Proposed Seismic Detailing Criteria for Piers and Wharves

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Overview

- Update on proposed seismic code
- Present goals of detailing provisions
- Review performance of several pile to deck connections
- Summarize spiral requirements

Update on Proposed Seismic Code

- New ASCE standard, "**Seismic Design of Piers and Wharves**" under development for 4 years
- Codifies current practice of performance-based seismic design
- Same format and legal standing as ASCE 7
- Pile supported structures only
- Volunteer effort

Proposed Table of Contents in Standard

Chapter 1 - General

Chapter 2 - Seismic Performance Requirements

Chapter 3 - Design Approach

Chapter 4 - Geotechnical Considerations

Chapter 5 - Force Based Analysis and Design

Chapter 6 - Displacement Based Analysis and Design

Chapter 7 - Design and Detailing Considerations ←

Chapter 8 – Ancillary Components

Chapter 7 Table of Contents

Goals of Detailing Provisions

- Include all commonly used pile connections
  - Backed by testing
  - Ductile and suitable for seismic

- Include commonly used deck systems.

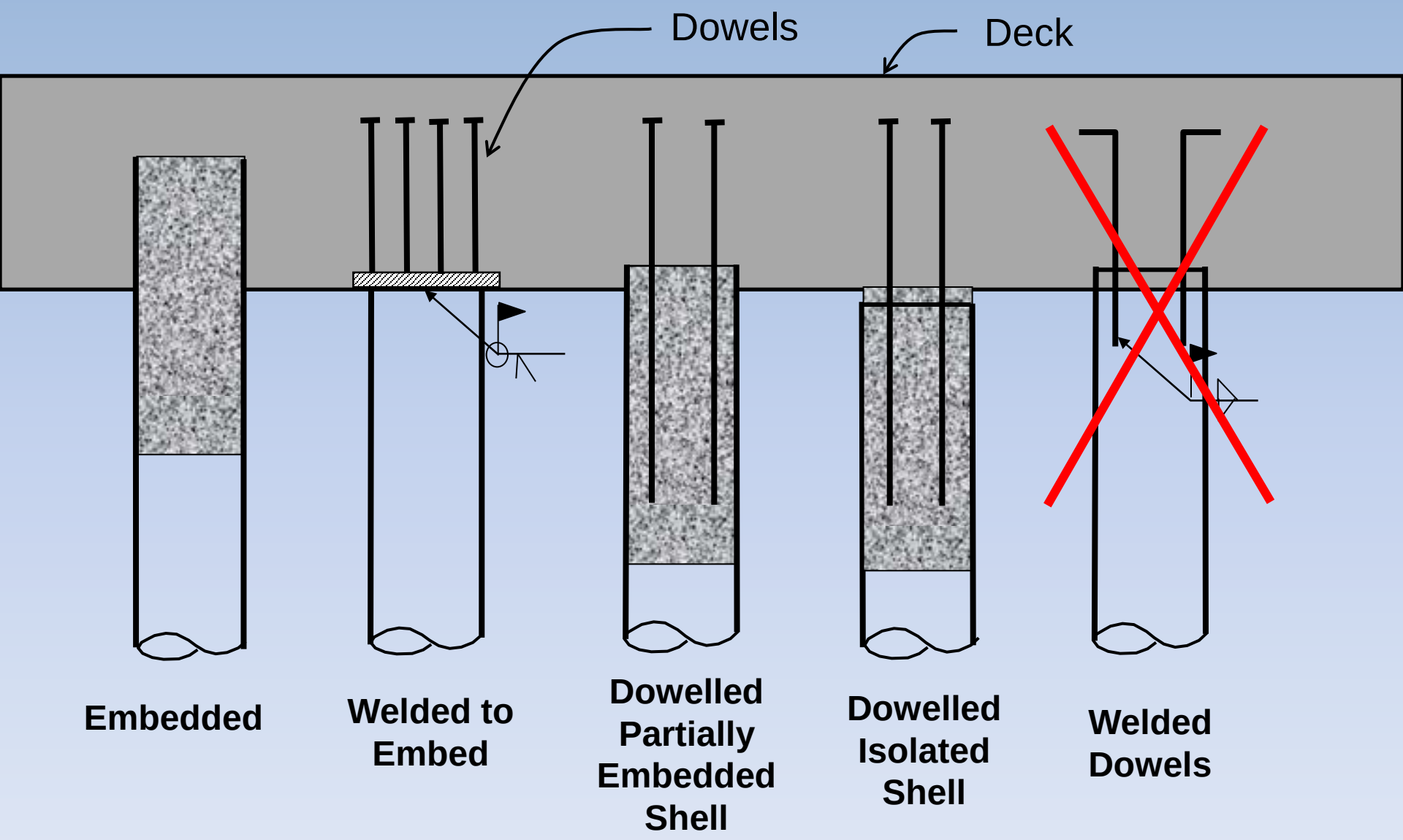
- Use existing codes
  - MOTEMS
  - POLA
  - POLB

