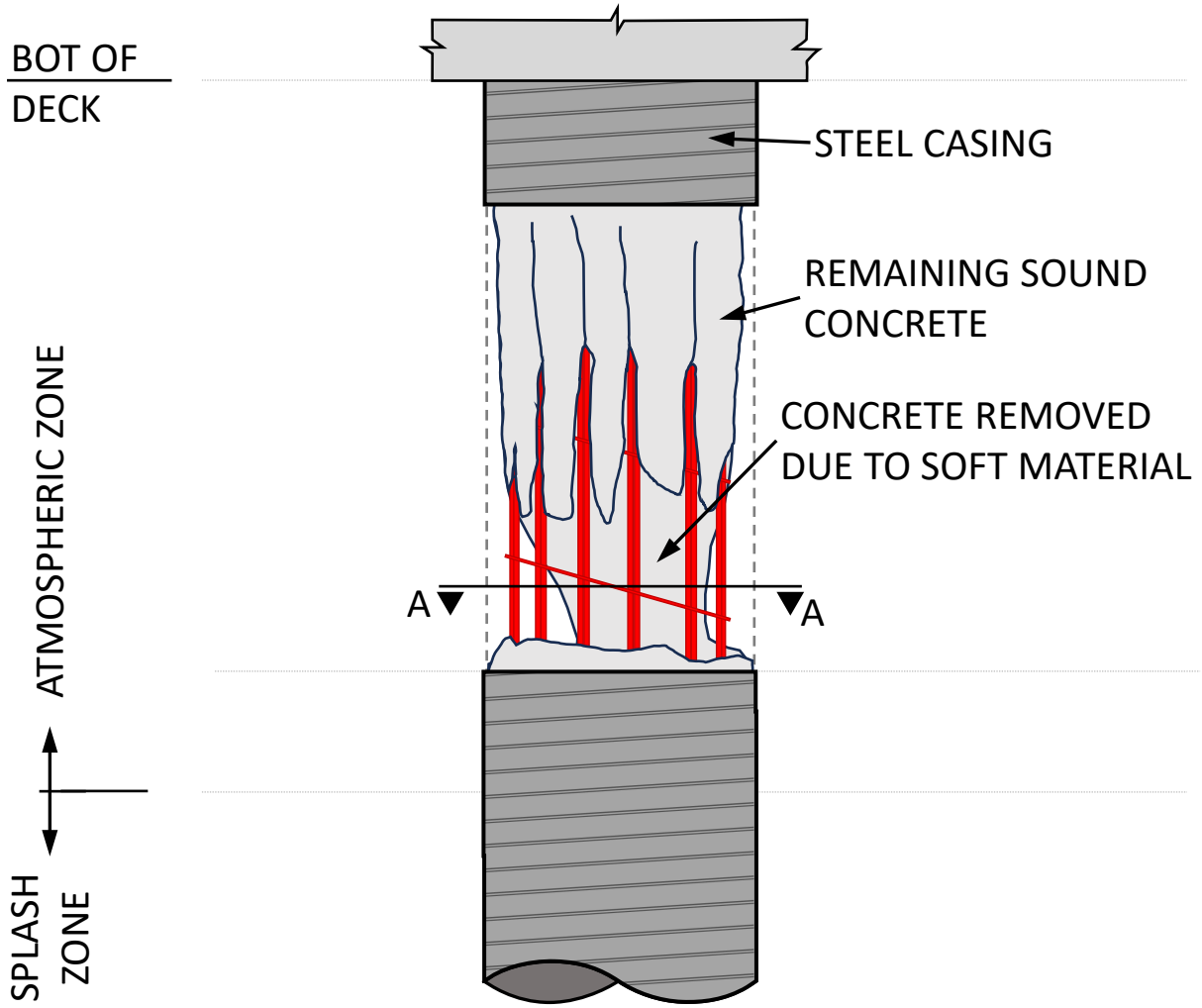
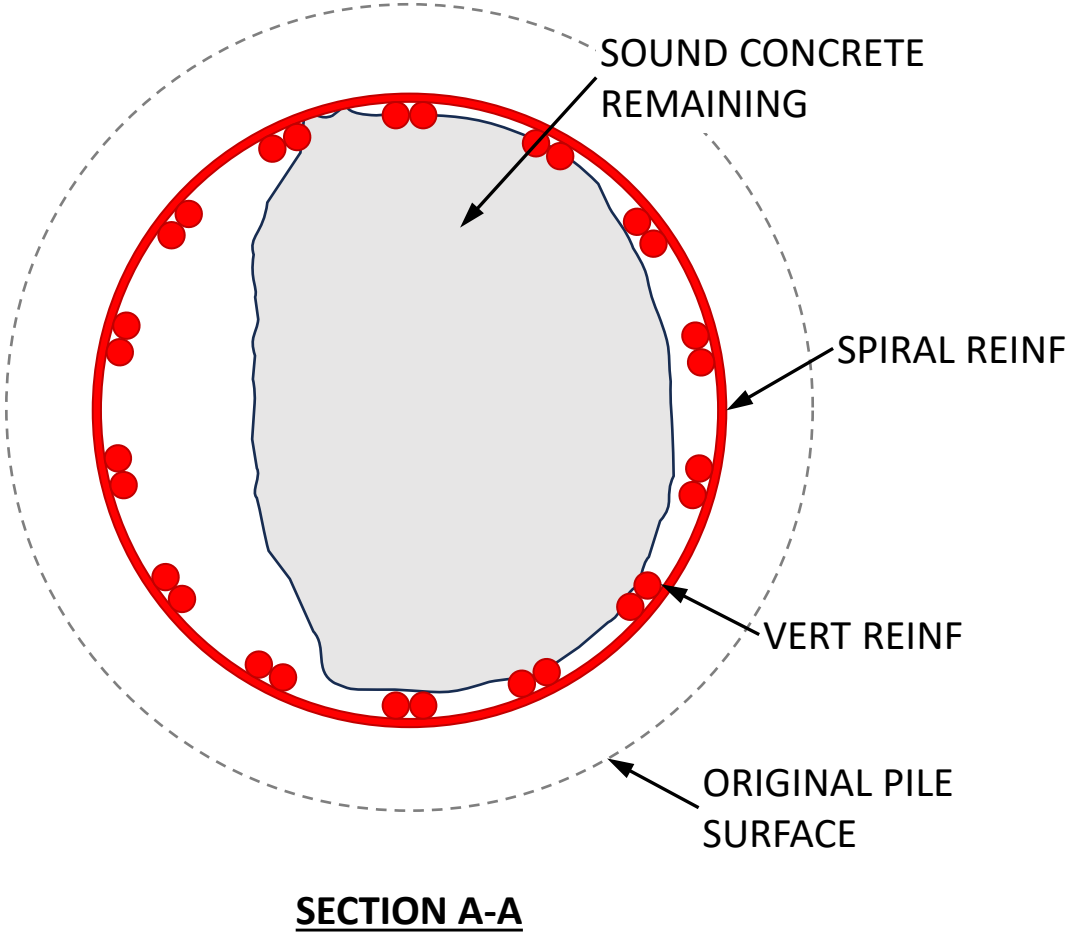
