Crane Loads As They Affect Wharf Design

Presented by

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Types of Cranes

- Container Gantry
- Dry Bulk Gantry
- Mobile

Typical Container Gantry Crane

Typical Dry Bulk Unloader

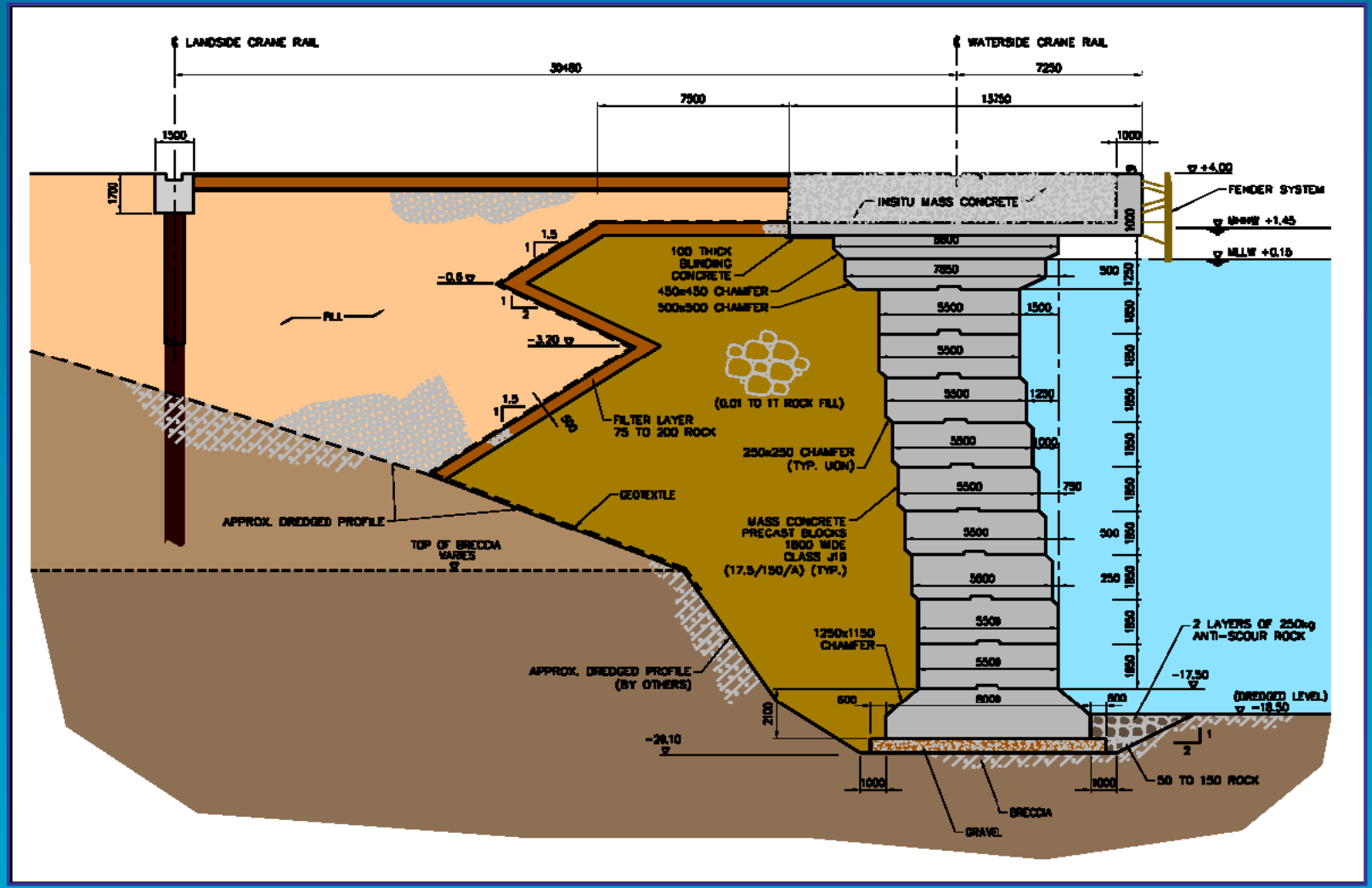
Typical Dry Bulk Loader

Typical Mobile Crane

Types of Wharf Structures

- Gravity
- Pile Supported

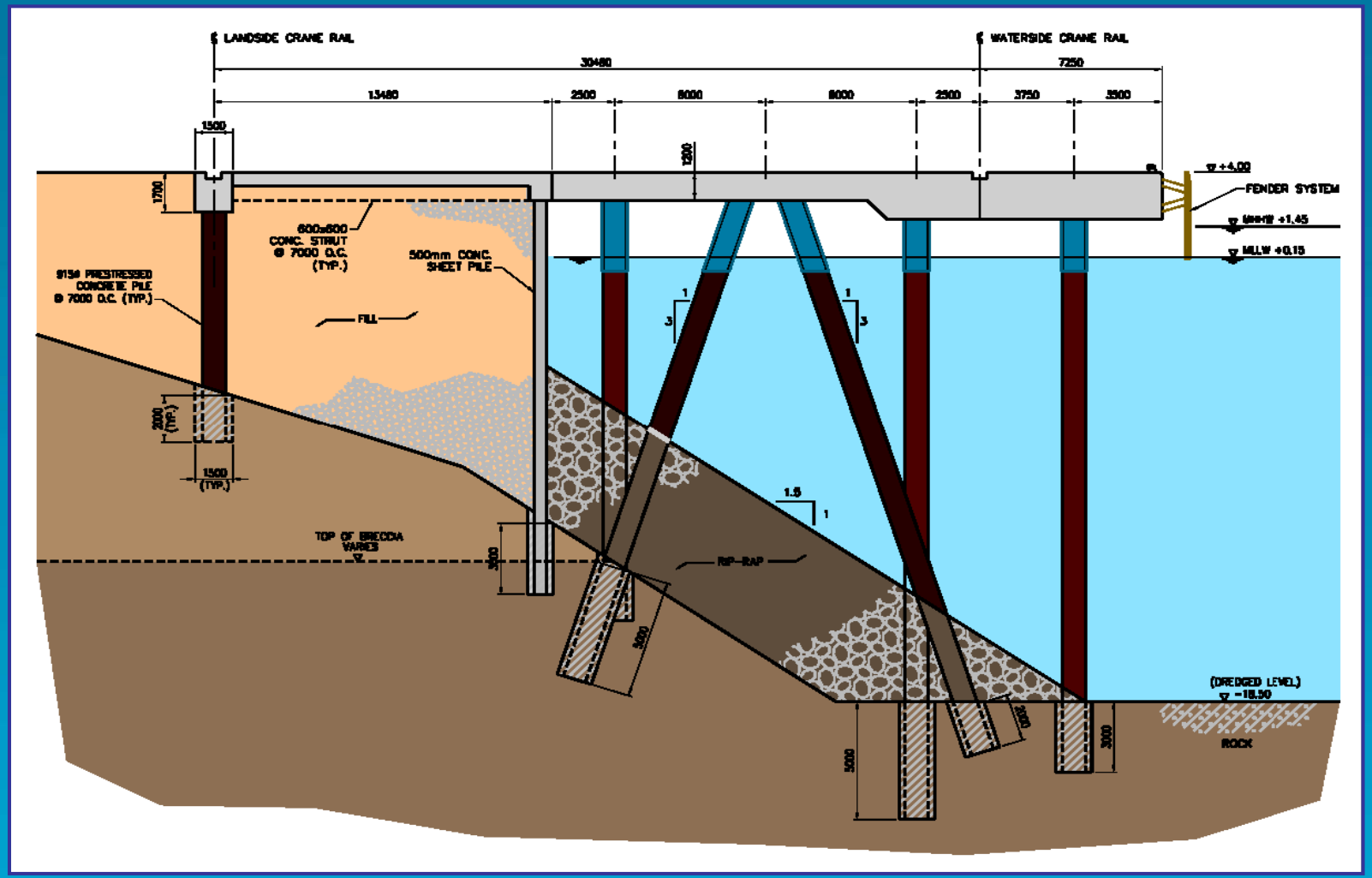
Typical Gravity Wharf Structure



- Cost relatively insensitive to crane loading

Port Salalah Container Terminal, Oman

Typical Pile Supported Wharf Structure



- Cost sensitive to crane loading

Pile Supported Pier

- Cost very sensitive to crane loading

Crane Characteristics Needed for Design

- Dimensional
- Loading

Crane Dimensional Characteristics

