Prevention First 2016

Upgrades & MOTEMS 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

Valero Benicia Refinery

Crockett

Crockett Hills Regional Park

Calquines State

Area

Carquinez Strait Regional Shoreline

Martinez

Bay Area Training Corporation

Shell Martinez Refinery MOT

Upstream Loading Berth Berth 1

Downstream Loading Berth Berth 2

YERE

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 MOTEMS 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 \$\$\$

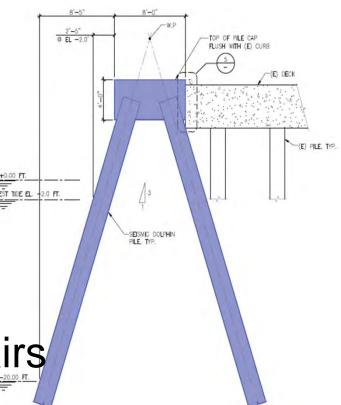
feasibility/disruption

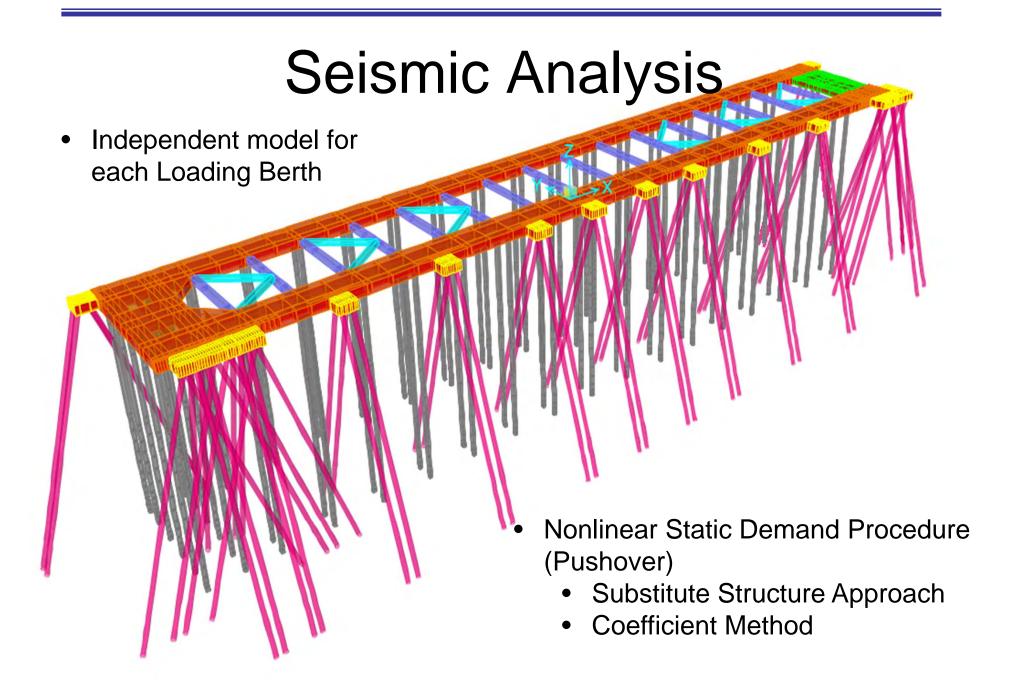
- Strengthen inside of wharf footprint
- Strengthen outside of wharf footprint



