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

7.1 Introduction

7.2 Definitions

7.3 Symbols and Notation

7.4 Pile to Deck Connections

7.5 Confinement

7.6 Joint Region Dowel Anchorage

7.7 Joint Shear

7.8 Joint Detailing

7.9 Decks

7.10 Constructibility

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

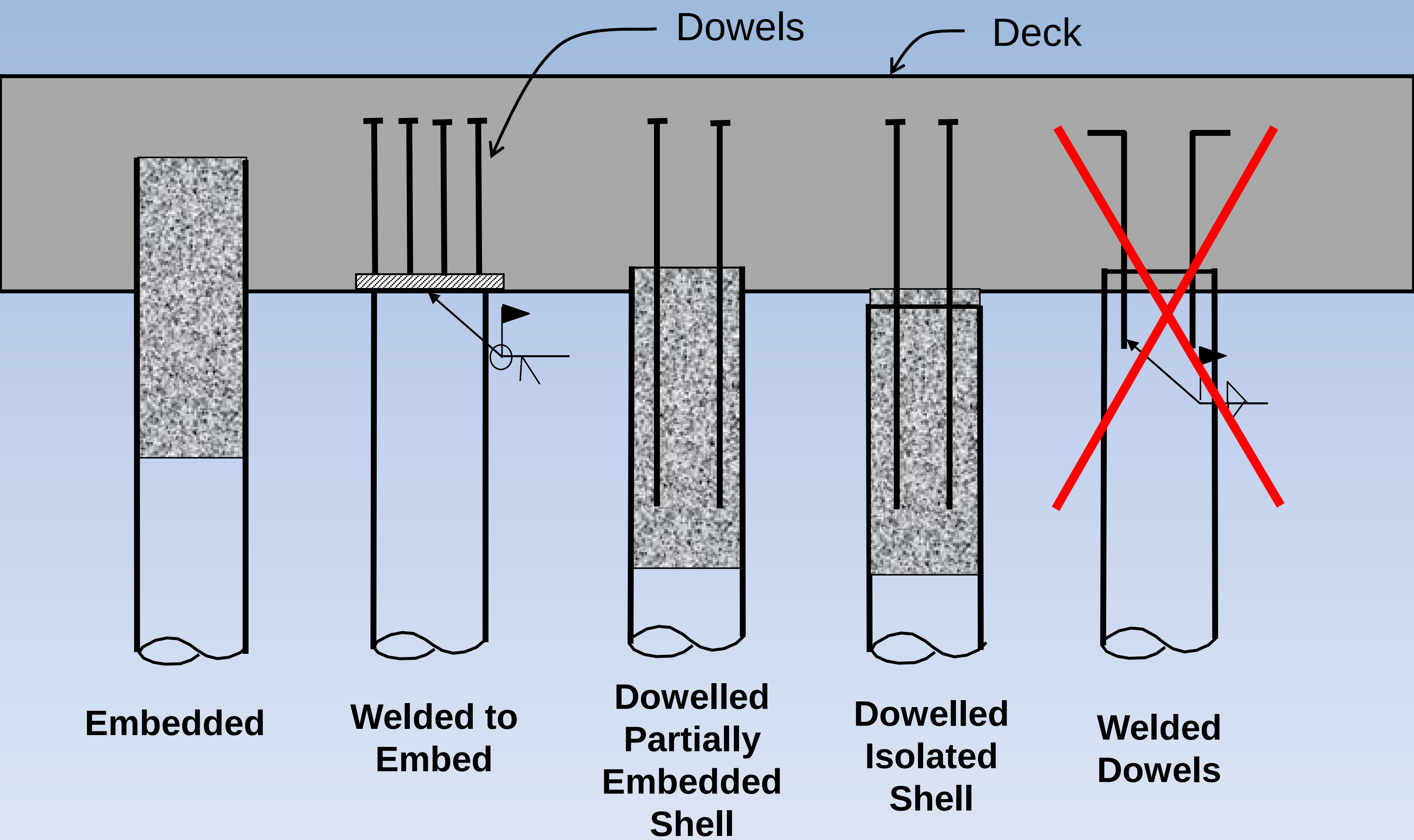
Pile to Deck Connection Testing

- Significant recent research and test data for prestressed concrete piles

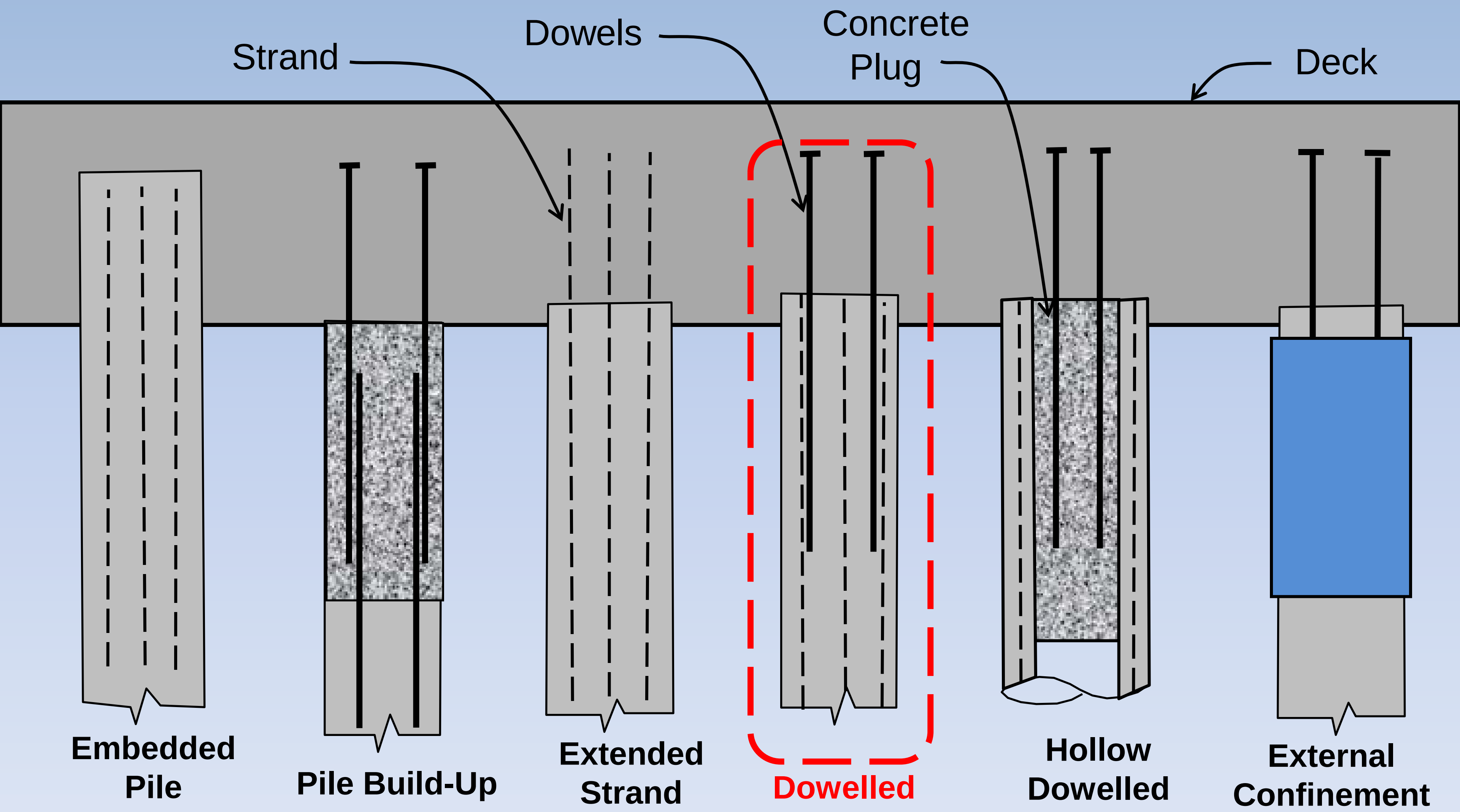
- Limited research and test data for pipe piles

