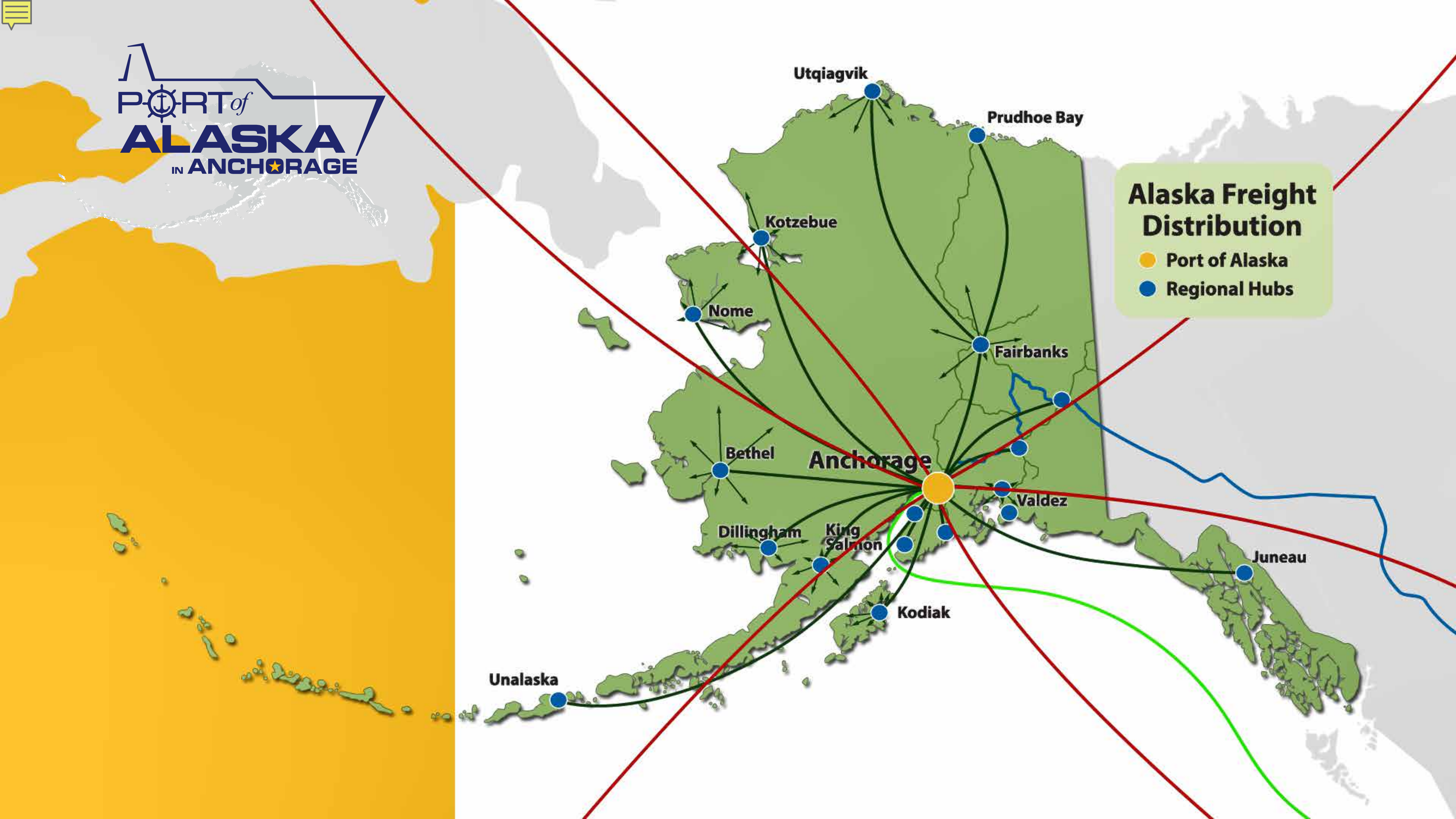
PORT of ALASKA IN ANCHORAGE

# APP Conference

John Daley PE PAMP Engineering Manager

February 9, 2023



PORT of ALASKA IN ANCHORAGE
Alaska Freight Distribution
Port of Alaska
Regional Hubs
Utqiagvik
Prudhoe Bay
Kotzebue
Nome
Fairbanks
Bethel
Anchorage
Valdez
Dillingham
King Salmon
Juneau
Kodiak
Unalaska

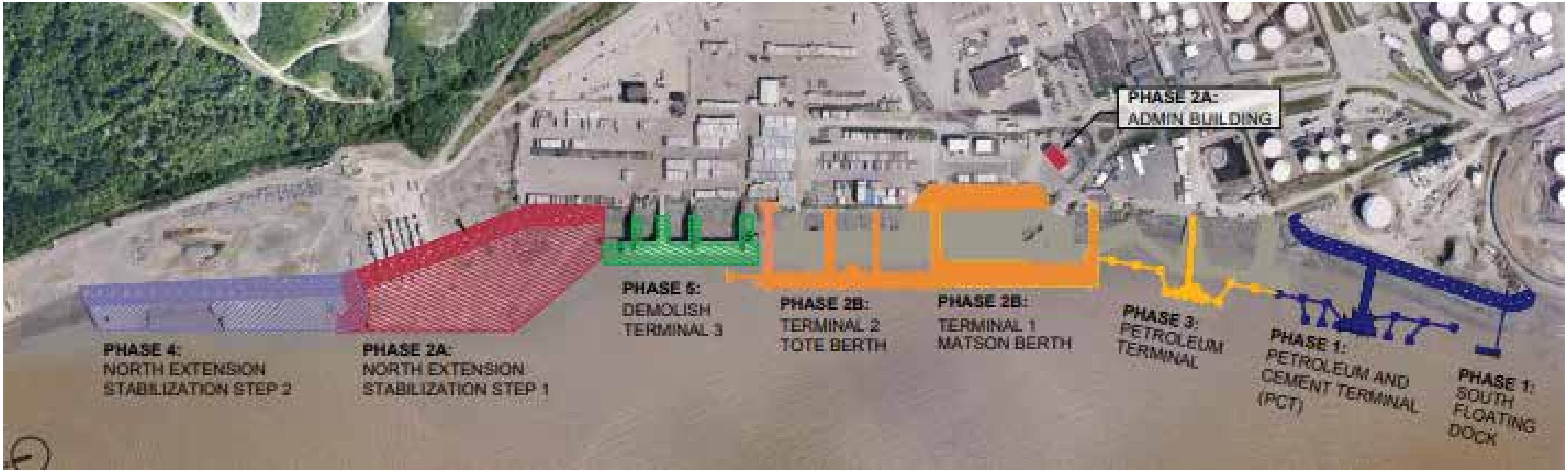
# Port of Alaska - Anchorage


THREE
GENERAL CARGO TERMINALS
(with lift-on/lift-off and
roll-on/roll-off capability)
ONE
PETROLEUM/CEMENT
TERMINAL
ONE
PETROLEUM ONLY
TERMINAL
CONTAINER
LIQUID BULK
DRY BULK
BREAK BULK
DRY BARGE LANDING
CRUISE SHIPS

# Port of Alaska Modernization Program

- Replace aging docks and related infrastructure
- Improve operational safety and efficiency
- Accommodate modern shipping operations
- Improve resiliency – to survive extreme seismic events and Cook Inlet's harsh marine environment

# Modernization Program



# Purpose and Need
# 50-Year-Old Existing Docks at Risk

- Severe Corrosion
- Seismic

# Biggest Threat

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# Photographs taken during 2020 Underwater Pile Inspections


Typical Field/Pile Splice Weld Corrosion (Terminal 1 Pile 47U)


Black water camera image of Pile 47.75V. Note complete corrosion of weld

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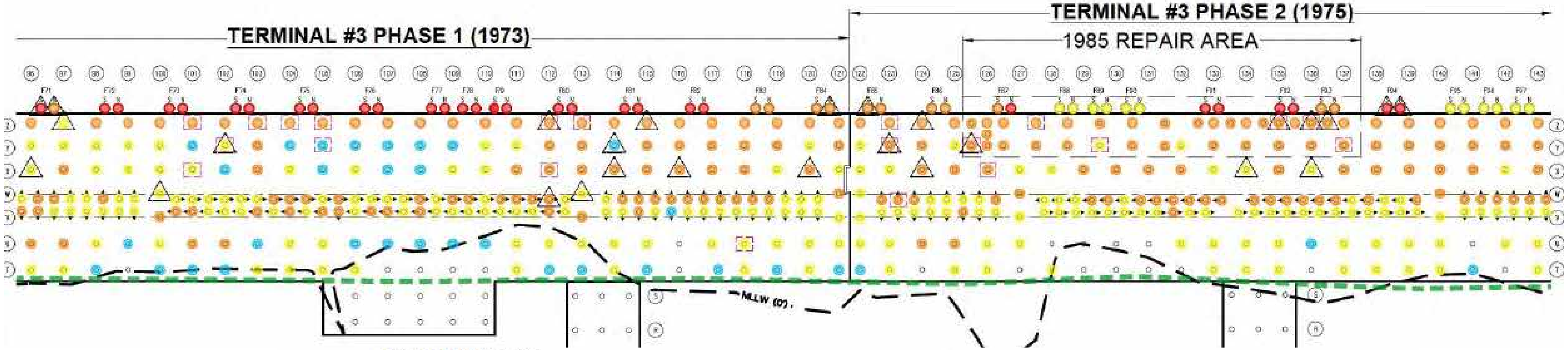
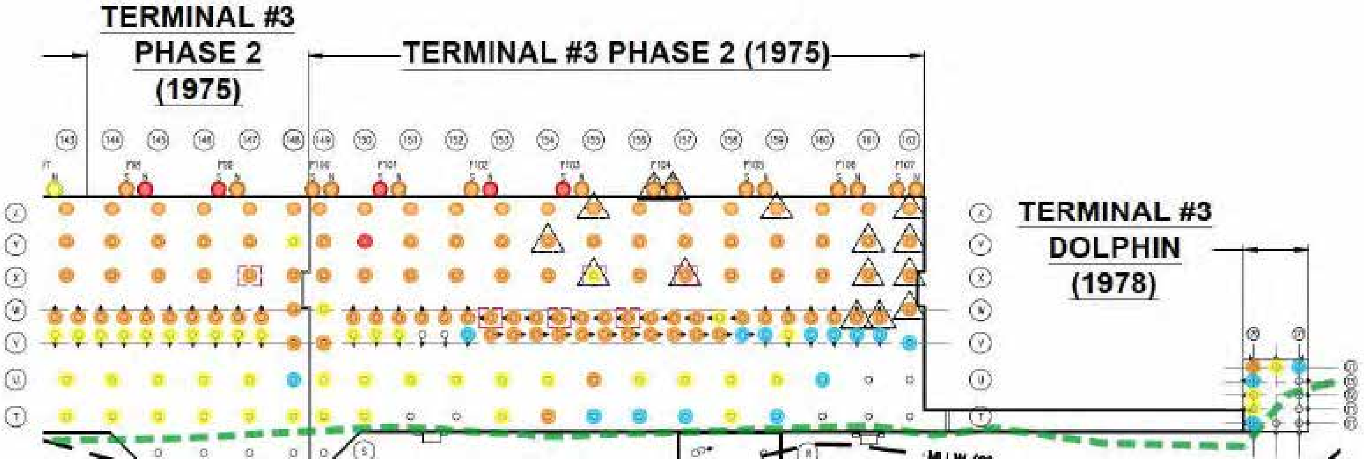
Damage Rating:
- Minor
- Moderate
- Major
- Severe