- Address seismic detailing issues unique to piers and wharves
  - Pile driving tolerances
  - Pile cut-offs and build-ups

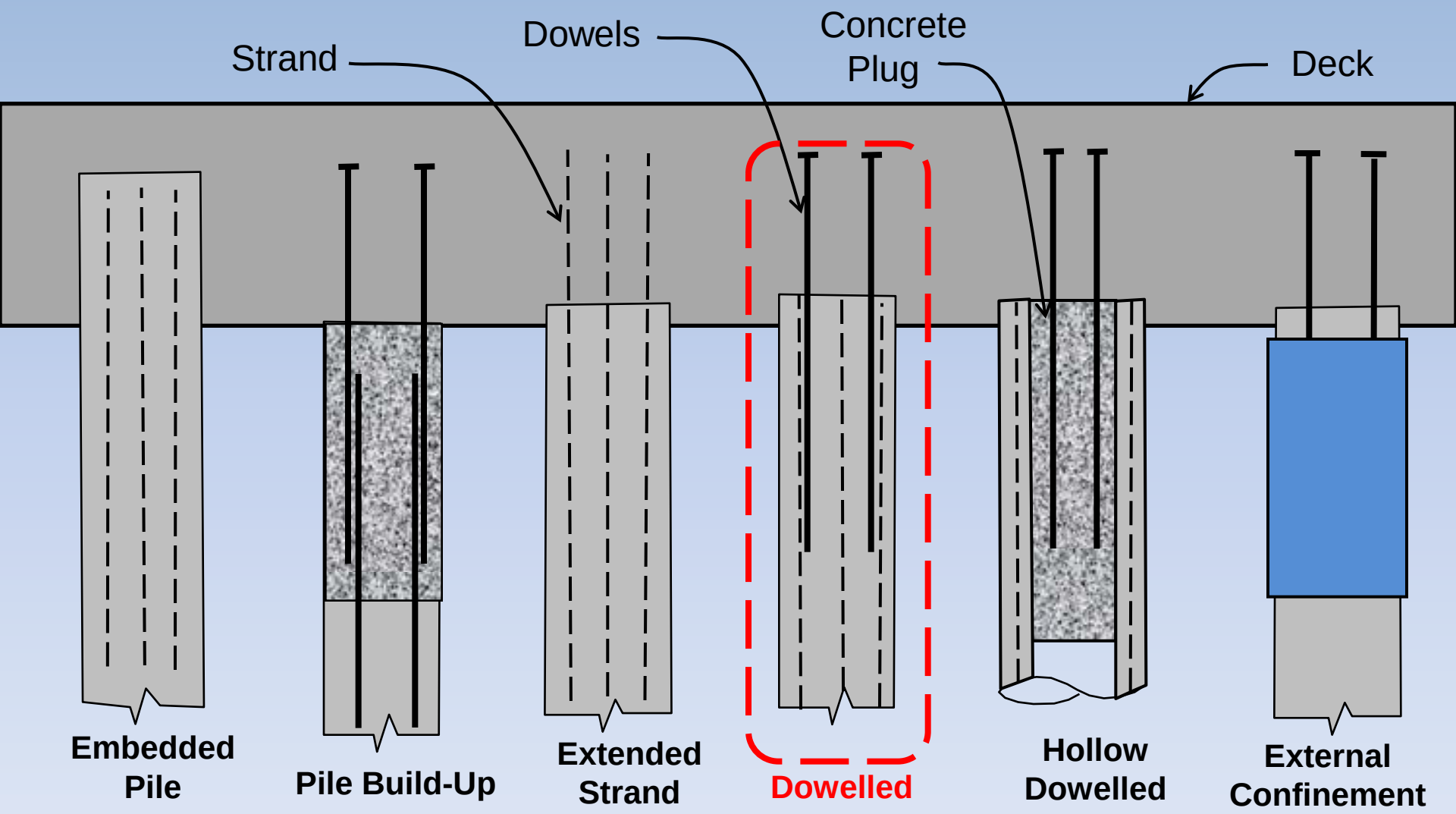
Pile to Deck Connection Testing

- Significant recent research and test data for prestressed concrete piles
- Limited research and test data for pipe piles
- Presentation focus is on prestressed concrete piles