- Gage (spacing between rails)
- C – to – c distance between corners
- Number of wheels per corner
- Spacing of wheels

Crane Loading Characteristics

Maximum Load Per Corner

- Operating Condition
  - Water Side Vertical
  - Land Side Vertical
  - Horizontal
- Extreme Condition
  - Water Side Vertical
  - Land Side Vertical
  - Horizontal

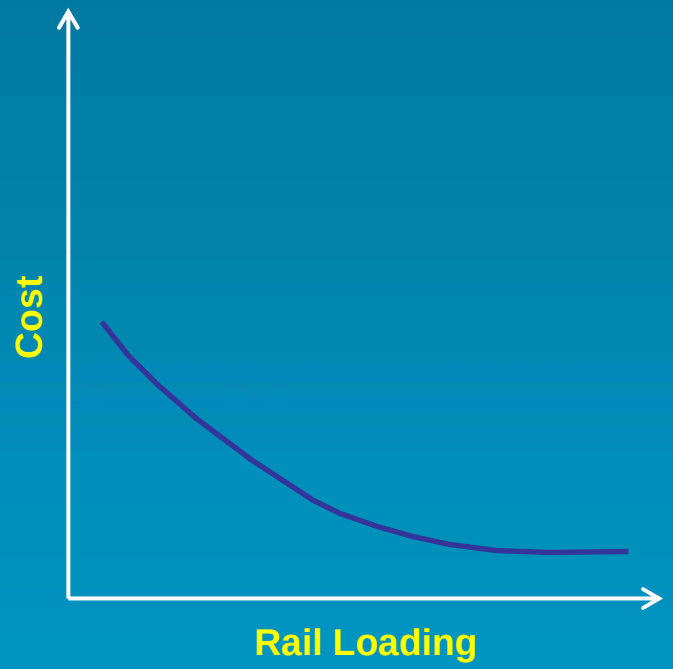
Example Super Post-Panamax Crane Dimensional Characteristics

Characteristic	Jebel Ali, Dubai	Doraleh, Djibouti
• Gage (spacing between rails)	42	30.48
• C – to – c distance between corners	14.1	15.5
• Number of wheels per corner	8	8
• Spacing of wheels	1.3	1.2

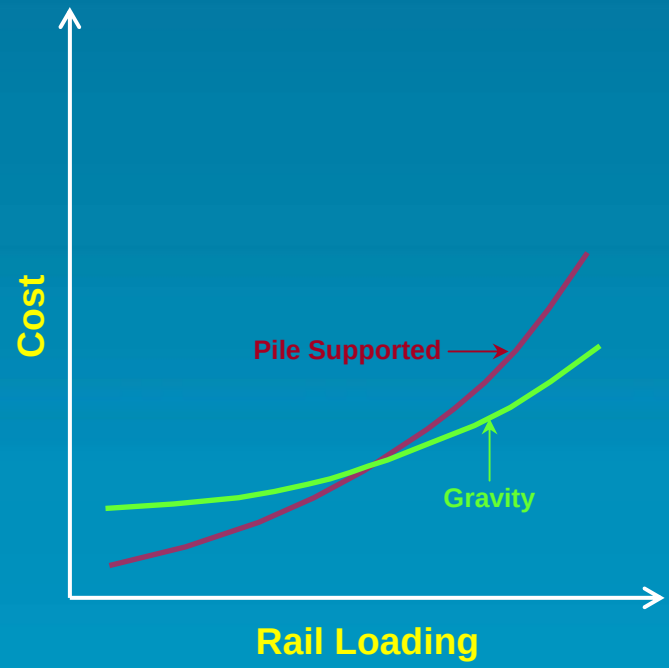
Example Super Post-Panamax Crane Loading Characteristics