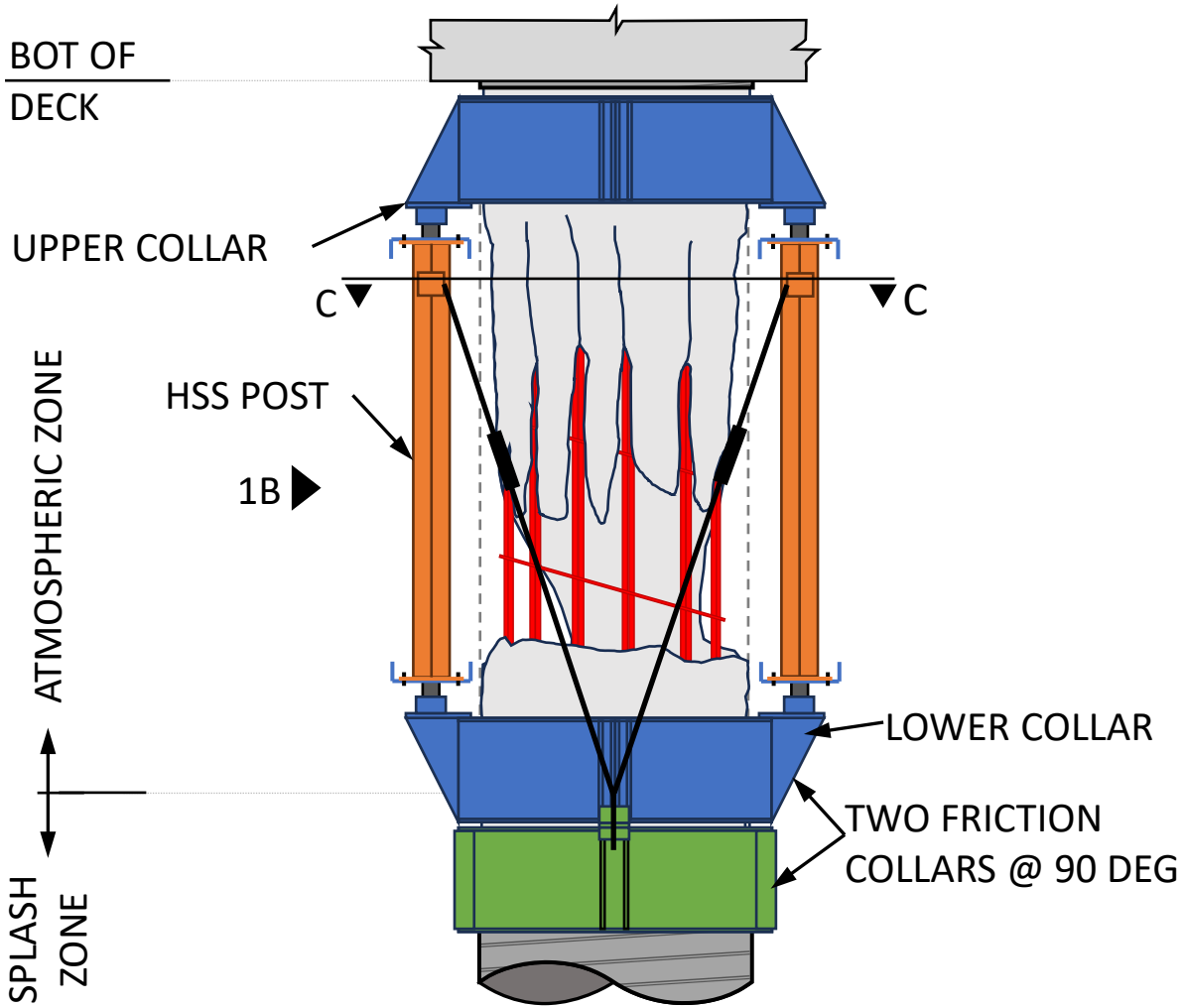




