Chevron Eureka MOT Seismic Upgrade – Assessment to Retrofit Design, Permitting and Construction

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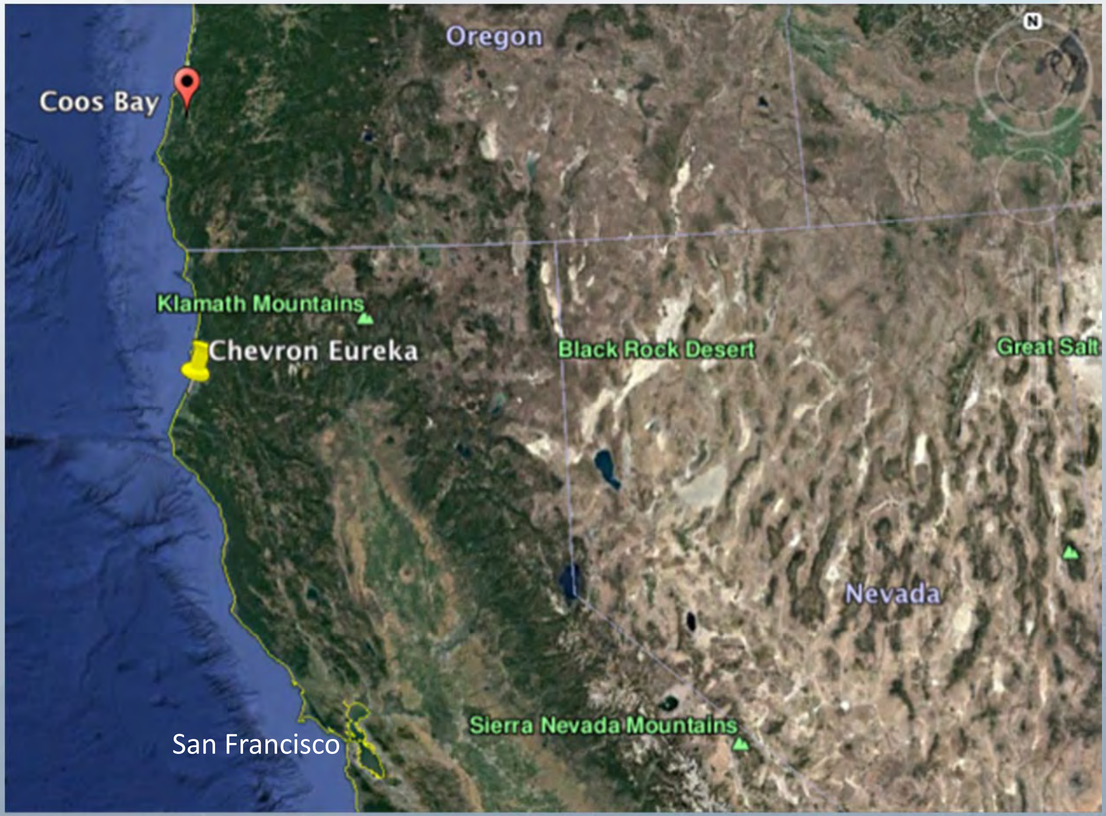
Background

- **Original 1900 construction, ~1950 expansion**
  - No drawings
- **Timber structure**
  - 600 ft trestle
  - 150 ft wide wharf
- **Fuel Deliveries**
  - 1 barge every 2 weeks
  - No equipment on dock

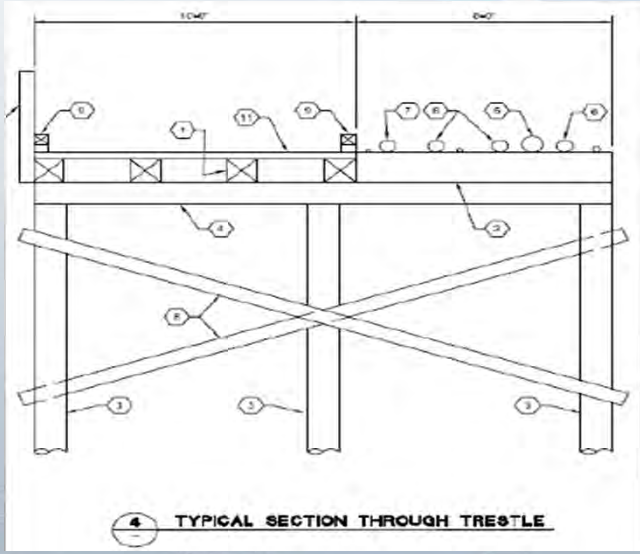
Location

- **Eureka located approximately 260 miles from the San Francisco Bay Area**
  - Isolated geographically
  - Approximately 150 miles from closest marine fuel terminal (Coos Bay)



