Repair and Support of Deepwater Bulkheads Utilizing Jet Grouting and Soil Mixing Methods

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Marine Facilities have many Design Challenges –

Large Surcharge forces on dock or desire to increase draft	***Soil Mixing*** ***Jet Grouting*** Anchors
Corrosion of Dock Facility	***Jet Grouting*** Compaction Grouting
Weak Soil – Deep very stiff sheeting	***Soil Mixing*** Anchors
Placed or unconsolidated Soils	Compaction Grouting ***Wicks*** DDC

Presentation Topics

- Soil Mixing Technology Introduction
- Soil Mixing Applications for Bulkheads
- Jet Grouting Technology Introduction
- Jet Grouting Applications for Bulkheads
- Closing Remarks

Soil Mixing – Soil Improvement for New Bulkheads

Soil Improved for increased load and stability

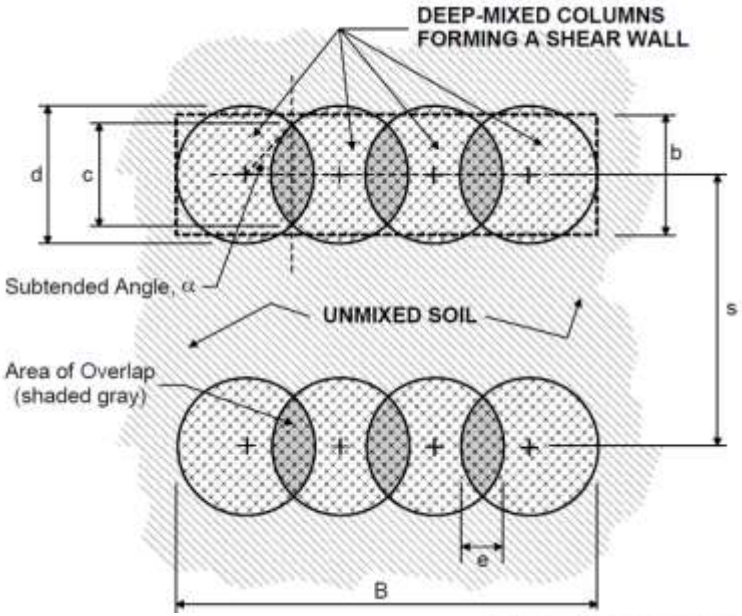
Soil Mixing methods can use a Wet process when dryer stiffer soils need to be mixed

Wet mixing process combines the binders with water and the binder is injected as a slurry during the mixing

Top down soil mixing process

The use of higher strength material in the design is possible with the wet installation process

Wet soil mix columns can be installed in a single column arrangements or using multi axis



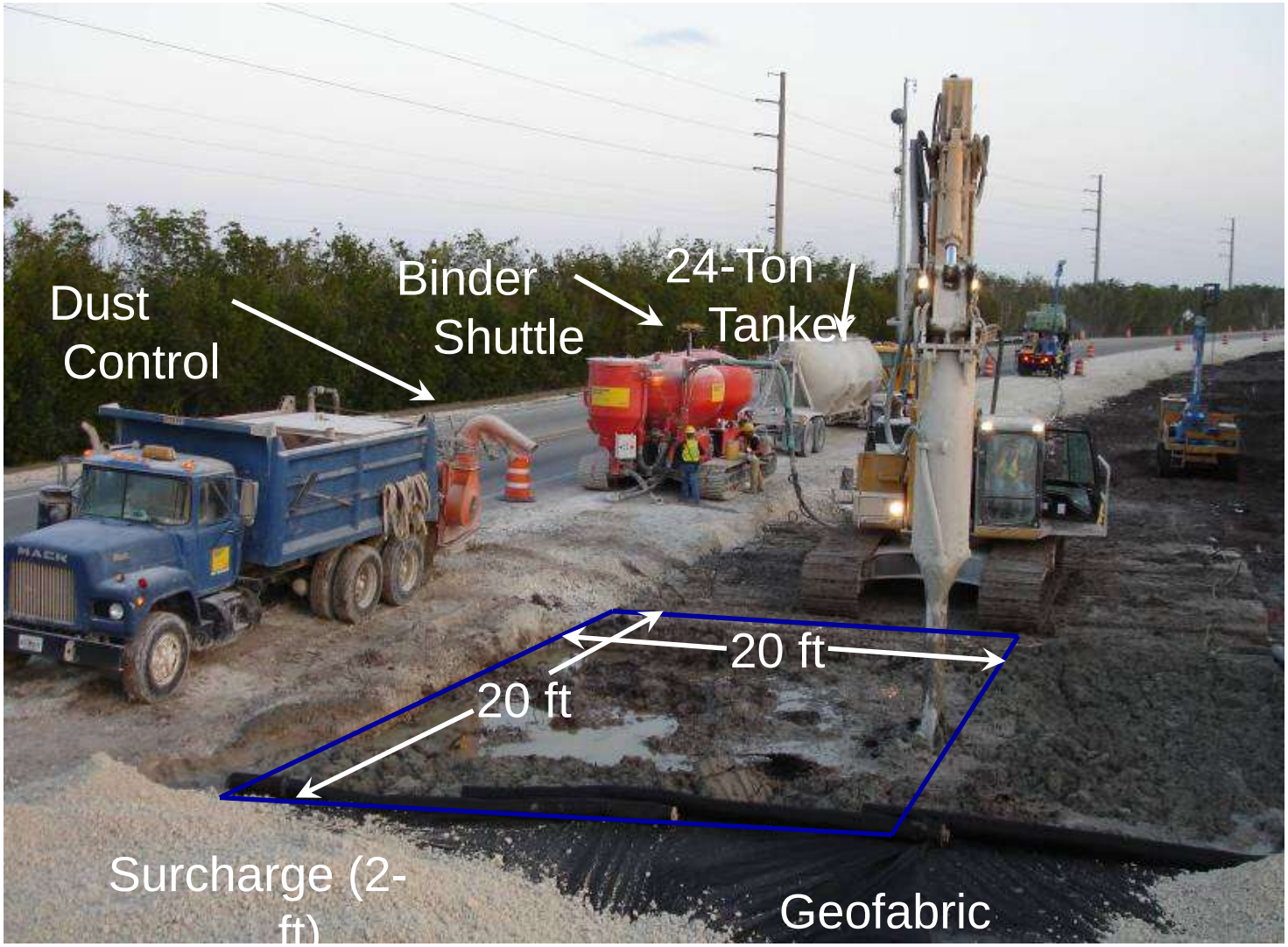
Dry Soil mixing methods are utilized in wetter softer soils or where REM is a problem