SECTION A-A

Level 3 Repairs



ELEVATION 1A

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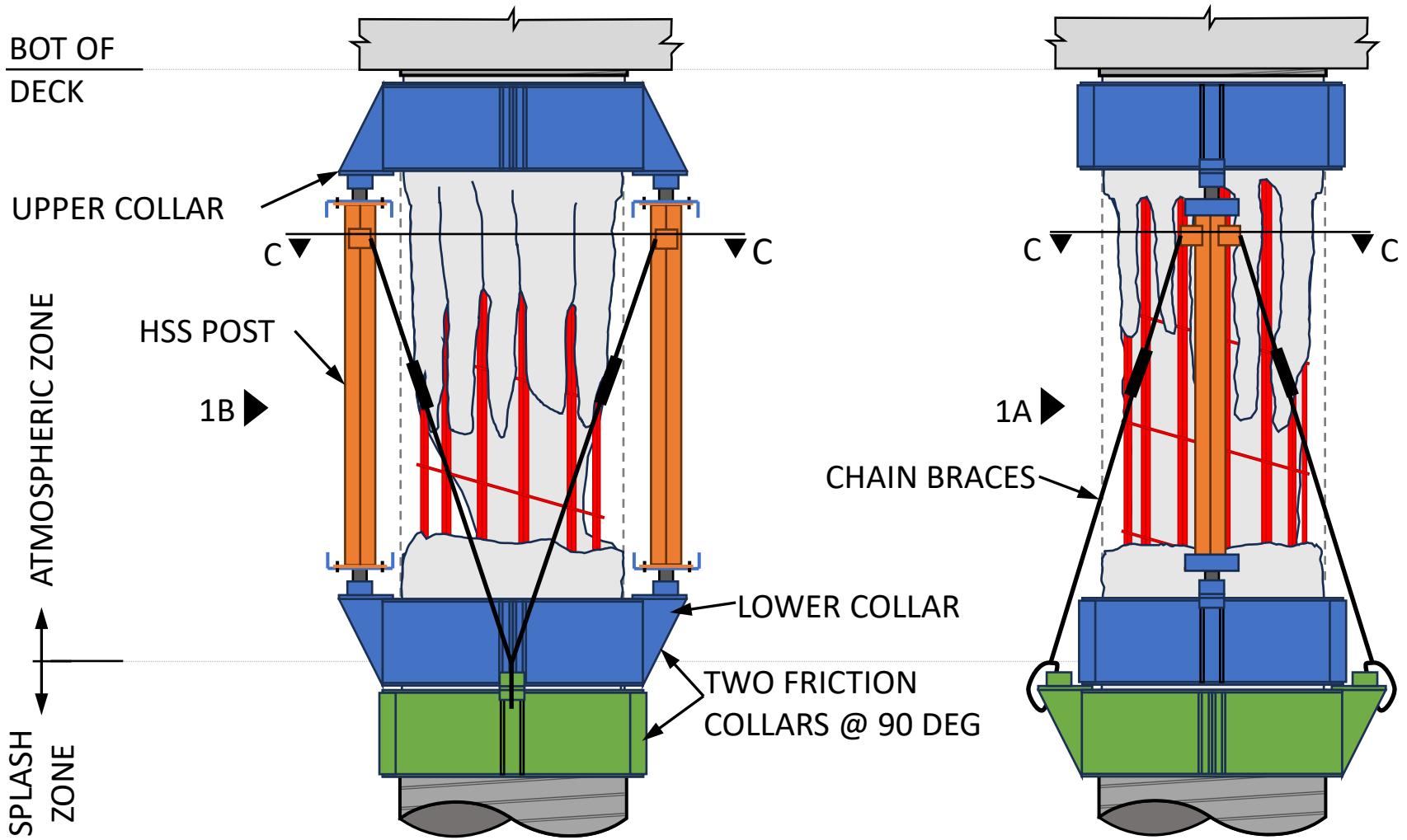