Example Pipe Pile Connections



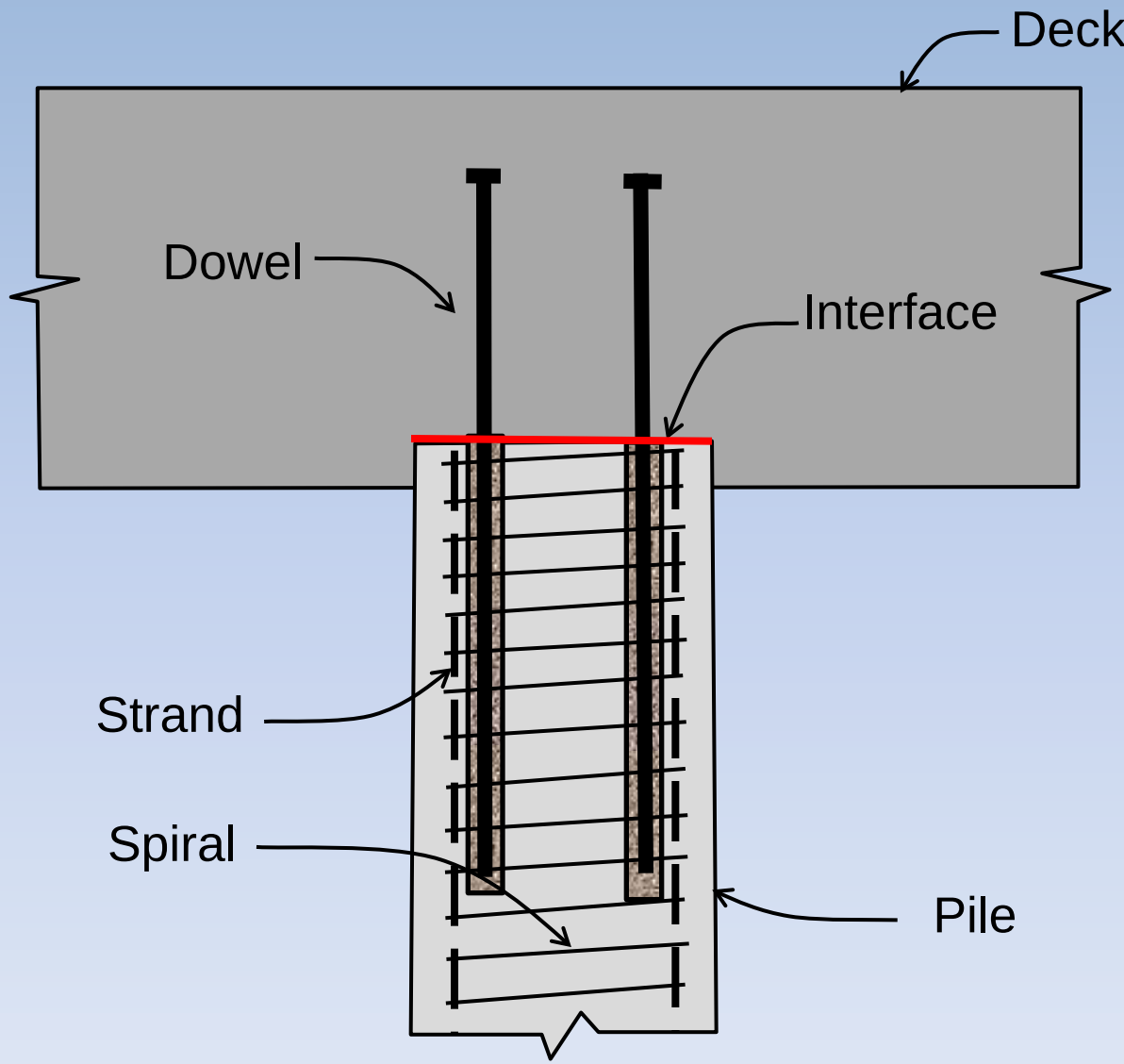
Example Prestressed Concrete Pile Connections