- Presentation focus is on prestressed concrete piles

Example Pipe Pile Connections



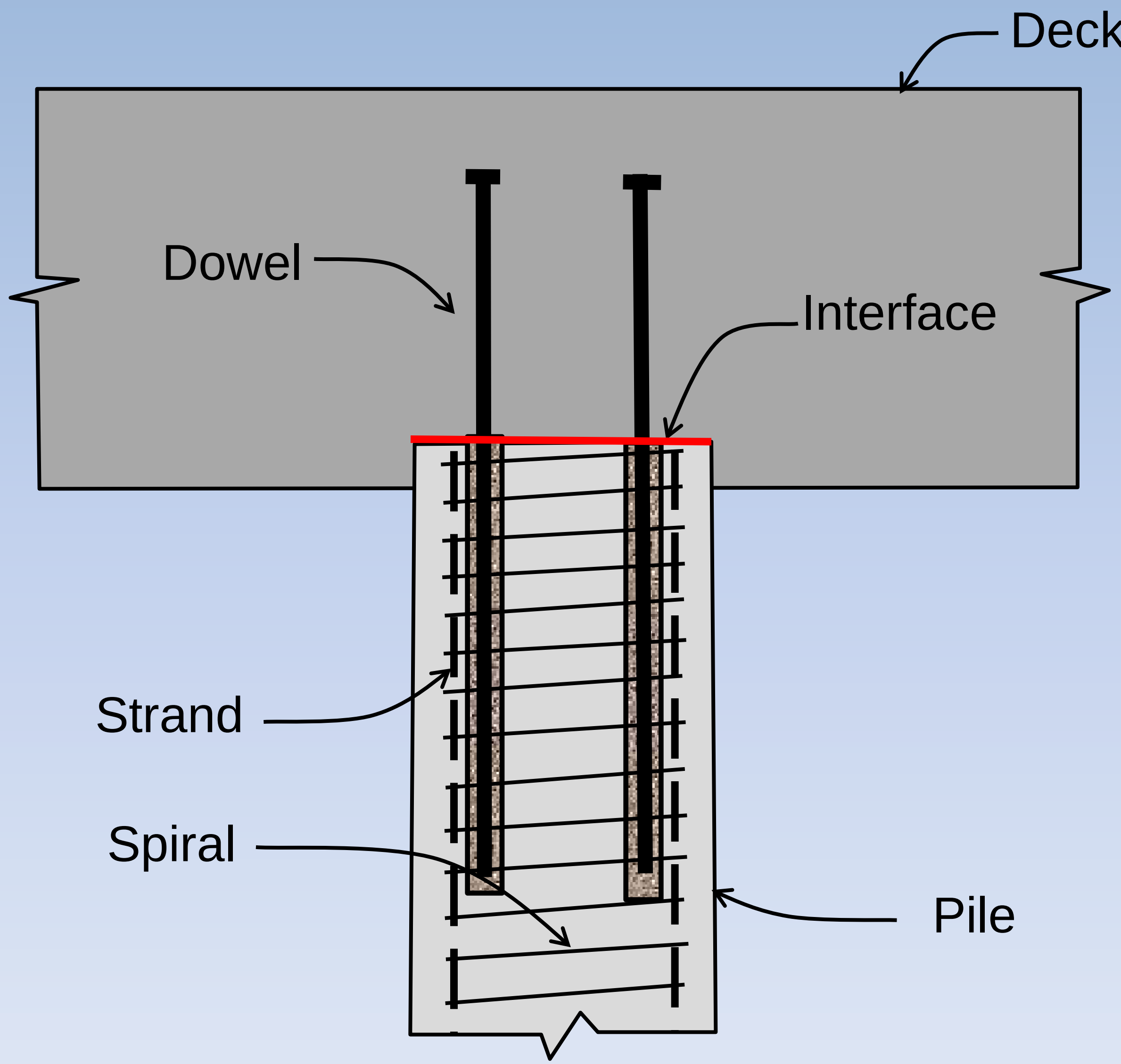
Example Prestressed Concrete Pile Connections



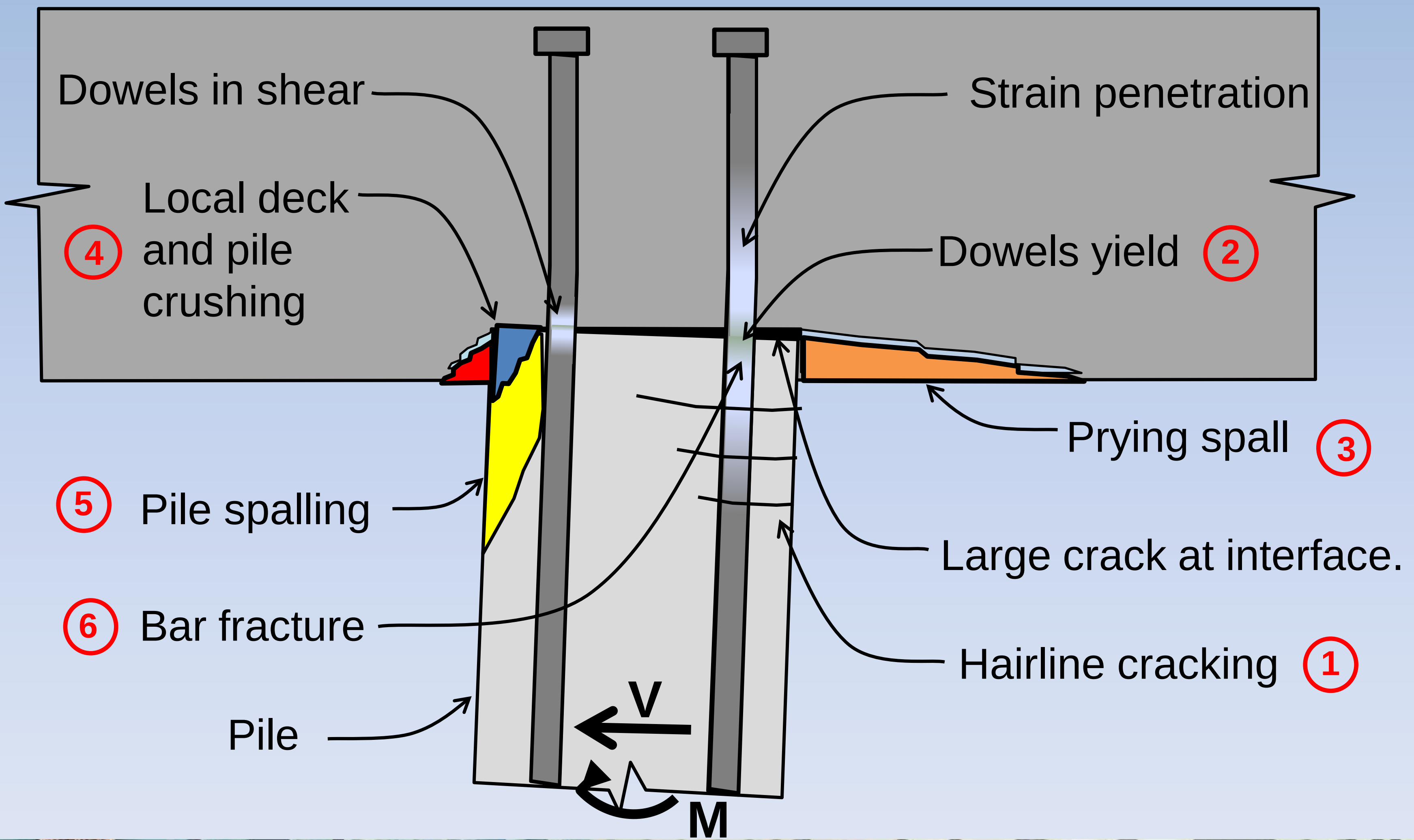
Prestressed Concrete Dowelled Connection Test Overview