Load	Maximum Load Per Corner	
	Jebel Ali, Dubai	Doraleh, Djibouti
• Operating Condition		
– Water Side Vertical, kN	11,200	8,400
– Land Side Vertical, kN	9,600	6,800
– Horizontal, kN	800	400
• Extreme Condition		
– Water Side Vertical, kN	12,000	10,400
– Land Side Vertical, kN	12,000	8,960
– Horizontal, kN	2,100	840

Crane and Wharf Cost vs. Rail Loading



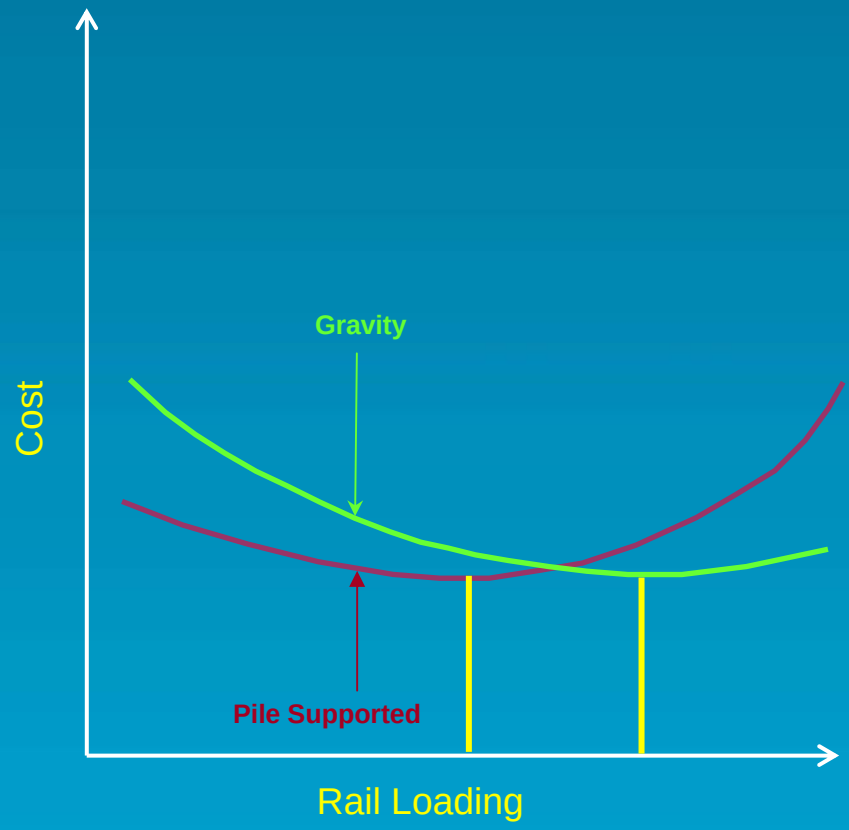
CRANE COST*



WHARF COST

* For given crane performance requirements

Crane + Wharf Cost vs. Rail Loading



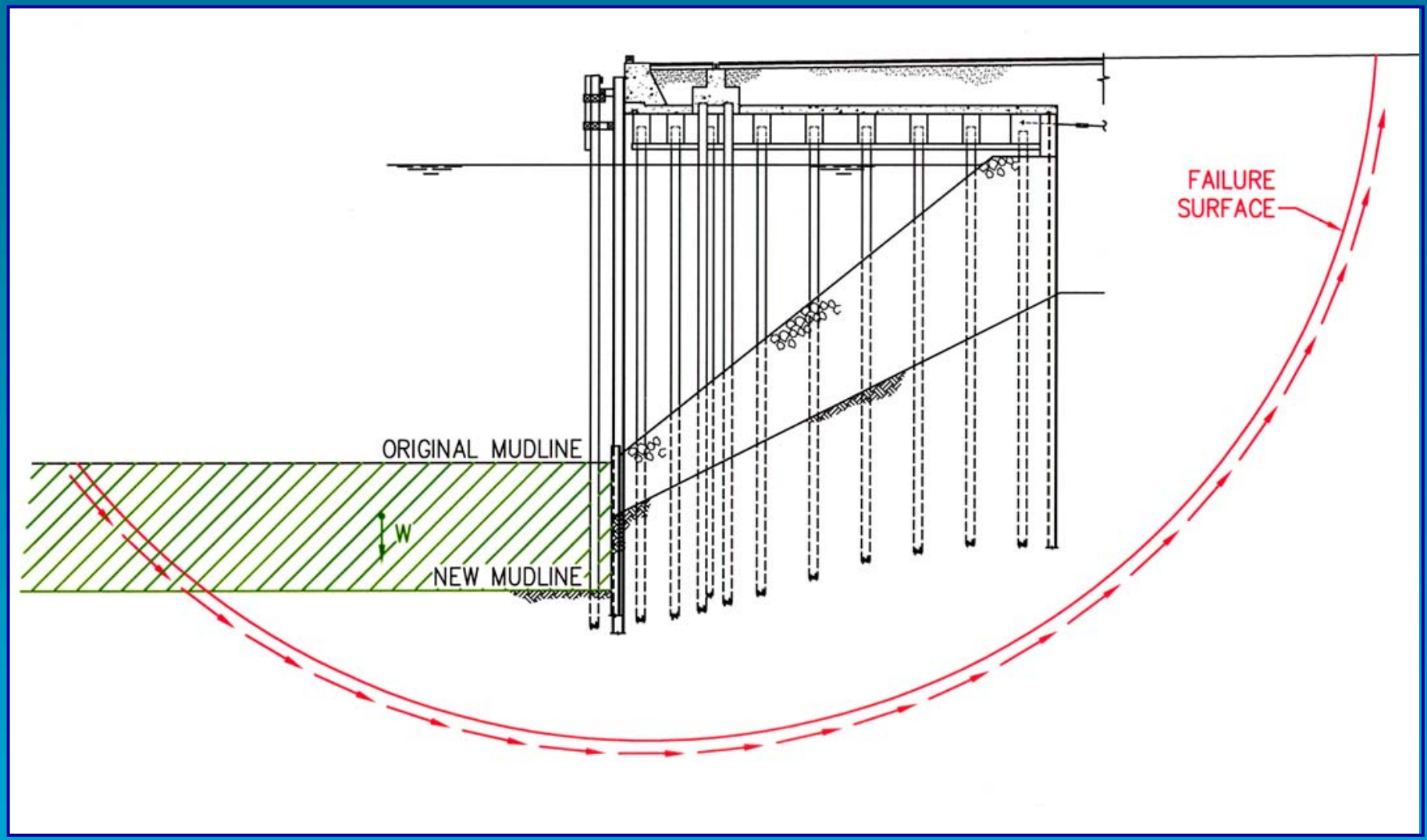
Modifying Existing Wharves

- Deepening issues
- Crane load issues
- Fender system
- Mooring system
- New code requirements