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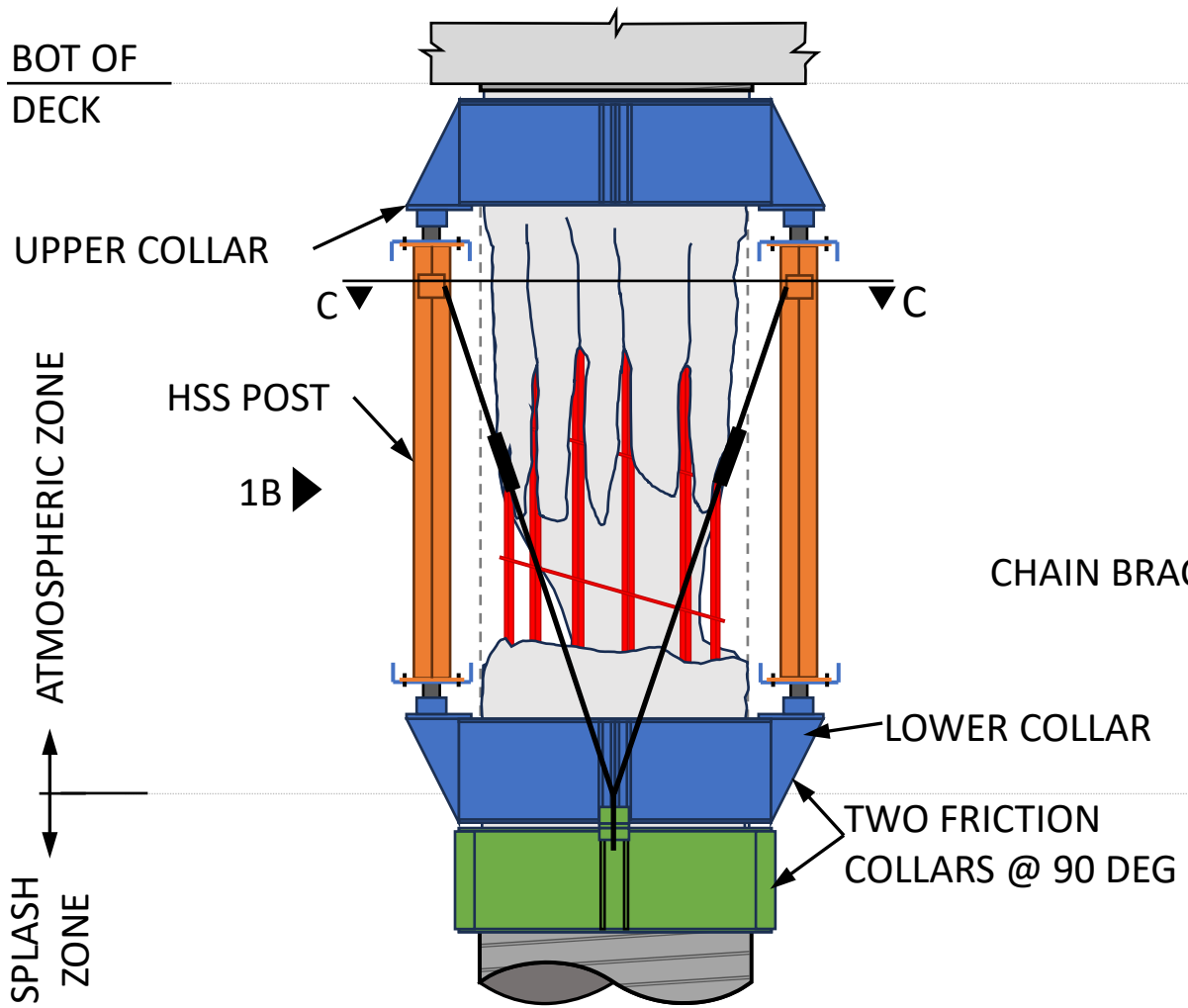
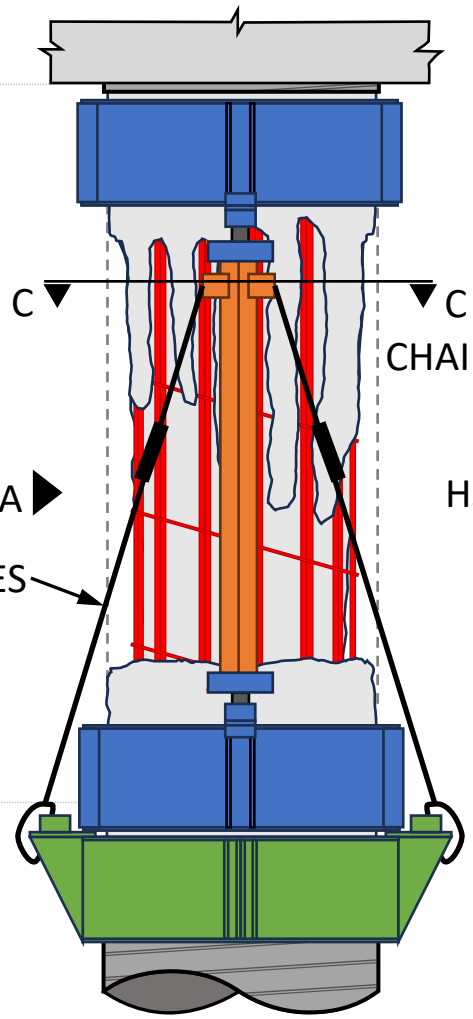