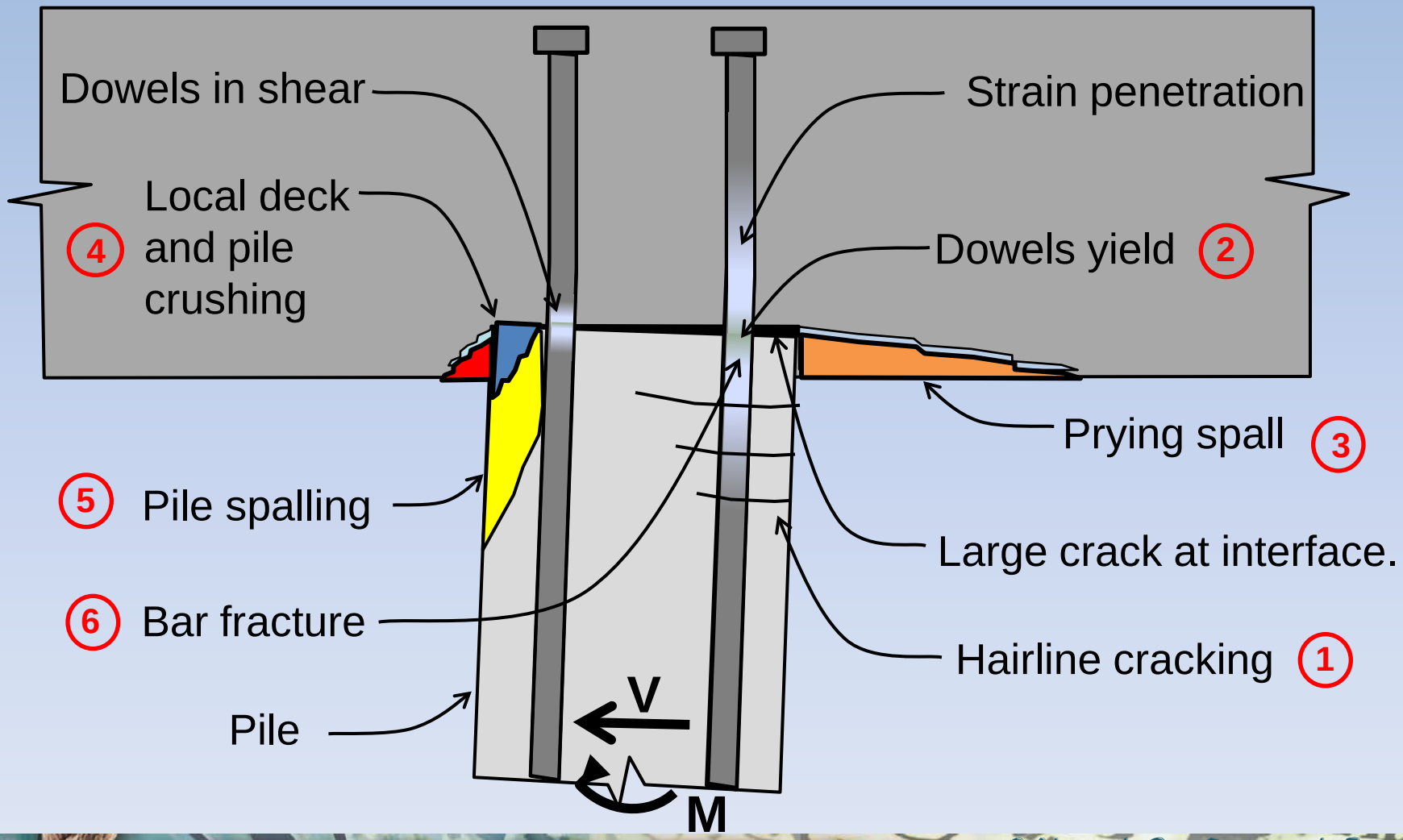
Prestressed Concrete Dowelled Connection Test Overview

- Define terms
- Review typical behavior
  - Strong pile
  - Weak interface
- POLA pile tests
- UW pile tests
- Summary