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

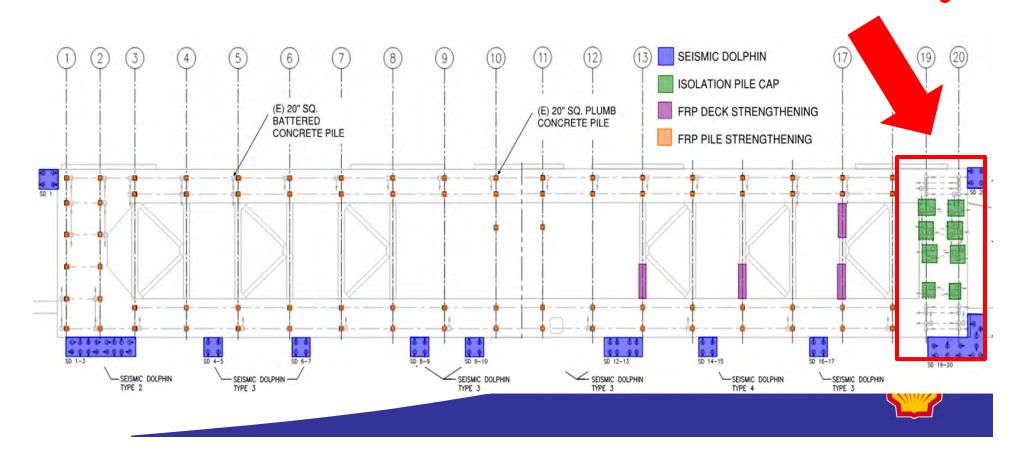




Final Strengthening Scheme

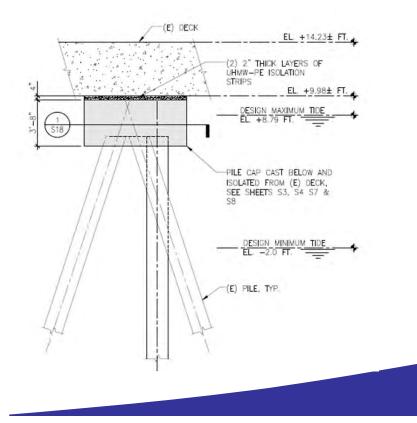
- 11 Seismic Dolphins
- Plumb Pile FRP

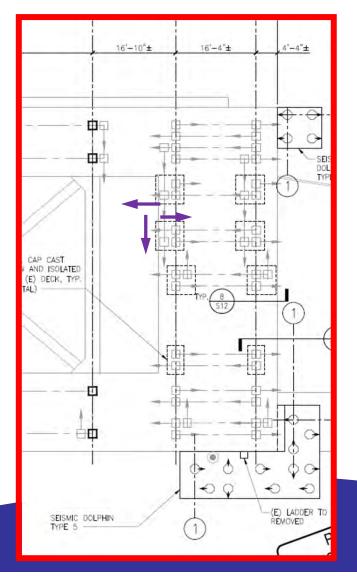
- Deck Beam FRP
- 8 Isolation Pile Caps



Isolation Pile Caps

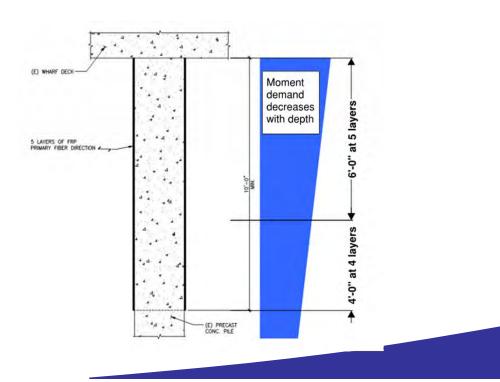
- 8 caps per Loading Berth
- Provide gravity support only
- UHMW to minimize lateral loads





Plumb Pile FRP

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



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





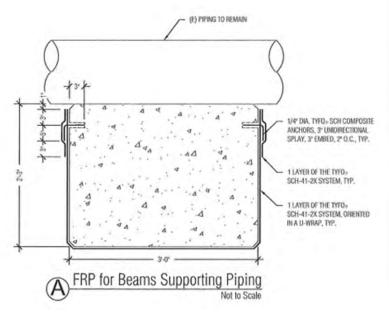
Plumb Pile FRP

- Movable work platform
 - Eliminated scaffolding
 - More access than scaffolding
 - Improved installer safety
 - Easy repositioning
 - Eliminated need for divers