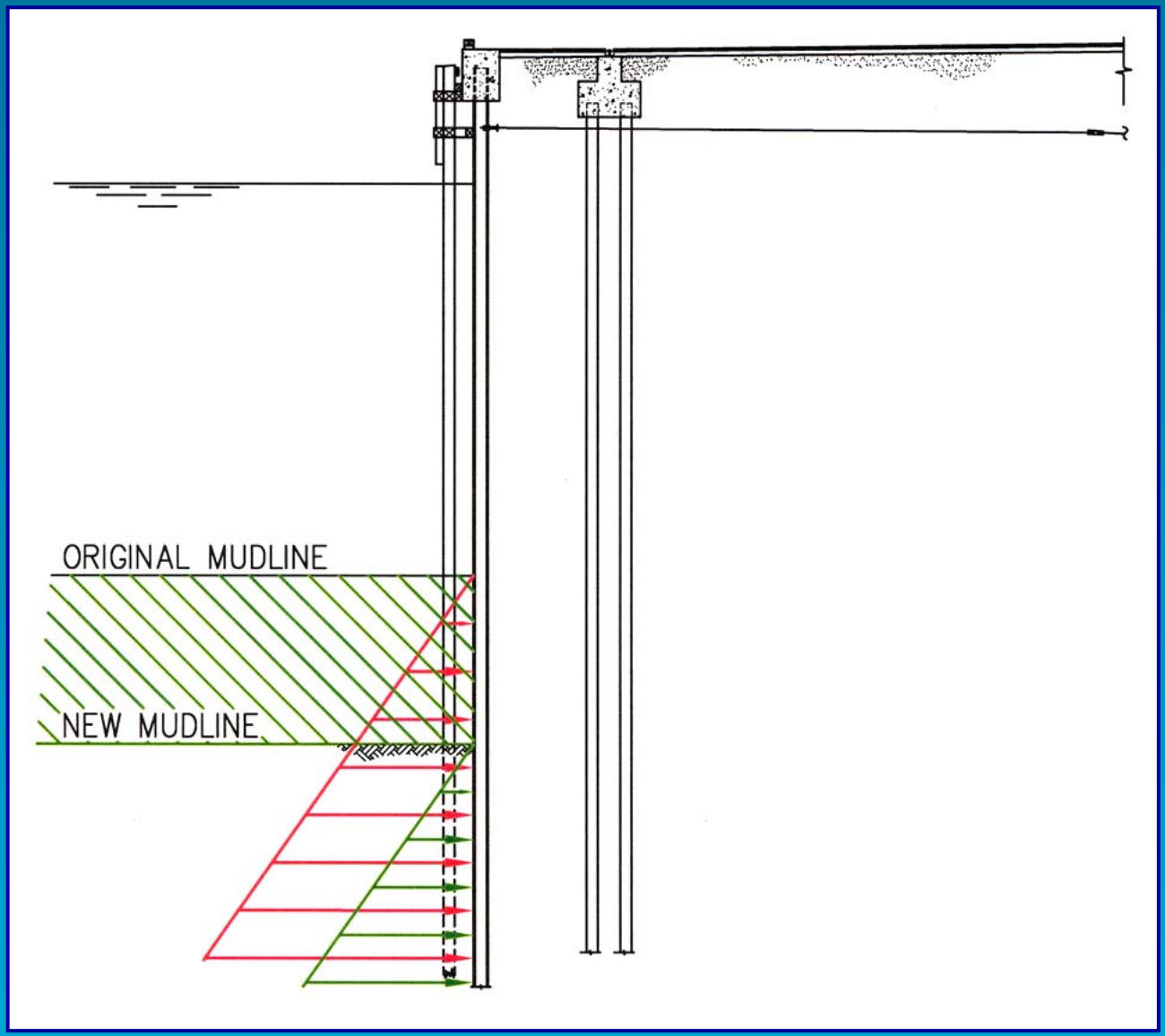
Berth Deepening

- Reduces Global Stability
- Reduces Local Stability
- Reduces Pile Embedment Capacity
- Reduces Pile Structural Capacity