Pile to Deck Connection Terms

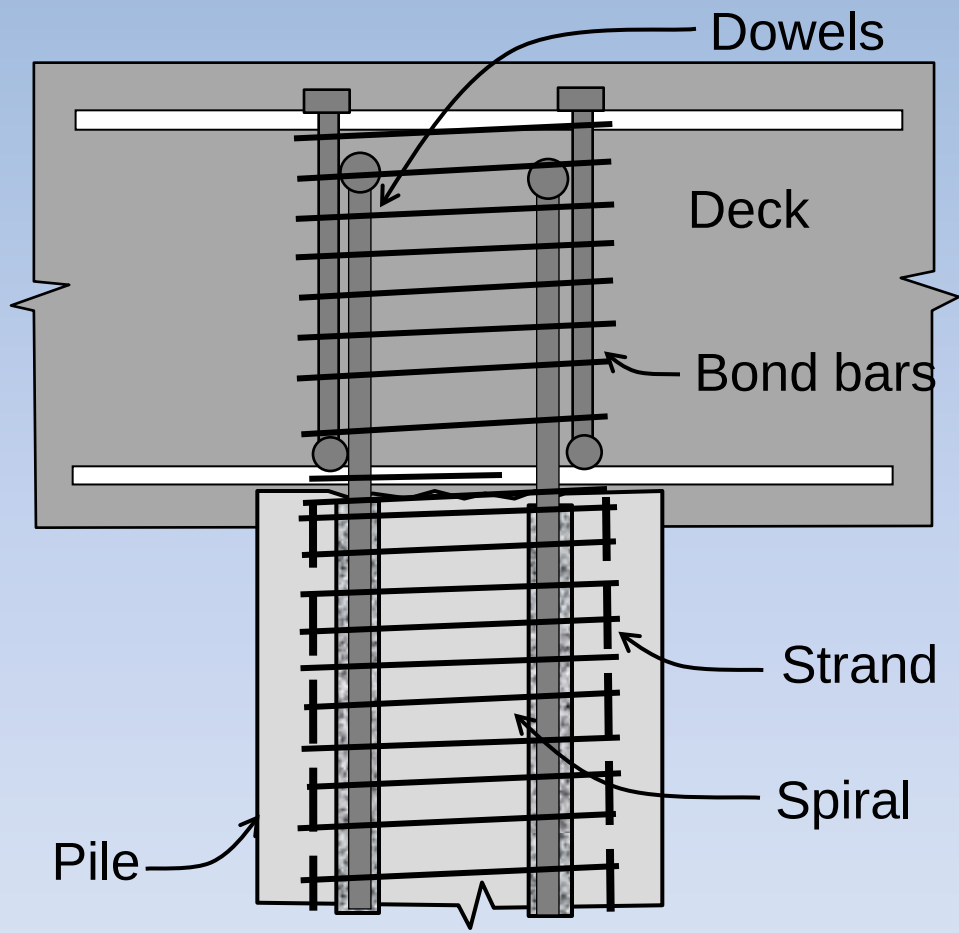


Typical Behavior of a Prestressed Concrete Pile Dowelled Connection



POLA Seismic Pile Tests (Ref. 2, 3)

- 36” deck
- 24” Octagonal Pile
- 16 - 0.6” dia. Strand
- 8 - #10 dowels
- W20 @ 2.5 Spiral



Embed 1 ½ spiral turns in deck

POLA Seismic Pile Behavior (Ref. 2, 3)

Slab Prying $\mu_\Delta = 1.5$ (1.2% drift)

Deck Crushing $\mu_\Delta = 2$ (1.6% drift)

Pile Crushing $\mu_\Delta = 3$ (2.4% drift)

Test Ended $\mu_\Delta = 16$ (12.9% drift)

POLA Full Scale Connection Tests (Ref. 4)

Test Frame (UCSD 2007)