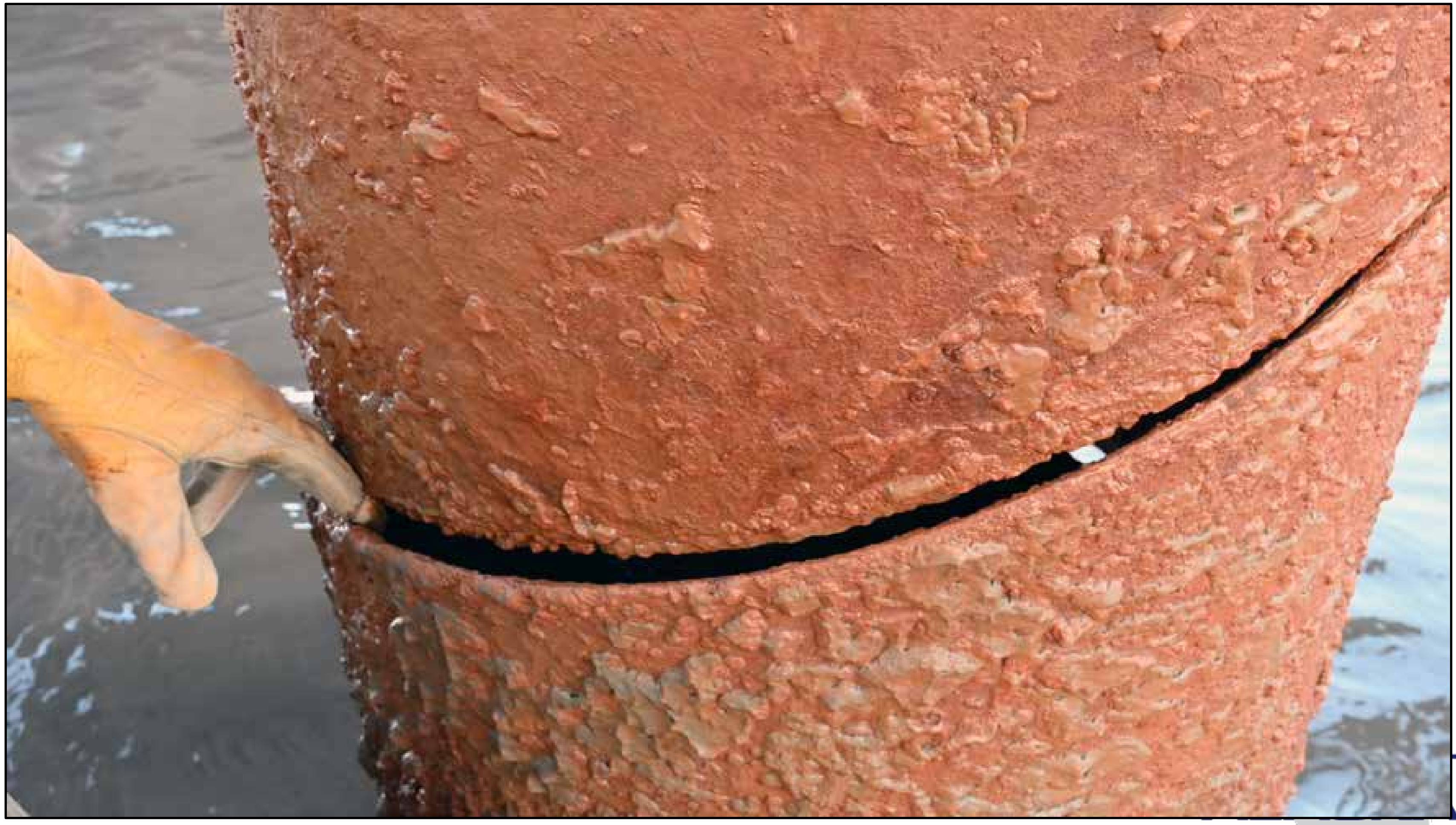



# 2018

# Earthquake Damage

# Case Study - Port of Alaska

POL2 pile damage discovered spring 2019



# Case Study - Port of Alaska

T1 pile damage discovered spring 2019

# Lateral Spreading @ Port of Alaska 2018

# Sand Boils Port of Alaska
# 2018 Anchorage, M 7.1

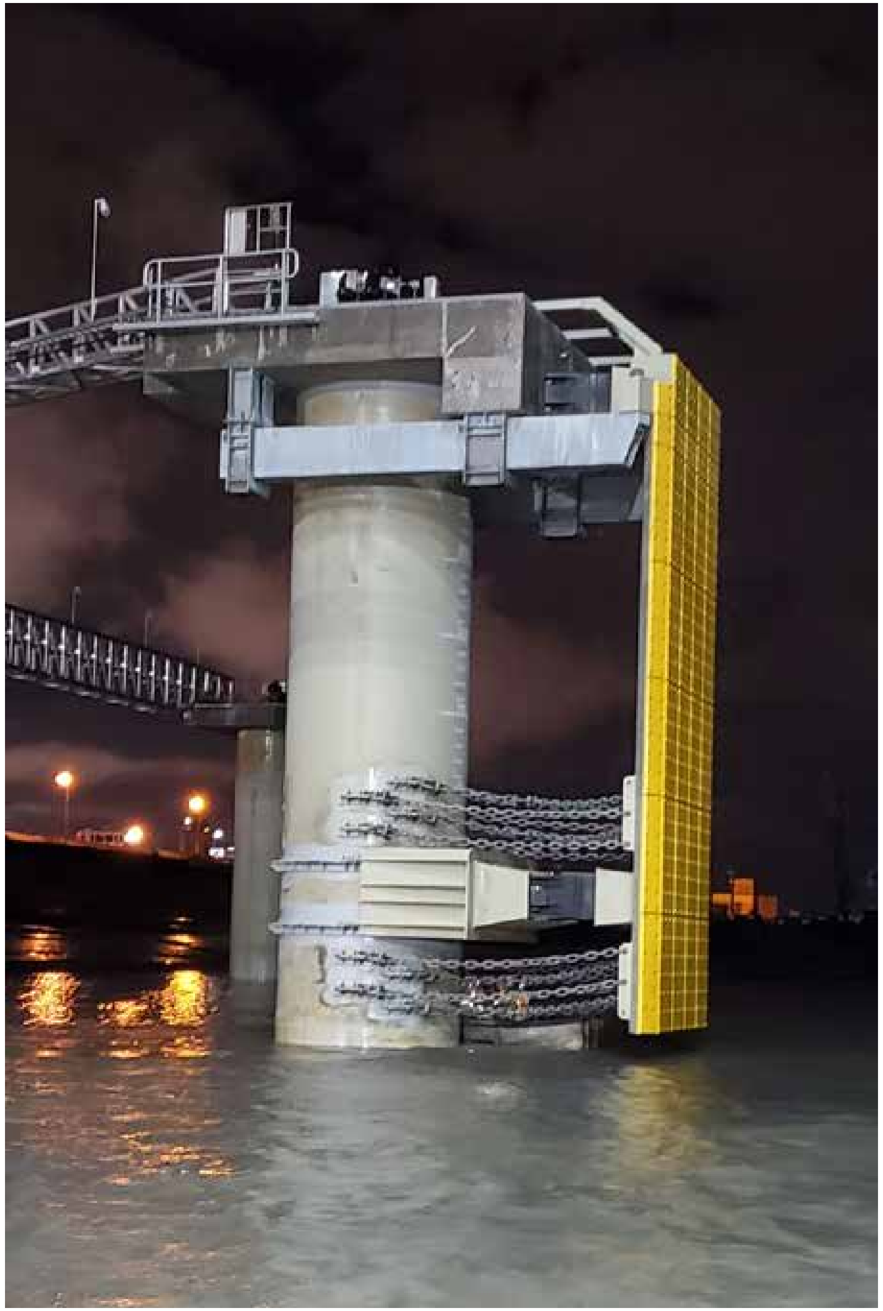
# Sand Boils Port of Alaska
# 2018 Anchorage, M 7.1

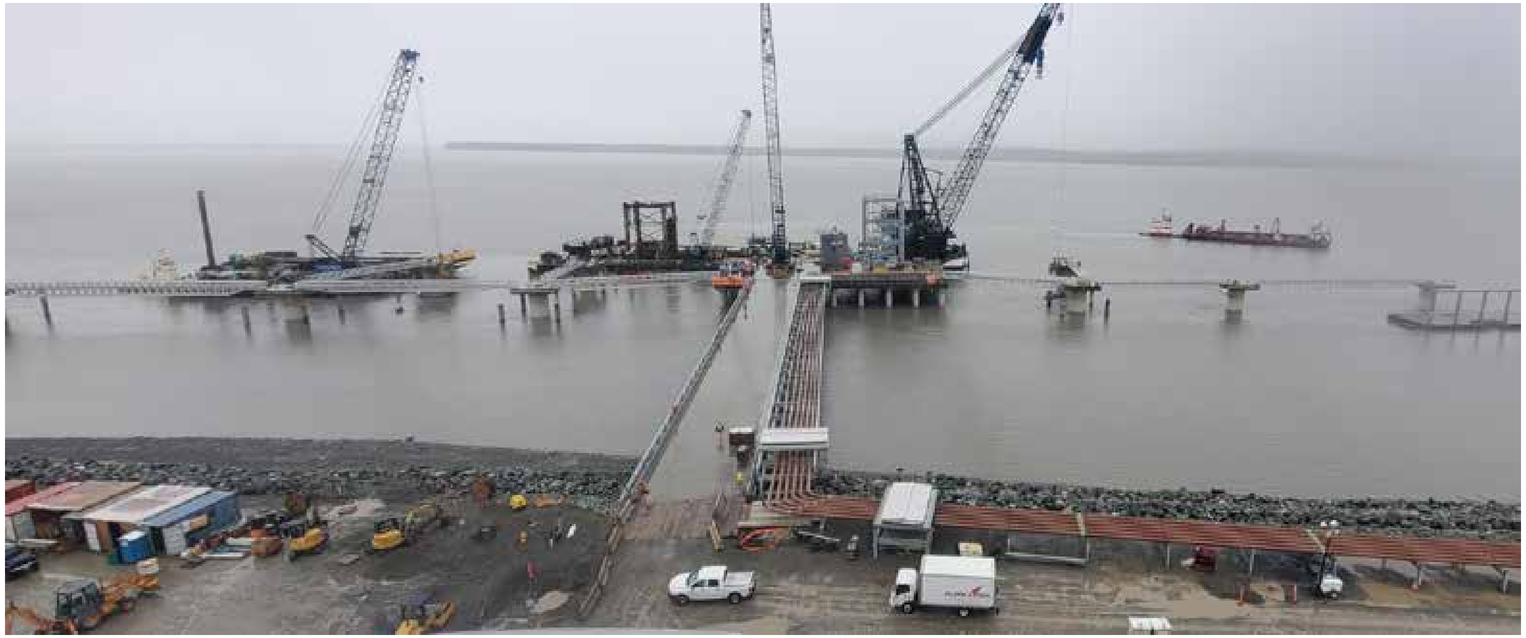
# Retaining Wall Failure
# Kings Harbor Marina, Redondo Beach
# 1994 Northridge, M 6.7 (EERI photo)

# PAMP Phase 1


PHASE 1
SOUTH BACKLANDS STABILIZATION
TERMINAL 3 TOTE BERTH
TERMINAL 2 MATSON BERTH
TERMINAL 1/POL 1 PETROLEUM AND CEMENT BERTH
POL 2
PETROLEUM AND CEMENT TERMINAL (PCT)
SOUTH FLOATING DOCK
NORTH EXTENSION
N

# PHASE 1 complete





# Phase 1 complete

# PCT Fact Sheet

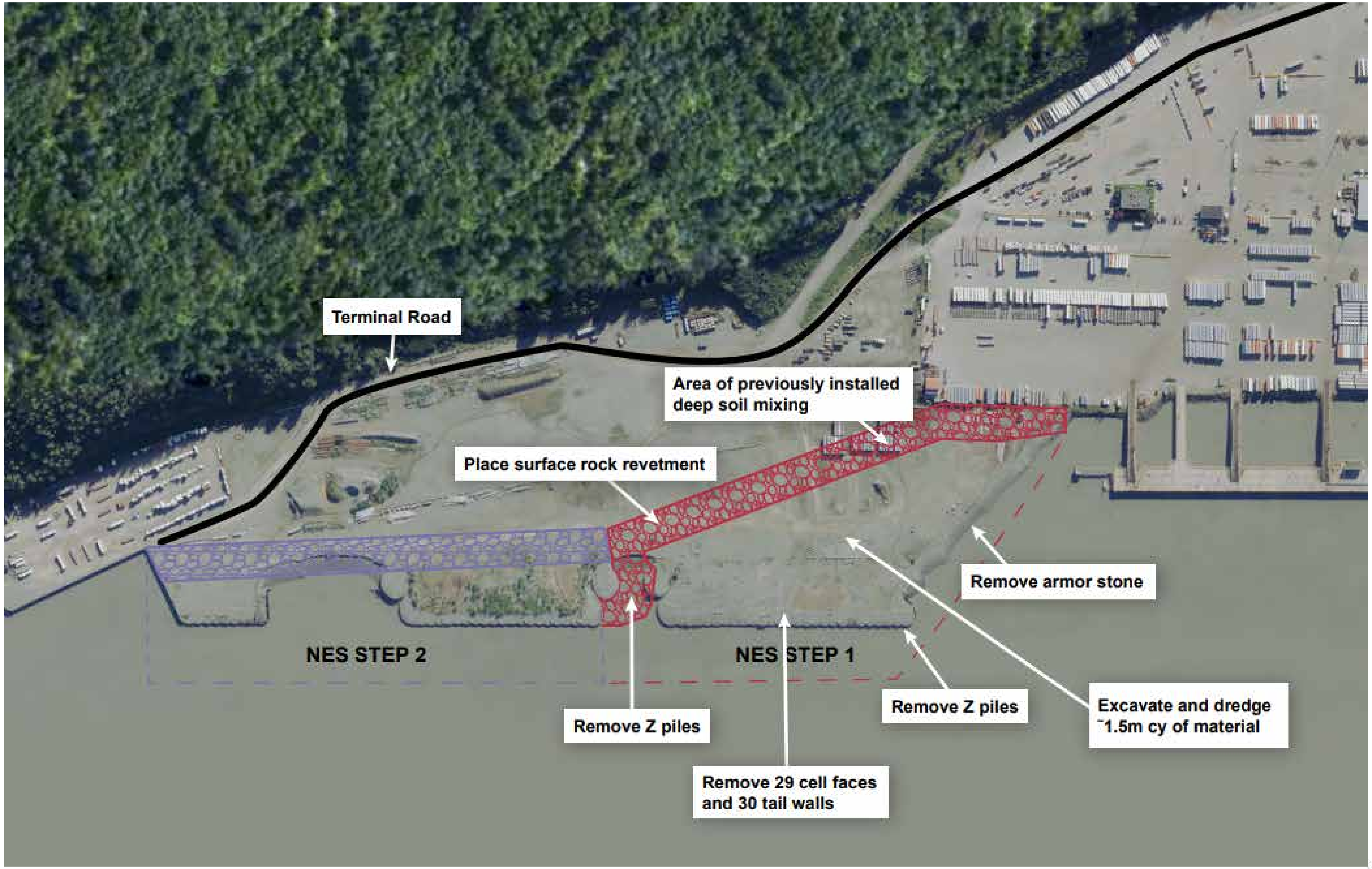
- Four primary contracts from 2018 to 2022
- Total cost approximately $220 million
- 140,000 manhours in 2021 alone
- 71 48-in-diameter piles, 180 feet long
- 9 12-ft-diameter monopiles
- Prime contractor for dock construction: Pacific Pile & Marine