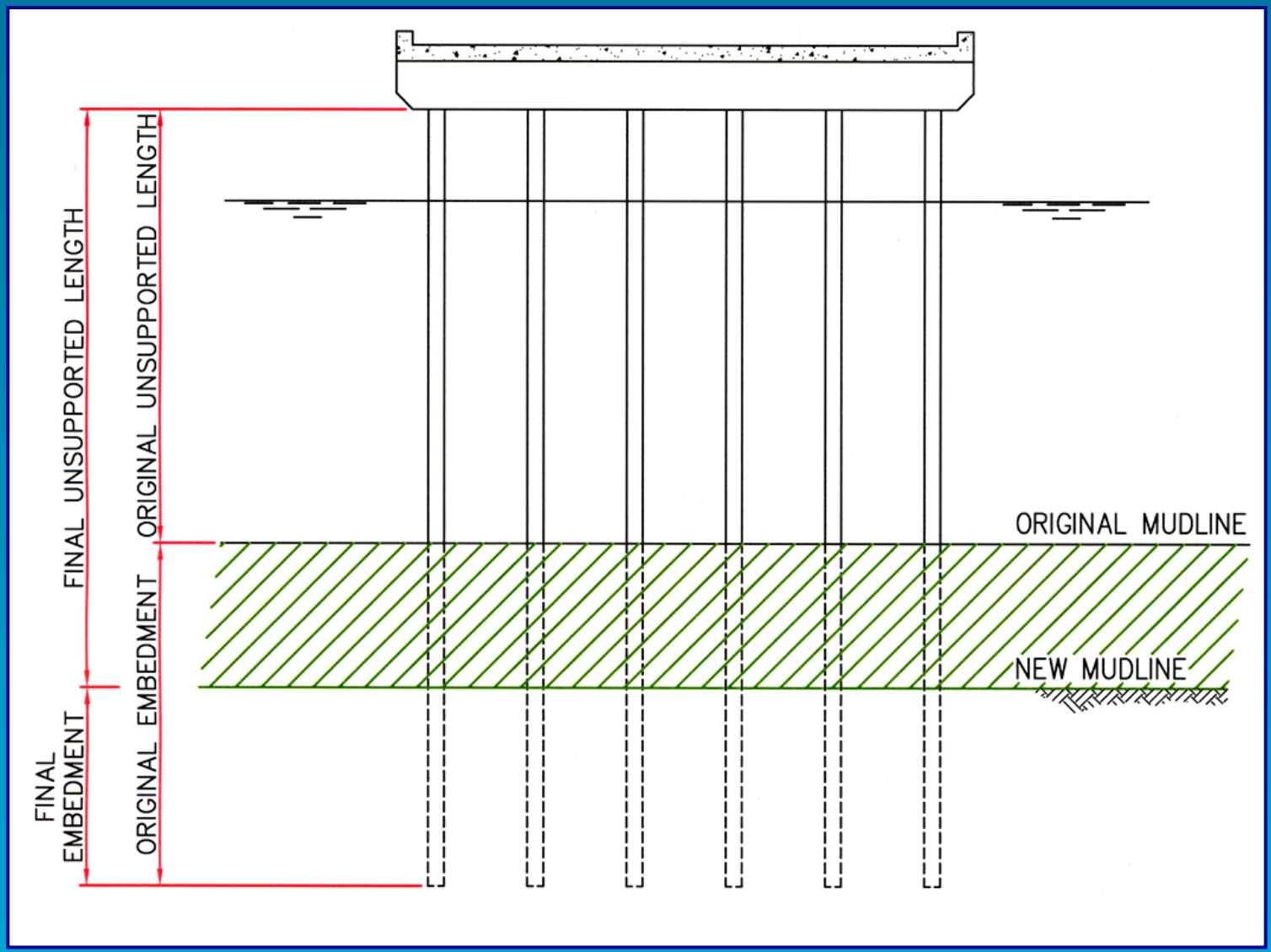
Global Stability



Local Stability



Pile Capacity



Crane Load Issues

- Increased reach
- Increased lifting capacity
- Increased weight

RESULT

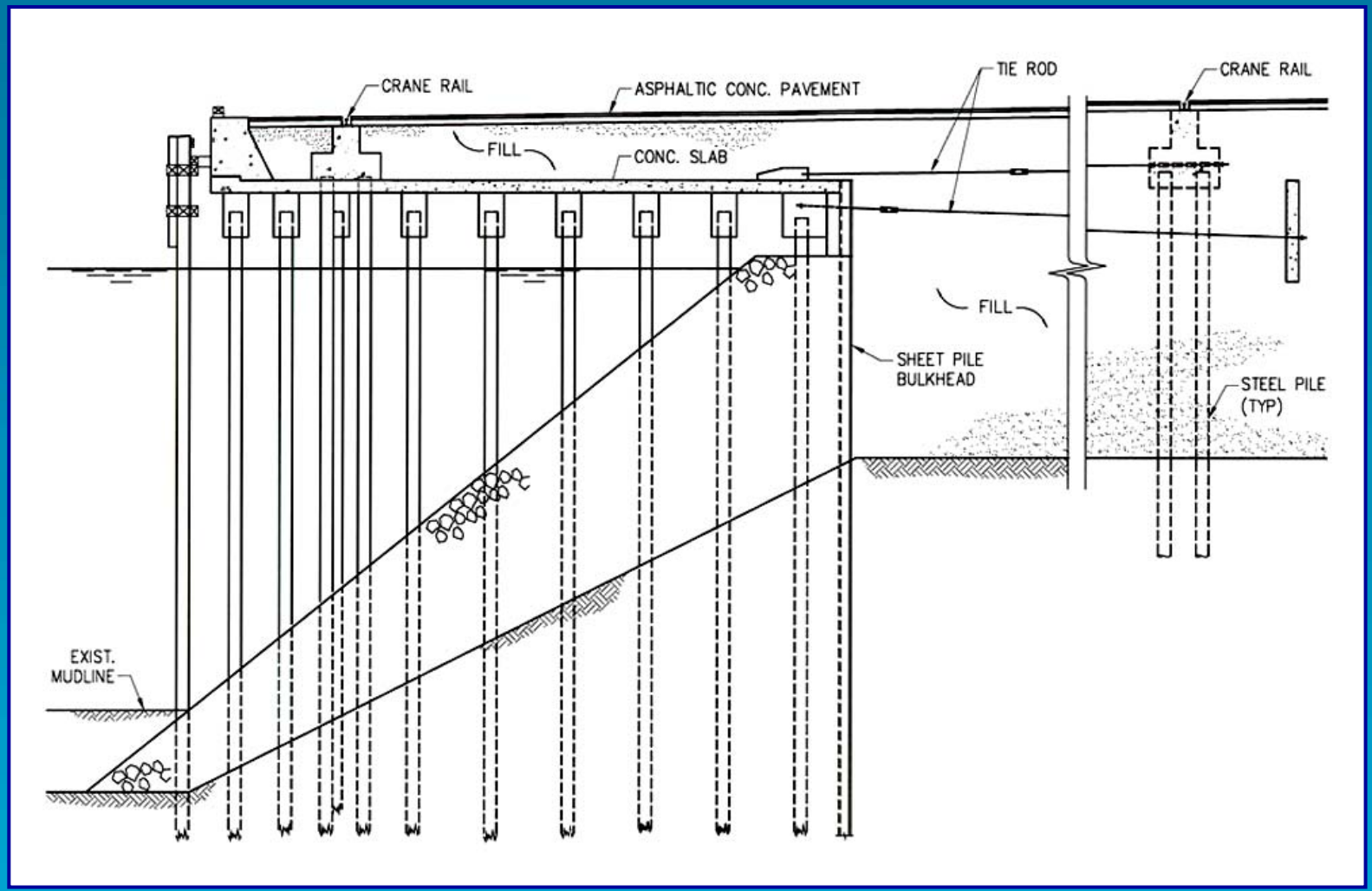
- Increased rail loading
- Increased tie-down forces

