Prevention First 2016

Upgrades & MOTEAMS Seismic Retrofit of the Shell Martinez Refinery Marine Terminal, Martinez, California

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Presentation Outline

• Discuss MOTEMS & Project Upgrades
• Lessons Learned
Shell Martinez Refinery MOT
MOTEMS & Project Upgrades

- Fender System Upgrade
- Mooring Hook Upgrade
- MOTEMS Seismic Retrofit
  - Approach Trestle
  - Loading Berths
New Fenders on Wharf
Lease Requirements on Shell Wharf
Lease Requirements for Shell Wharf
Mooring Hooks
Loading Berth Seismic Upgrade

– Existing Structure
  • 20” square, prestressed concrete piles
  • Precast/CIP deck perimeter
  • Prestressed deck ‘K’ struts
MOTEMS Seismic Deficiencies

• Risk of Progressive Collapse at L2 EQ
  – Batter piles fail in tension
  – Large lateral displacements
  – Failure of plumb piles
  – Potential for oil spill
Seismic Mitigation Goals

• Full MOTEAMS L2 seismic compliance
• After earthquake …
  – No oil spill
  – Life-safety
• Maintain current operational function
• Minimal disruption of …
  – Environment
  – Operations … during construction
Project Constraints

- Continued operations
- Remains of old wharf
- Environmental in-water work windows
  - Salmonoids
  - Clapper Rail
- Construction access
  - Approach trestle w/ 4-ton load limit
  - Shallow backside < 5’ draft (MLLW)
Concepts Considered

- New Platform $$$
- Strengthen inside of wharf footprint
- Strengthen outside of wharf footprint

feasibility/disruption
Seismic Dolphin Concept

• “Catch” Loading Berth to …
  – Limit lateral displacement
  – Allow (e)batter piles to fail

• Prevent …
  – Failure of plumb piles
  – Catastrophic collapse

• Utilizes typical batter pile pairs
  – Relatively stiff system
  – Axial capacity limited by soil
Seismic Analysis

- Independent model for each Loading Berth

- Nonlinear Static Demand Procedure (Pushover)
  - Substitute Structure Approach
  - Coefficient Method
Final Strengthening Scheme

- 11 Seismic Dolphins
- Plumb Pile FRP
- Deck Beam FRP
- 8 Isolation Pile Caps
Isolation Pile Caps

- 8 caps per Loading Berth
- Provide gravity support only
- UHMW to minimize lateral loads
Plumb Pile FRP

- Increase confinement
- Higher P-M capacity
- Horizontal fibers

- Address (e)Build-ups:
  - Strengthen splice
  - Longitudinal fibers
Plumb Pile FRP

• Movable work platform
  – Eliminated scaffolding
  – More access than scaffolding
  – Improved installer safety
  – Easy repositioning
  – Eliminated need for divers
Deck Beam FRP

- Localized shear strengthening
- Minimize impact to pipelines and conduit
- U-shaped
- ACI 440.2R-08
Finished Deck Beam FRP
Soil Explorations

- **1963 Data**
  - 8 borings; 60-90’ below ML

- **2013 Data**
  - 4 borings; 108-121’ below ML
  - 6 CPTS
Results of Geotech Evaluation

- Lower response spectrum
- Refined soil springs, 7 discreet regions
- Discovered, prepared for, alluvial channel
- Fewer Piles
  - 12 less at Downstream
  - 14 less at Upstream
  - 26 less piles \(\rightarrow 17\%\) reduction
Pile Stingers

- 5’ typical; 20’ in alluvial channel
- Improves driveability
- Penetration through debris
- Optimize skin friction, weight
Dolphin-to-Deck Connection

- Custom designed pipe anchor connection
- Eliminated “Swiss Cheese” connection
- Easy installation, flexibility to avoid rebar
Pile Driving

(Batter) Pile Handling/Alignment
Overhead Interferences

Scheduling (vessels & tides)
Dolphin Installation

• Template ➔ Falsework • Rebar Pre-fab
Finished Dolphins
Project Status Today

- Berth 2 completed
- All FRP work completed
- Berth 1 pile driving underway
- Expect full operations to be maintained during Berth 1 construction
Additional Lessons Learned

• Good Owner-Contractor-Engineer team = Project success!
• Good geotechnical data improves pile design
• Contractor needs well defined work rules/limits/boundaries
• Be flexible – Vessel traffic is fickle
Thank you!