

Seismic Retrofit of Piers Supported on Battered Piles Using Lead-Rubber Bearings

Jeff Kilborn, MASCE, PE, SE

Robert Harn, MASCE, PE, SE

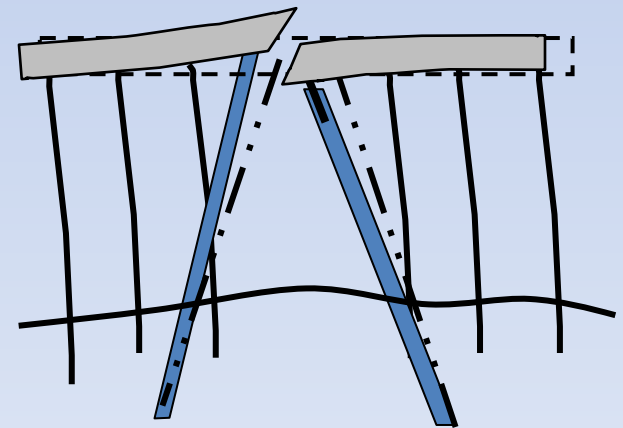
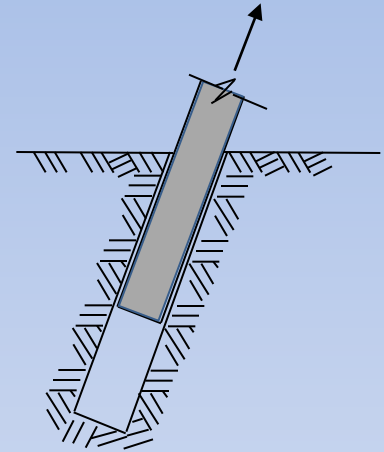
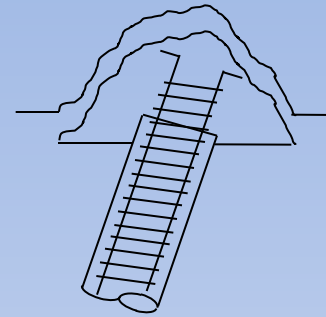
Yeliz Firat, PhD

Presentation Overview

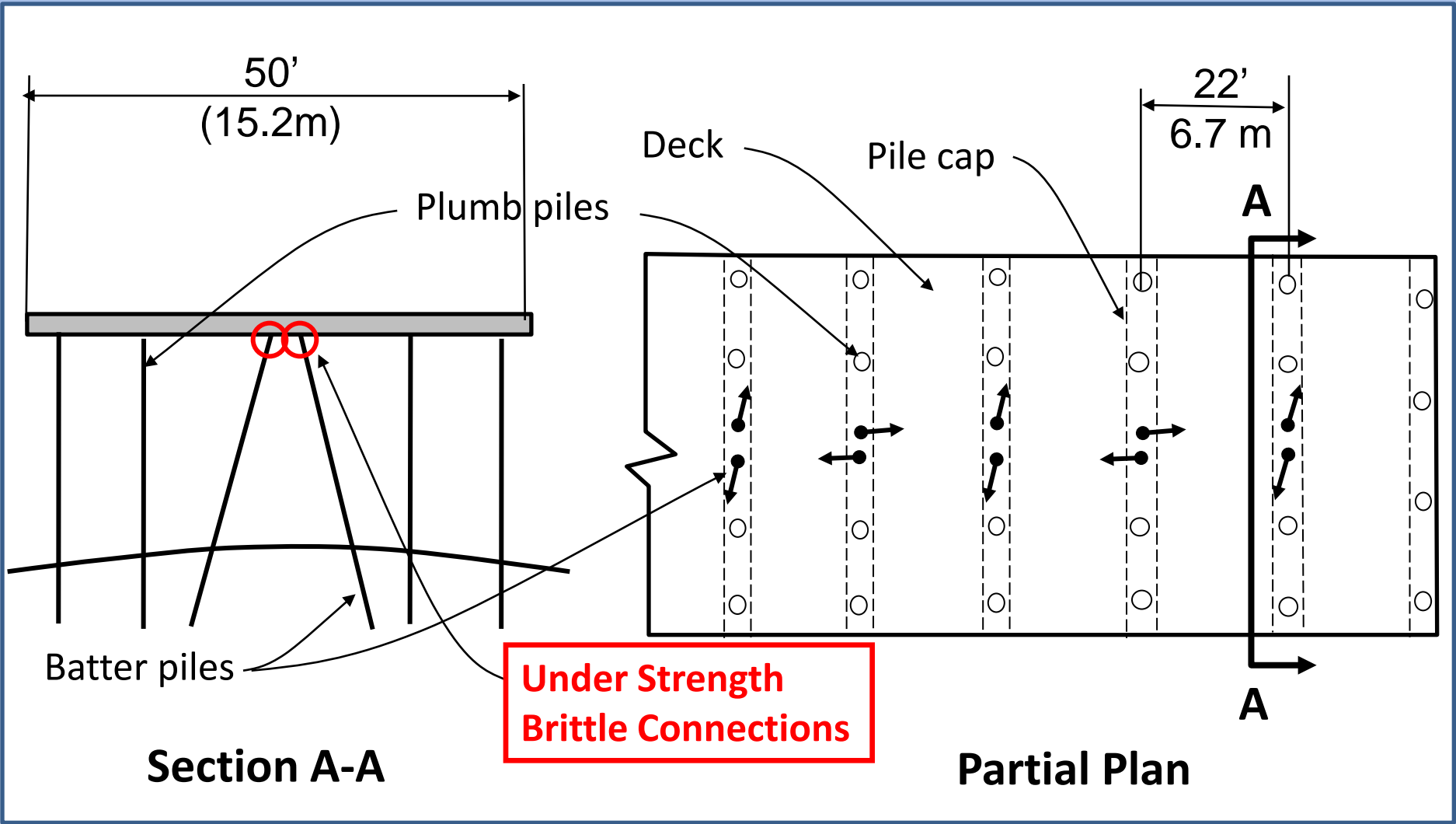
- Why Retrofit Batter Piles?
- Retrofit Case Study
 - “Existing Pier” Response and Deficiencies
 - Conventional Batter Pile Retrofit Scheme
 - Lead Rubber Bearing (LRB) Retrofit Scheme
- Design Considerations
- Construction Process
- Advantages of LRB Retrofit Scheme