Dry binder materials are pneumatically injected into the soil during the dry mixing process

Bottom up method of soil mixing

There must be adequate soil moisture for the binders to fully hydrate often limiting design strengths

Dry Mixing can be used to treat 100% of the soil to form blocks



Mass Soil Mixing Movie

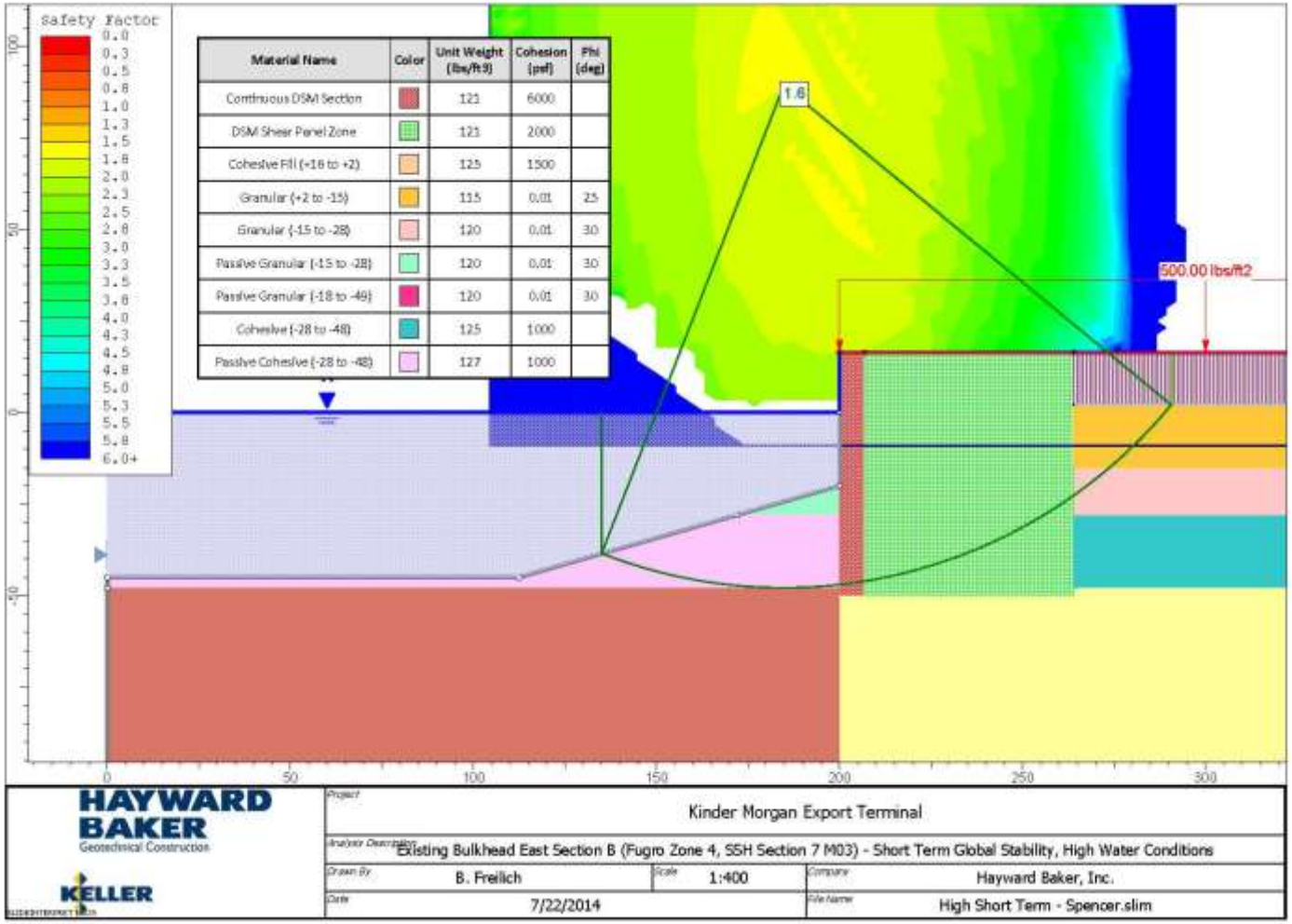
Deep Cutoff Walls can be installed using the quality offered by the TRD Soil Mixing System