# PCT Fact Sheet

- Modern seismic design exceeding national standards
- Ice resistant coatings
- Cathodic protection system

# North Extension Stabilization Step 1 (NES1)

# North Extension Stabilization Step 1 (NES1)



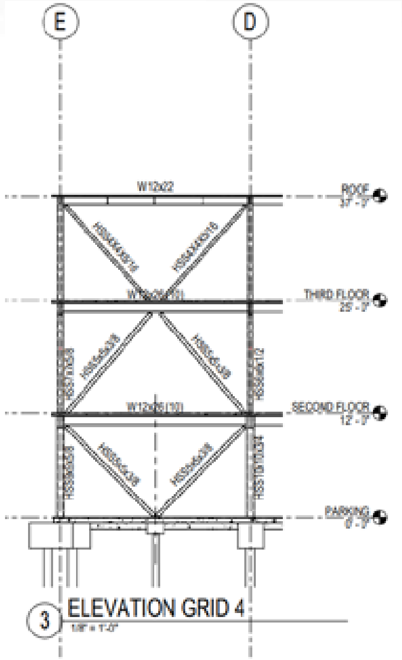
# NES1 Design-Build Contract

- Total contract value: $97 million plus contingency

Prime contractor: Manson Construction Co.

# New Administration Building

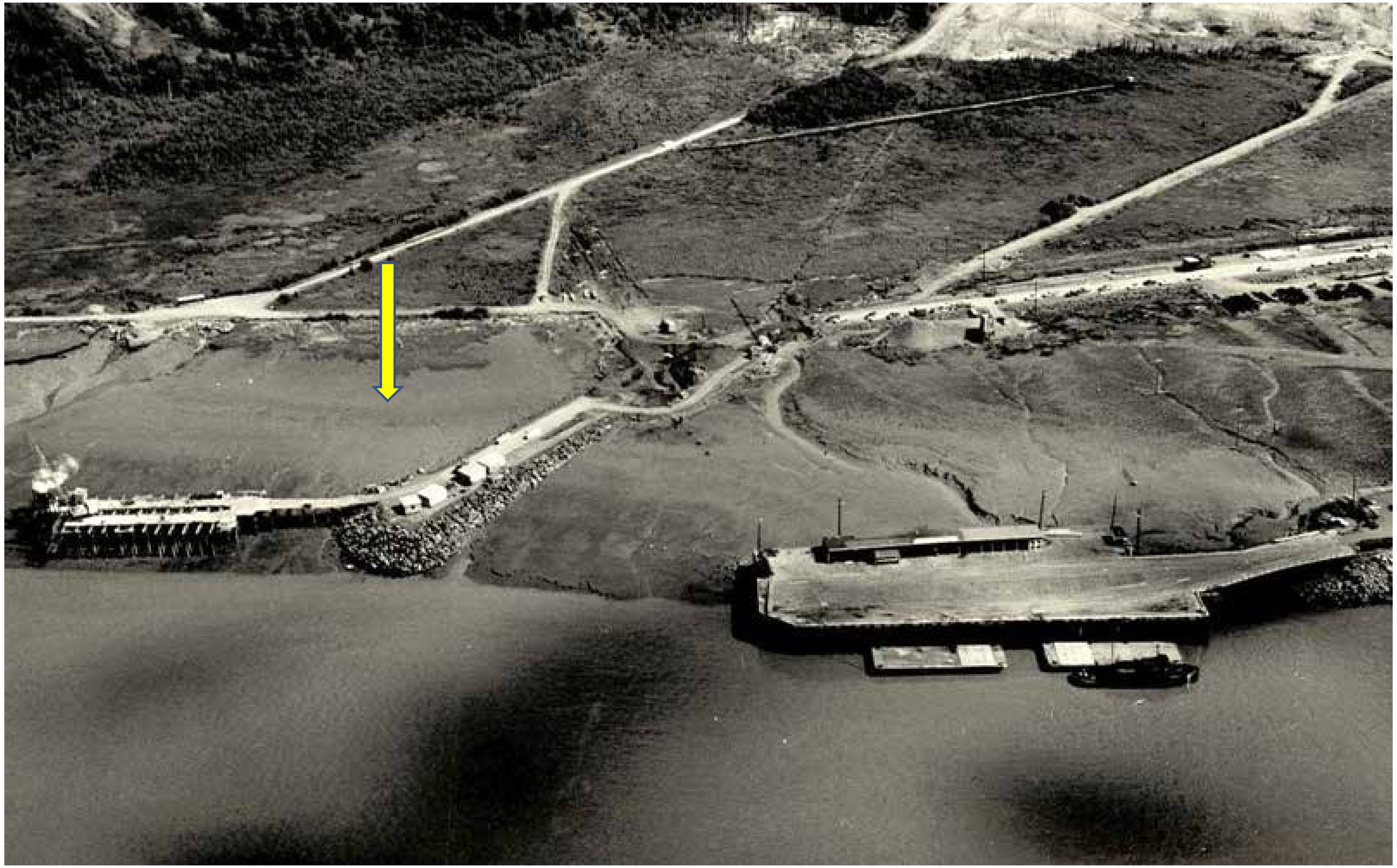
- Design-Build Contract
- Contract value: $8.3 million plus contingency
- Construction completion: End of 2023
- Prime contractor: STG Pacific
- Concentrically braced frame on pile foundation



# Helical pile damaged by debris.

# Concrete debris at the Admin Building site

# Admin Building site 1959 – No Fill



# Admin Building site 1964 – Partial Fill

# Admin Building site late 1960s – Filled

# Phase 2A

- Work on-gong at Admin Building. Move in December 2023?
- Work starting on NES1. Complete December 2024?

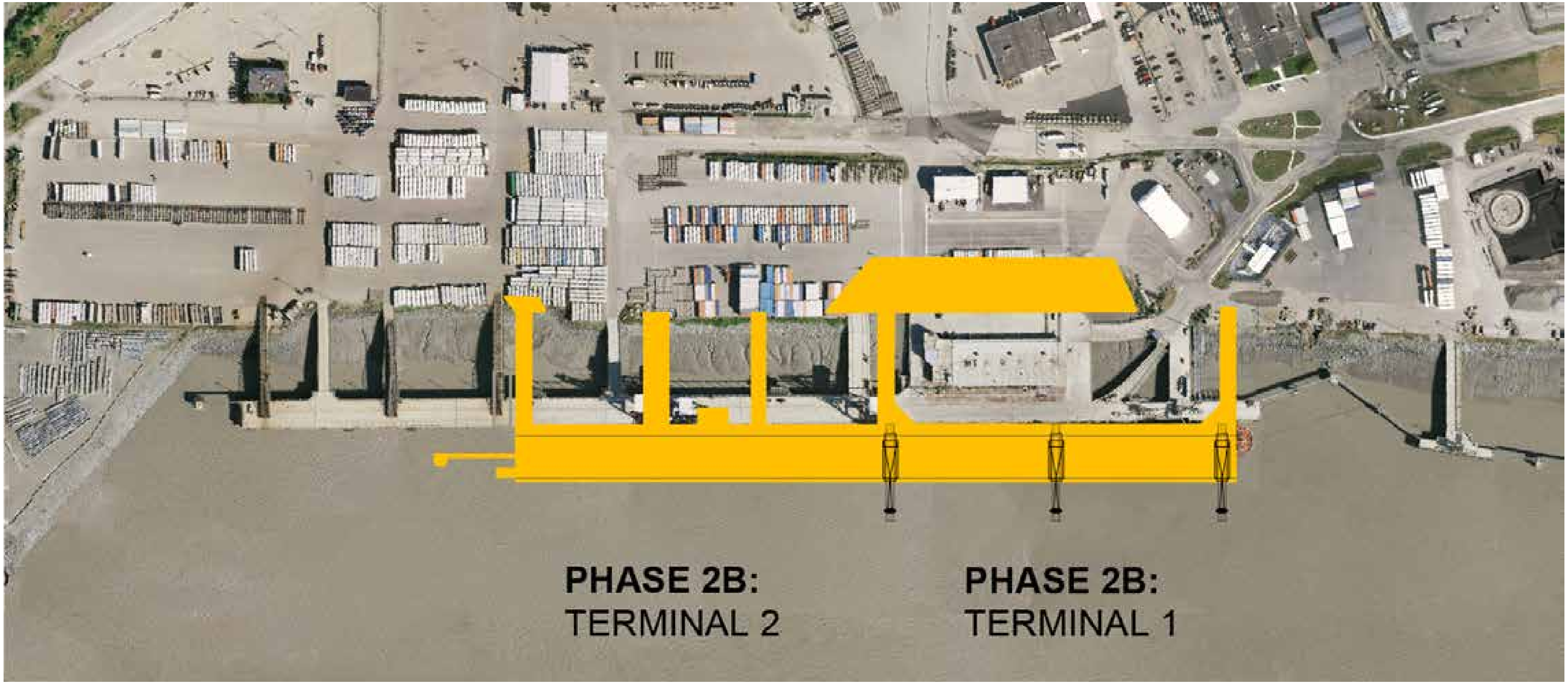
# Phase 2B New Cargo Terminals

- Designer of Record (DOR) being selected now
- Permitting underway
- Design complete in one year

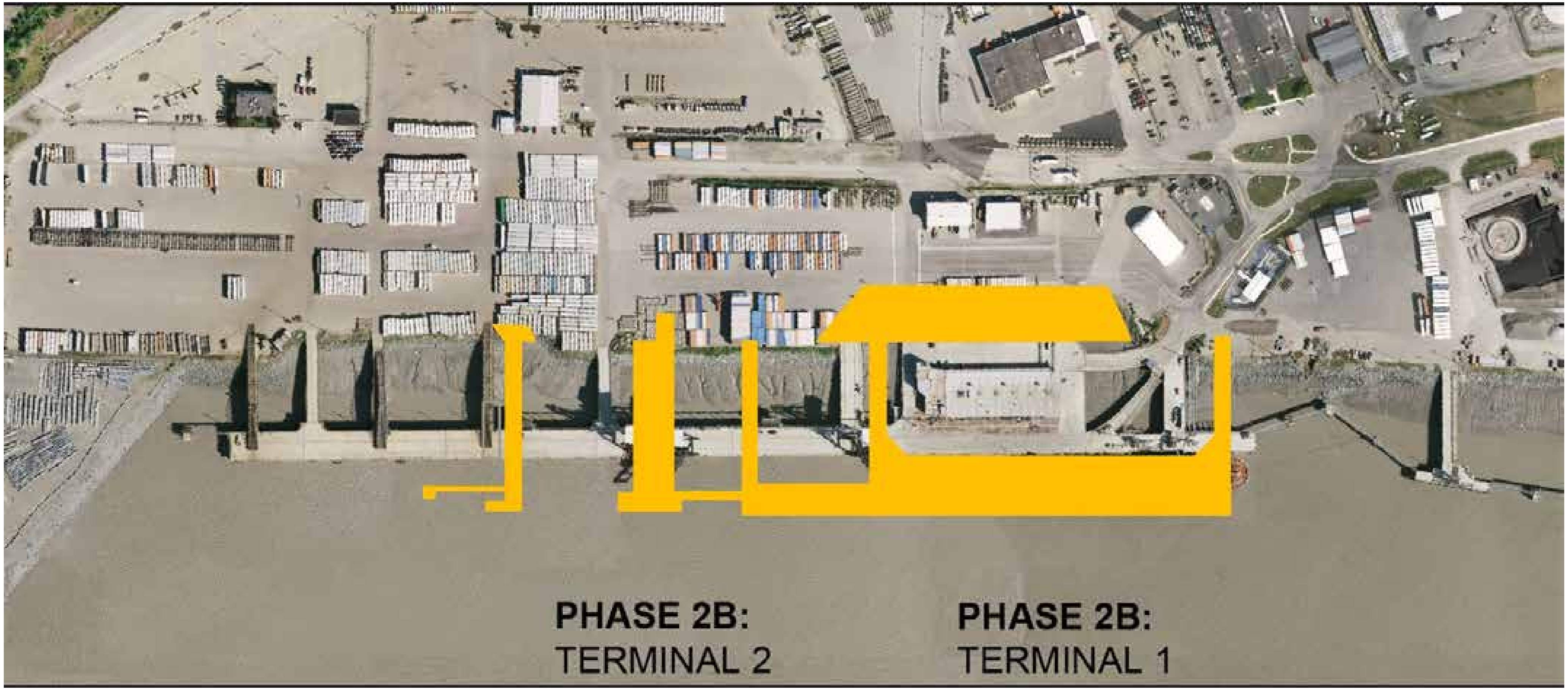
# Challenges New Cargo Terminals

- Who Pays?
- Layout - Multi Purpose versus User Specific?
- Seismic Performance?