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

Pile to Deck Connection Terms

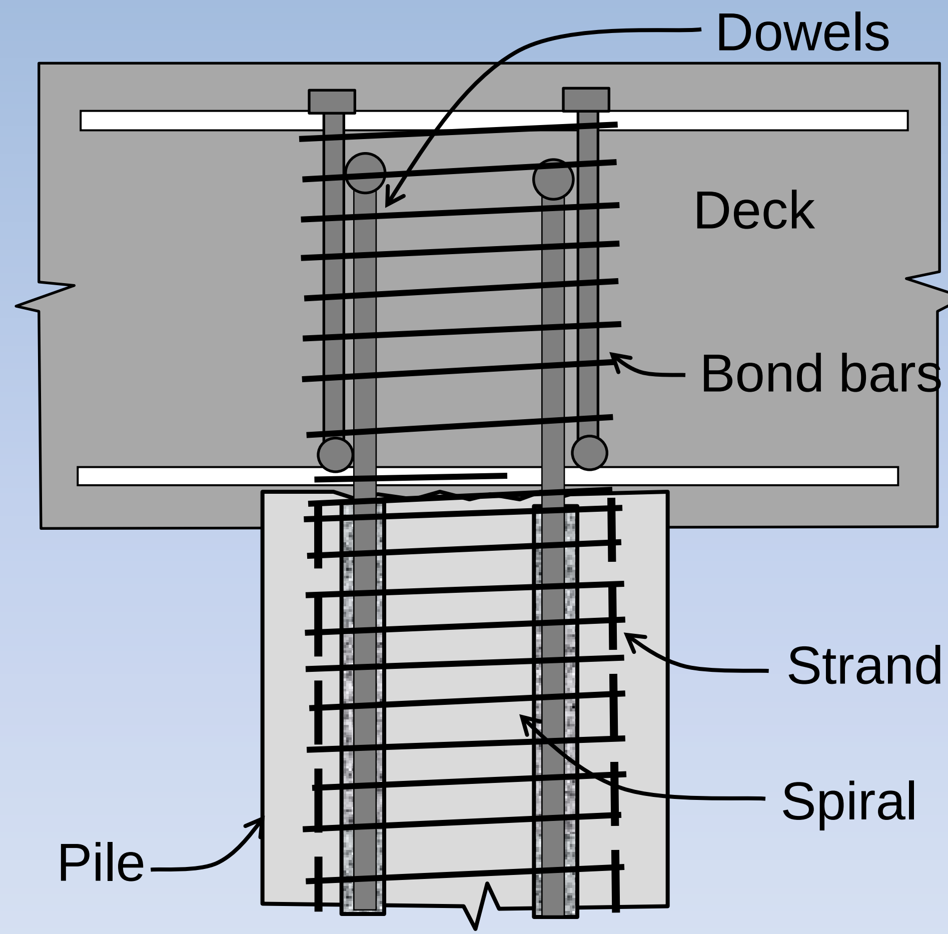


Typical Behavior of a Prestressed Concrete Pile Dowelled Connection



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)