TRD allows a homogeneous vertically mixed wall

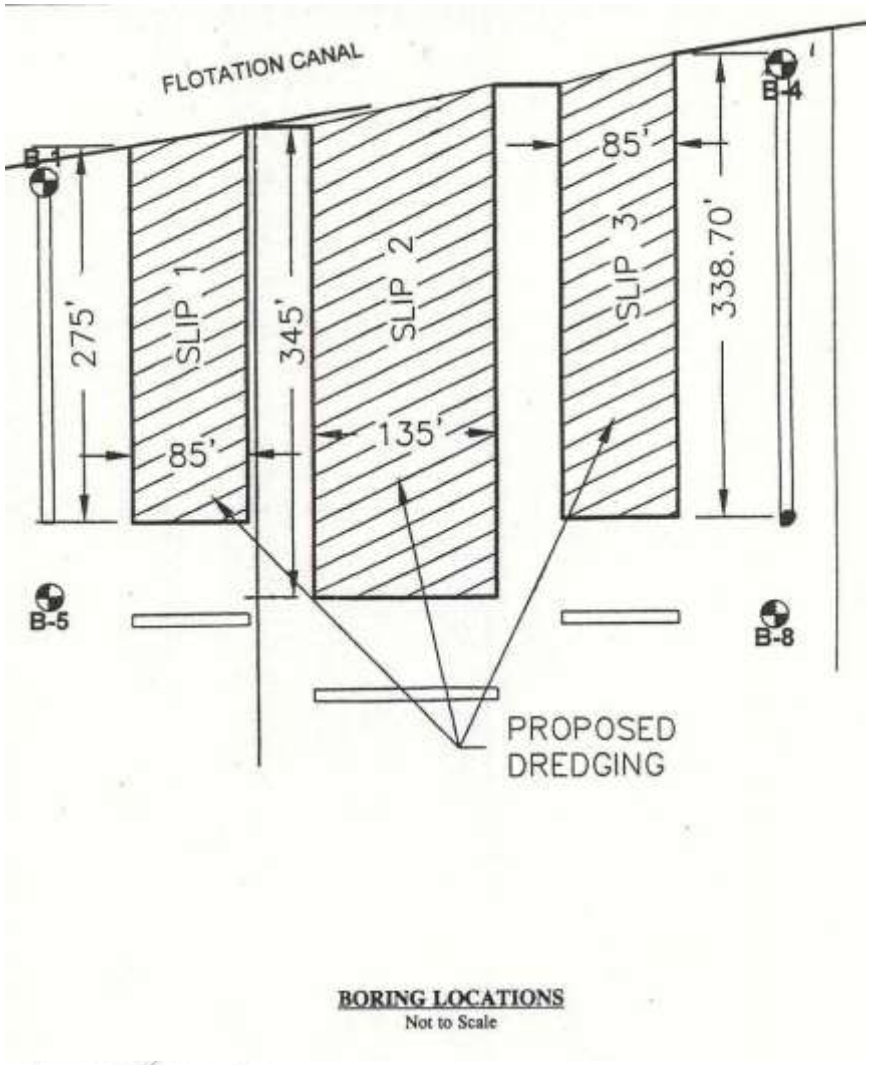
Depths of installation can be as deep as 150 feet

Using the TRD Soil Mixing System, continuous grids for seismic considerations can be made without joints