APM Port Elizabeth Container Terminal

APM Port Elizabeth Container Terminal

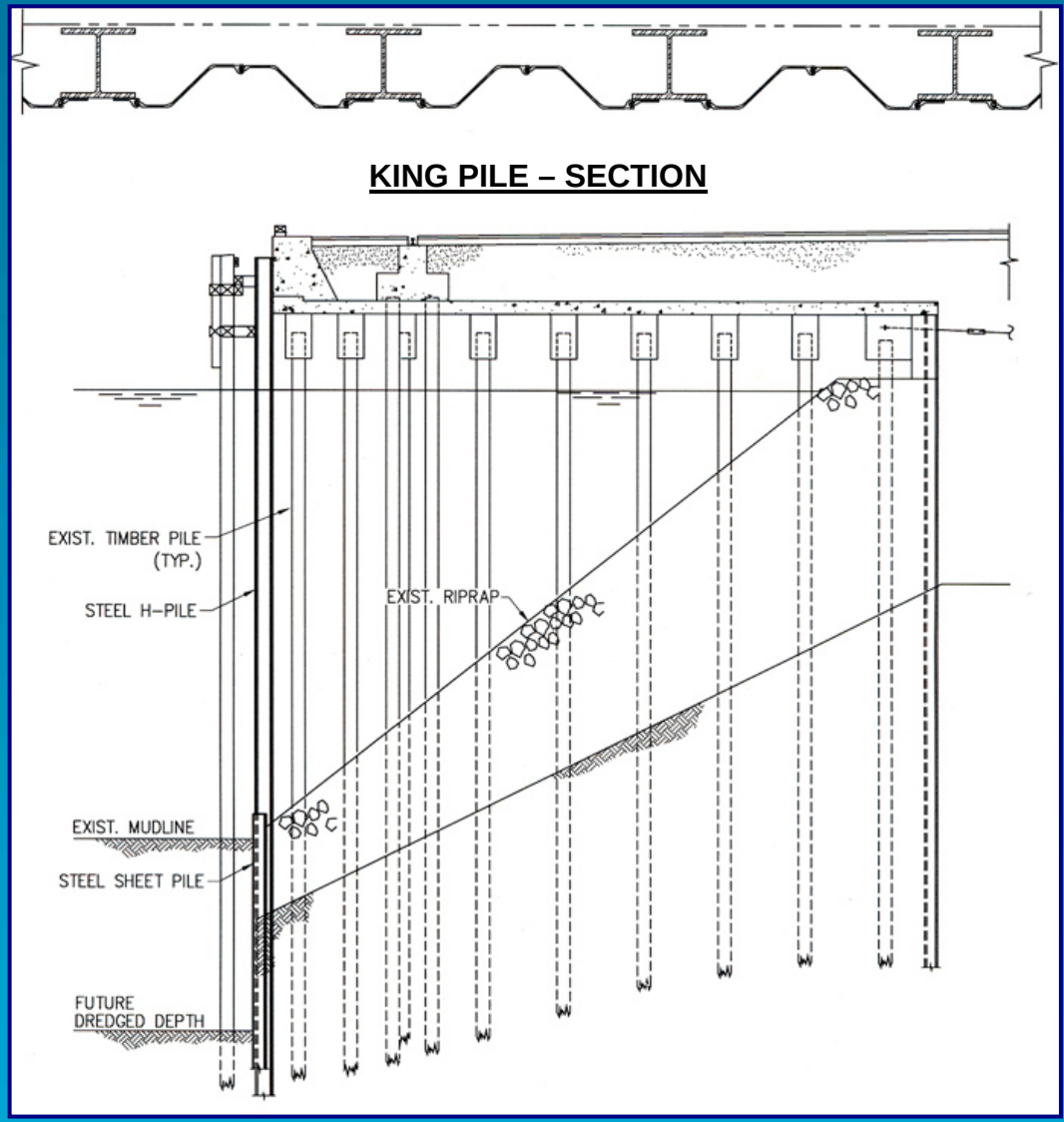
- **Existing Features**
  - Constructed ca. 1970
  - 40 ft water depth
  - 50 ft wide platform
  - 30 ton timber piles
  - 20 kips per ft rail load
  - 100 ft rail gage
  - 500 psf deck live load
  - 85 ton bollard @ 120 ft
  - Minimal timber/rubber fender system
  - No seismic criteria
- **Upgrading Requirements**
  - 52 ft water depth
  - 250 ton steel piles
  - 50 kips per ft rail load
  - 165 ton bollards @ 40 ft
  - Fender system for Super Post-Panamax vessels
  - Seismic zone 2