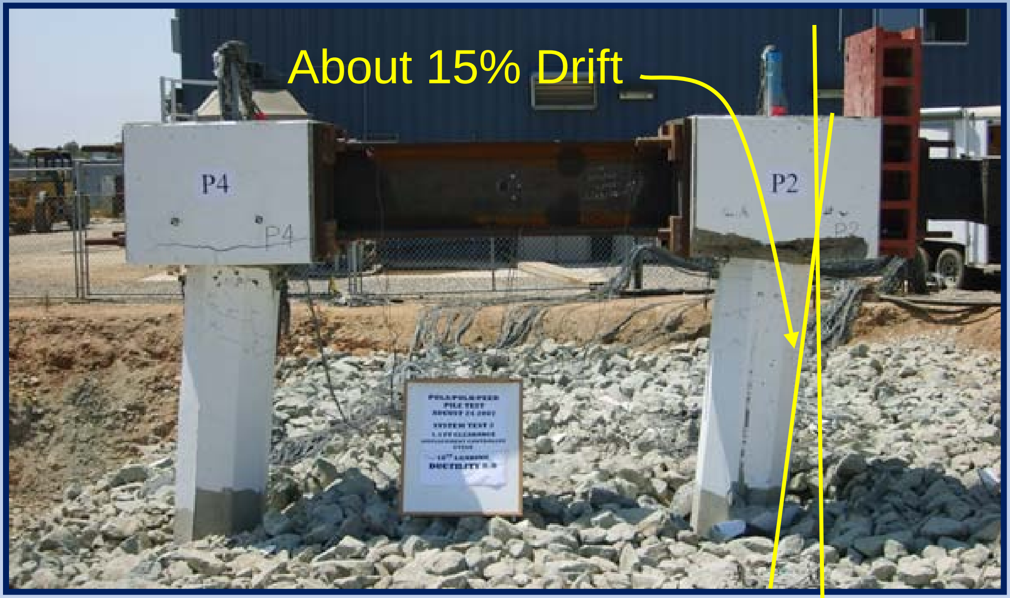
Slab Prying $\mu_\Delta = 1.5$ (1.2% drift)

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)