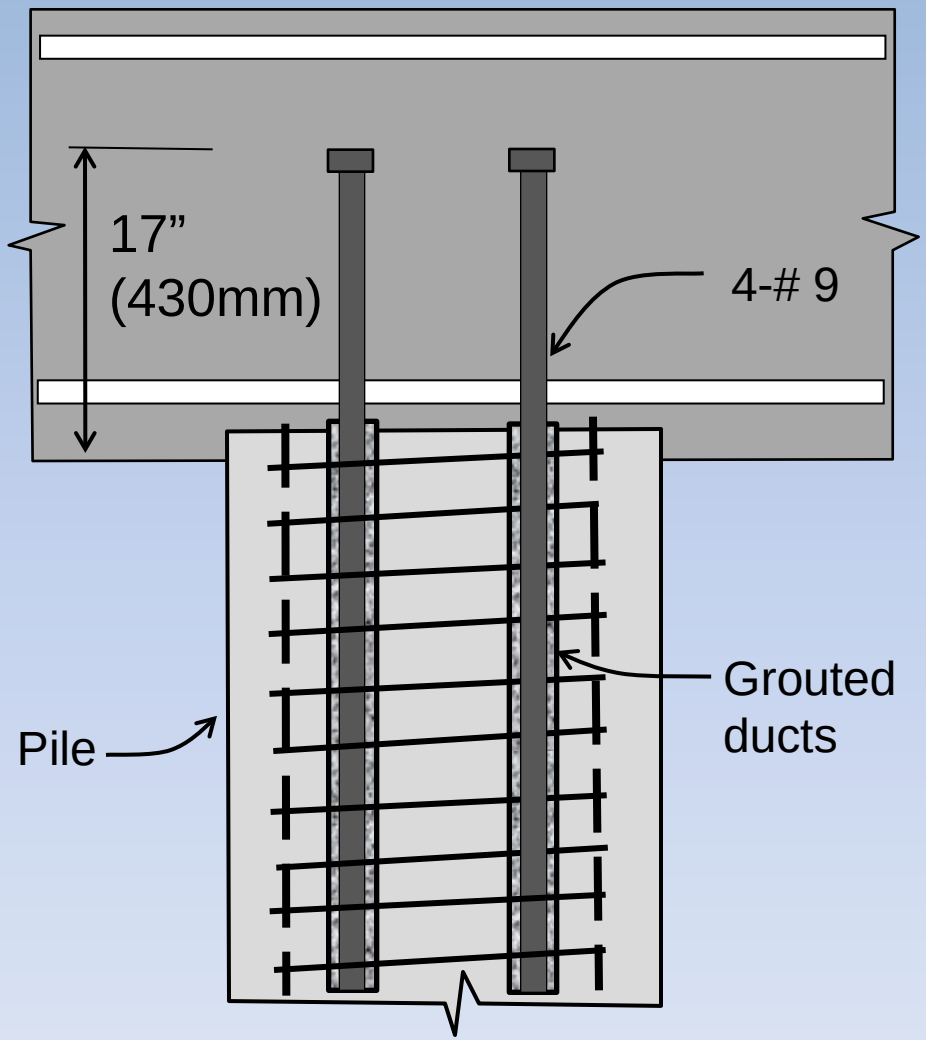
Deck

Deck Prying Spall & Interface Gap

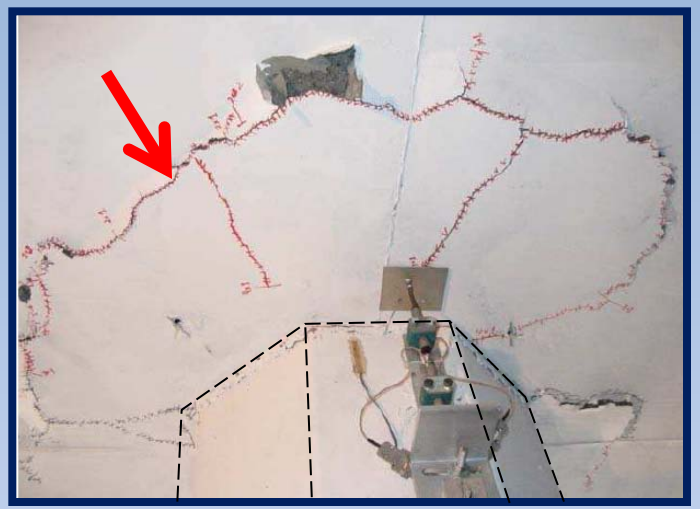
In-Ground Hinge

POLA Secondary Seismic Pile Tests (Ref. 2,3)

- 24” deck (600mm)
- 4-# 9 headed dowels
- 16 - 0.6 in. strands



POLA Secondary Pile Behavior (Ref. 2,3)



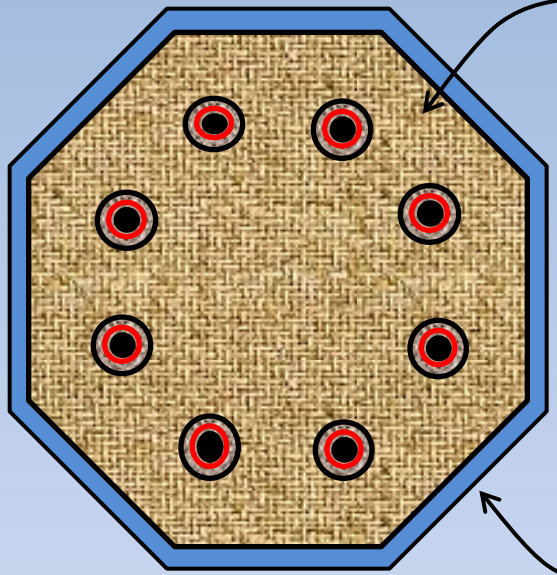
Deck Spalling $\mu_\Delta = 3$ (1.5% drift)

Spall Removed $\mu_\Delta = 4$ (2.3% drift)

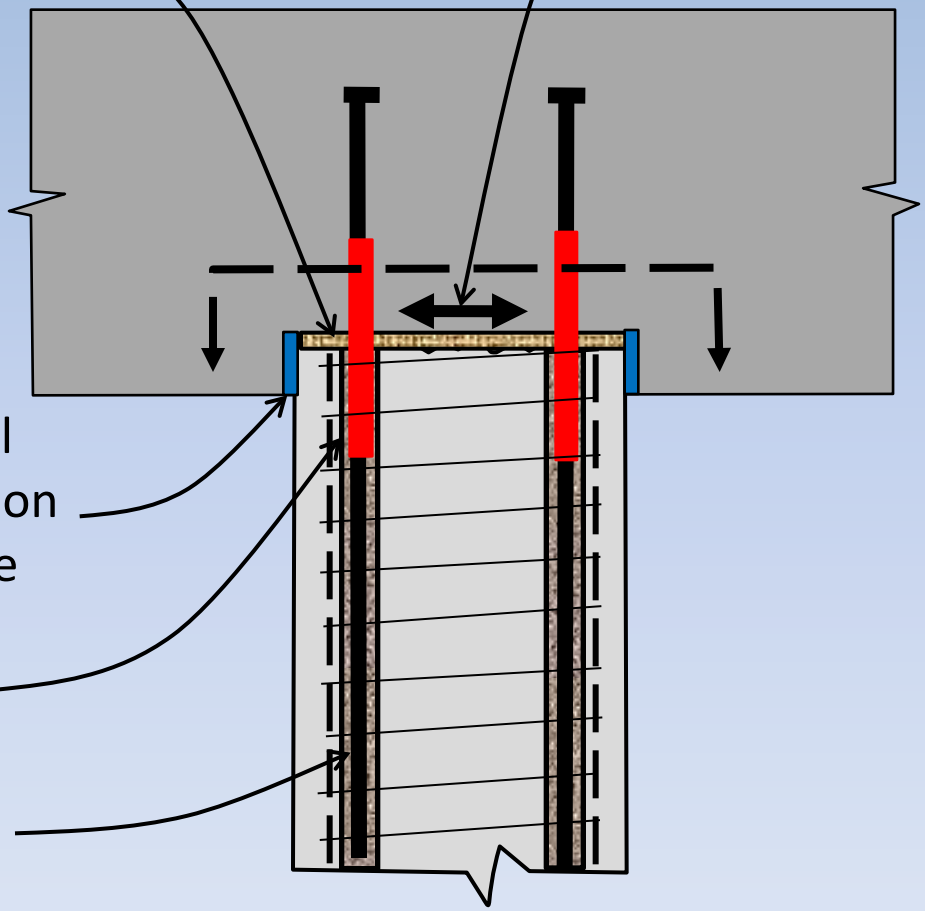
Pile Crushing $\mu_\Delta = 6$ (3.4% drift)

