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

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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”

Section A-A

- **Plumb piles**
- **Batter piles**
- **Under Strength Brittle Connections**

Partial Plan

- **Deck**
- **Pile cap**

Dimensions:

- 50’ (15.2m)
- 22’ 6.7 m
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

Section A-A

24 new battered pipe piles driven through the existing deck

Decouple longitudinal battered piles typical

12 new pile caps

Partial Plan
Batter Pile Retrofit Response

Performance is Acceptable!

1 Kip = 4.45 kN
1 Inch = 2.54 cm
Lead Rubber Bearing Elements

Lead Core

Internal Plate

Rubber Cover

Steel Shims Between Rubber Layers

Flange Plate
LRB Retrofit Scheme

Section A-A

New LRBs mounted on new subcaps supported on the existing battered piles

Jacket/strengthen existing plumb pile connection if required

Partial Plan
LRB Retrofit Response

Better Performance Than Conventional Scheme!

Δ = 4.3”

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
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 !!

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