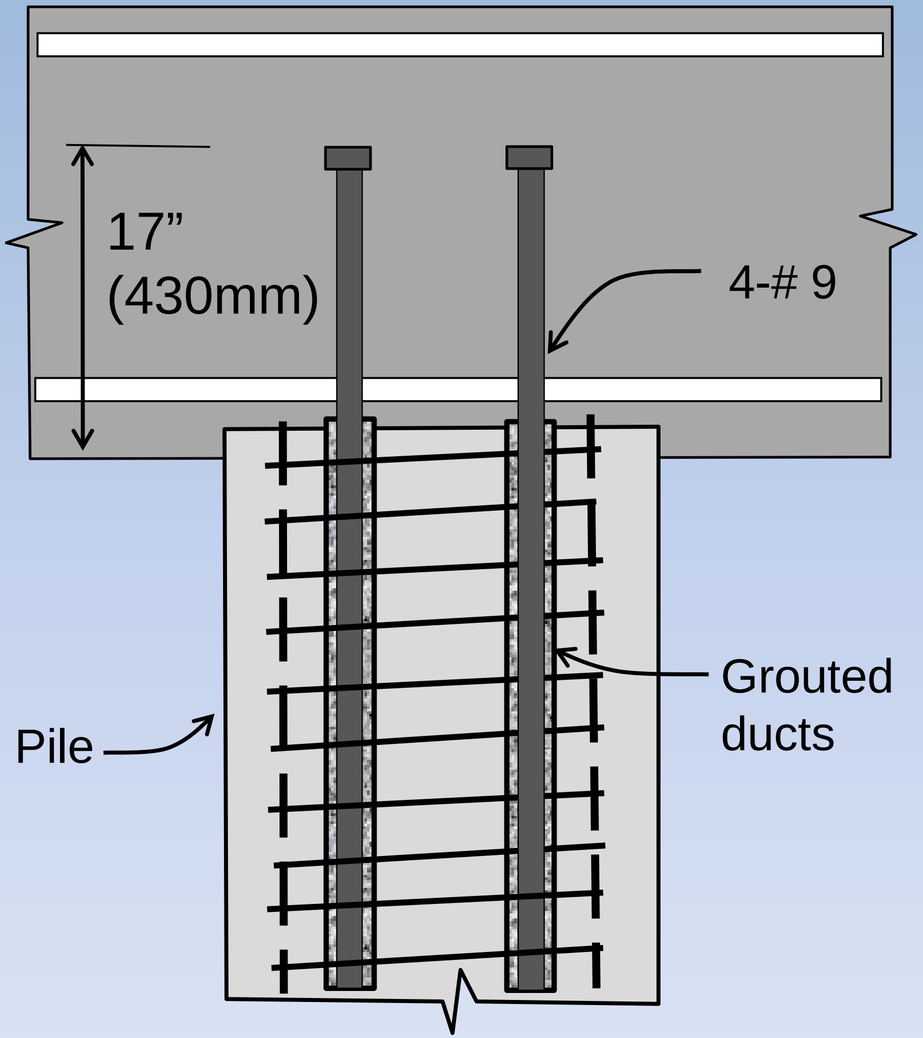
Deck

Deck Prying Spall & Interface Gap

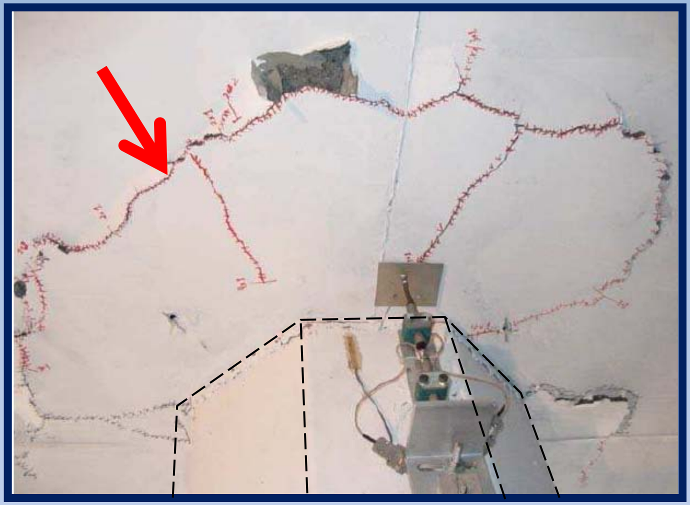
In-Ground Hinge