Why Retrofit Batter Piles?

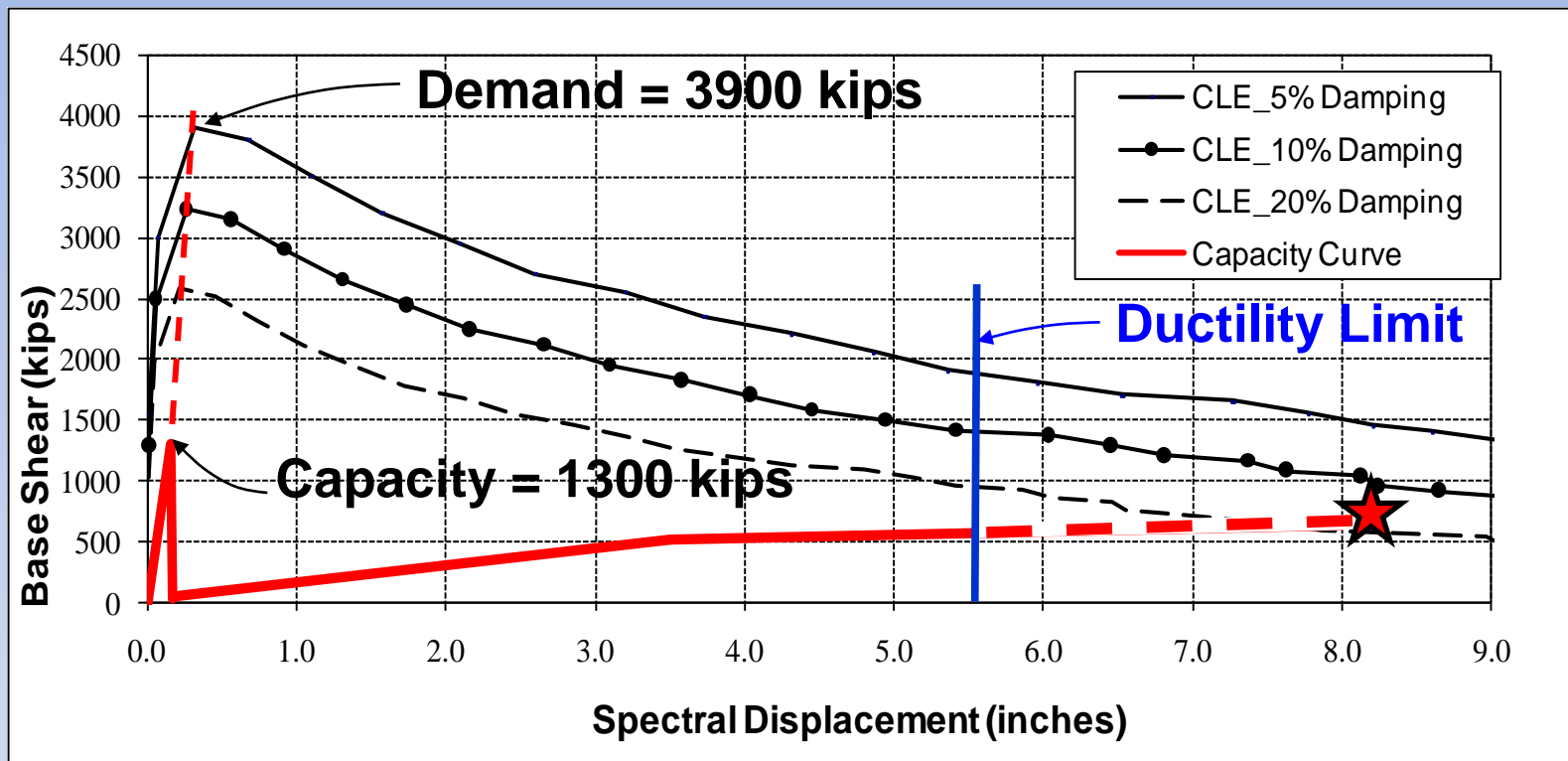
- Brittle Pile-to-Deck Connections
- Inadequate Geotechnical Capacities
- Inadequate Deck/Cap Reinforcement