# Phase 2B new Cargo Terminals – Port Preference



# Phase 2B new Cargo Terminals – User Preference



# Challenges New Cargo Terminals

Who Pays?

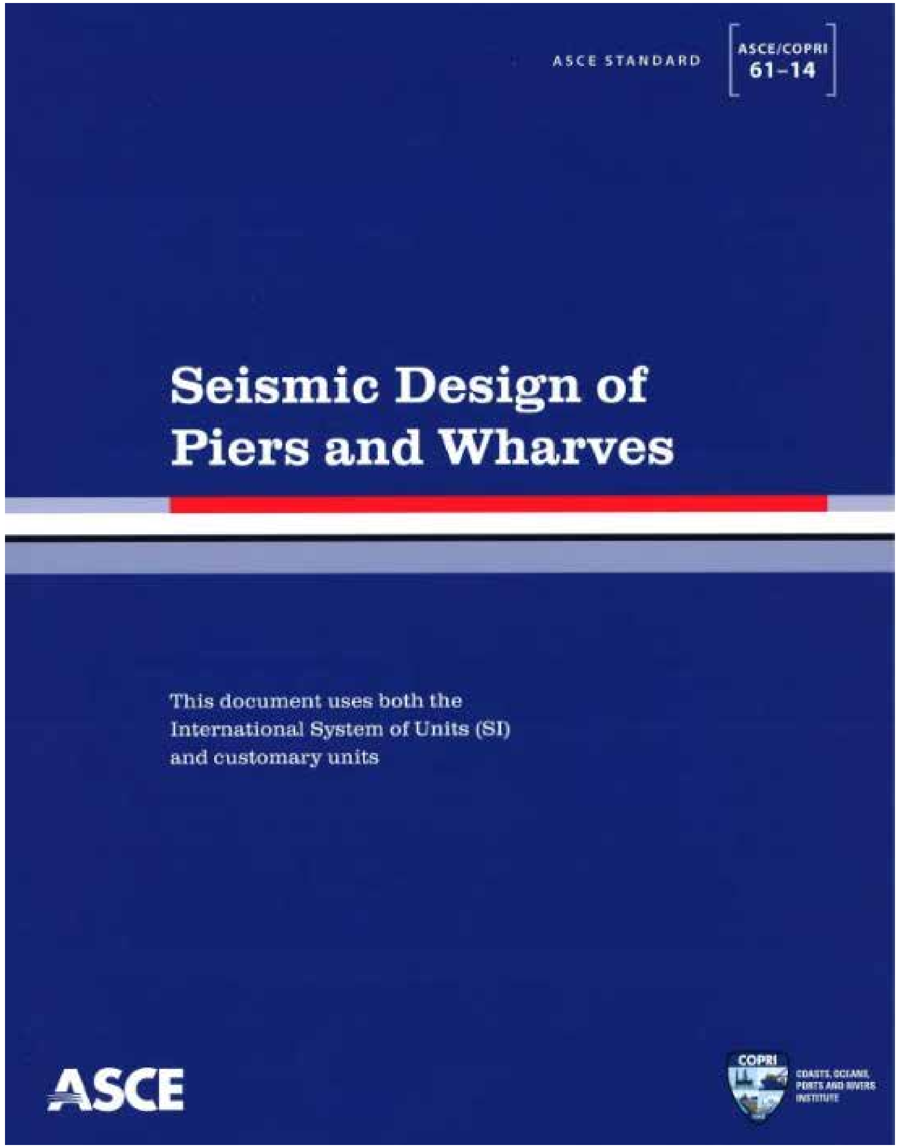
- Cost Causer - Cost Pays model
  - Whom ever benefits pays in tariffs
- Uniform Tariff model
  - Rising tide floats all ships

# Challenges New Cargo Terminals

Who Pays?

- Under discussion – a LOT of discussion

# ASCE 61 -14 Performance Requirements (Code)



# ASCE 61 -14 Performance Requirements (Code)

| DESIGN CLASSIFICATION | SEISMIC HAZARD LEVEL AND PERFORMANCE LEVEL | | | | | |
|---|---|---|---|---|---|---|
| | Operating Level Earthquake (OLE) | | Contingency Level Earthquake (CLE) | | Design Earthquake (DE) | |
| | Ground Motion Probability of Exceedance | Performance Level | Ground Motion Probability of Exceedance | Performance Level | Seismic Hazard Level | Performance Level |
| HIGH | 50% in 50 years (72-year return period) | Minimal Damage | 10% in 50 years (475-year return period) | Controlled and Repairable Damage | as per ASCE 7 | Life-Safety Protection |
| MODERATE | n/a | n/a | 20% in 50 years (224-year return period) | Controlled and Repairable Damage | as per ASCE 7 | Life-Safety Protection |
| LOW* | n/a | n/a | n/a | n/a | as per ASCE 7 | Life-Safety Protection |

# Anchorage Geotechnical Advisory Commission

From September 23, 2014 GAC letter:

We agree with the Port that, at a minimum, one container dock and one POL dock should be designed for "minimal damage" at the CLE ground motions (rather than "controlled and repairable damage" as the CLE motions referenced in the code), and "controlled and repairable damage" at the DE ground motions. These structures will be referred to as the "seismic berths" in this letter.

# Current GAC Recommended Performance Requirements
# Minimal Damage in 2/3 MCE

| DESIGN CLASSIFICATION | SEISMIC HAZARD LEVEL AND PERFORMANCE LEVEL | | | | | |
|---|---|---|---|---|---|---|
| | Operating Level Earthquake (OLE) | | Contingency Level Earthquake (CLE) | | Design Earthquake (DE) | |
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| LOW* | n/a | n/a | n/a | n/a | as per ASCE 7 | Life-Safety Protection |

effective

# Port Preferred Performance Requirements

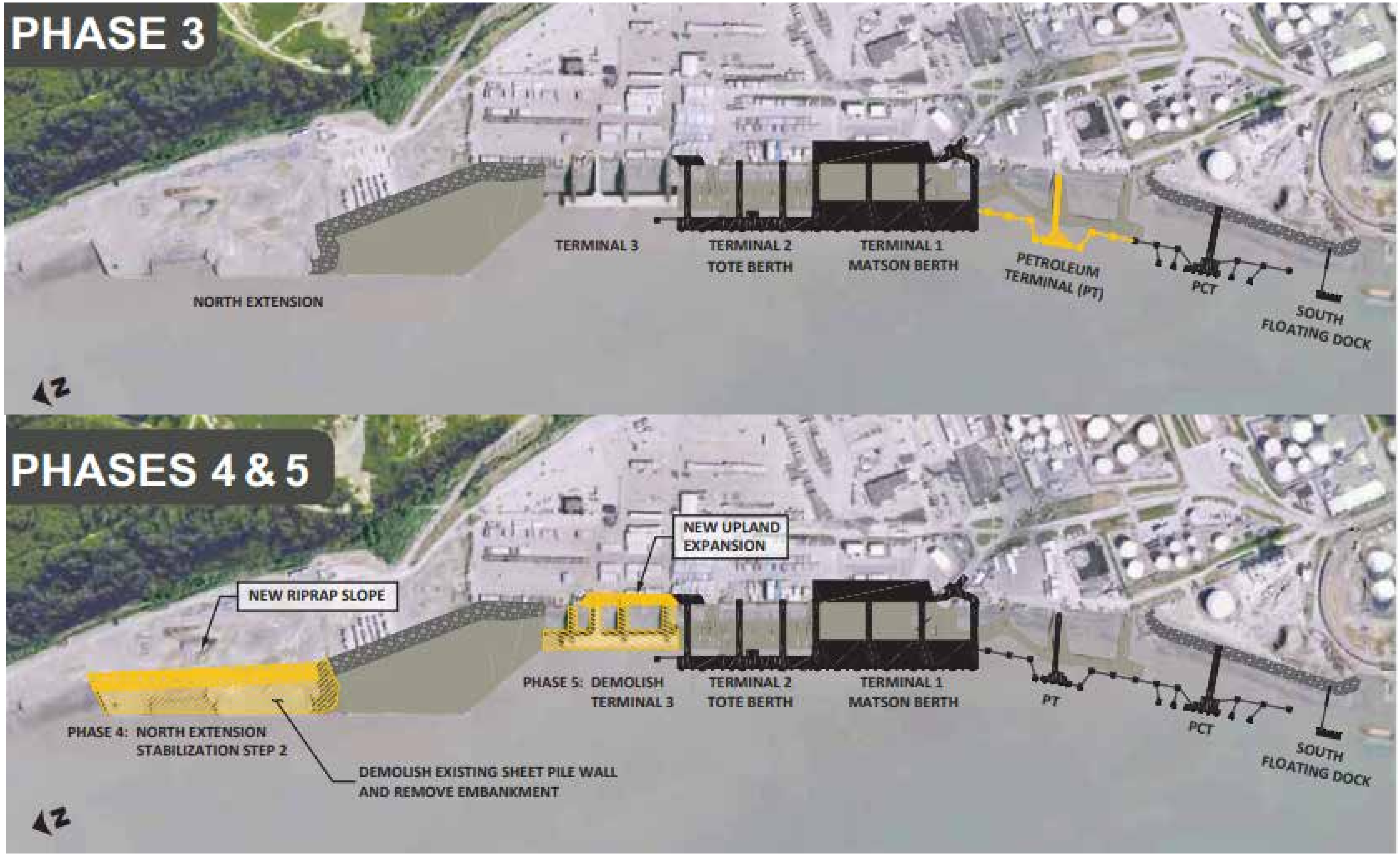
| DESIGN CLASSIFICATION | SEISMIC HAZARD LEVEL AND PERFORMANCE LEVEL | | | | | |
|---|---|---|---|---|---|---|
| | Operating Level Earthquake (OLE) | | Contingency Level Earthquake (CLE) | | Design Earthquake (DE) | |
| | Ground Motion Probability of Exceedance | Performance Level | Ground Motion Probability of Exceedance | Performance Level | Seismic Hazard Level | Performance Level |
| HIGH | 50% in 50 years (72-year return period) | Minimal Damage | 10% in 50 years (475-year return period) | Controlled and Repairable Damage | as per ASCE 7 | Life-Safety Protection |
| MODERATE | n/a | n/a | 20% in 50 years (224-year return period) | Controlled and Repairable Damage | as per ASCE 7 | Life-Safety Protection |
| LOW* | n/a | n/a | n/a | n/a | as per ASCE 7 | Life-Safety Protection |