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)



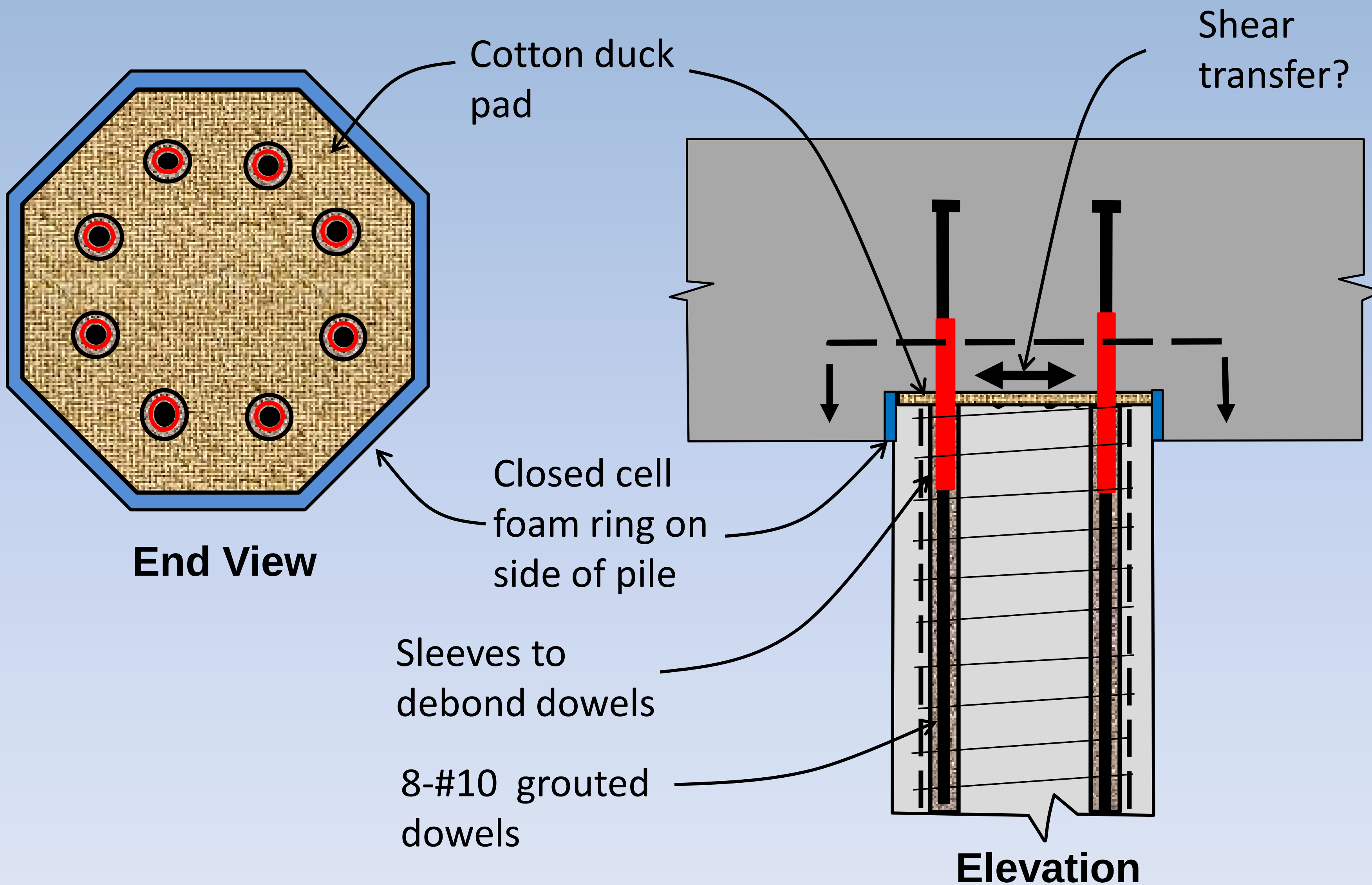
Deck Spalling $\mu_\Delta = 3$ (1.5% drift)