Test Ended $\mu_\Delta = 18$ (10% drift)

2008 UW / NEES Test on Isolated Interface (Ref. 5)



End View



Elevation

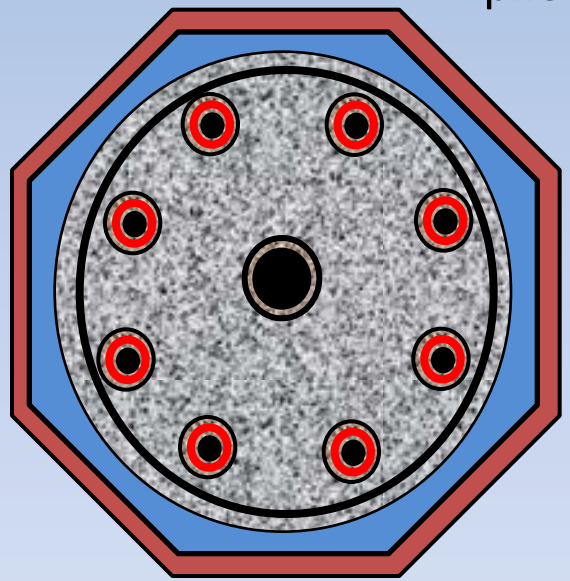
UW / NEES Isolated Interface Behavior (Ref. 5)

2.5% Drift

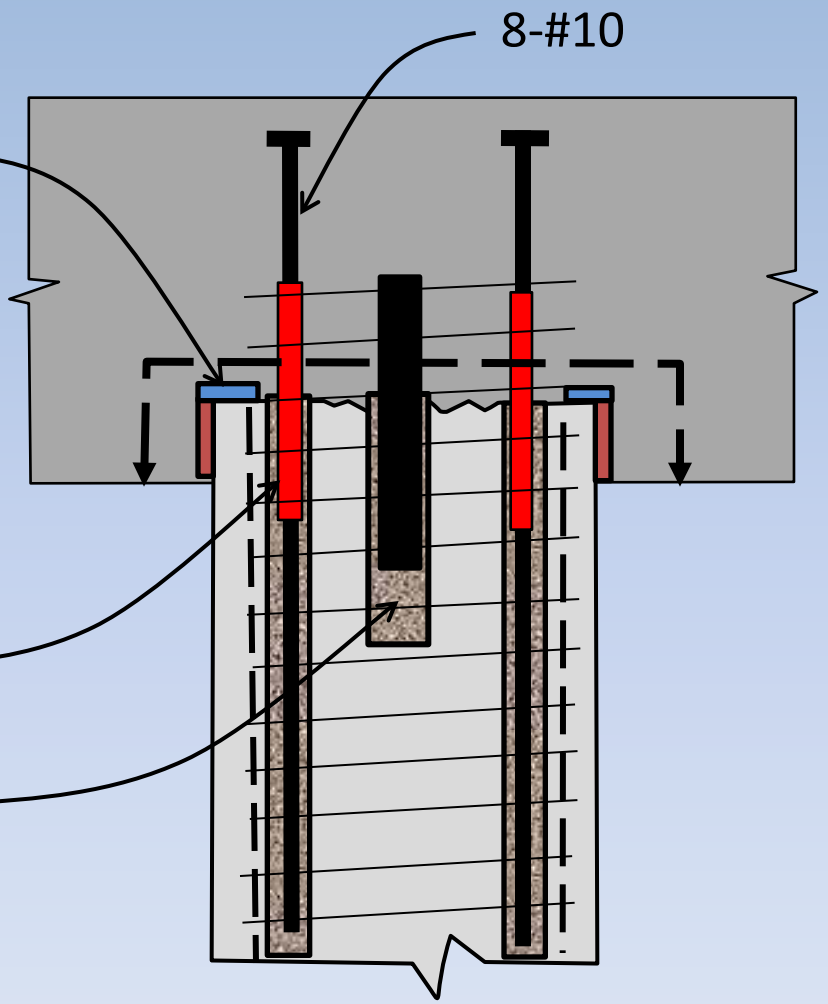
5% Drift

8.4% Drift

Possible Improvement to Isolated Interface Connection (verify by testing)