# Challenges New Cargo Terminals

Seismic

- Under discussion – a LOT of discussion

# PAMP Phases 3, 4 & 5



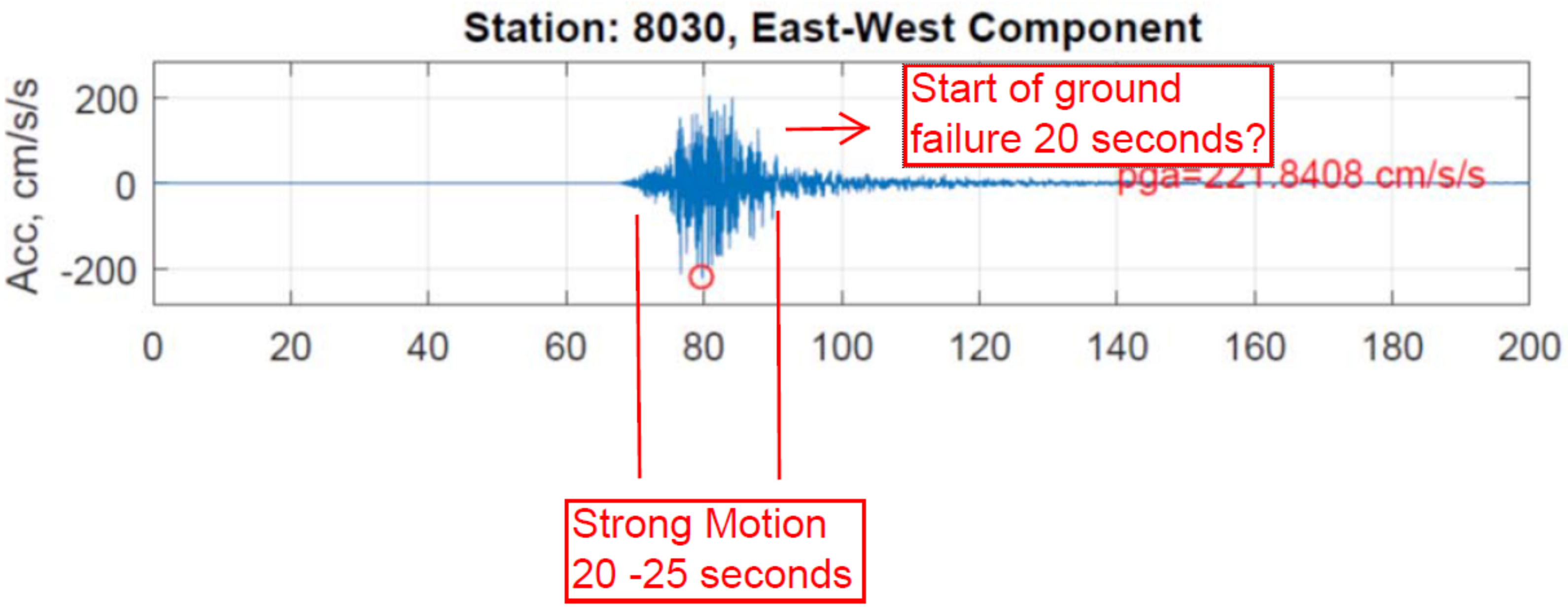
# Additional Challenges

- Slope Stability
- Structural detailing

# Seismic Slope Stability

- A risk for waterfront projects

# Combined Inertial and Kinematic November 2018 Anchorage



# Durations

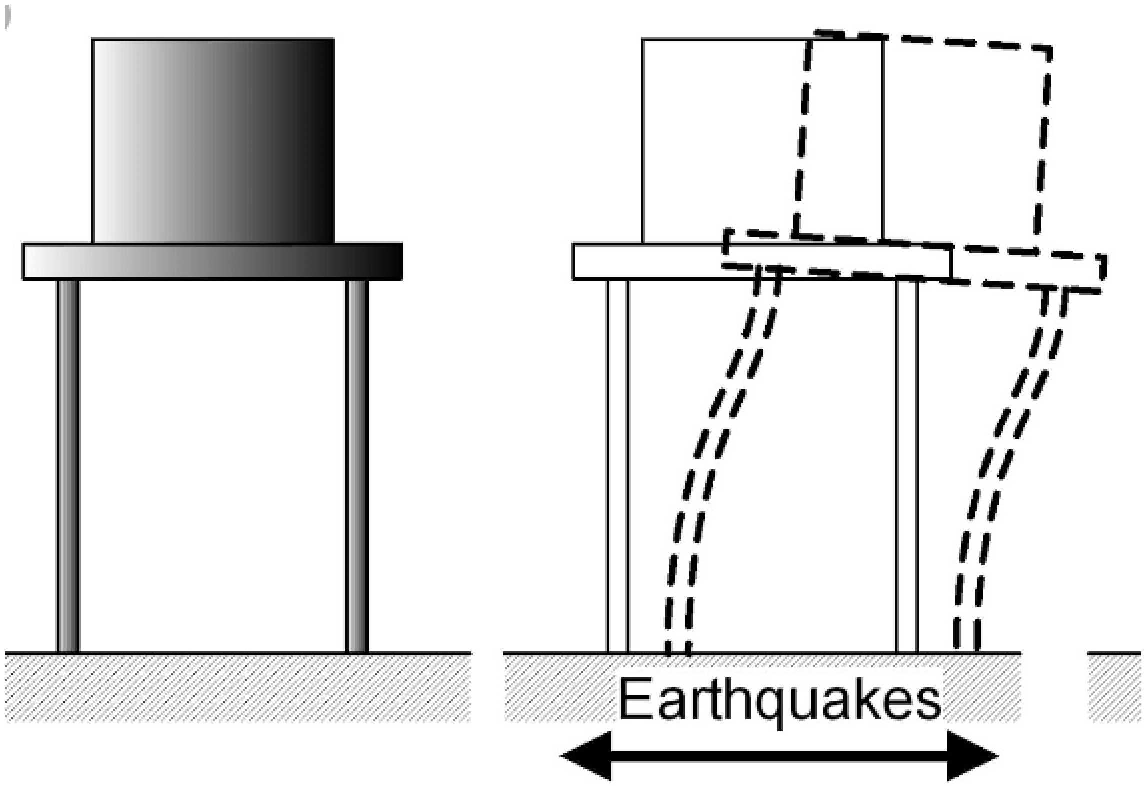
Approximate Peak Ground Acceleration and
Duration of Strong-Phase Shaking
(California Earthquakes)

| magnitude | maximum acceleration (g) | duration (sec) |
|---|---|---|
| 5.0 | 0.09 | 2 |
| 5.5 | 0.15 | 6 |
| 6.0 | 0.22 | 12 |
| 6.5 | 0.29 | 18 |
| 7.0 | 0.37 | 24 |
| 7.5 | 0.45 | 30 |
| 8.0 | 0.50 | 34 |
| 8.5 | 0.50 | 37 |

Liquefaction threshold?

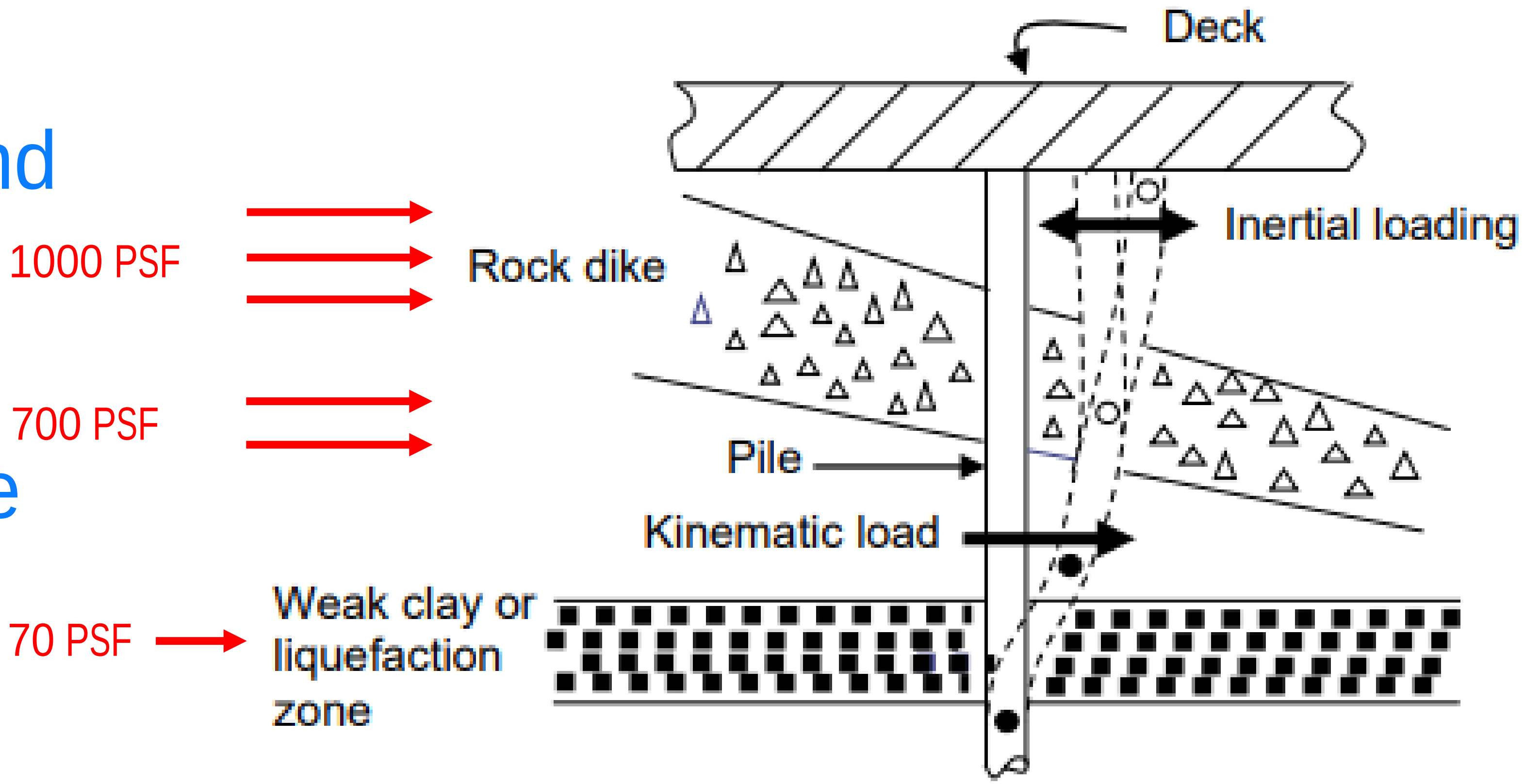
# Inertial Loads

- Mass of structure responding to ground movement.
- Related to mass and stiffness.
- Cyclical



# Kinematic Loads

- Monatomic load
- Different  type and location from seismic load
- Separated in time for most events



# Kinematic Loads

- Moving soil
- (2010 Chile event)

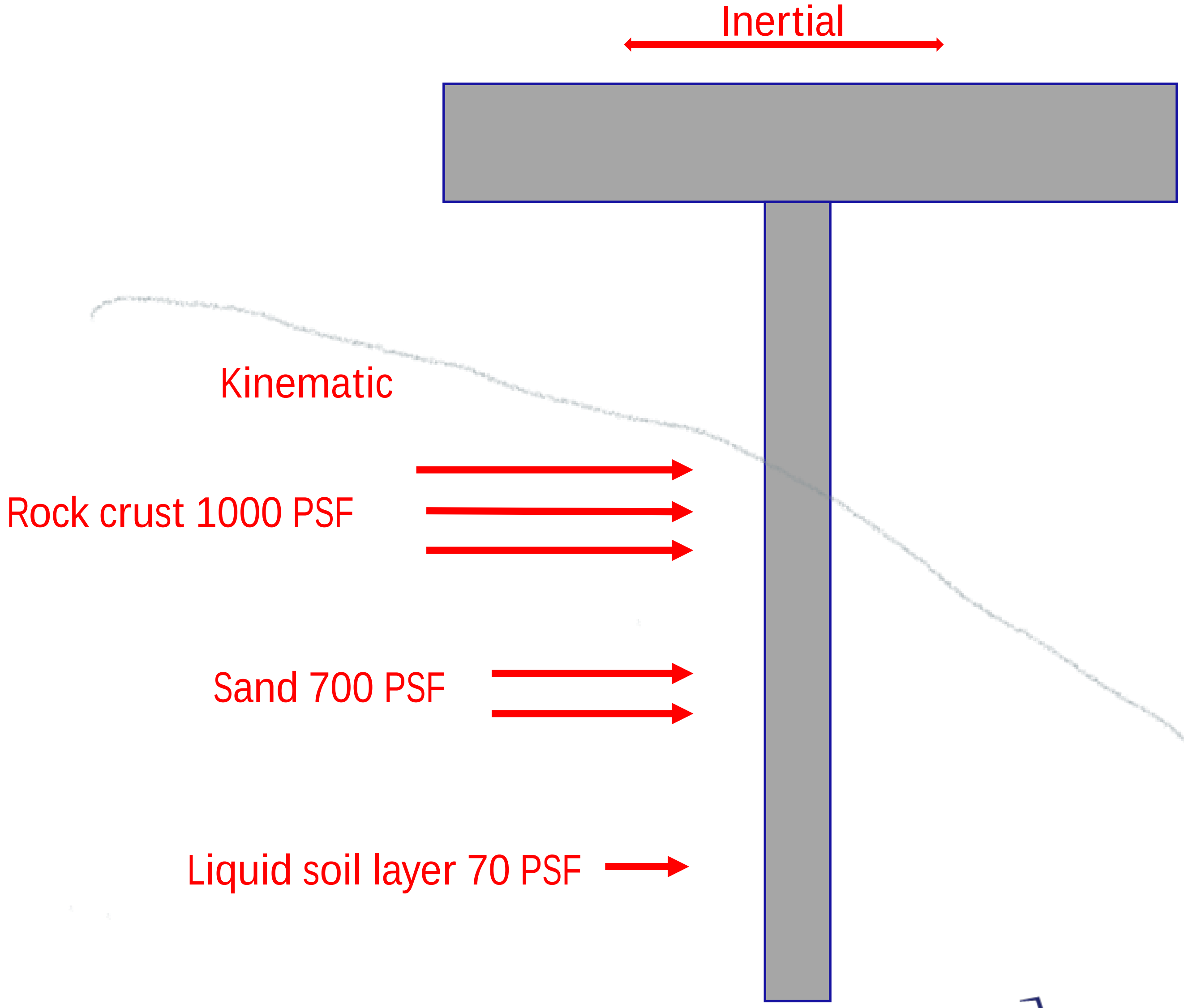
# Retaining Wall Failure
# Kings Harbor Marina, Redondo Beach
# 1994 Northridge, M 6.7

# Combined Inertial and Kinematic

- Short duration Earthquake - ground failure occurs after most of strong motion is over.
- Long duration Earthquake - combines strong motion and ground failure at the same time!

# Kinematic Loads

- Moving soil pushing on piling



# February 2010 Maule, Chile Earthquake
# Magnitude 8.8 Ground Failure/Lateral Spreading Port of Coronel

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1995 Kobe Japan Mw 6.9

Many large container cranes were damaged on Rokko Island. The damage to the cranes is primarily due to rails spreading and settling. Crane damage consisted of buckling of legs at the portal ties.