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)



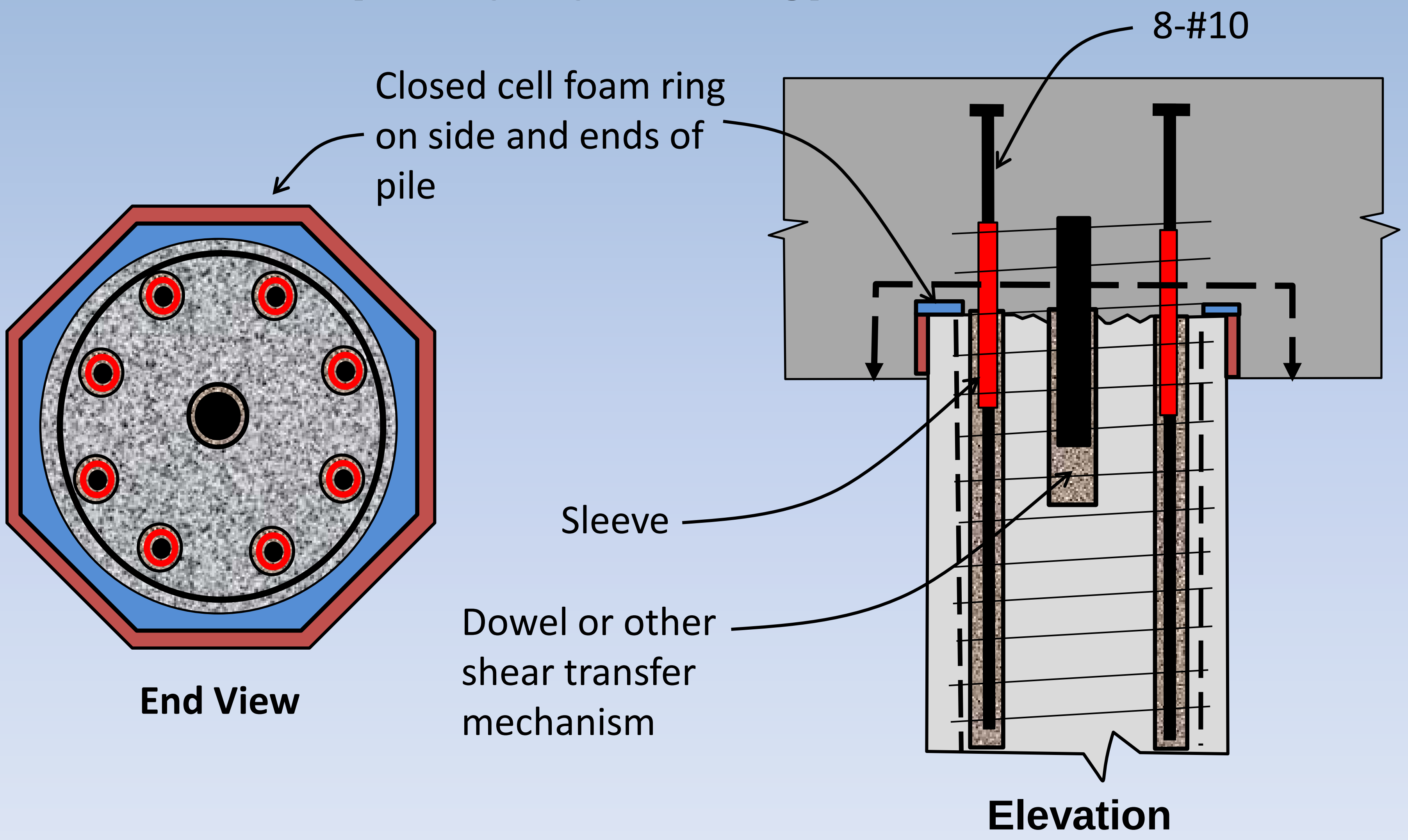
UW / NEES Isolated Interface Behavior (Ref. 5)