APM Port Elizabeth Container Terminal
Existing Wharf Structure



APM Port Elizabeth Container Terminal

King Pile Cut-Off Wall



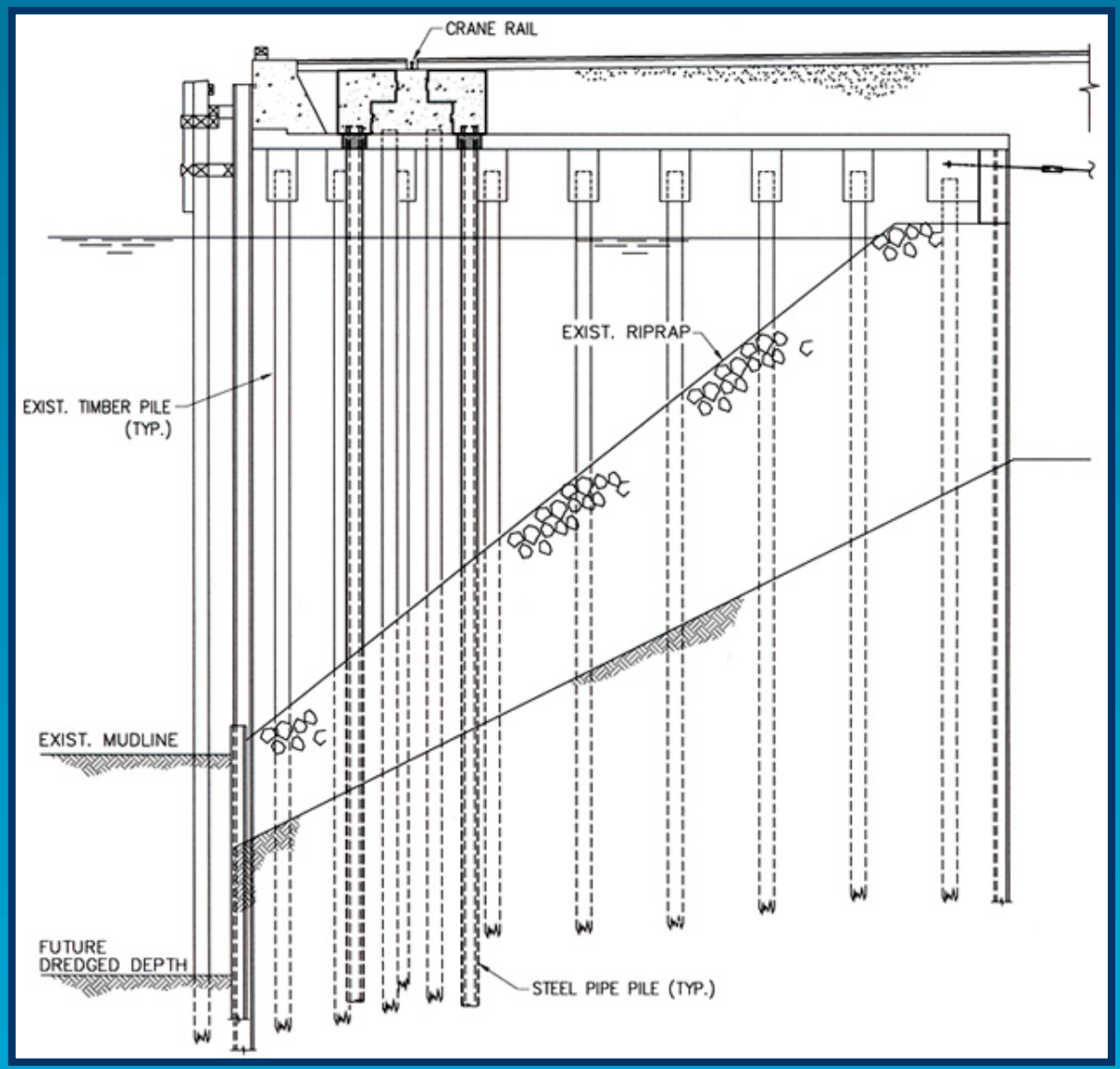
APM Port Elizabeth Container Terminal

Crane Rail Capacity Increase

- **Same Location as Existing Rails**
- **Landward of Existing Rails**
- **Seaward of Existing Rails**