End View

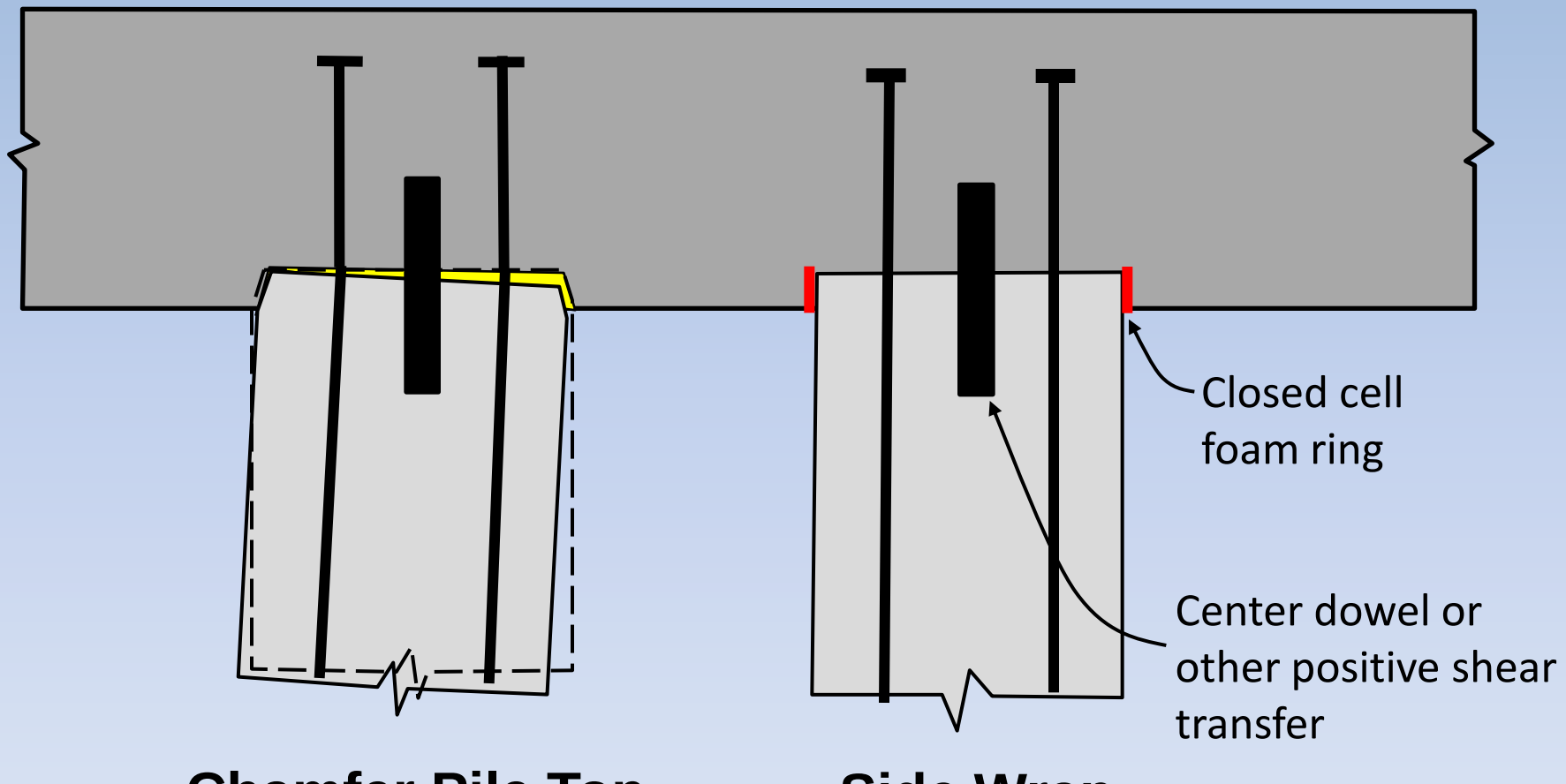


Elevation

Summary of Dowelled Connection Tests

- Connections performed as expected
- Pile rocking dominated performance
- Interface gap complicates shear transfer
- Deck spalling may be preventable
- Interface isolation appears promising if positive shear transfer is provided

Possible Methods to Minimize Deck Spalling



Pile Spiral Confinement Requirements

- Proposed minimum spiral requirements less than ACI 318
  - $\rho_s = 0.007$ in the ductile region
  - $\rho_s = 0.005$ outside the ductile region

- Spiral amount based on capacity versus demand analyses
  - Pile shear
  - Rotation in plastic hinge zones
  - Joint shear

- Spiral development requirements same as ACI 318.

Presentation Summary

- Connections considered
  - Pipe piles
  - Prestressed concrete piles
- Focused on prestressed concrete piles
- Presented damage reduction strategies
- Spiral requirements summarized

Acknowledgments

Associates

1. Gayle Johnson
2. Tim Mays
3. COPRI committee members

References

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