Case Study - "Existing Pier"



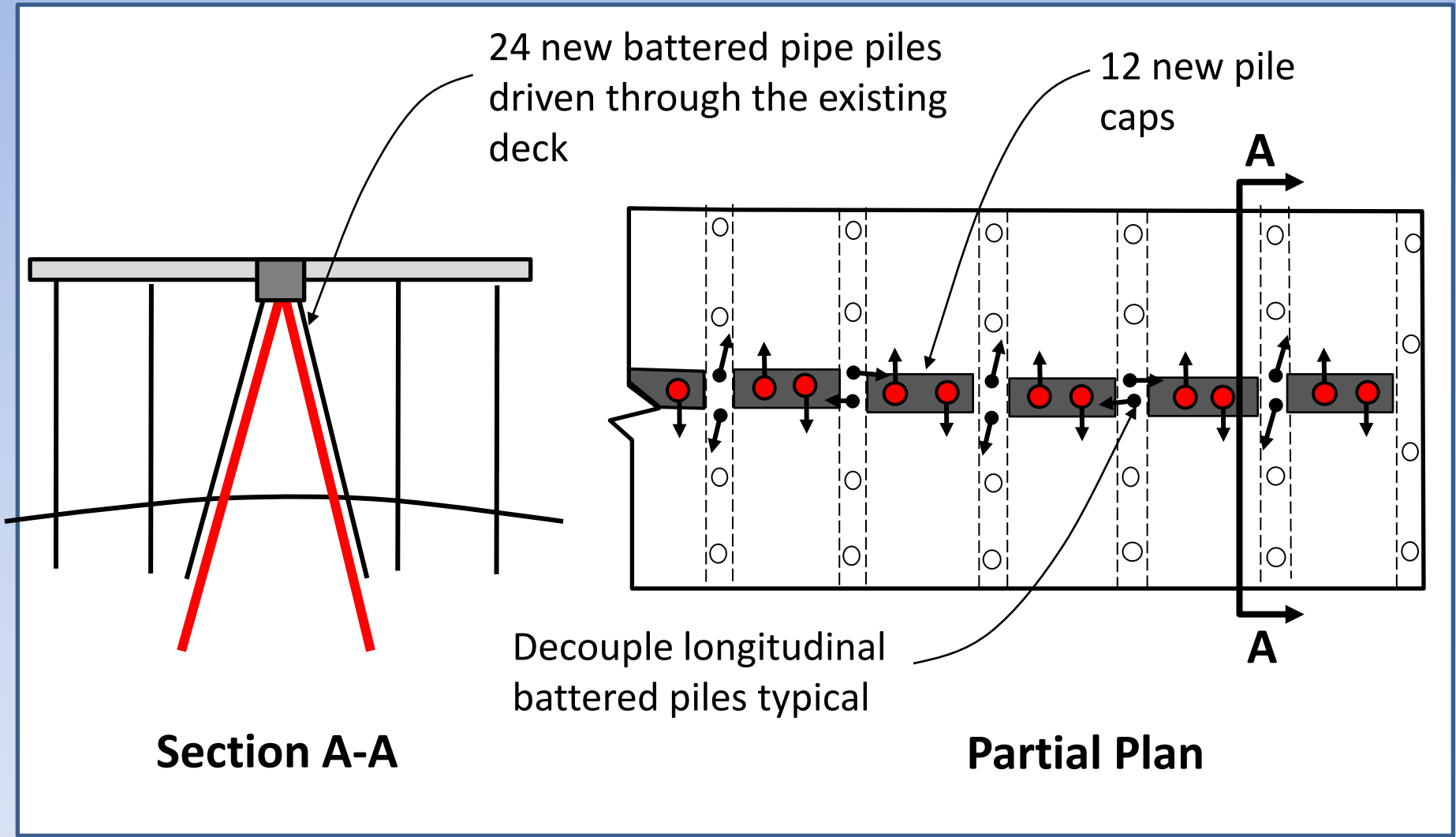
Seismic Response of Existing Pier