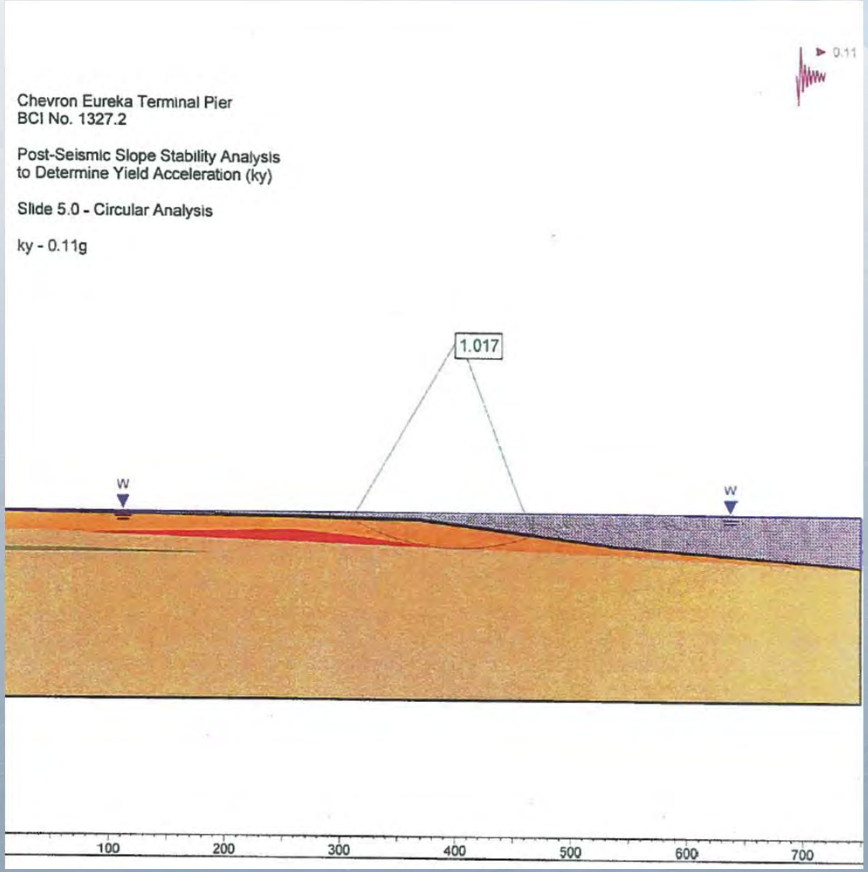
Existing Structure

- **Light timber construction**
- **Simple pin or through bolt connections**
- **Piping seated on pile caps or wharf deck**
- **Plumb pile dominated response**
- **Batter piles w/ weak connections**
- **MOTEMS Seismic "Low" Risk**
  - Level 1: 36 year return period
  - Level 2: 224 year return period
  - Large acceleration due to nearby subduction zone



Initial Audit Conclusions

- **Initial Audit performed by others**
  - Concluded structurally deficient and required upgrade
  - Used conservative approach for soil spreading (up to 7 ft soil movement)



Refined Analysis and Retrofit Design

- **Refined seismic and geotechnical analysis**
  - Refined seismic analysis (Moffatt & Nichol)
  - Geotechnical assessment with state of the art methods (EMI)
  - Materials testing (Scientific Construction Laboratories)
- **Retrofit strategy**
  - Support critical elements (pipelines, loading platform)
  - Keep terminal in operation as much as possible
- **Retrofit design**
  - Design (Moffatt & Nichol)
  - Permitting (Pacific Affiliates)/Review (CSLC, California Coastal Commission, City of Eureka, Humboldt Bay Fire, Humboldt Bay Harbor Recreation and Conservation District, US Army Corps of Engineers, National Marine Fisheries Service, State Water Resources Control Board, California Department of Fish and Wildlife, North Coast Unified Air Quality Management District)
- **Construction**
  - Contractor (West Coast Contractors)
  - Construction support services (M&N, Pacific Affiliates, ORCA, Points West Surveying, EMI)

M&N Refined Seismic Analysis

- **M&N performed refined seismic analysis, including refined kinematic load determination (by EMI)**
  - Reduced initial 24-84” movement to 23”
  - Now manageable
- **Used more refined analysis methods, material testing**