Typical design of bulkhead using improved zone



Port Fourchon -Northern Expansion Design Requirements

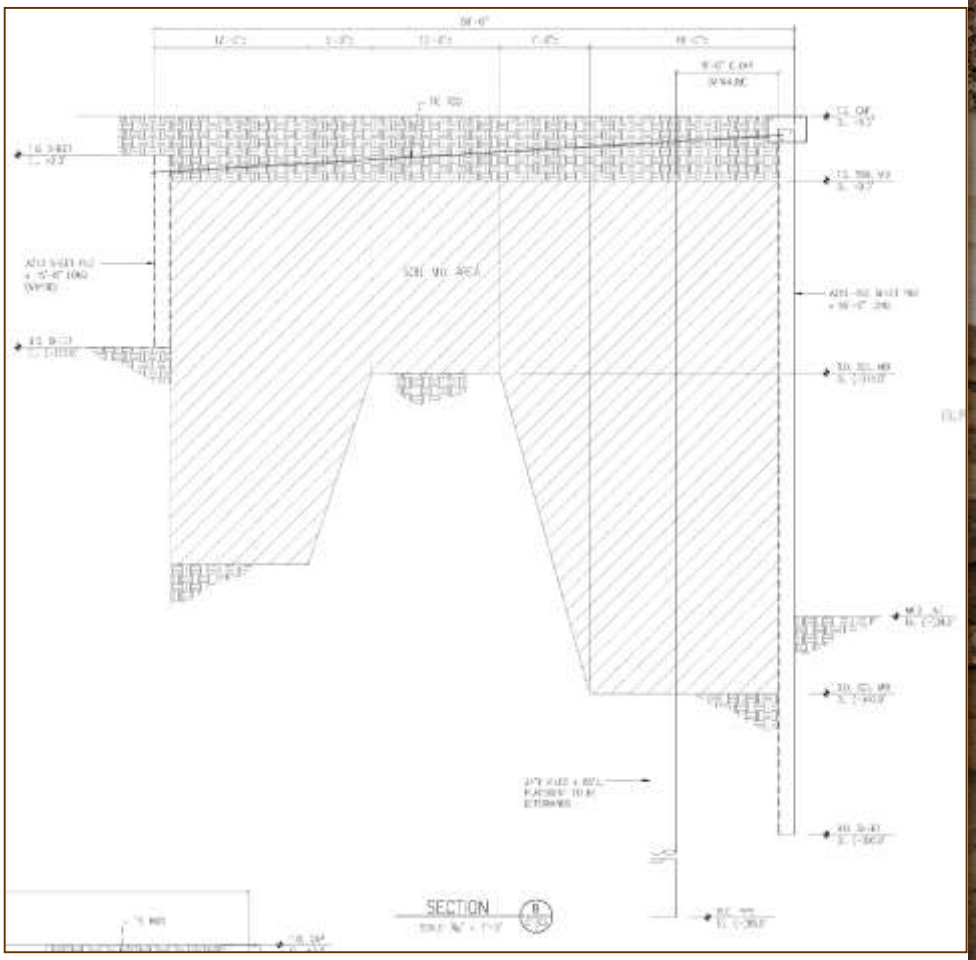


BORING LOCATIONS
Not to Scale

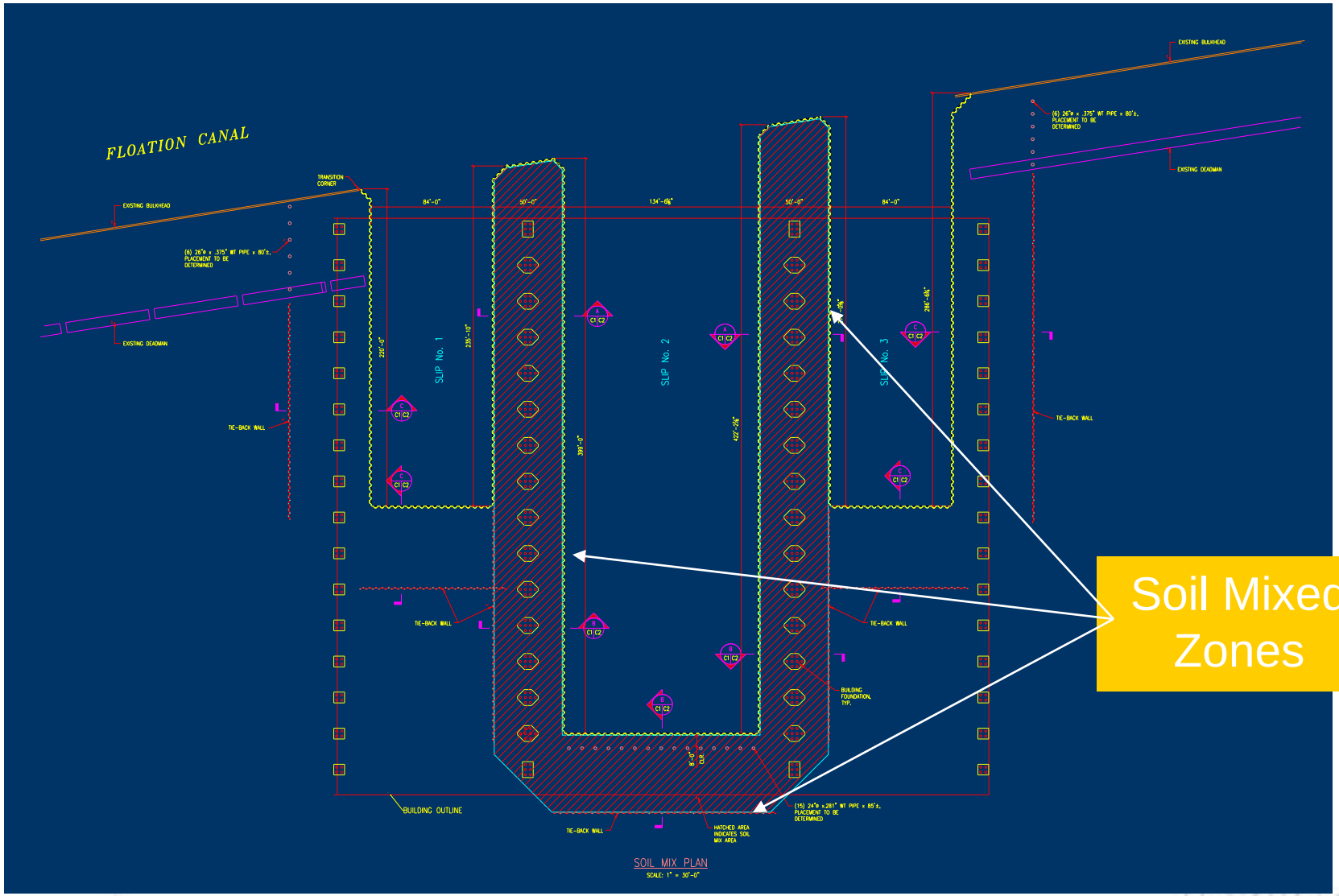
- 3 Slips planned
- Maximum dredge depth of 34 feet (water depth in front of wall)
- 2,225 lineal feet of bulkhead wall
- PZ27 and PZ40 Sheet piles installed to greater than 100 ft depth