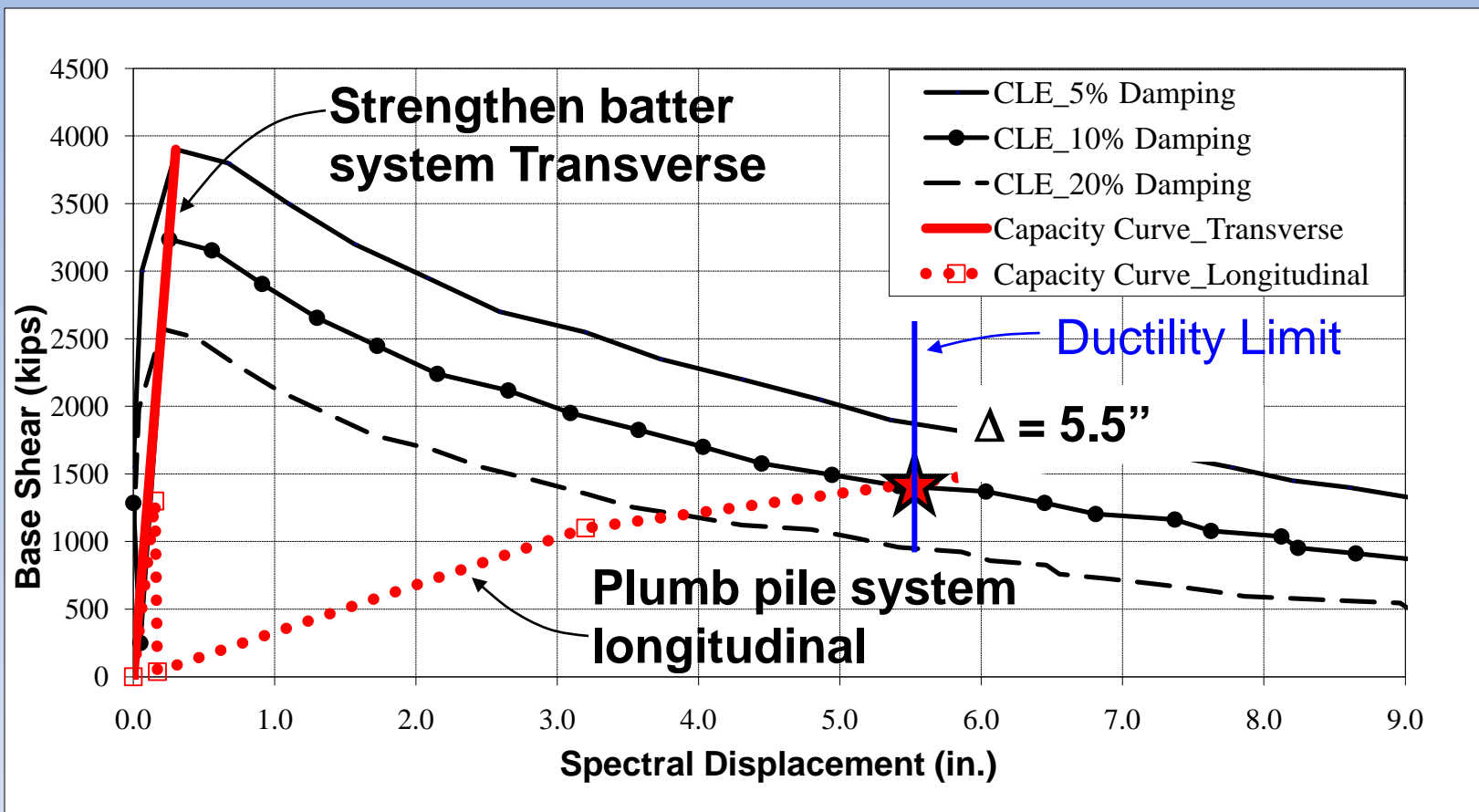
1. Initial Batter Pile System Fails
2. Less Stiff Plumb Pile System remains
3. Plumb Piles are Overwhelmed