1995 Kobe Japan Mw 6.9
Liquefaction and lateral spreading damaged the crane rails

# Lateral Spreading – Bulkhead Failure
# 1995 Magnitude 6.9 Kobe Japan

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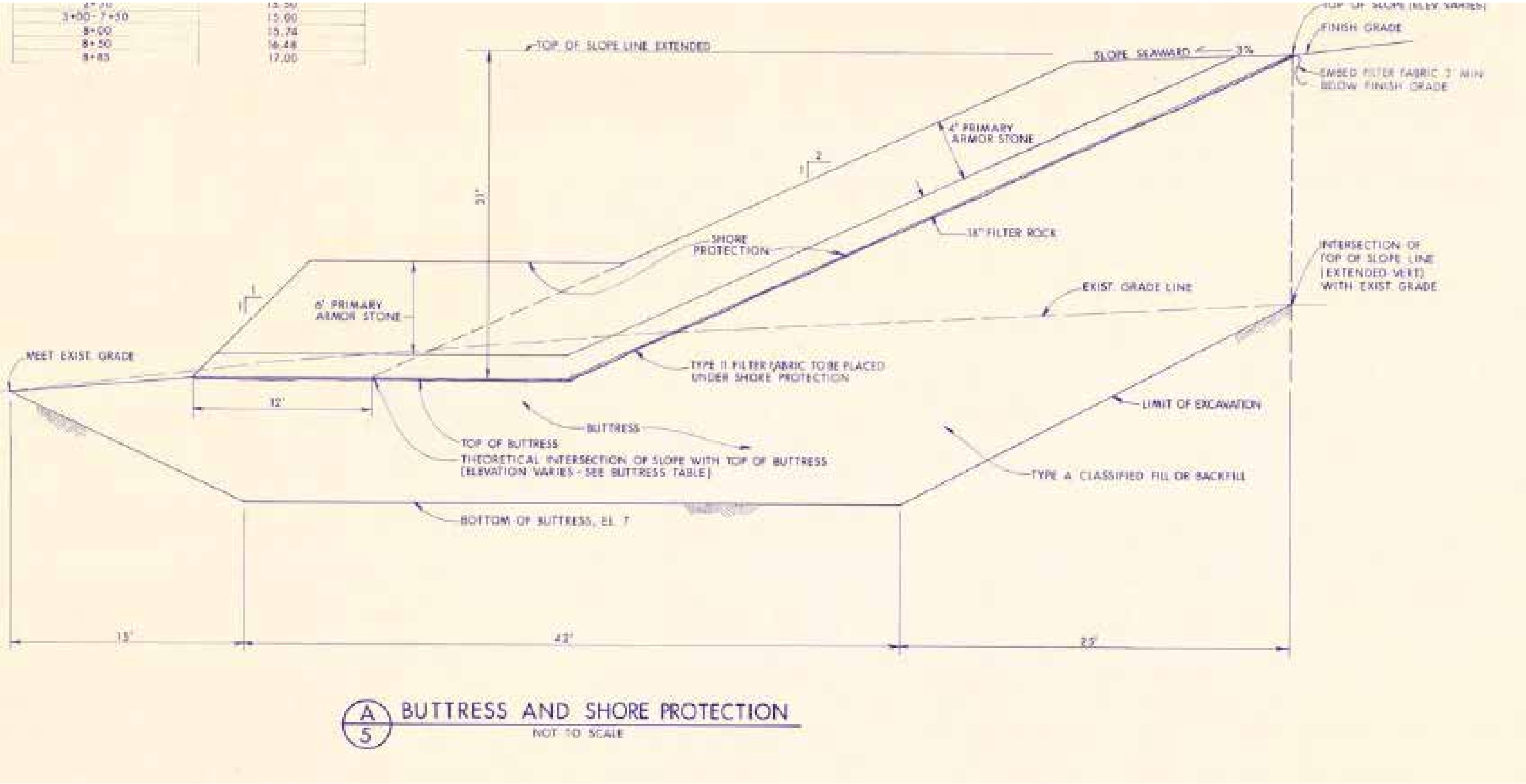
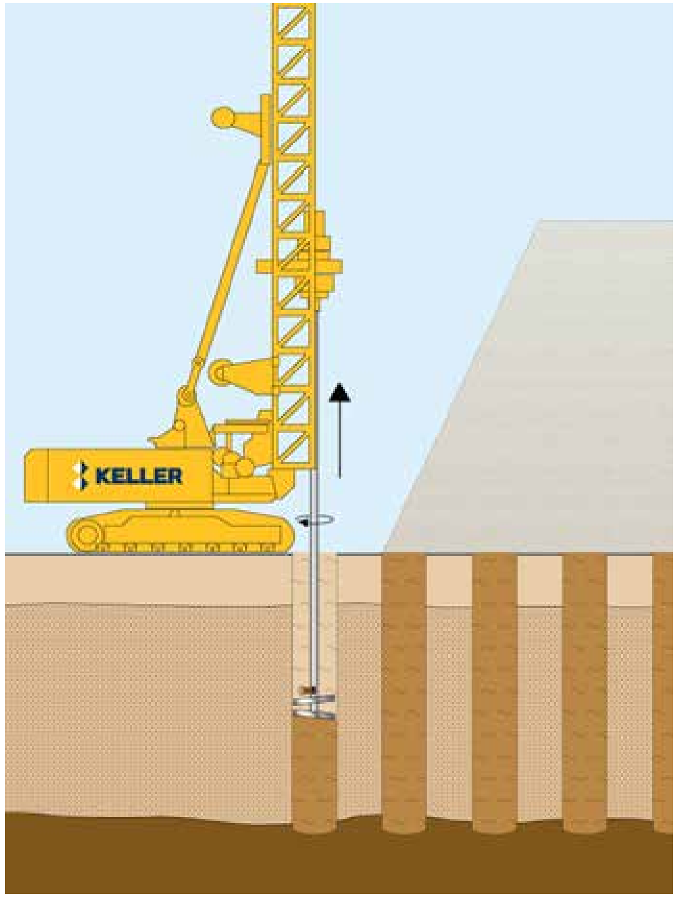
# How to resist these types of forces?

- Engineered Slopes
- Ground Improvements
- Bulkheads

# Engineered Slopes 1990s POA Transit Yard



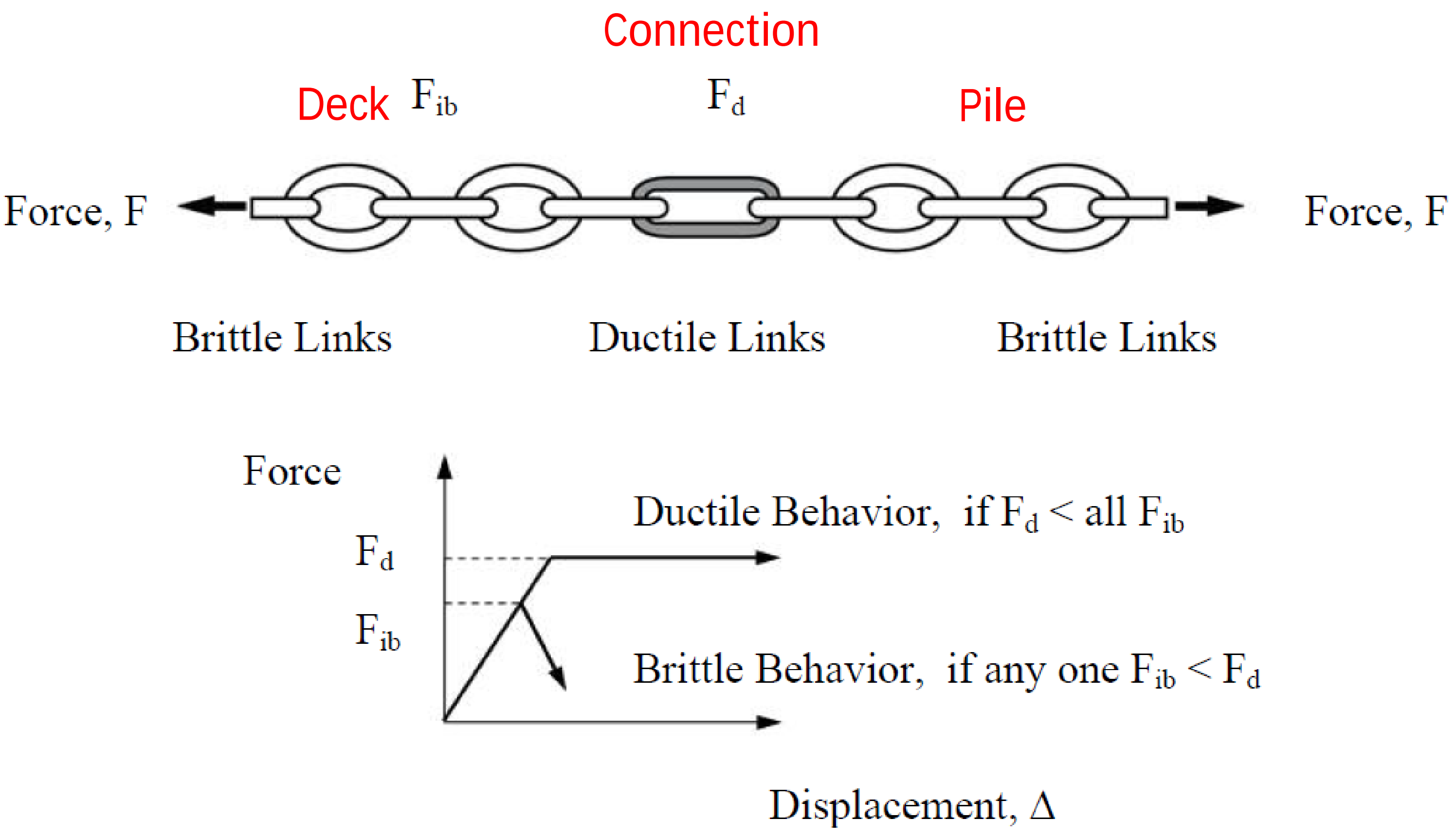
# Engineered Slopes - Deep Soil Mixing




# Structural Ductile Detailing

- Reducing risk for waterfront projects

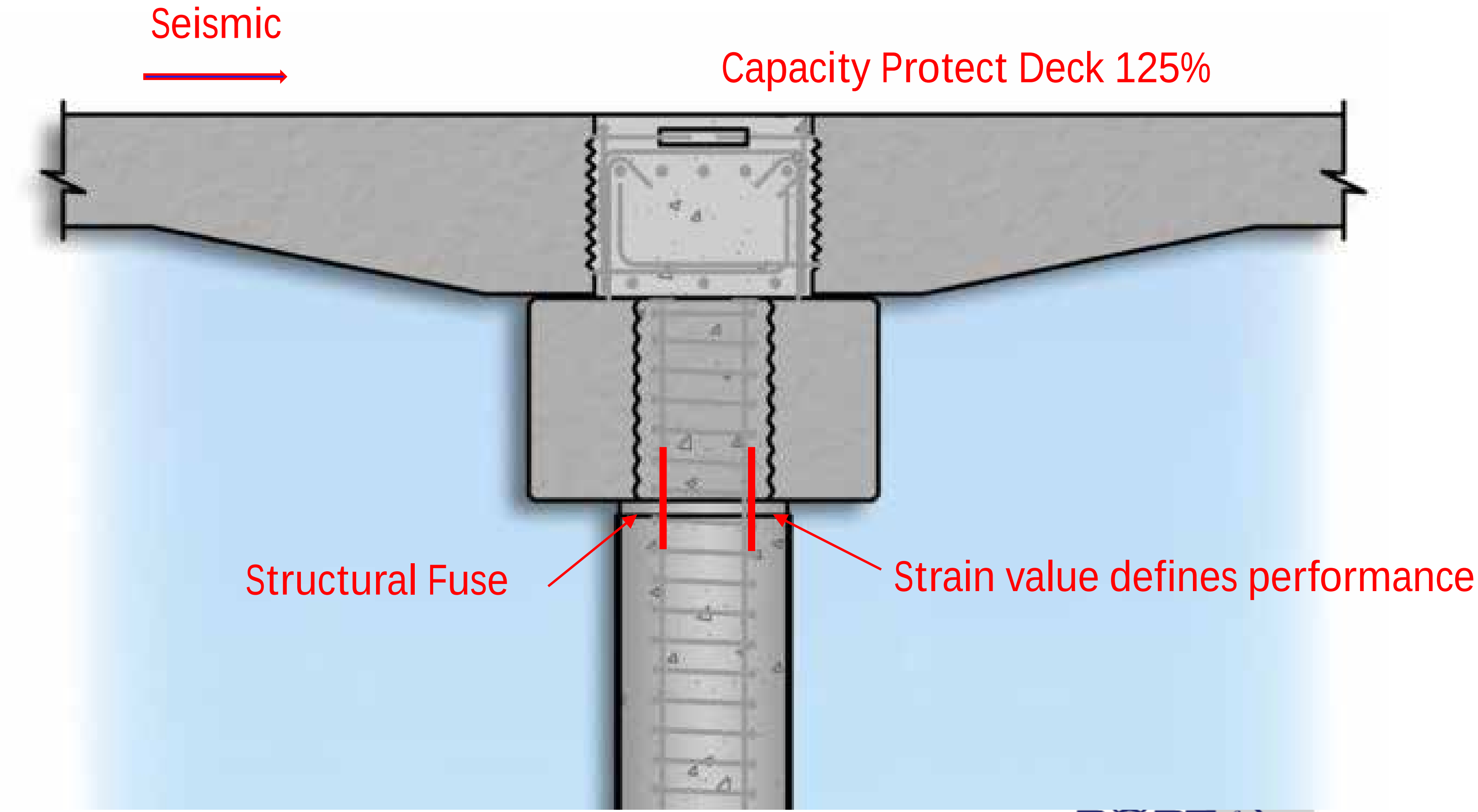
# Ductile Fuse Concept




Chain Analogy for Capacity-Protected Design (after Paulay and Priestley, 1992)