Deck Beam FRP

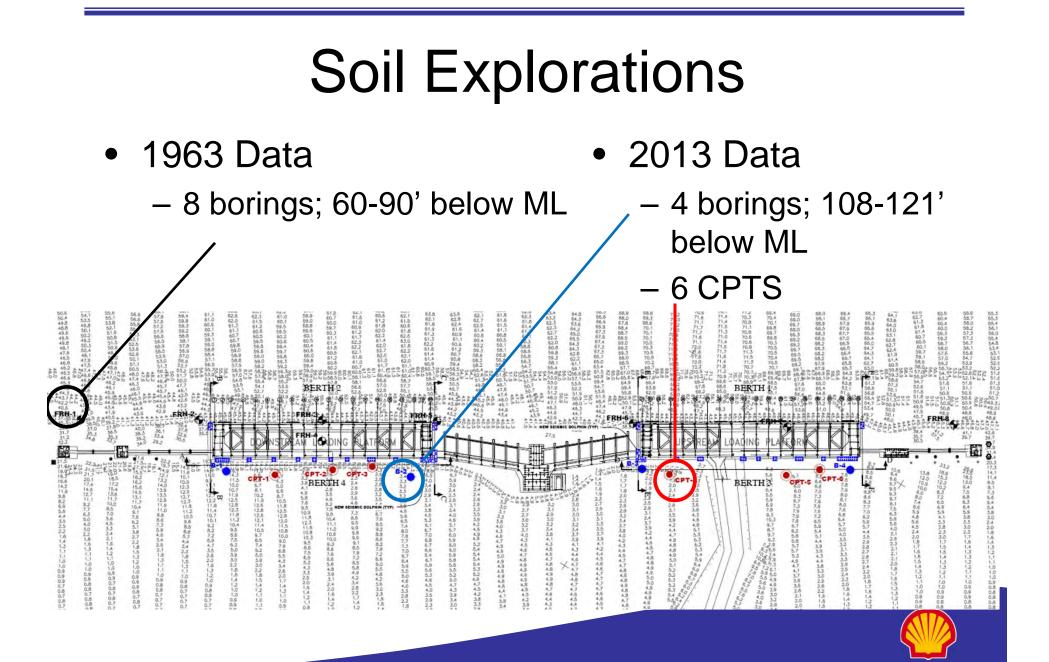
- Localized shear strengthening
- Minimize impact to pipelines and conduit
- U-shaped
- ACI 440.2R-08