1 Kip = 4.45 kN
1 Inch = 2.54 cm

Conventional Batter Pile Retrofit Scheme



Batter Pile Retrofit Response

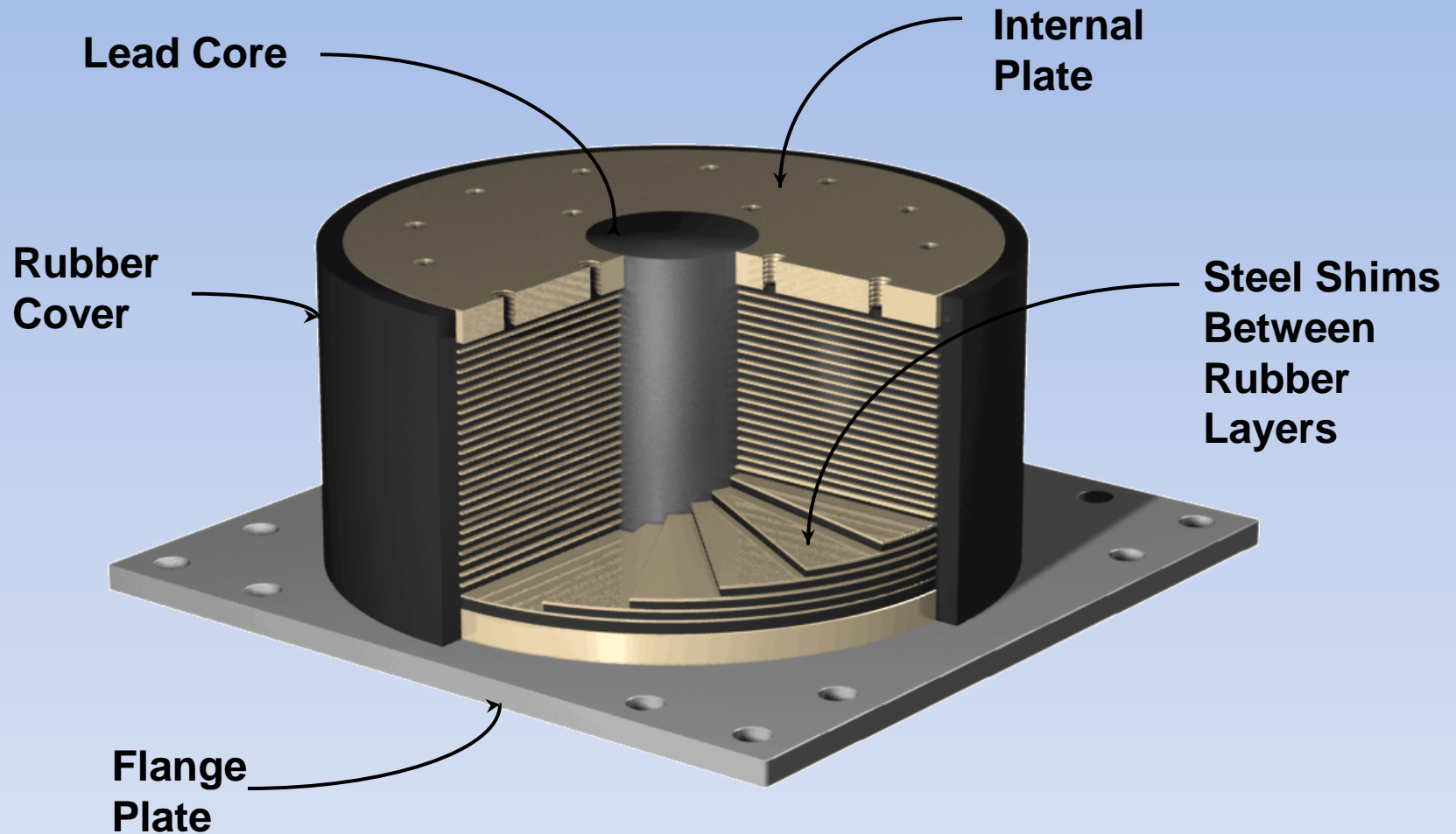


Performance is Acceptable!