ELEVATION 1A



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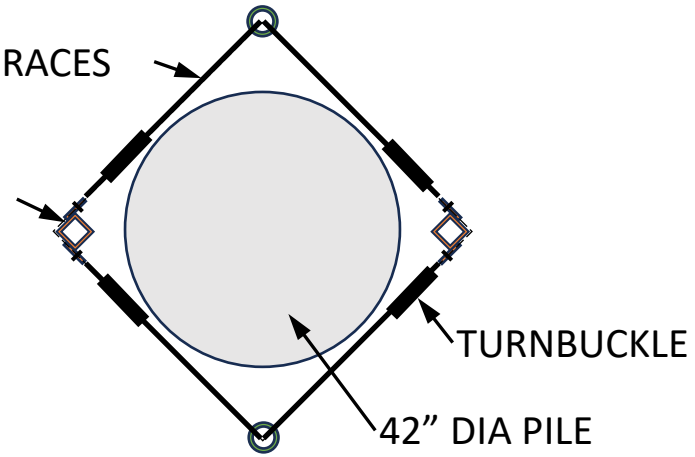
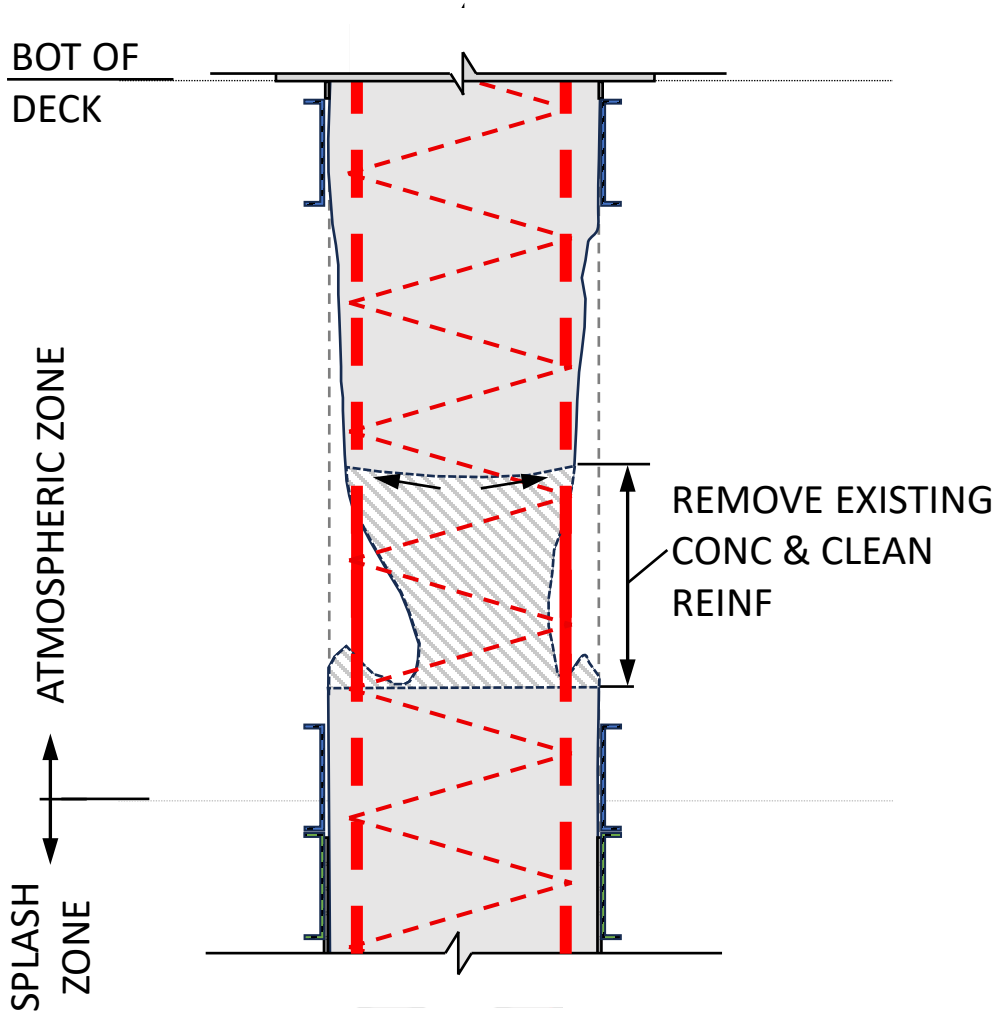


SECTION C-C

Level 3 Repairs



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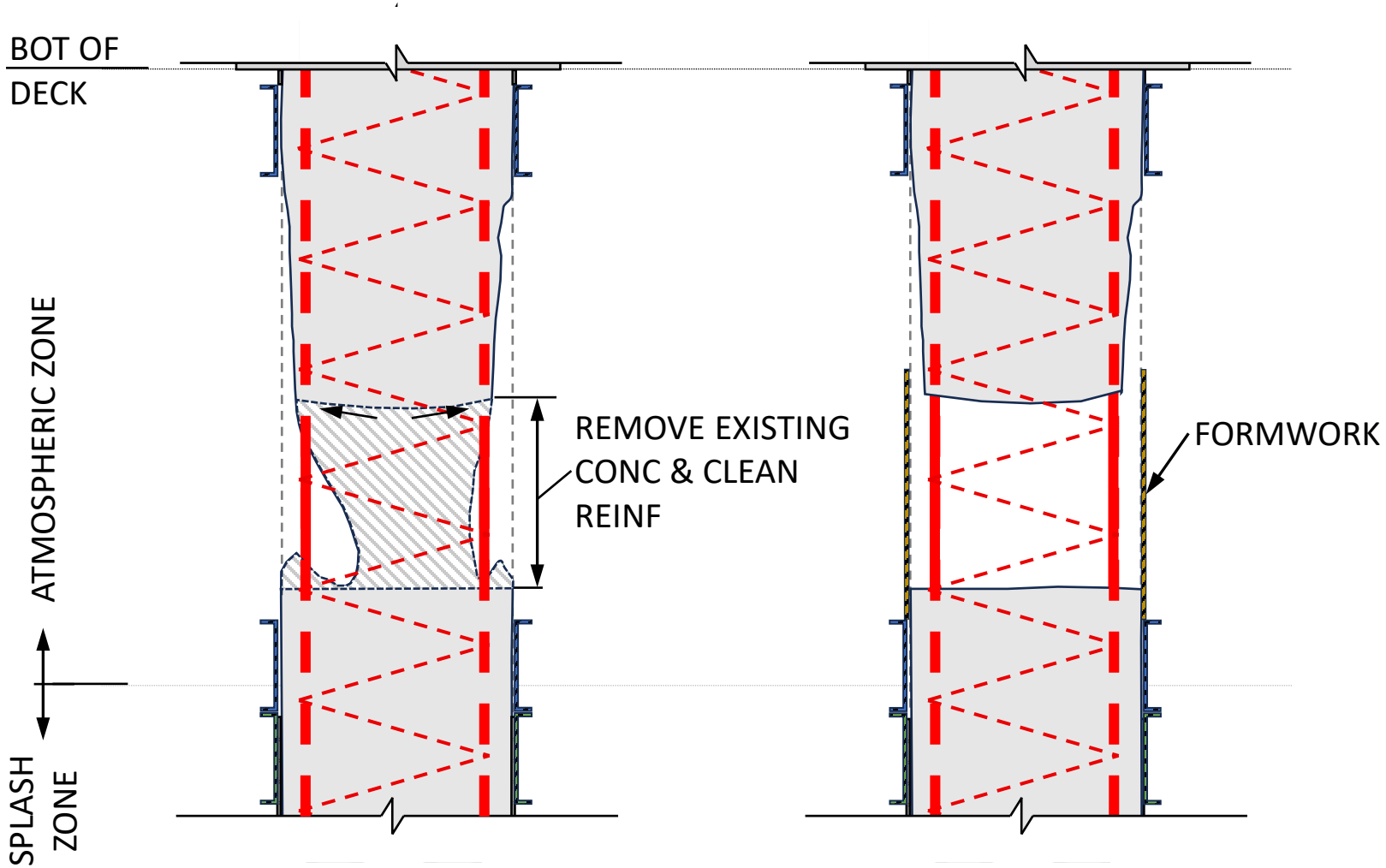