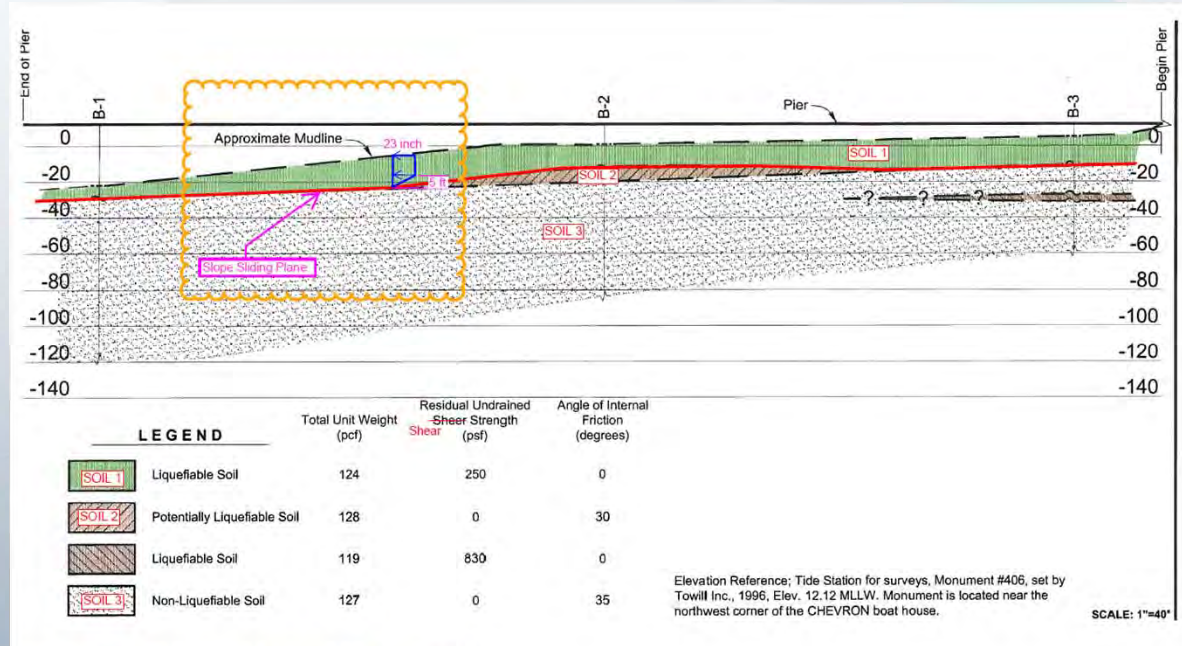
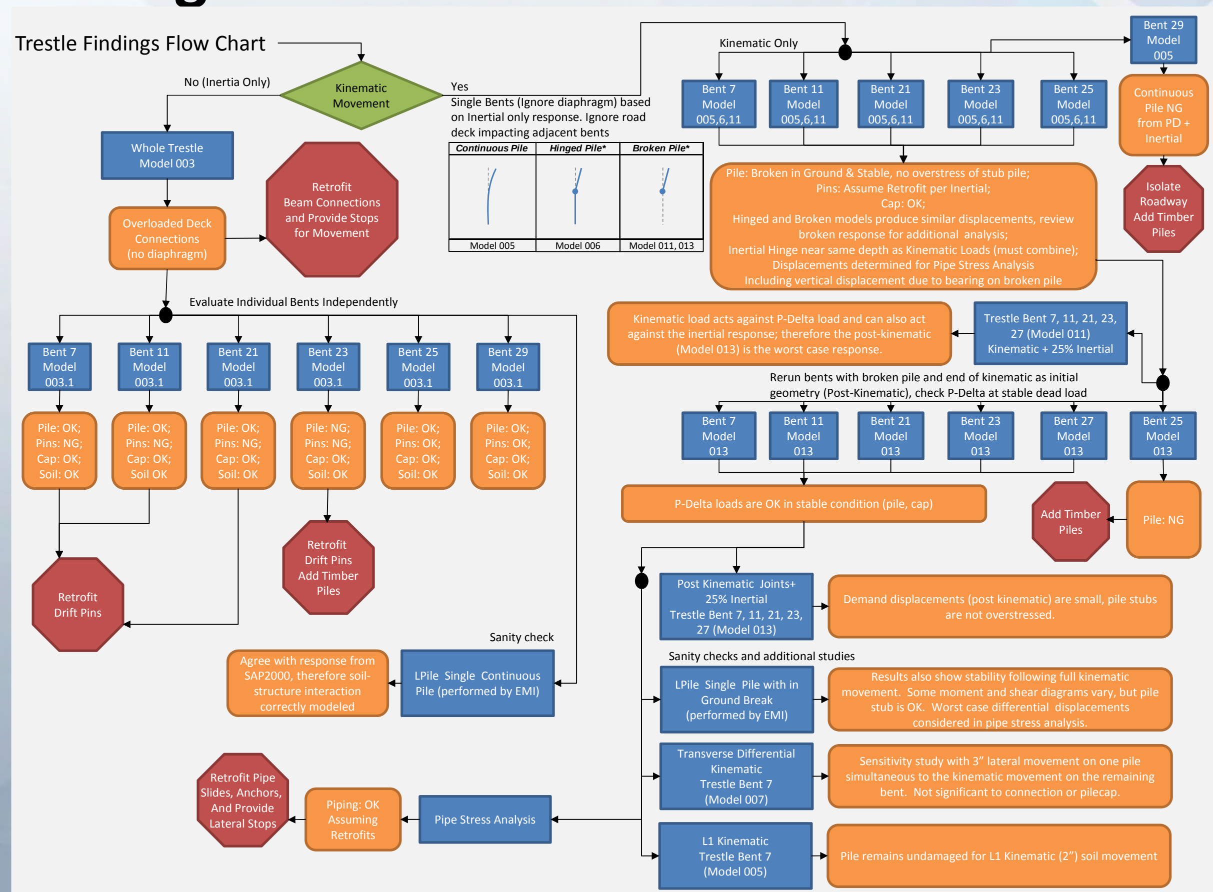