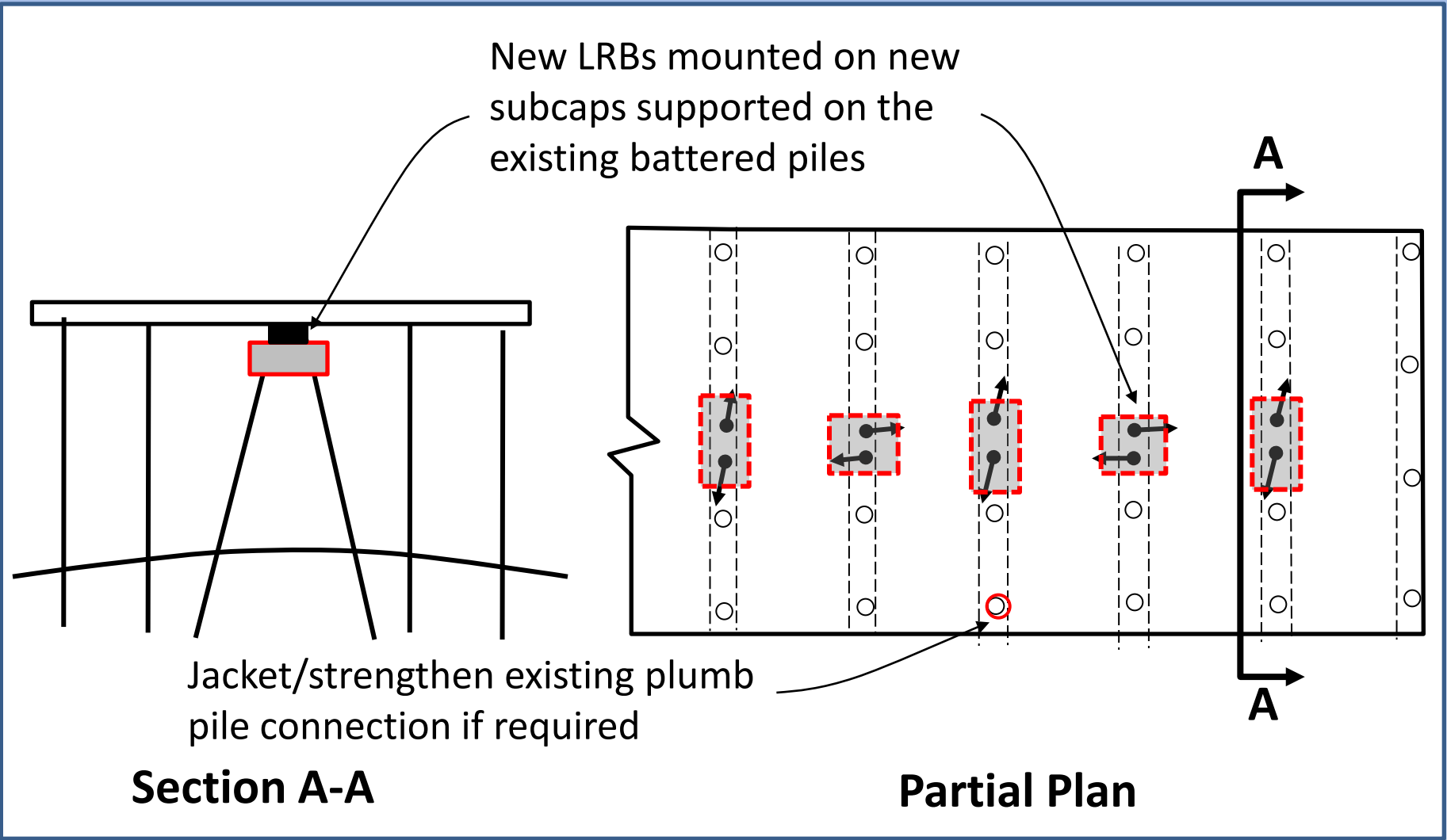
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