Northern Expansion Alternate Design reduced the sheet lengths

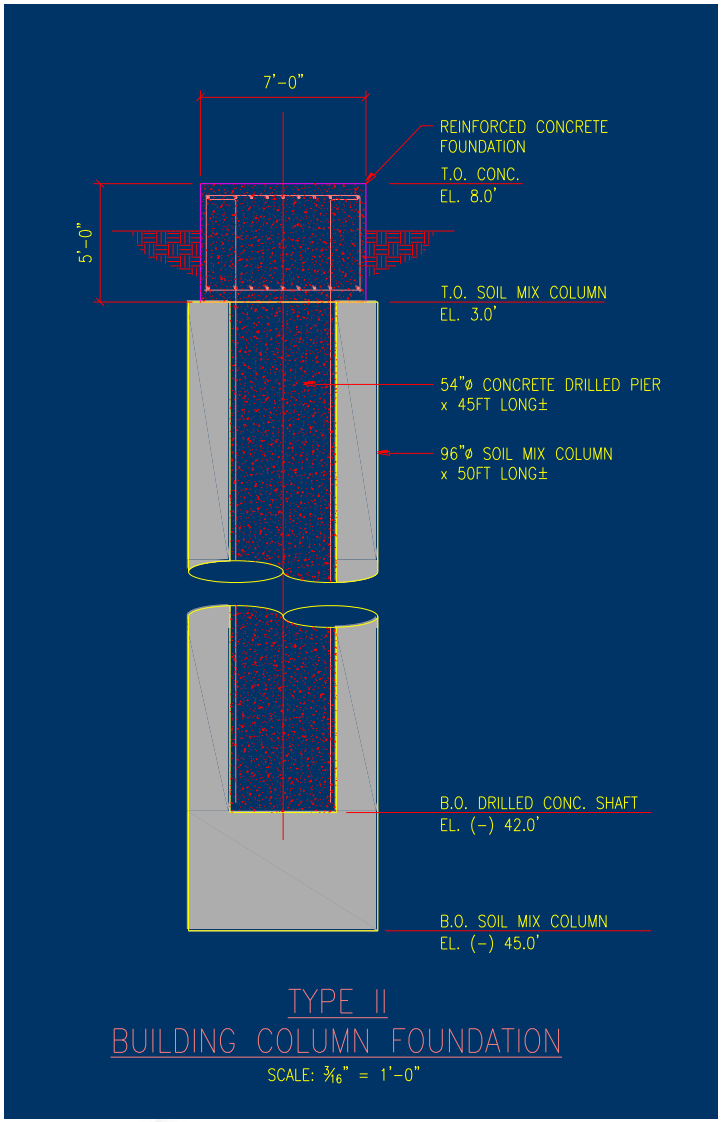
- Soil Mixing Chosen to reduce load on bulkhead
- Used on previous projects
- Reduced section and driven depth of sheet pile
- Fit the schedule



Plan of new Soil Mixed areas to support the deepest part of the expansion

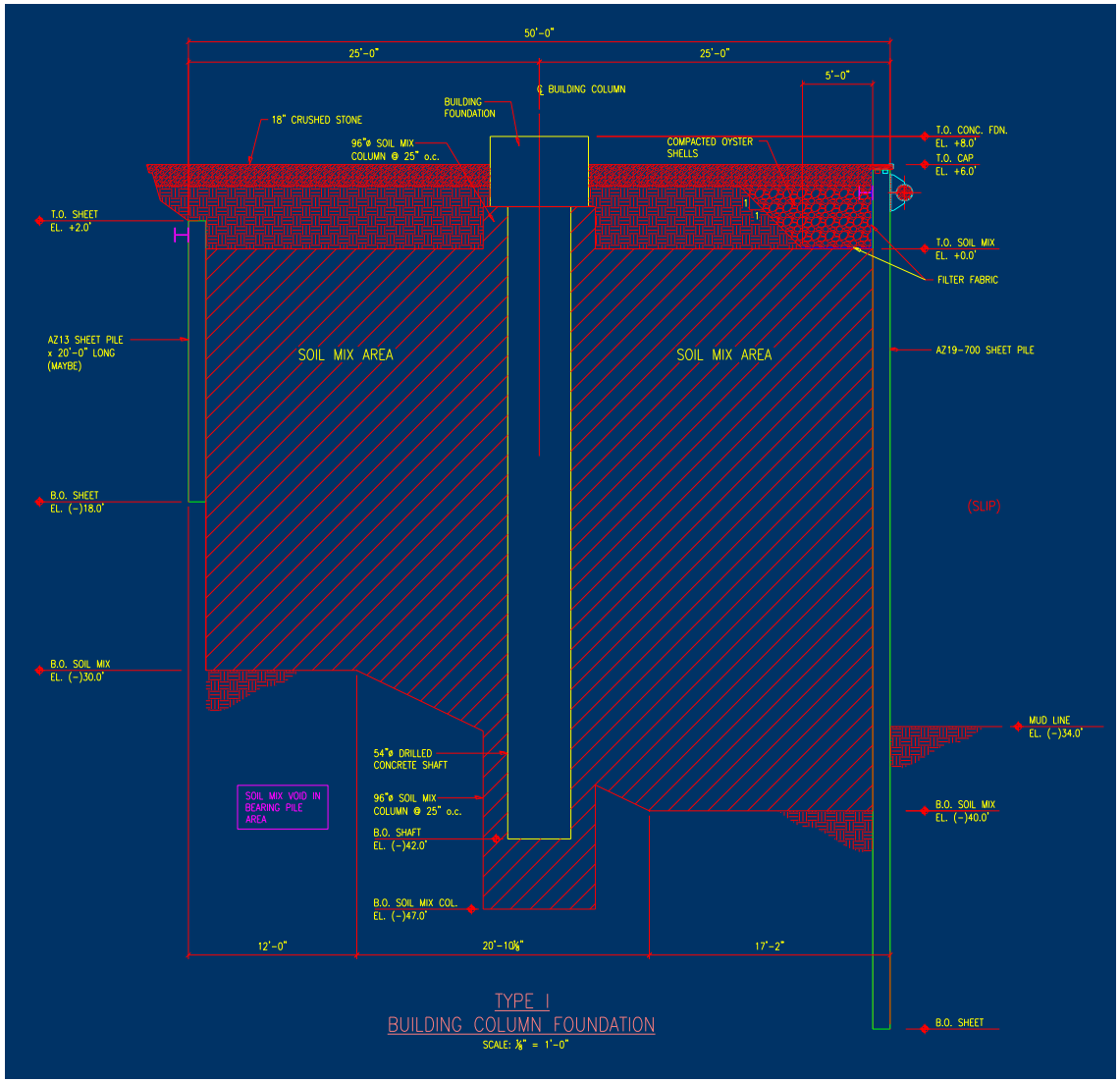


Soil Mix Alternate to Footings to blend with the soil mixing performed for wall stabilization