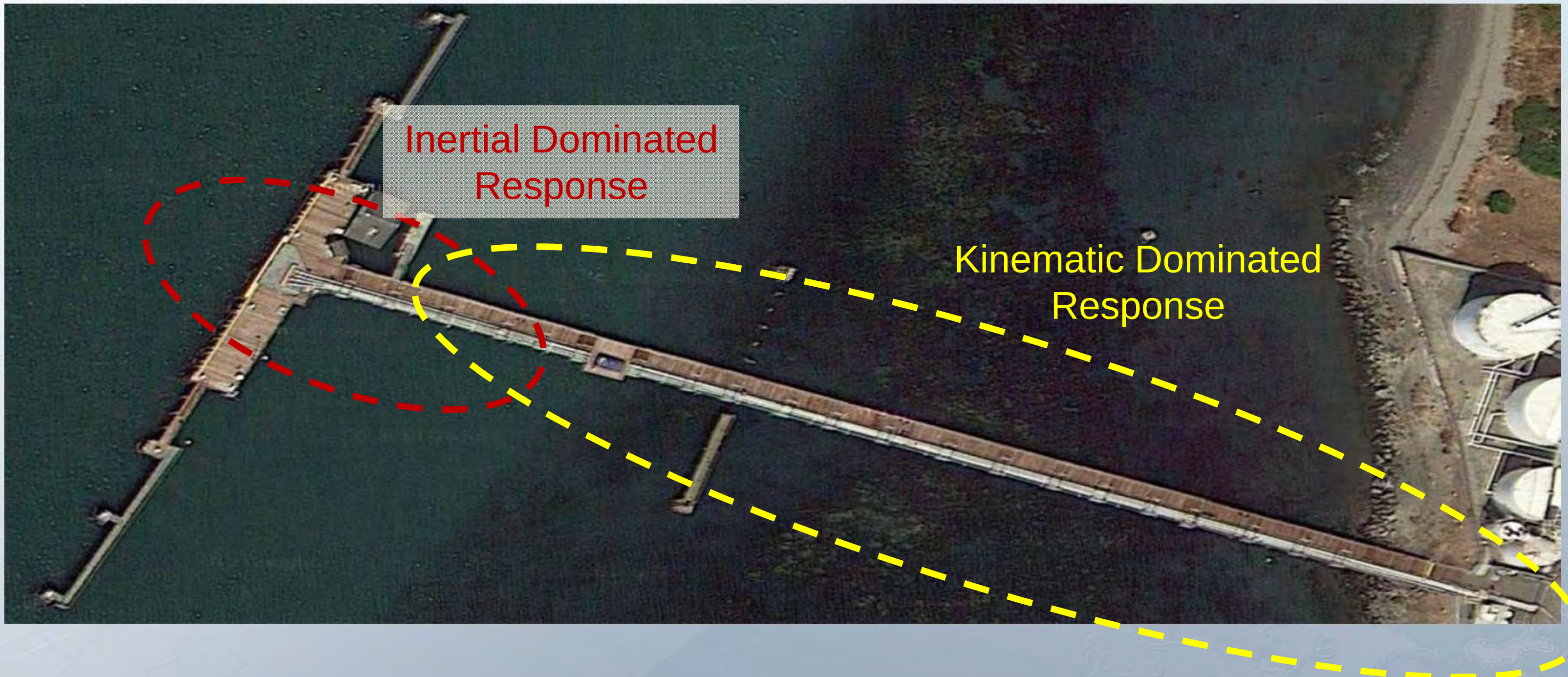
Figure 7: Soil Lateral Spread [EMI, 2014]

M&N Refined Seismic Analysis Findings Tree

- **Many cases based on soil conditions and pile type**
  - Vertical stability maintained
  - No loss of containment
- **Seismic retrofit**
  - Critical elements protected



M&N Refined Seismic Analysis
Summary of Findings



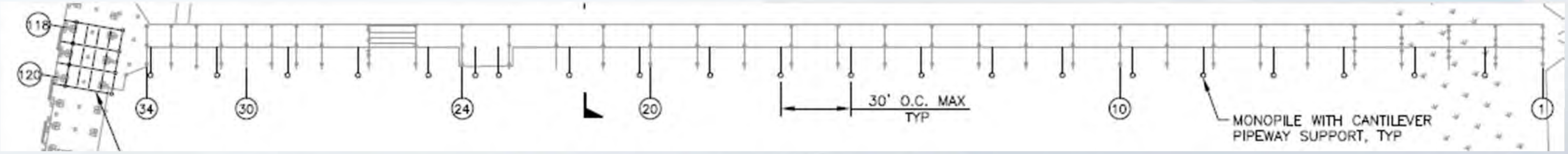
- **System response controlled by inertial and kinematic loading in different areas for different failure modes**
- **Retrofit required to satisfy MOTEMS requirements**

Seismic Retrofit Design
Boundary Conditions

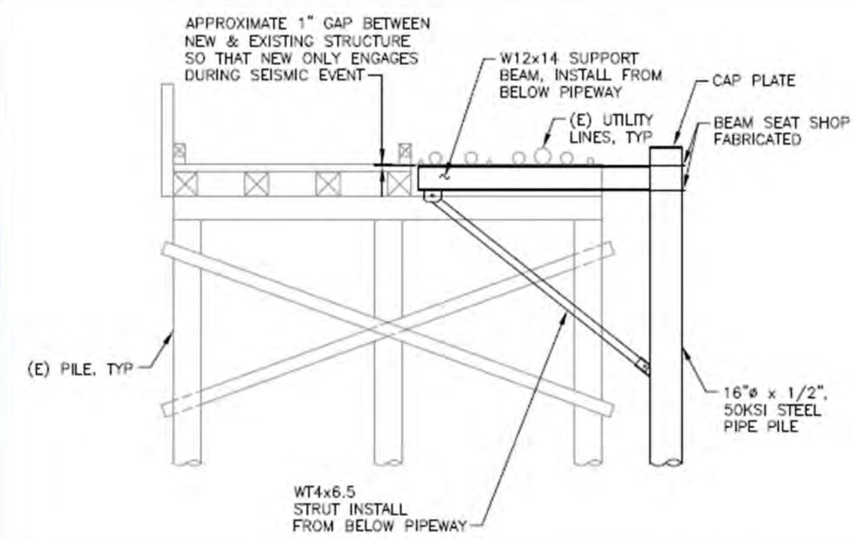
- **Environmental**
  - Eel grass + acoustic monitoring→ VERY expensive driving → minimize # of piles
  - Drive at minimum tide
  - Vibratory driving preferred
- **Existing Piping**
  - Cannot be removed, so nothing w/in footprint of piping