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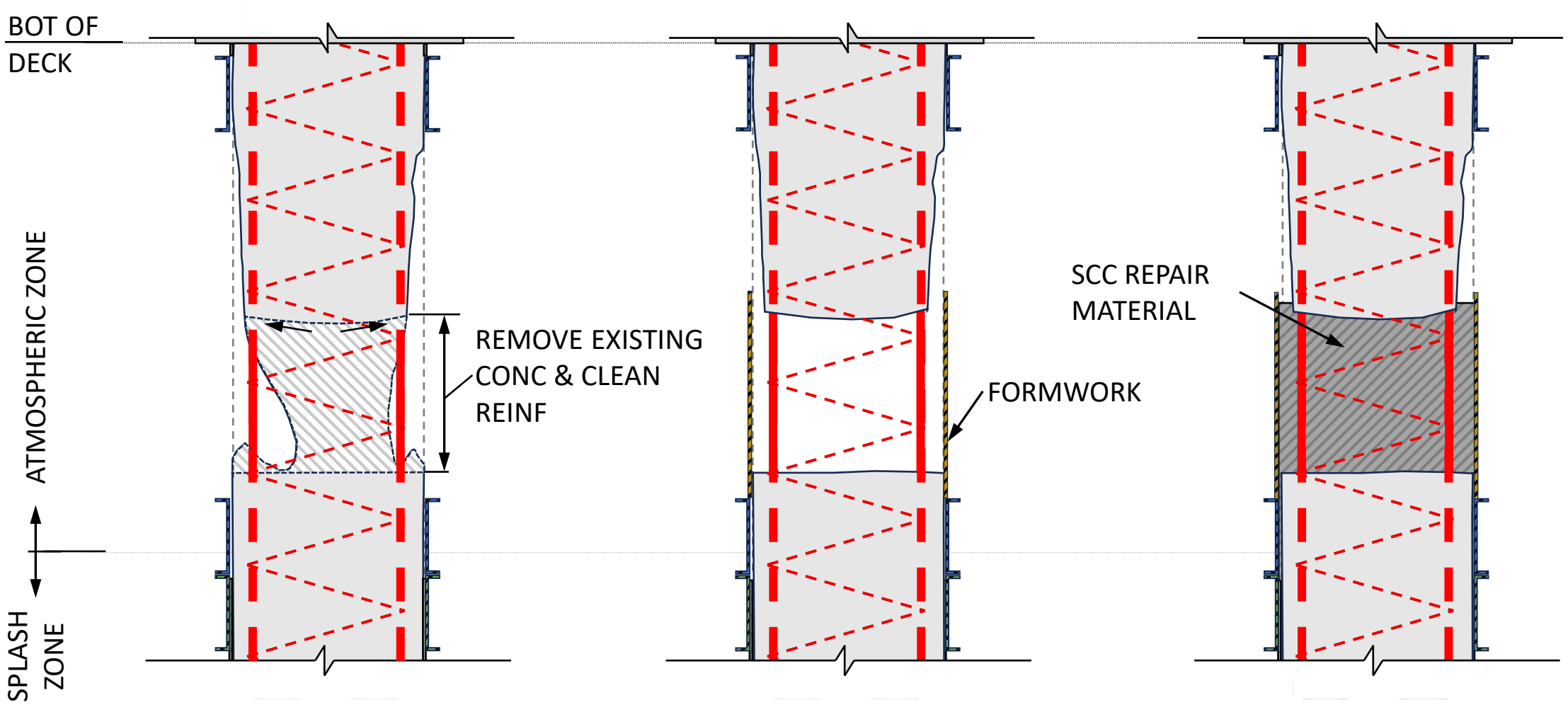