- Composite soil mixed column drilled shaft
- 54 inch diameter drilled shafts
- 8 foot diameter soil mix columns

Interface of Soil Mix Zone and other Footings resolved speeding the schedule



The use of soil mixing in the new footing design saved time and money


B300
CAT
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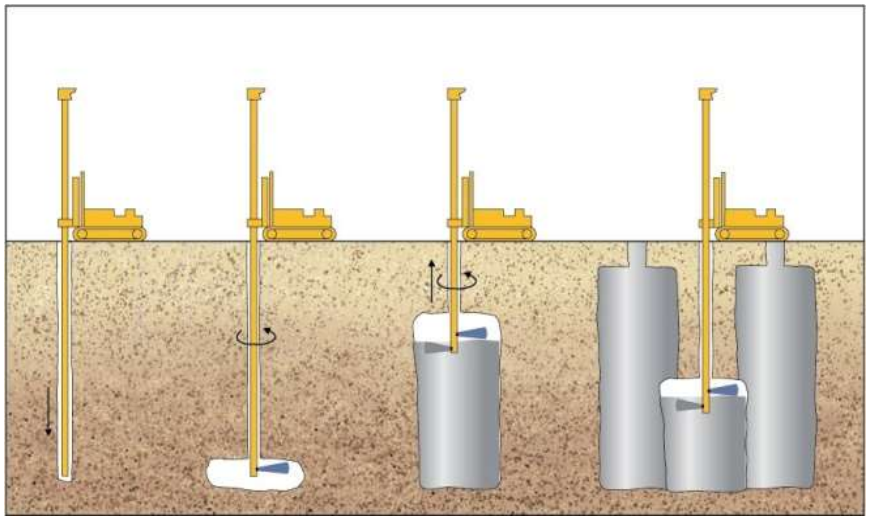
Installing the drilled shafts through the previously mixed soil mix column

Port Fourchon Northern Expansion finished product

Soil Mixing has been used on other Port Facilities

- Terrabone Parish – LA Ship facility – Houma, LA, draft depth 47 feet
- Berths 57 and 58 – Port of LA – Los Angeles, CA, draft depth 50 feet
- Wharf 47 – Port of Houston – Houston, TX, draft depth 47 feet
- Chevron facility – Port Everglades, FL, bulkhead enhancement
- Marathon Oil – Port Everglades, FL, bulkhead enhancement