Photo 12. Recreational Clamming Activities around Trestle

Seismic Retrofit Design
Alternate Concepts – Cantilevered Trestle Bents (Option 2B)

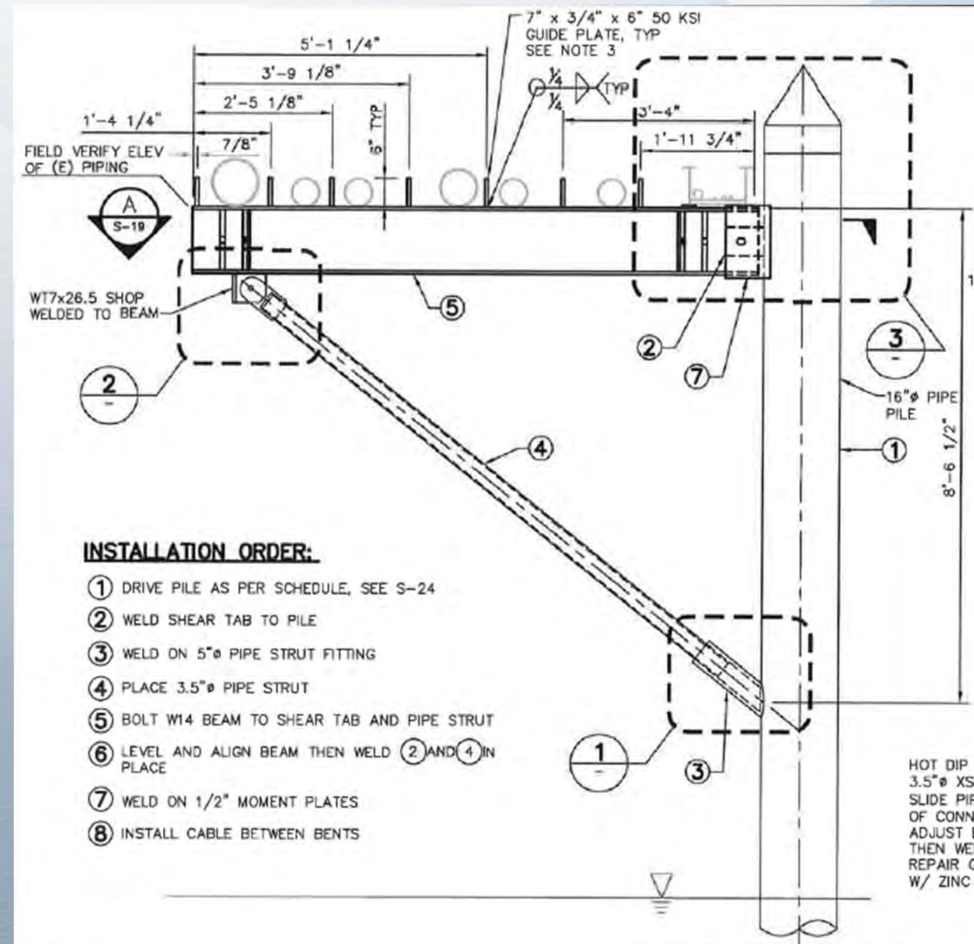


- **Underpin trestle (pipeway only)**
  - 1 pile bent
  - Steel or concrete piles w/ steel framing
- **Underpinning only activated when timber piles fail**



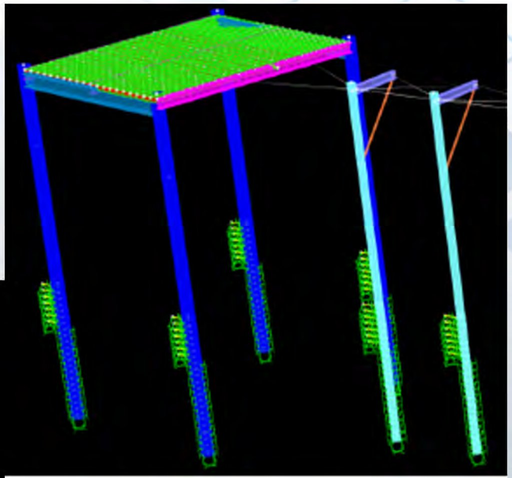
Seismic Retrofit Design
Pipeway

- **Cantilever beam design for**
  - Minimize pile quantity
  - Minimum footprint
  - Adjustability
    - Sliding brace into connection, shear tab to beam for erection
  - Simplicity
- **Will also support new utility racks**
- **Two bents in Season 1, remainder in Season 2**