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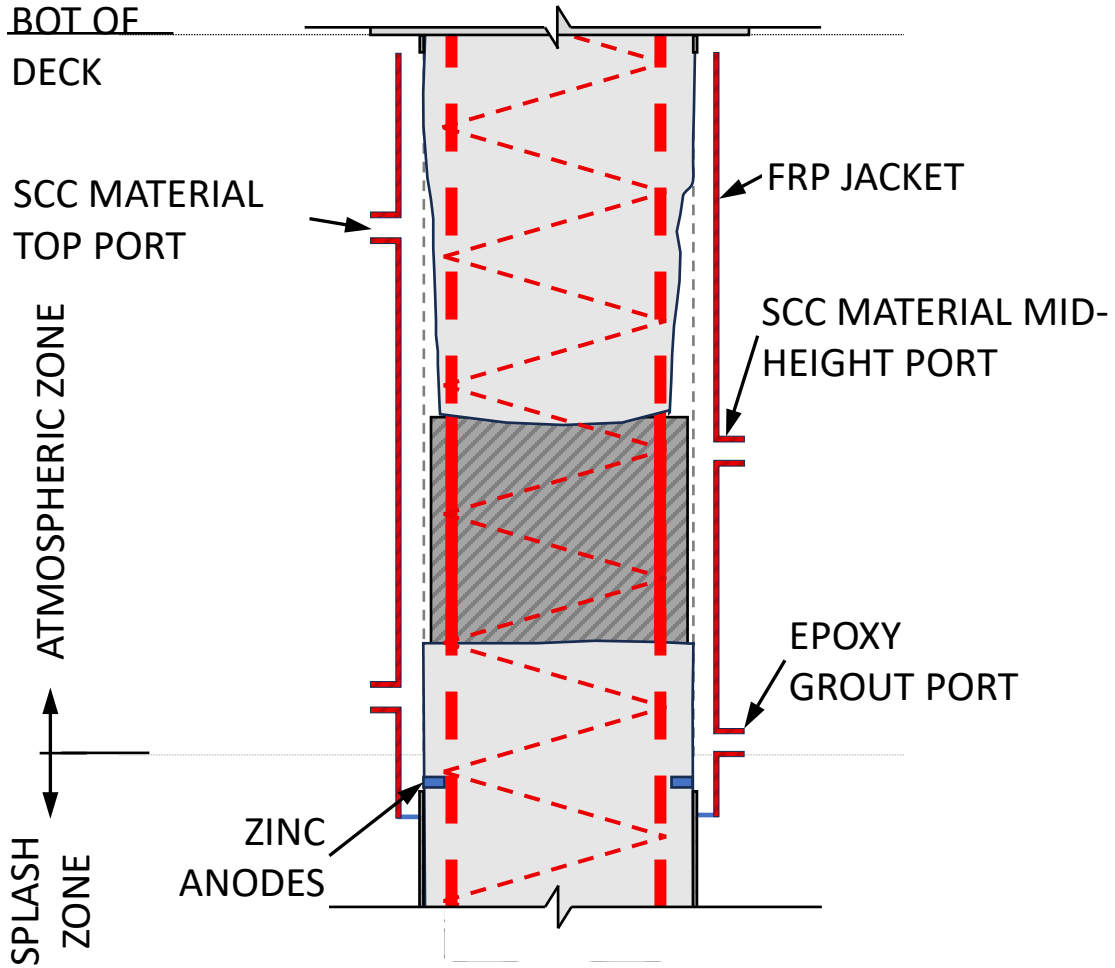

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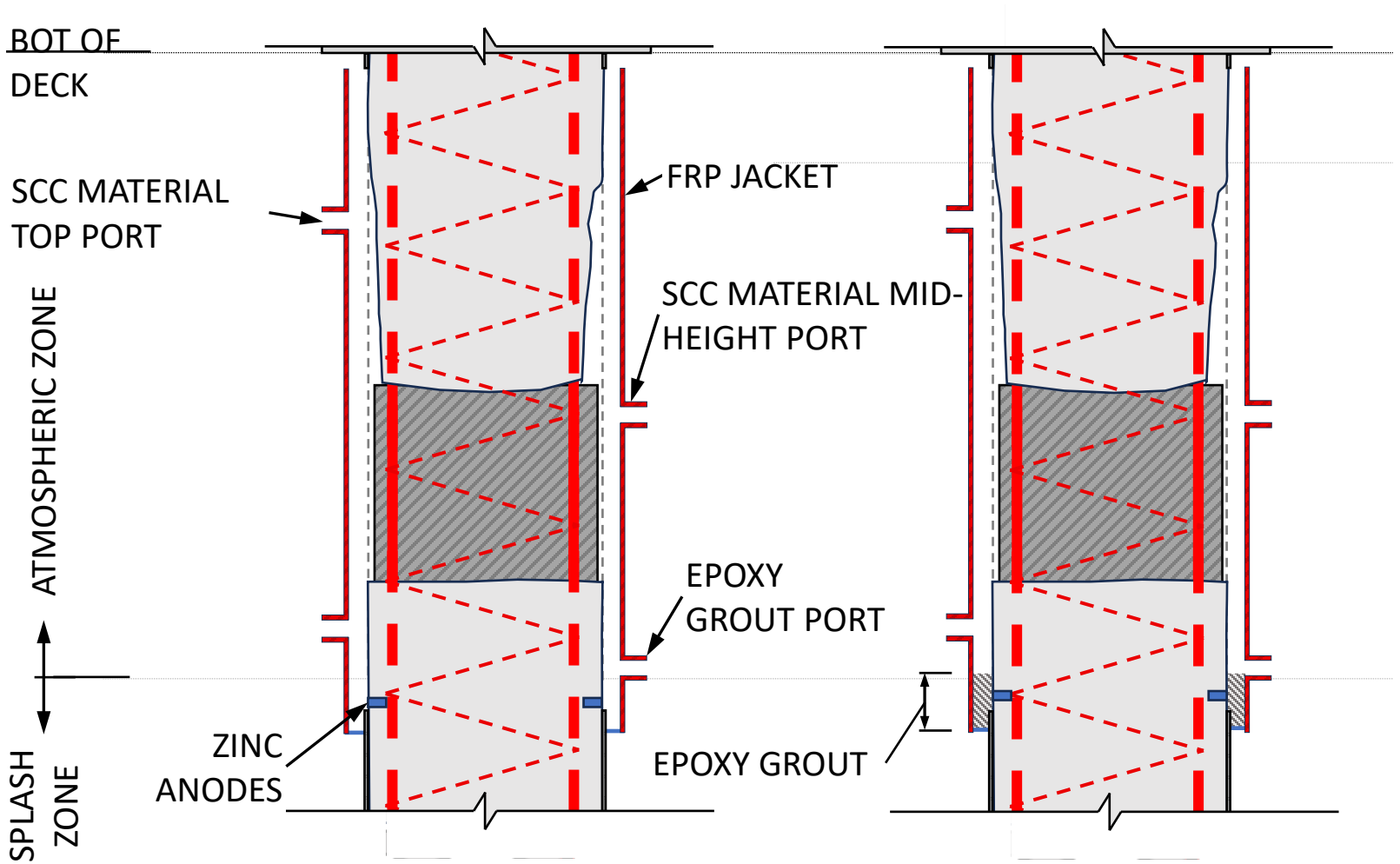