Jet Grouting: The process used to create soilcrete from design depth to surface

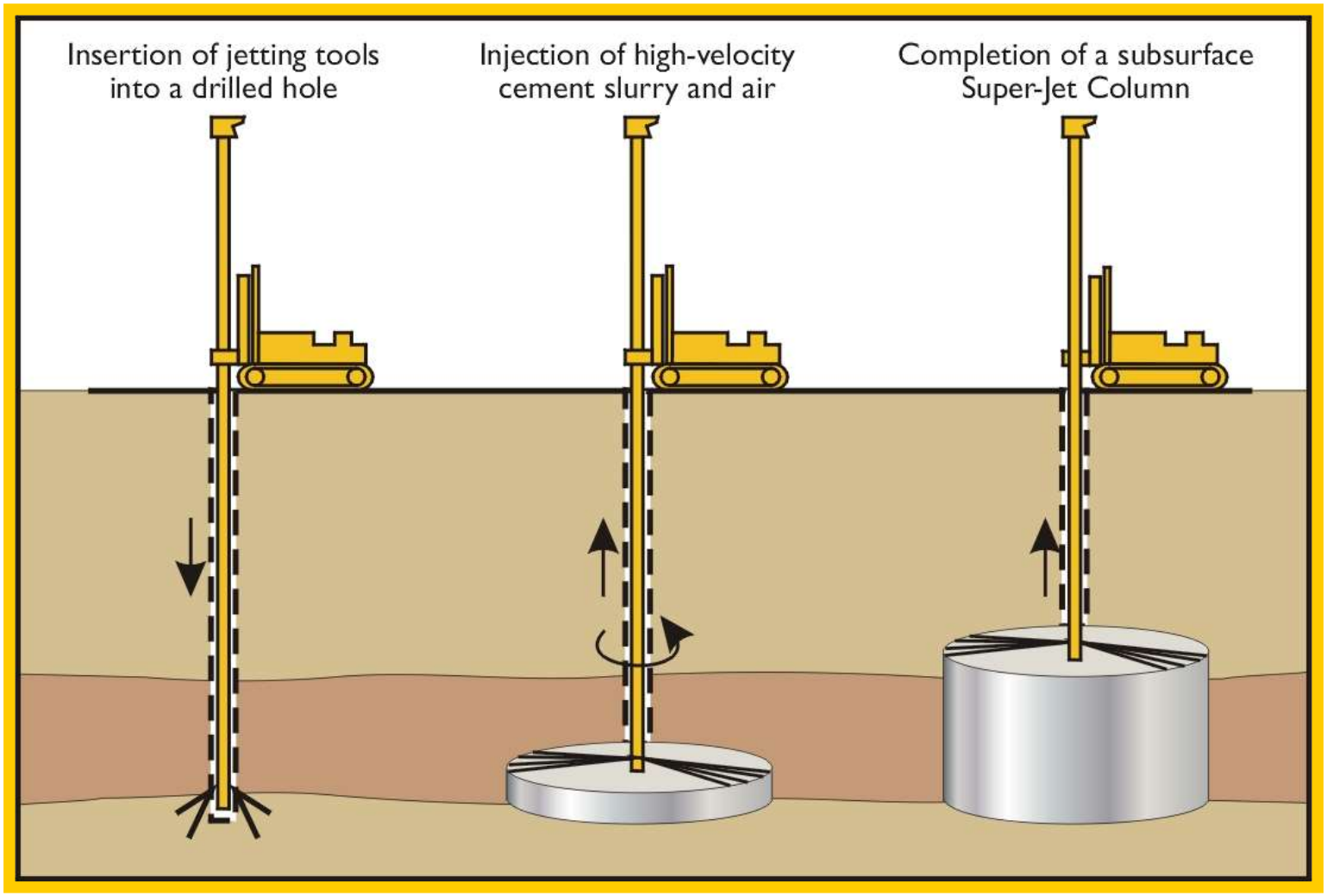


High velocity erosion is used to mix soil in place to form soilcrete geometries

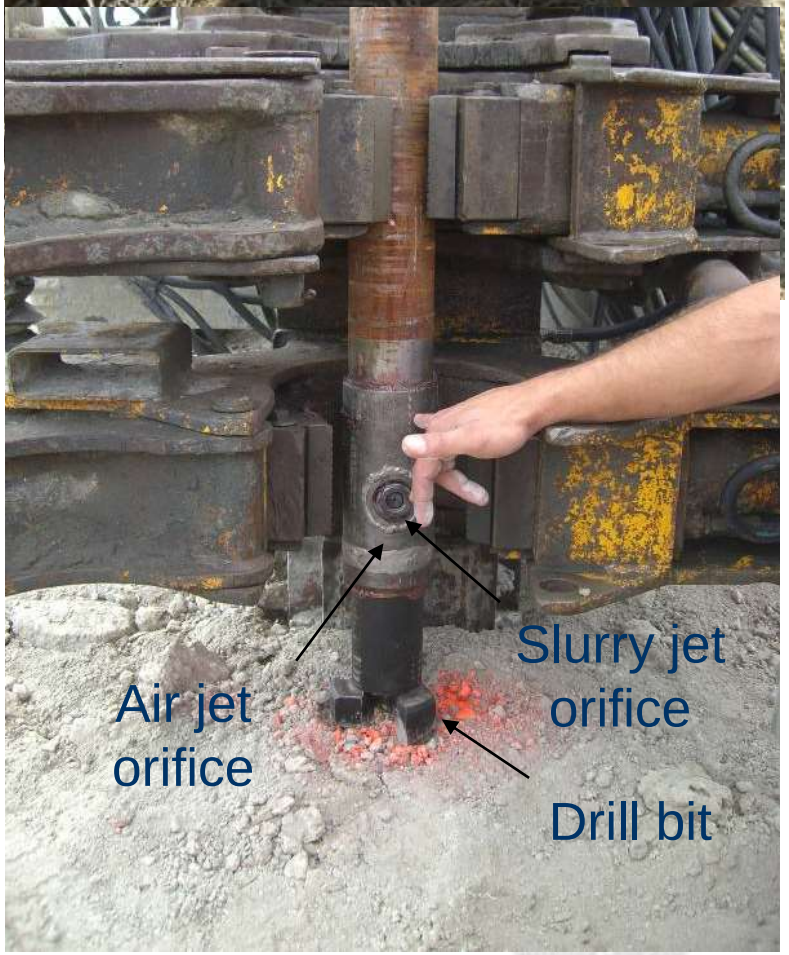
Soilcrete produced by circular rotation of the rods and simultaneous withdraw

Any partial circular geometry possible

Super-Jet Grouting Process similar to a double system with efficiencies



Jet Grouting Drill and jet grout rods



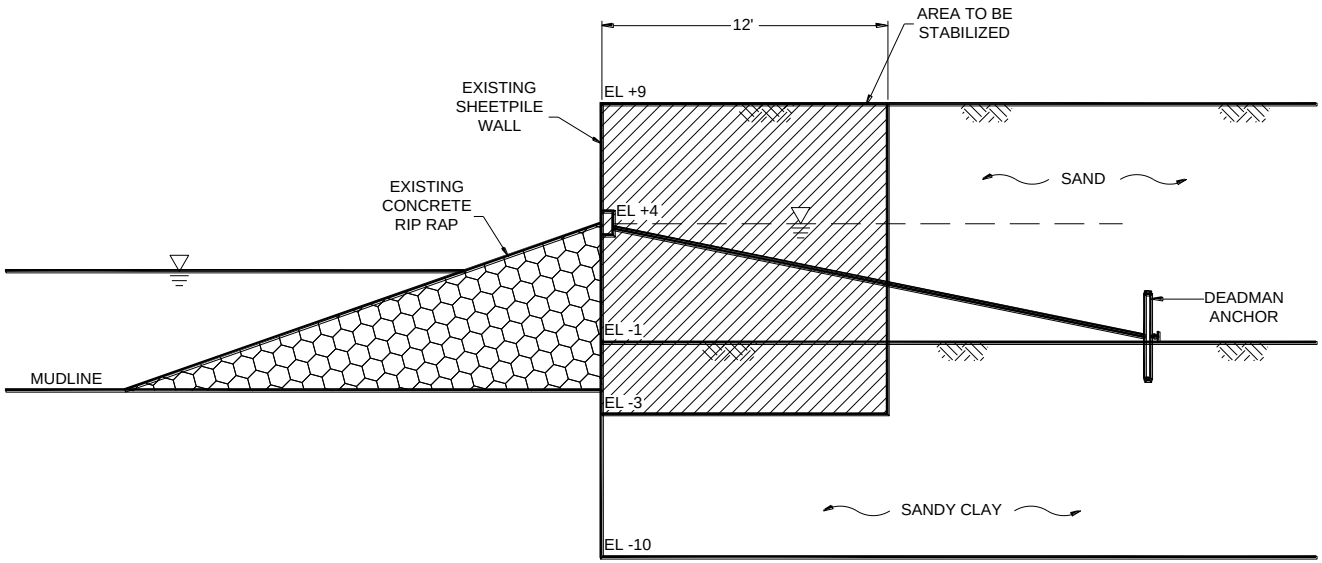
Jet Grouting – Marine Bulkhead Remediation