APM Port Elizabeth Container Terminal

New Rails Same Location as Existing Rails

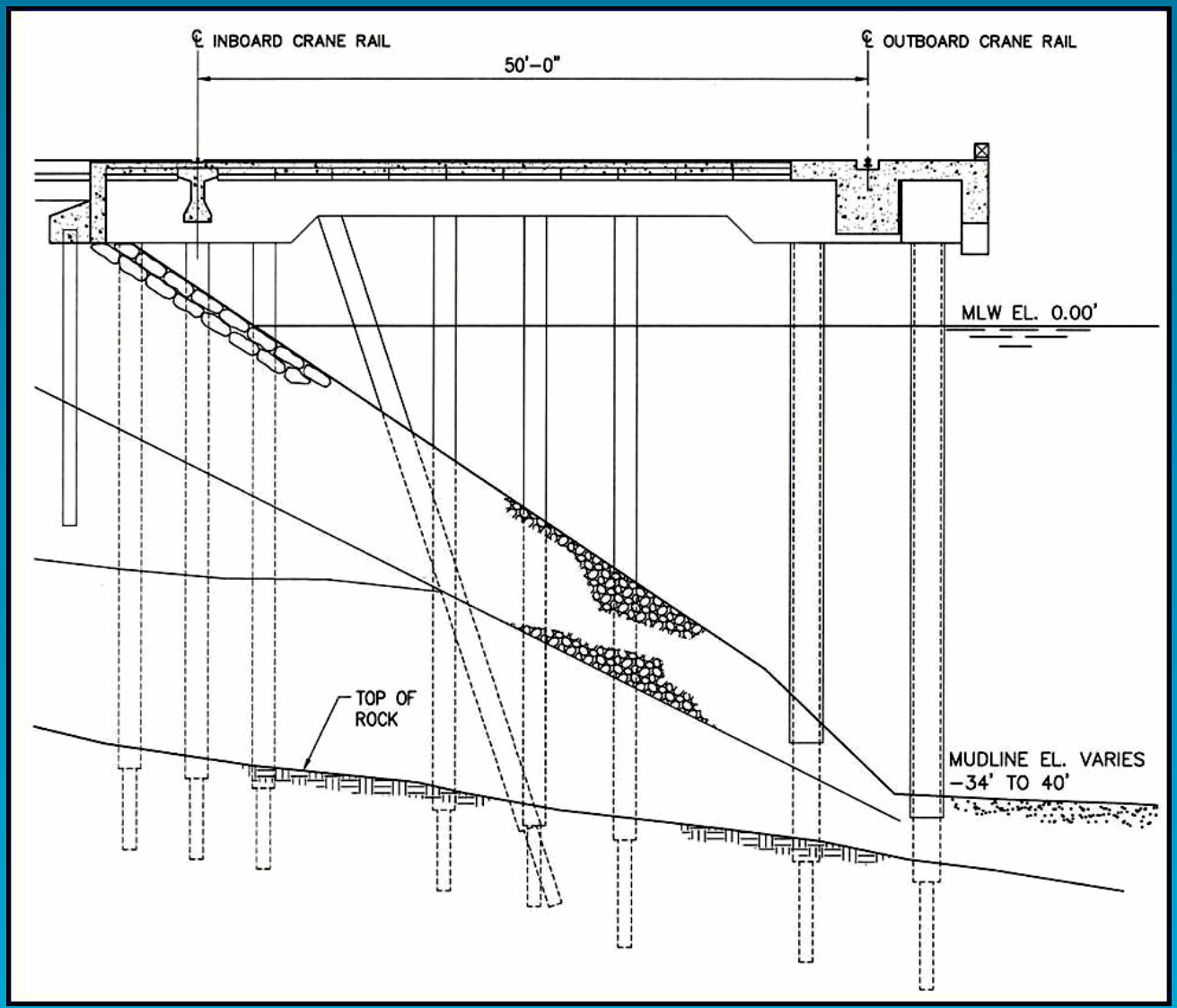


Howland Hook Container Terminal

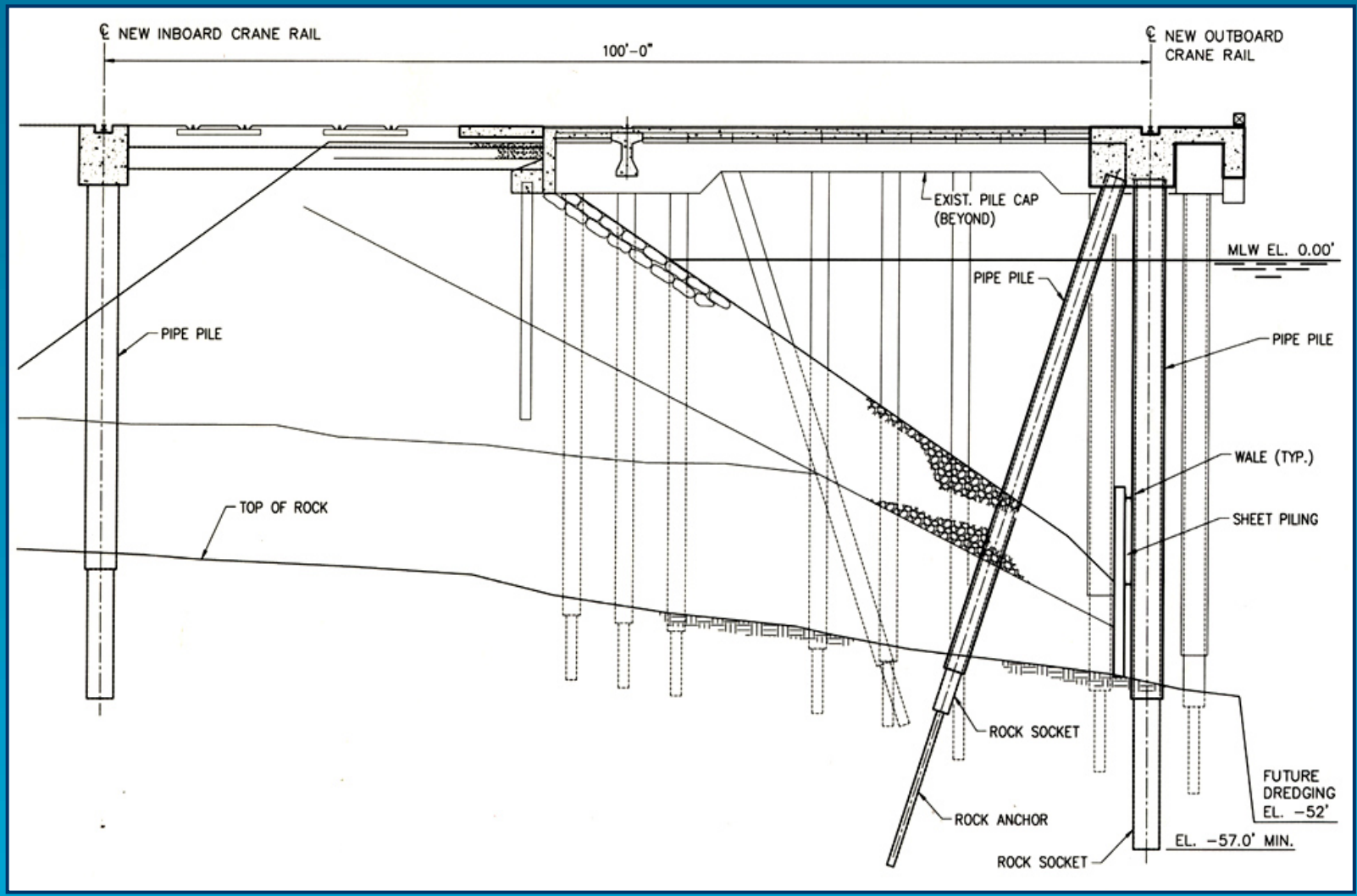
Howland Hook Container Terminal

- **Existing Features**
  - Constructed ca. 1970
  - 35 ft water depth
  - 67 ft wide platform
  - concrete and steel piles
  - 20 kips per ft rail load
  - 50 ft rail gage
  - 500 psf deck live load
  - 85 ton bollard @ 88 ft
  - 15”ϕ rubber cylinder fender system
  - No seismic criteria
- **Upgrading Requirements**
  - 52 ft water depth
  - 300 ton steel piles
  - 42 kips per ft rail load
  - 100 ft rail gage
  - 100 ton bollard @ 44 ft
  - Fender system for Super Post-Panamax vessels
  - Seismic zone 2

Howland Hook Container Terminal
Existing Wharf Structure



Howland Hook Container Terminal
Upgraded Wharf Structure



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