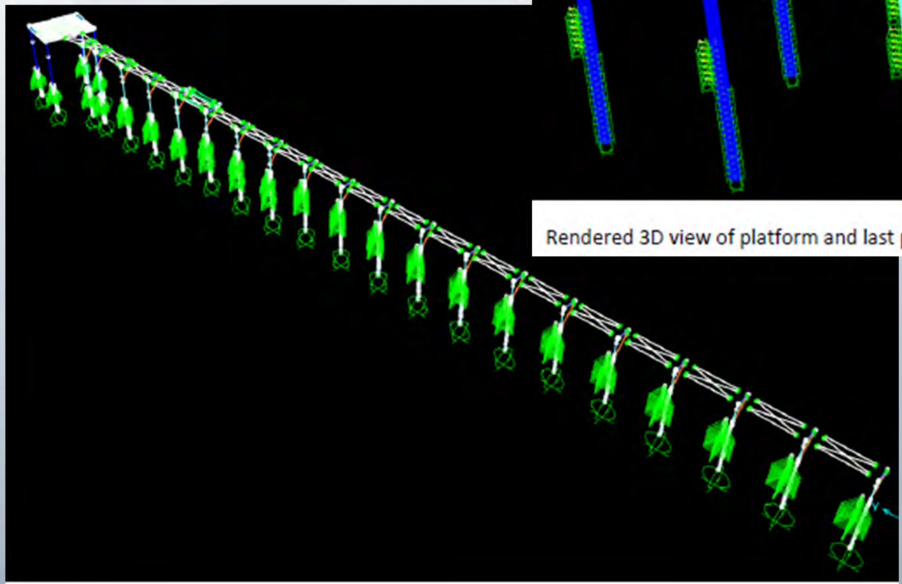


2015 Retrofit Design
Global Modeling

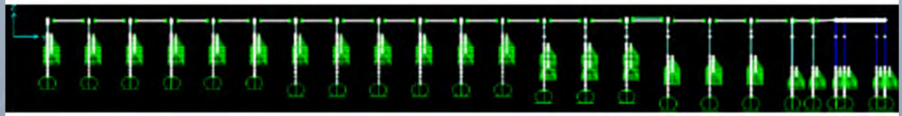
- **SAP2000 Steel Design**
  - Hand calcs to verify results
- **Conservatively designed using RSA with R = 1.0**
  - Elastic for inertia, kinematic, both (easy → superposition)
  - Global Model w/ trestle & Cabling
  - Cable takes compression (wrong)
- **Differential displacements don't capture out of phase movement**



Rendered 3D view of platform and last pipeway bent



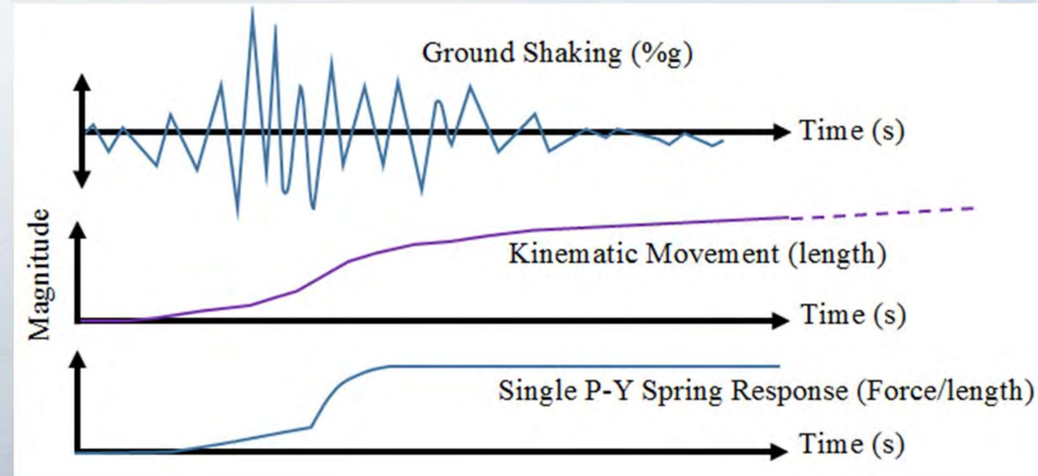
3D overall view



Side on view of trestle and wharf

2015 Retrofit Design
Combined Inertial and Kinematic

- **CSLC wanted site specific rationalized combo**
  - No direction in code(s)
- **Use early (full inertial) and late (full kinematic) combinations**
- **Shallow slope→ EMI agreed with 25% combination factors**



$$100\%{*}H_D + \Delta_{dpkA}$$

$$B{*}H_D + 100\%{*}\Delta_{dpkB}$$

Where:

H_D = Full kinematic displacement demand

Δ_{dpkA} = Demand displacement determined at post kinematic movement and design spectra reduced by A (note: A <u>not</u> applied to displacement)