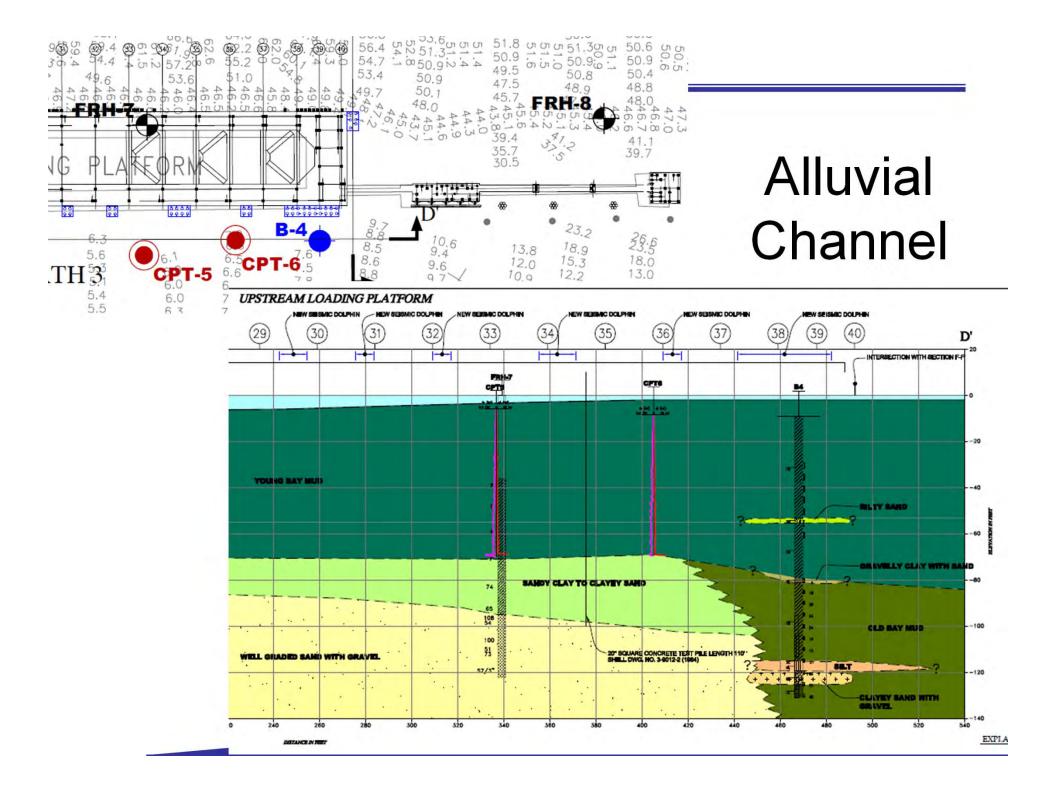




Finished Deck Beam FRP

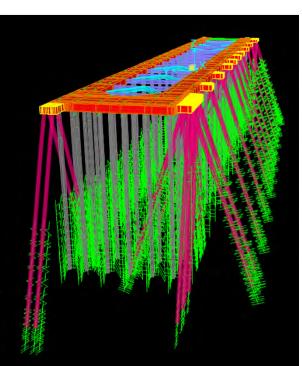






Results of Geotech Evaluation

- 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

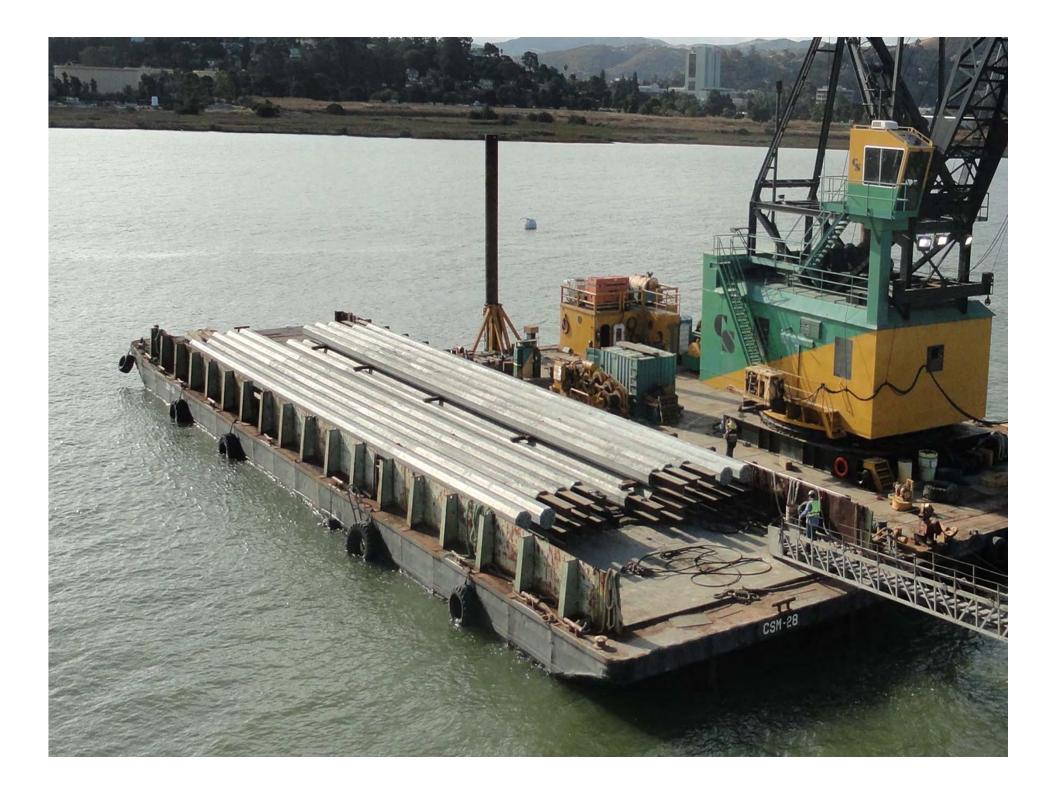
- 5' typical; 20' in alluvial channel
- Improves driveability
- Penetration through debris
- Optimize skin friction, weight