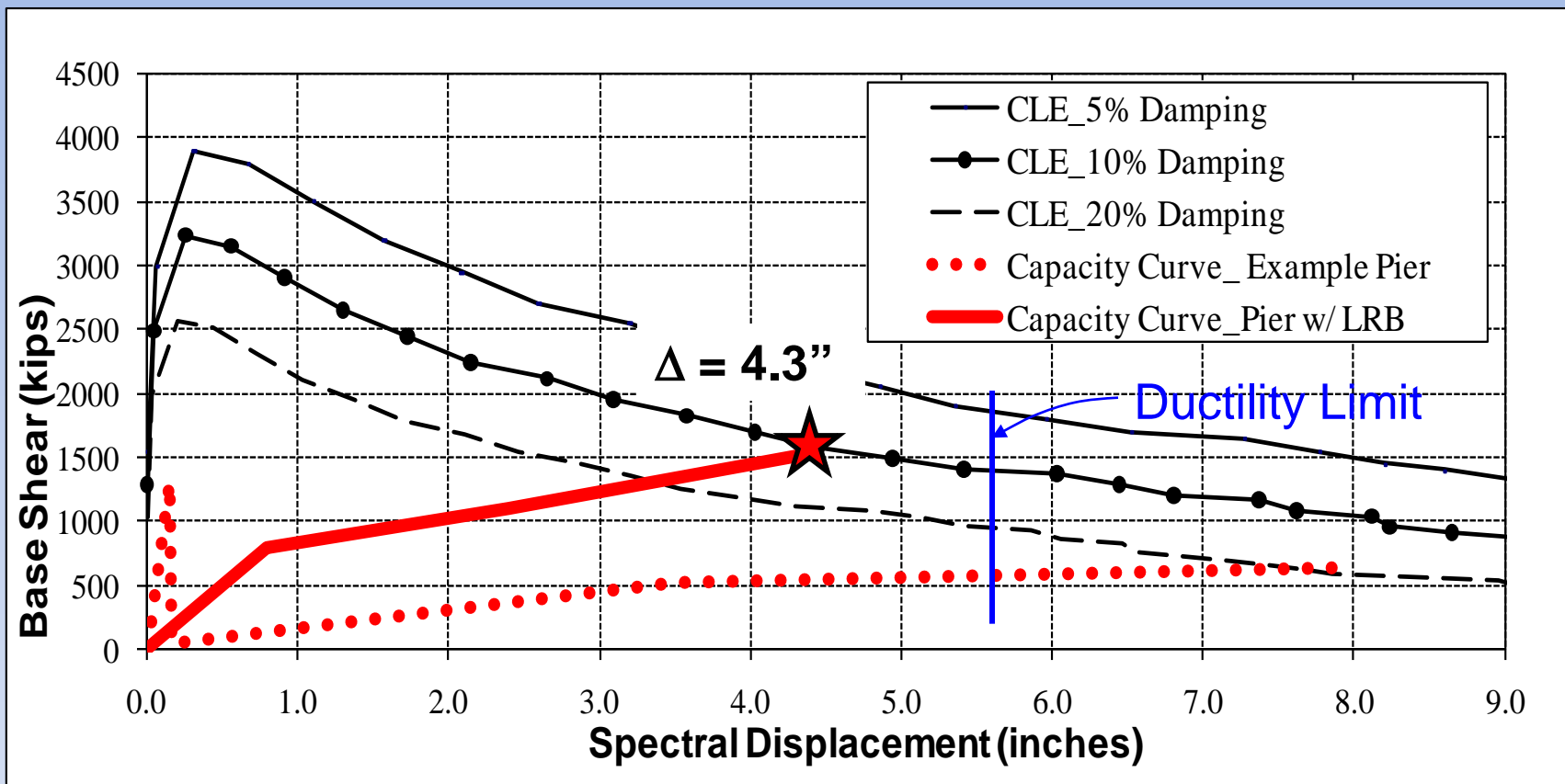
Lead Rubber Bearing Elements