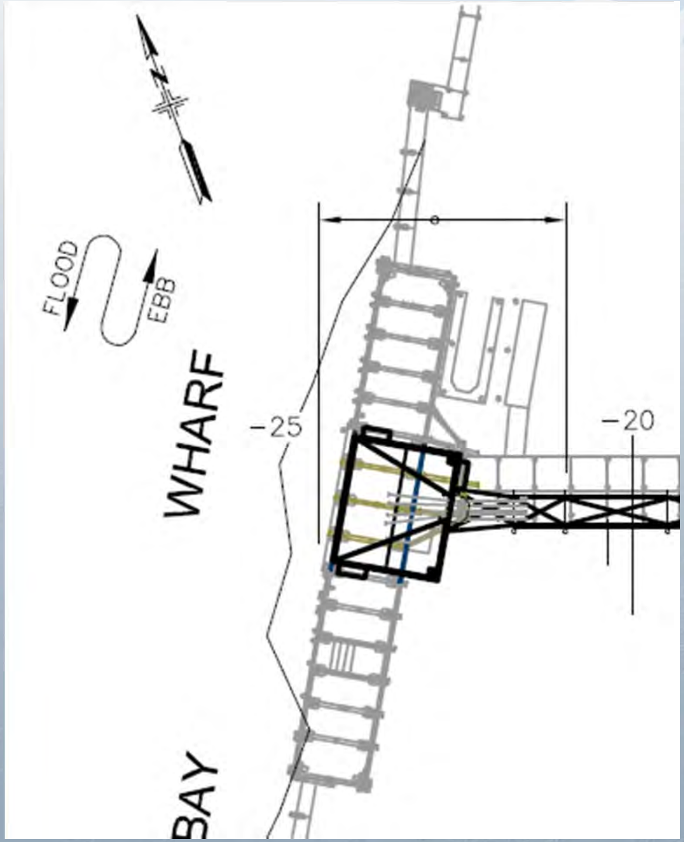
Δ_{dpkA} = Demand displacement determined at post kinematic movement $B{*}H_D$

A, B = multipliers that are typically considered between 0.25 and 0.5

Source: Percher M., Iwashita R., Kinematic Loading from a Structural Perspective, Ports 2016

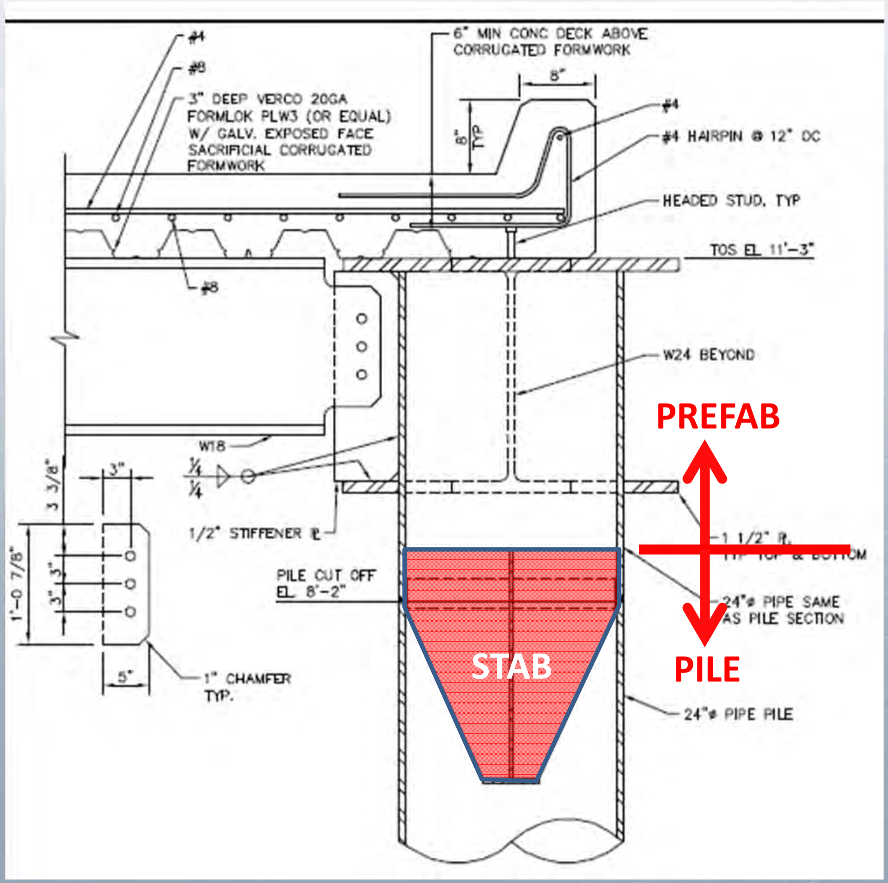
Seismic Retrofit Design
Unloading Platform

- **Replacement Platform**
  - Staged construction
    - Pre shutdown
    - 2-3 week shutdown
    - Post shutdown
  - Concrete deck with steel framing and steel pipe piles
  - Isolated from existing timber structure
  - Supports critical utilities



2015 Retrofit Design
Unloading Platform – Shutdown

- **Detailing for rapid construction**
  - Lots of shop welding for framing
  - Galvanized assemblies
  - CIP concrete deck on the barge
  - Verify pile locations prior to fabrication
- **Conventional offshore stab detail**
  - Minimize field welding