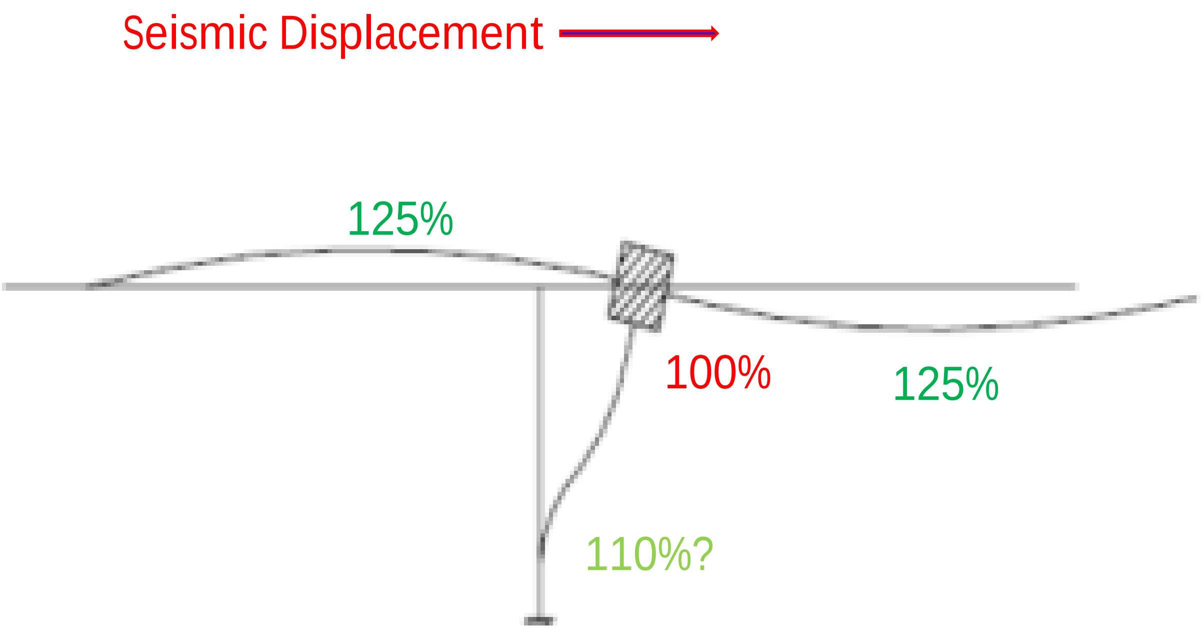
# POLA Code

- Strong Deck - Weak Pile ductile moment frame.
- Structural fuse at pile to deck connection.
- Deck is capacity protected.



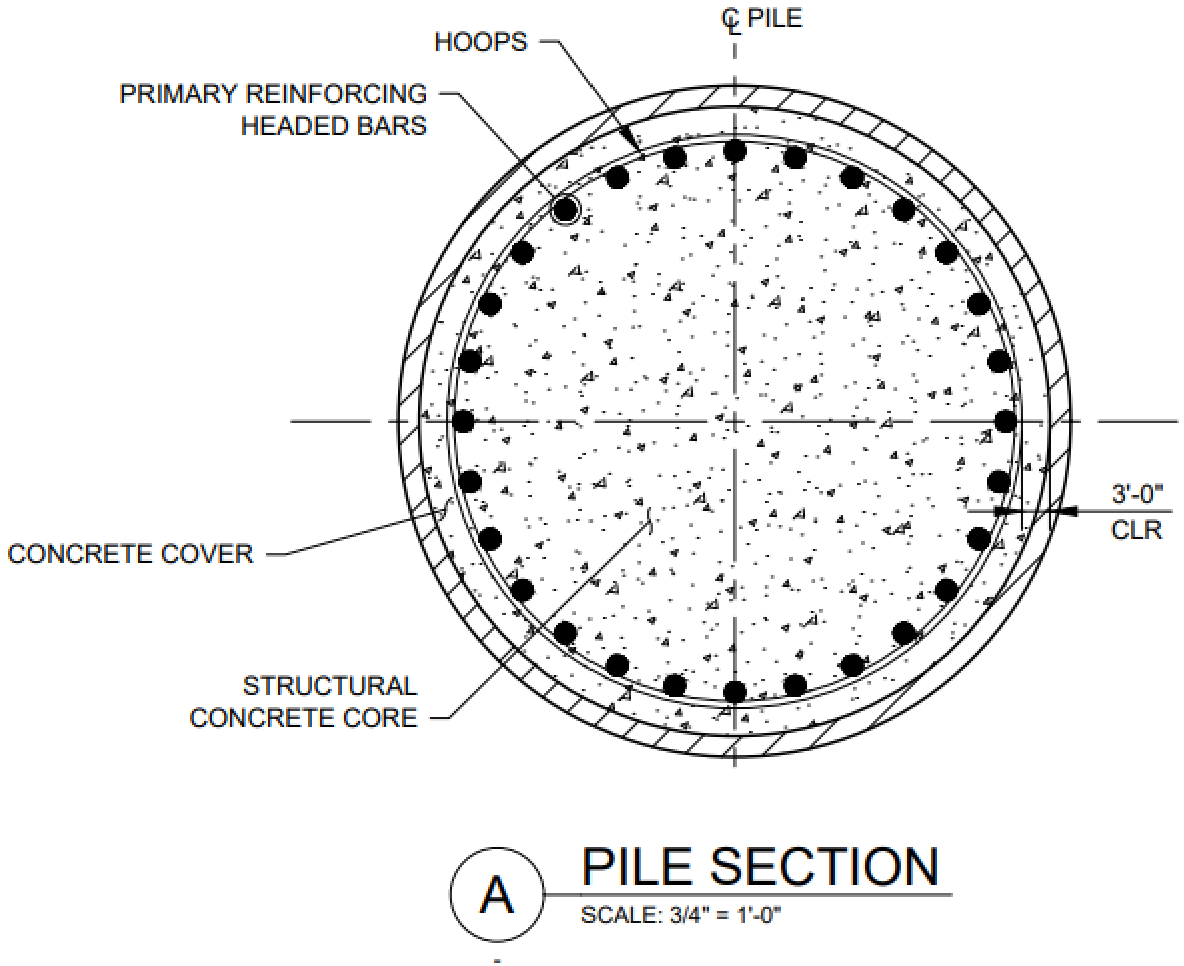
# Displacement Based Design

- Use expected materials properties
- Impart a displacement in model
- Yielding element will “jump out”
- Deck needs more capacity than hinge.



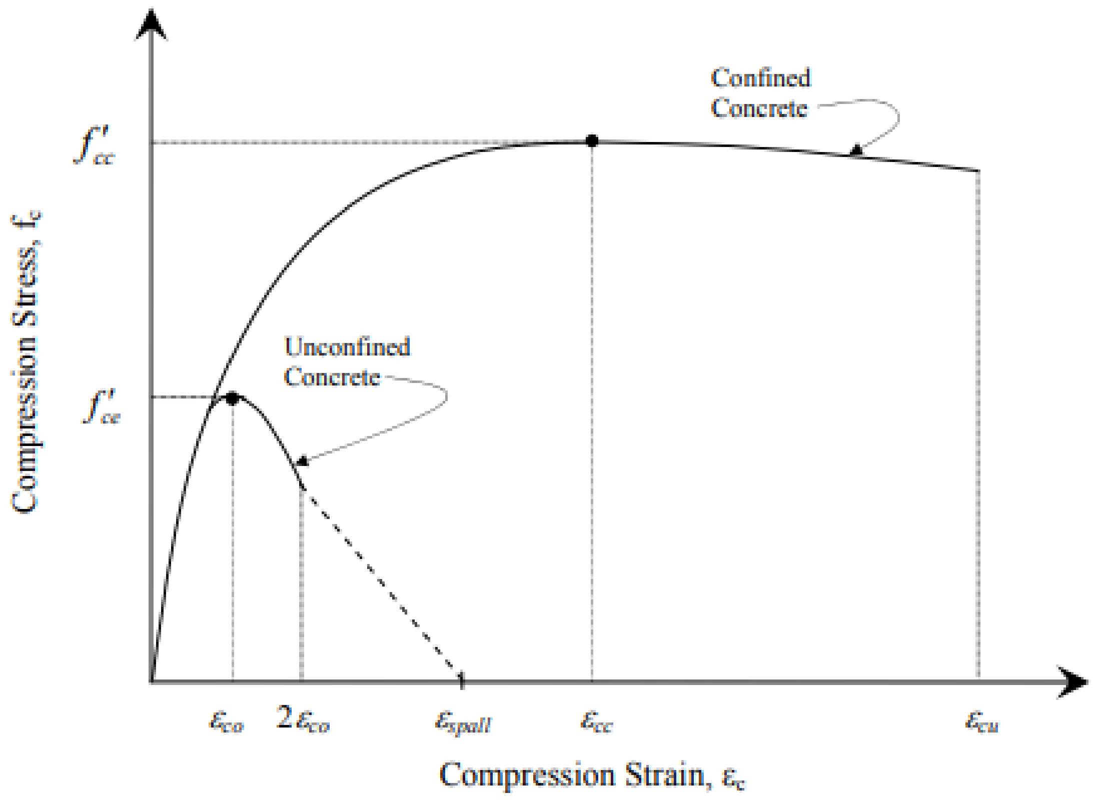
# Composite Pile

- Need to understand post yield behavior of pile to deck connection
- Composite section with several materials
- Push each material past yield
- Nonlinear and complicated



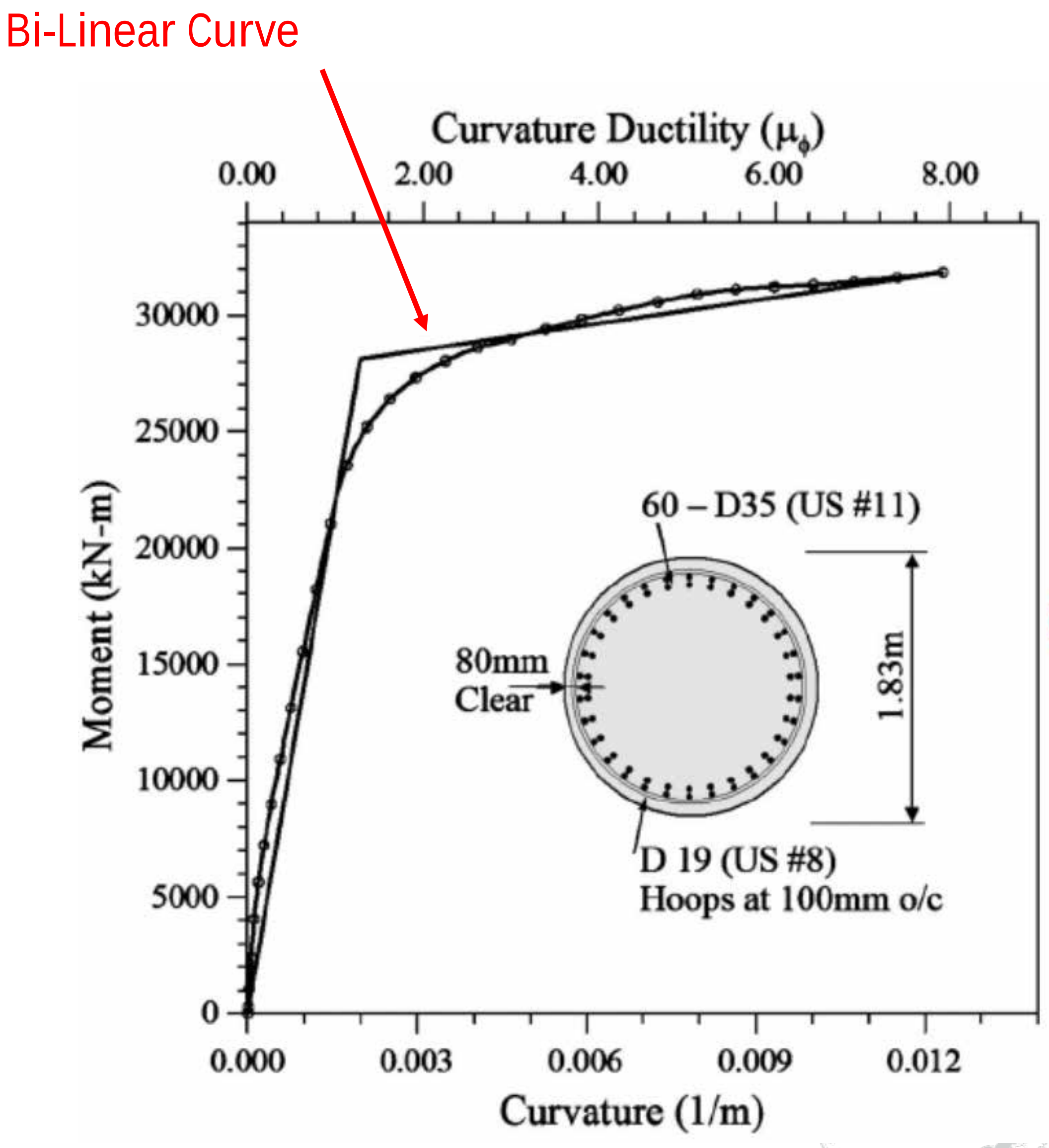
# Confined Concrete

- Mander and Park model for confined and unconfined concrete
- Confined concrete can be ductile!