2.5% Drift

5% Drift

8.4% Drift

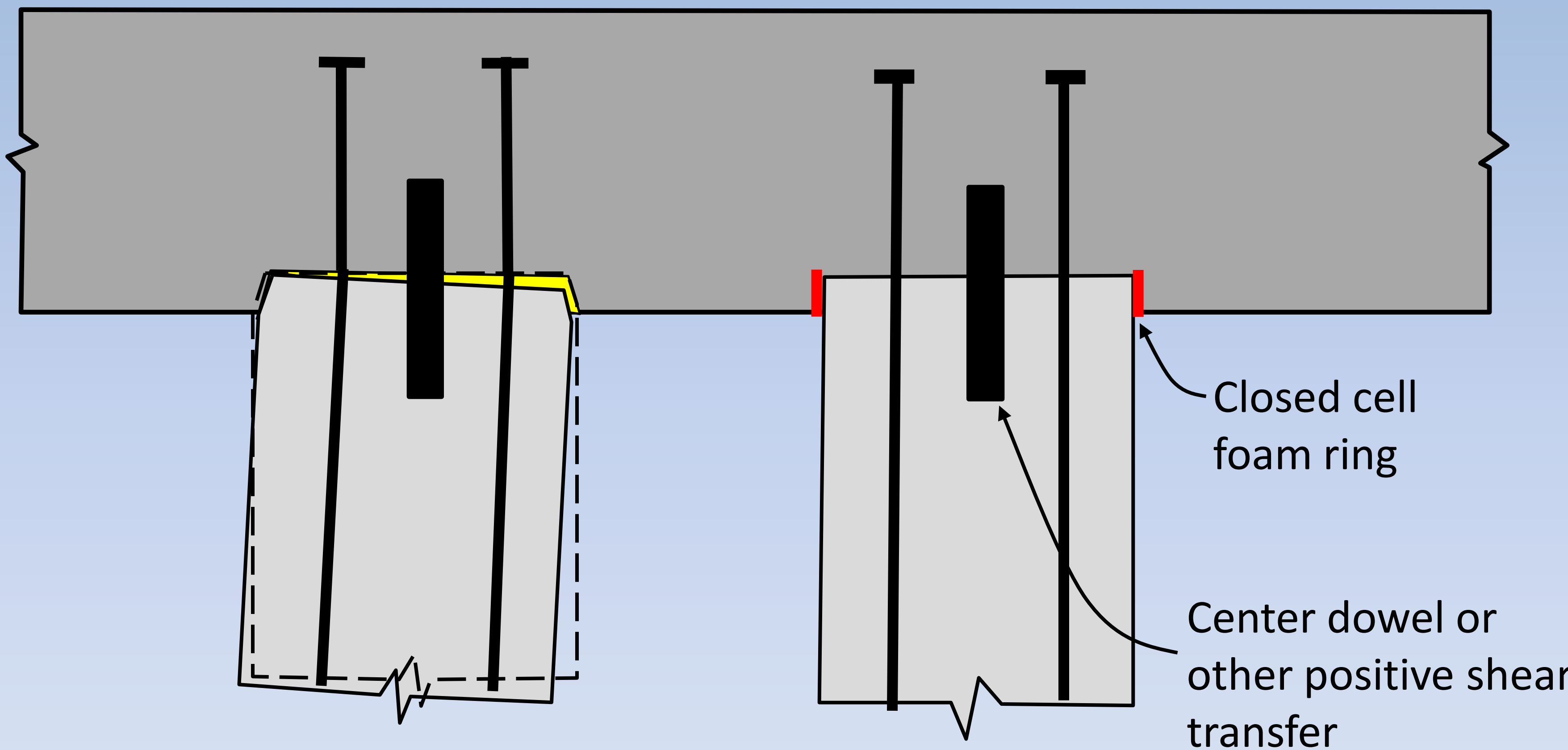
Possible Improvement to Isolated Interface Connection (verify by testing)



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



Chamfer Pile Top

Side Wrap

Pile Spiral Confinement Requirements

- Proposed minimum spiral requirements less than ACI 318
  - ρ_s = 0.007 in the ductile region
  - ρ_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

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