Permitting

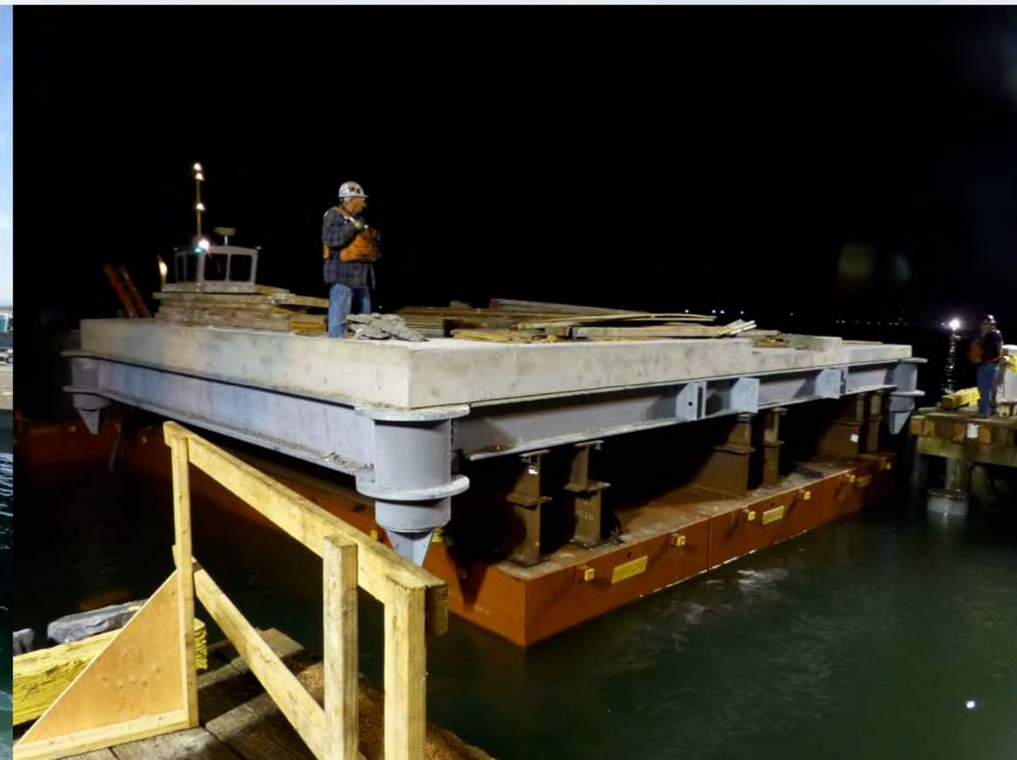
- **Pacific Affiliates as lead**
- **CSLC provided context of project to other agencies**
  - California Coastal Commission, City of Eureka, Humboldt Bay Fire, Humboldt Bay Harbor Recreation and Conservation District, US Army Corps of Engineers, National Marine Fisheries Service, State Water Resources Control Board, California Department of Fish and Wildlife, North Coast Unified Air Quality Management District
- **Permitting effort of 8 – 9 months**
  - Typical expectation of 18 months
  - Early stakeholder meetings
  - Local and responsive presence

Summary

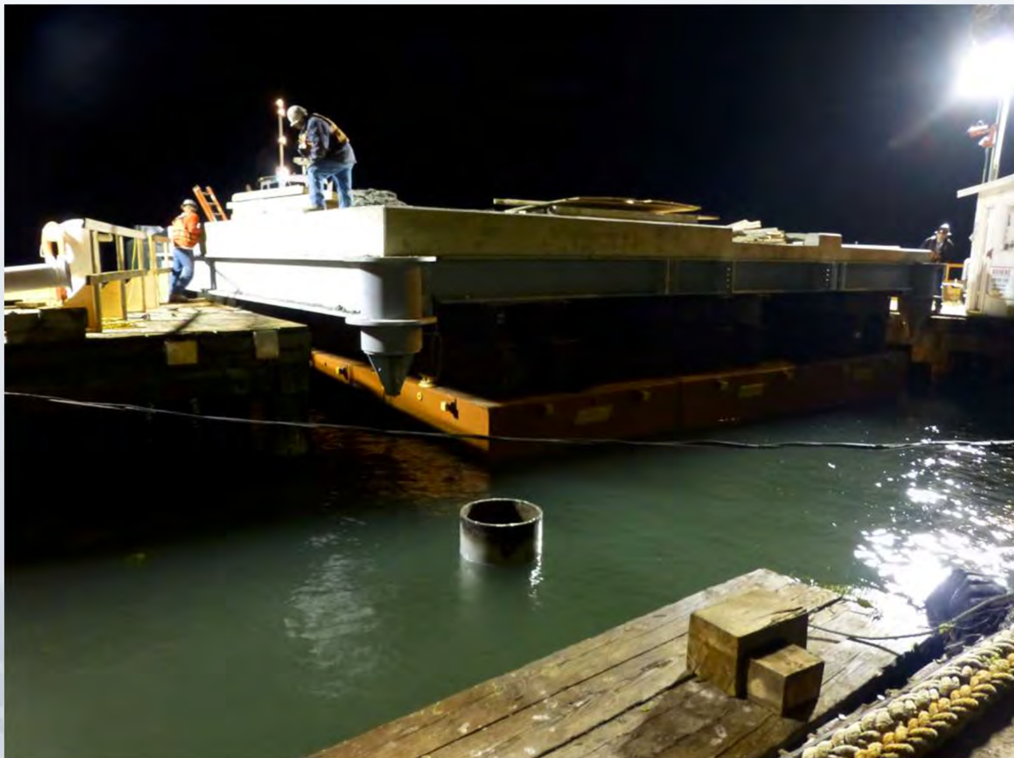
- **Retrofit cost approximately 25% of structure replacement cost**
  - Reduced footprint
  - Saved on number of piles (easier to permit, reduced construction time, reduced cost)
  - Phase 1 shut down of 17 days
  - Manageable seismic loads
- **Permitting**
  - Early stakeholders meeting put project on agencies radar
  - CSLC involvement elevated importance of project to other agencies

Seismic Retrofit Construction Photos

Seismic Retrofit Construction Photos



Seismic Retrofit Construction Photos



Seismic Retrofit Construction Photos

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Questions?