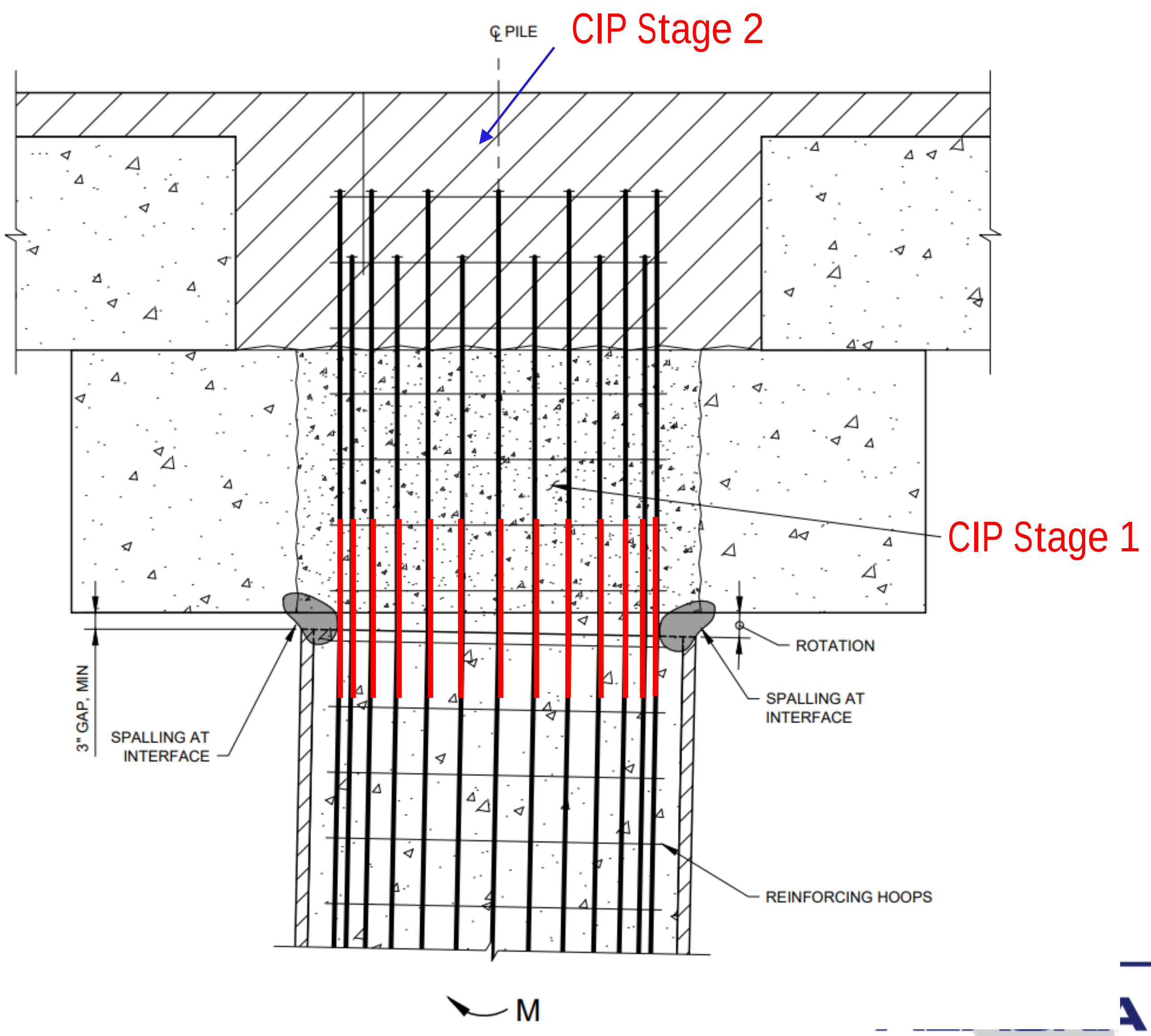
# Computer Analysis

- Need moment curvature properties of composite section ductile hinge
- Use computer program such as Xtract
- (Similar to stress strain curve but different.)



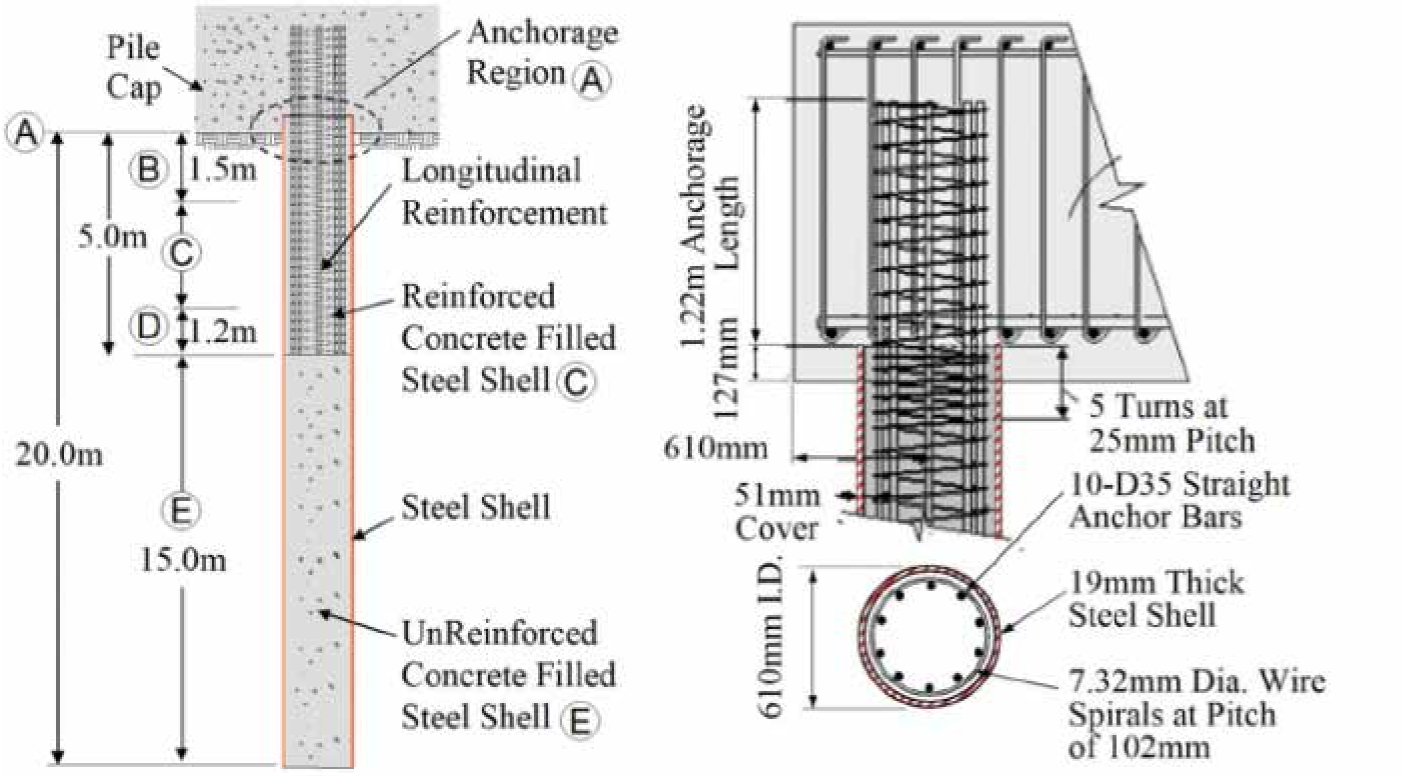
# Engineered Hinge

- Deck capacity protected
- Spalling at pile to cap interface, primarily in cover
- Limited strain in primary reinforcing
- Concrete core remains essentially intact
- No buckling of primary reinforcing



# ASCE 61 / POLA Code

- Highly engineered hinge
- Similar to bridge bent




(a) Reinforcement along Pile Length (b) Prototype Class 200 CISS Pile

# Ductile Concrete (Northridge 1994 Mw 6.7)

Before

After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1995 Kobe Japan Mw 6.9

Five-year-old 6-story concrete frame with garage level collapse. This was an exception to the rule of good performance of newer concrete buildings.

1995 Kobe Japan Mw 6.9
Five-year-old 6-story concrete frame with garage level collapse. Ductile detailing problems in the columns are shown.

1995 Kobe Japan Mw 6.9

Perhaps the most memorable image flashed around the world after the earthquake, was a bridge on the Hanshin expressway which "rolled over." This is an aerial view of that collapsed section of the Hanshin expressway. This spectacular failure occurred at the location where the superstructure deck changed from steel to concrete.

1995 Kobe Japan Mw 6.9

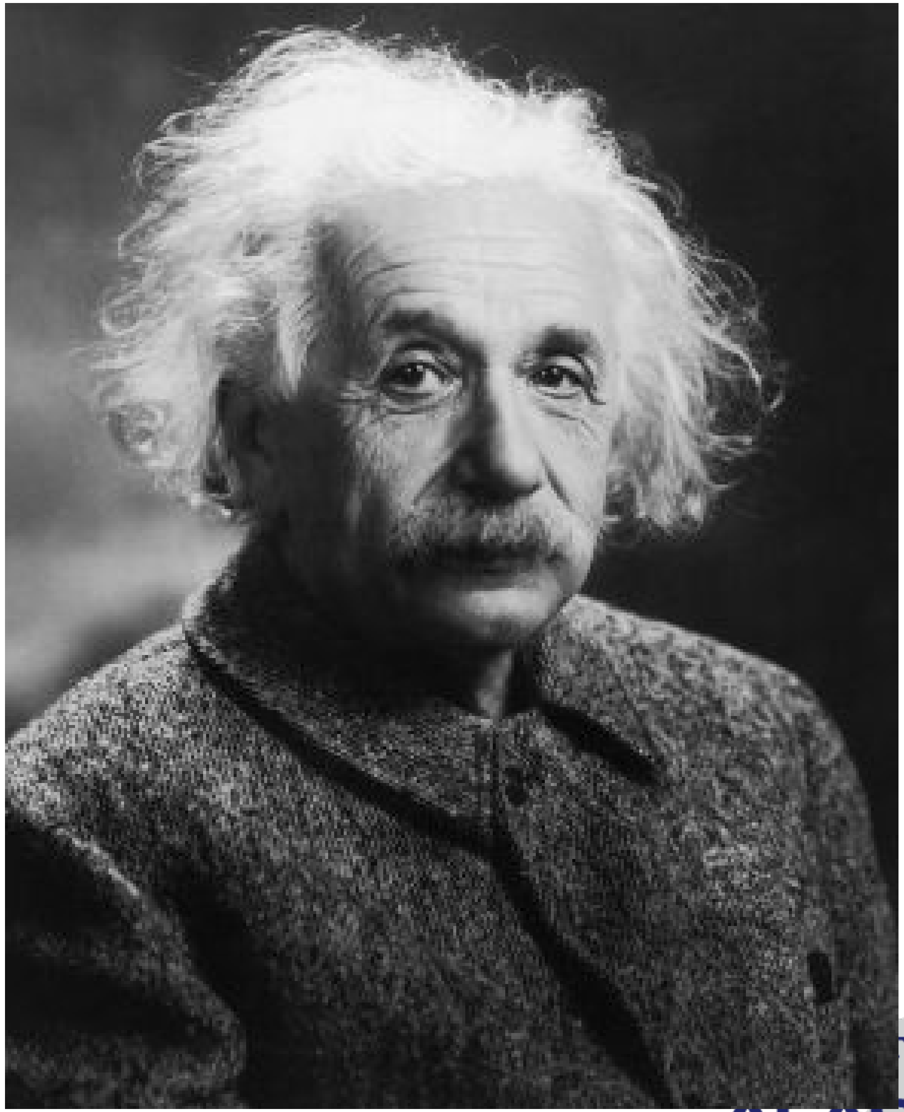
The columns in this segment of the Hanshin expressway are cast monolithically. Between each of these segments there is a simple span deck section which is connected by four bolts across the joint. The whole deck remained intact; none of the segments pulled apart.

1995 Kobe Japan Mw 6.9

Nearly every column along the elevated Hanshin expressway through Kobe was damaged. For the concrete columns, there was inadequate transverse reinforcement, making the columns very weak in shear, causing the longitudinal steel to birdcage and concrete to fail at low stresses. Note lack of cross ties and large spacing of horizontal ties.

# Map and Territory

- Once we are done with slopes and docks we are safe…right?
- How well will our maps match reality?



# Electrical Service Integrity?


# POL Service Integrity?

# Transportation System Integrity?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# Thank You