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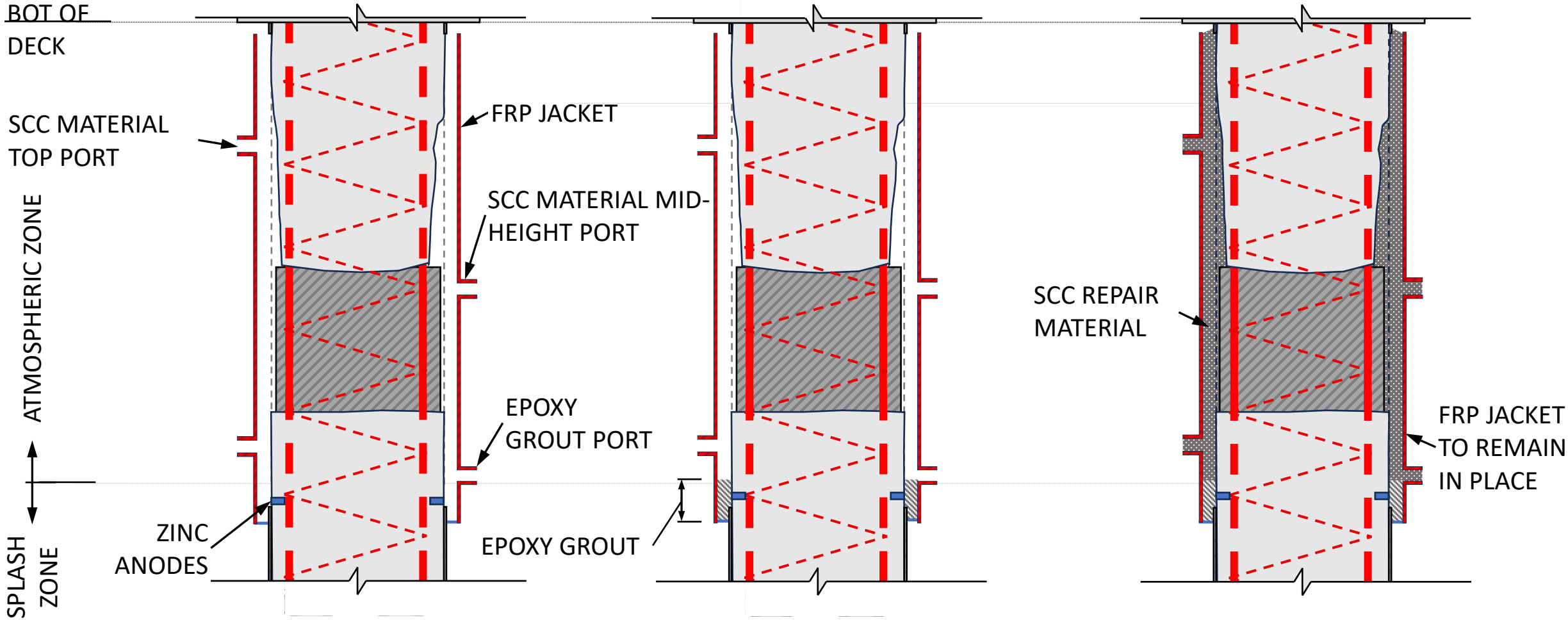


GREIF
EASY POUR
Coleman

Conclusions

- Tremie placement using bentonite slurry, although effective, must be carefully monitored to avoid concrete contamination
- NDT methods provide valuable information about the condition of the structure
  - Often, simple methods provide a significant amount of information and should not be disregarded
  - More advanced methods can be used to confirm initial assessments

Conclusions

- Consider constraints
  - Use established industry solutions as a starting point
  - Consult with repair product manufacturers
  - Utilize readily available structural components
- Re-establish long-term performance
  - *“Strength is essential but otherwise unimportant” Hardy Cross*
  - Do not overlook durability!

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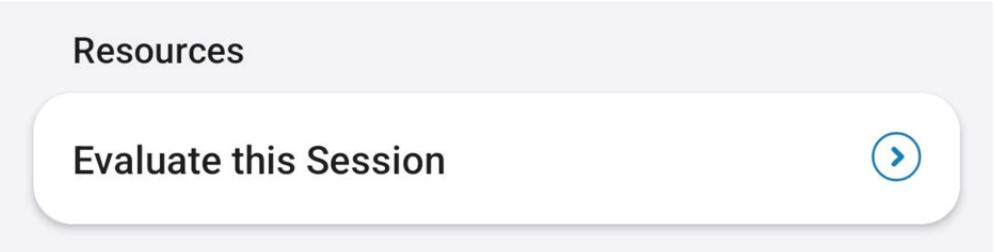
CONCRETE REPAIR
Restore | Repurpose | Renew

ANY QUESTIONS?

SESSION EVALUATION



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NAVIGATING CHALLENGES IN WHARF PILE REHABILITATION

Esteban Zecchin, PhD, EIT
Staff Engineer
Pivot Engineers