CUT OFF

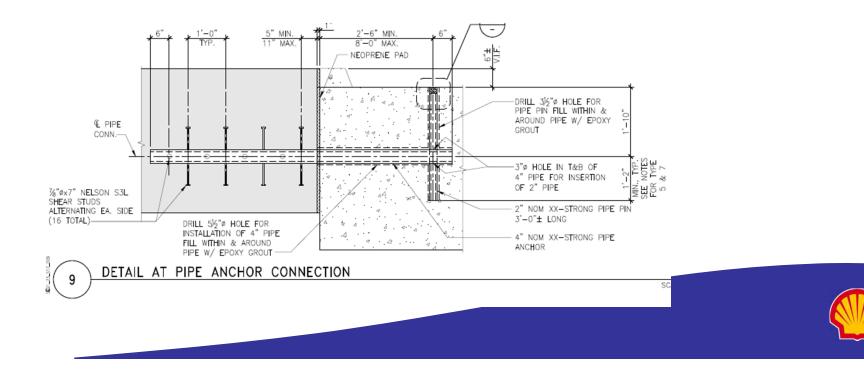
-DOWEL TUBES

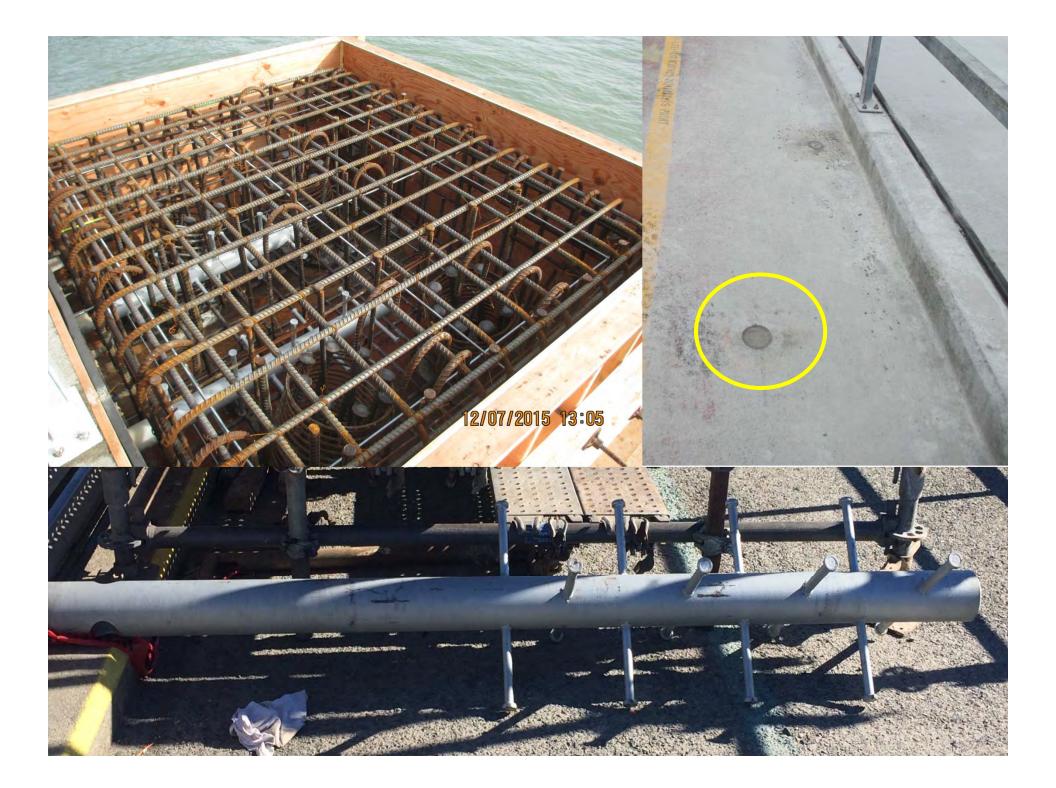
AT 26" PITCH



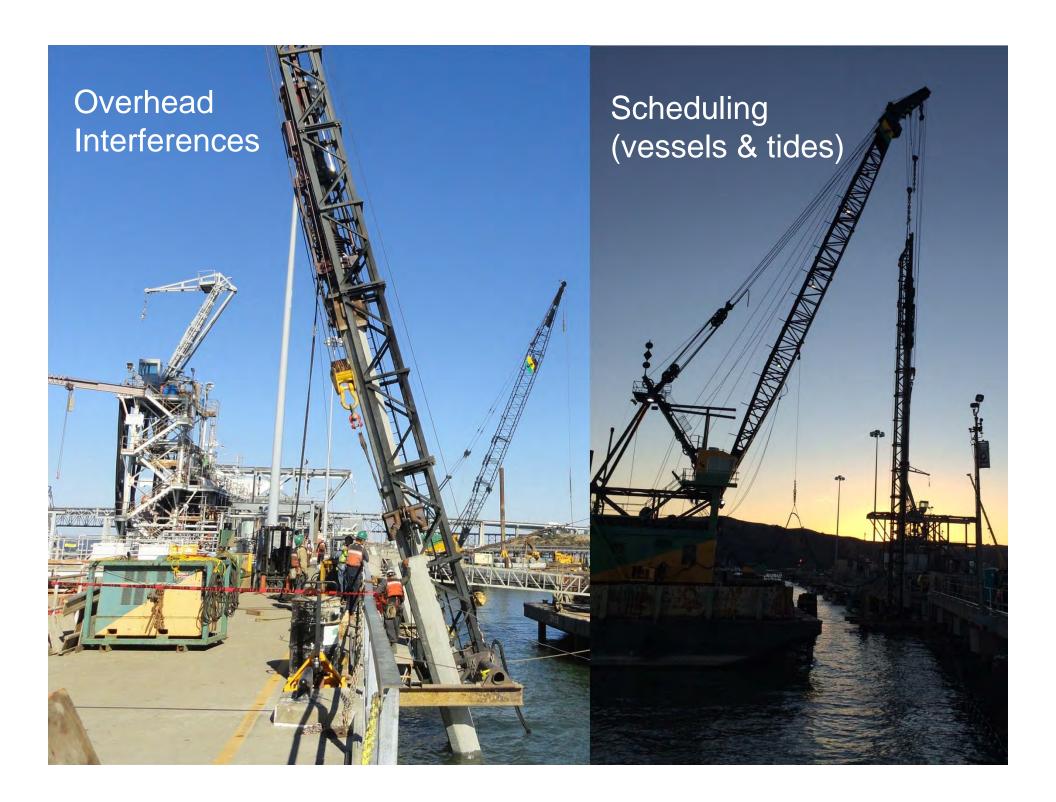
Dolphin-to-Deck Connection

- Custom designed pipe anchor connection
- Eliminated "Swiss Cheese" connection
- Easy installation, flexibility to avoid rebar









Dolphin Installation

Template → Falsework Rebar Pre-fab

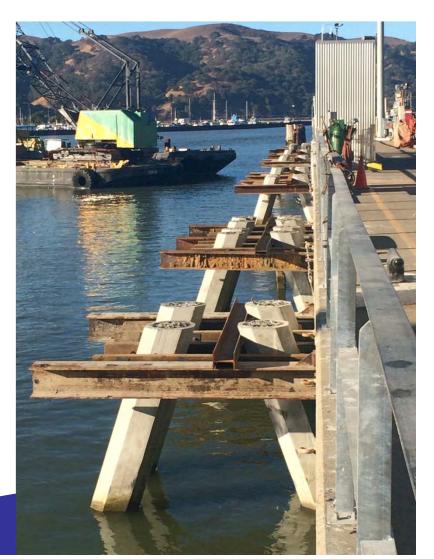


Finished Dolphins



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