LRB Retrofit Scheme



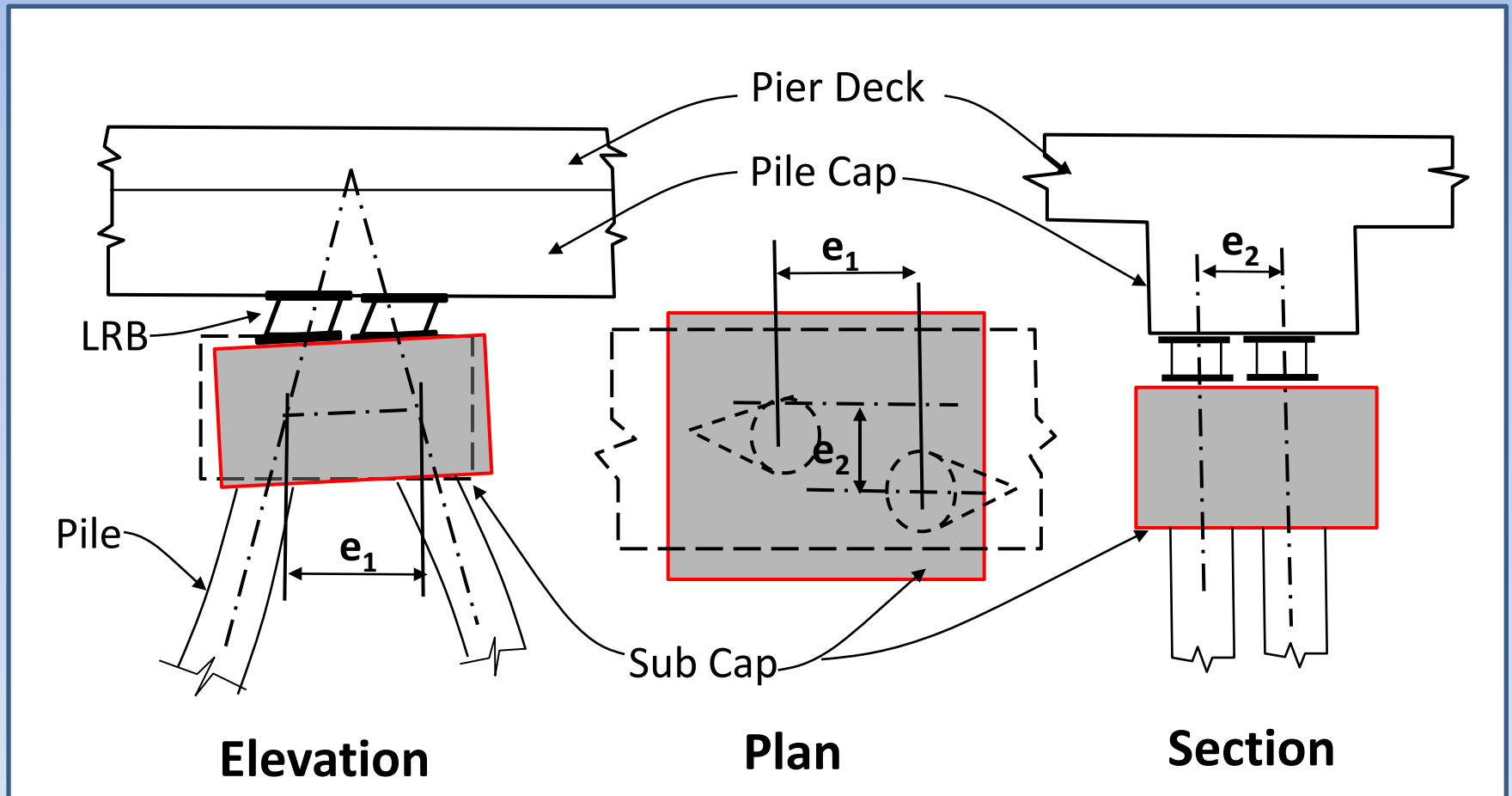
LRB Retrofit Response



Better Performance Than Conventional Scheme!

1 Kip = 4.45 kN
1 Inch = 2.54 cm

Design Considerations



Construction Process

Pile Shell Removal



Stage 1 Pilecap Construction



Shoring & Pile Cutoff



Anchoring Pile Reinforcement



Example of LRB Installation



Advantages of LRB Retrofit Scheme

- Avoid Pile Driving
- Work Occurs Under Deck
- Bearings Remain Undamaged
- Cost Competitive
- Reliable & Designable Stiffness, Strength, and Damping
- Global Torsion Can Be Designed Away
- Forces Reduced for All Elements

THANK YOU !!

Acknowledgements

- Bob Harn
- Yeliz Firat