Extension of Existing bulkheads are possible

Corpus Christi NAS - Existing Conditions – riprap being used as a countermeasure

Damaged Bulkhead – Looking North

Design Analysis complete with stabilizing Jet Grout Block



Design Strength of Soilcrete
f'c = 100 psi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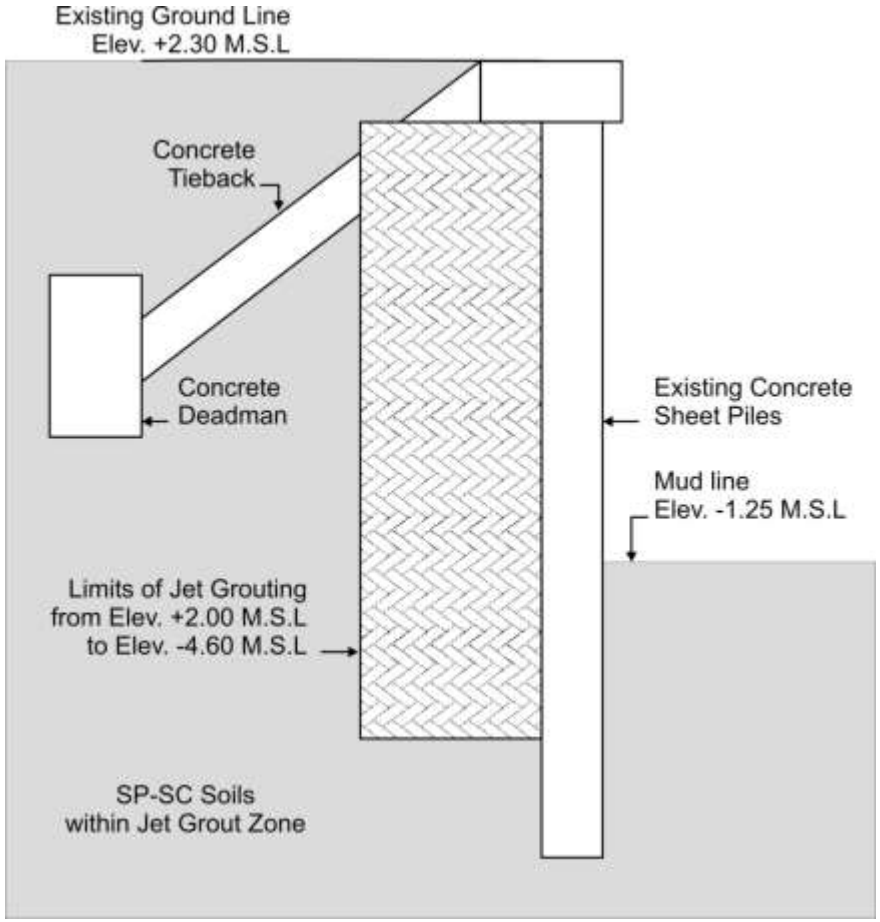
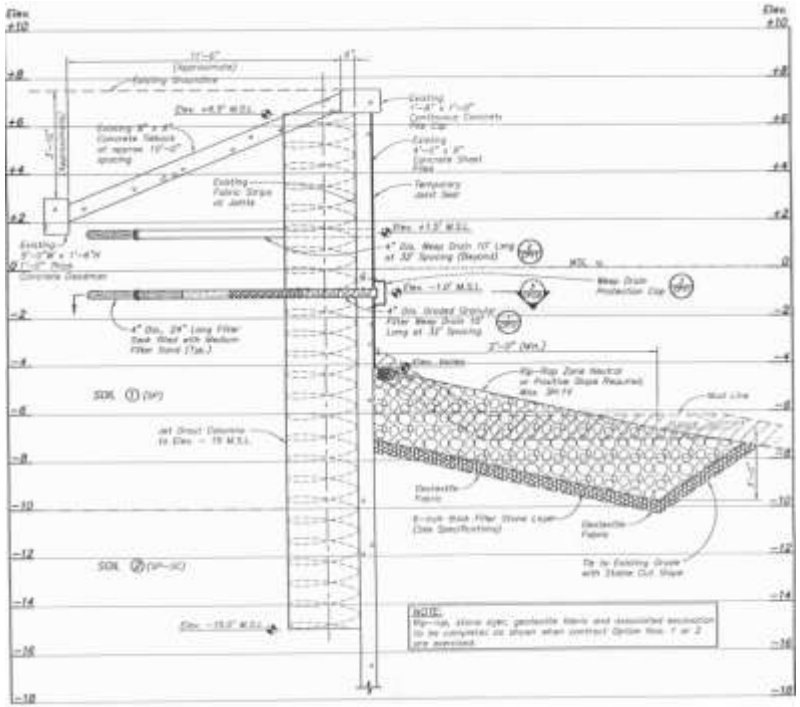
Repair Cross Section for RPARC - Tampa





THINK SAFE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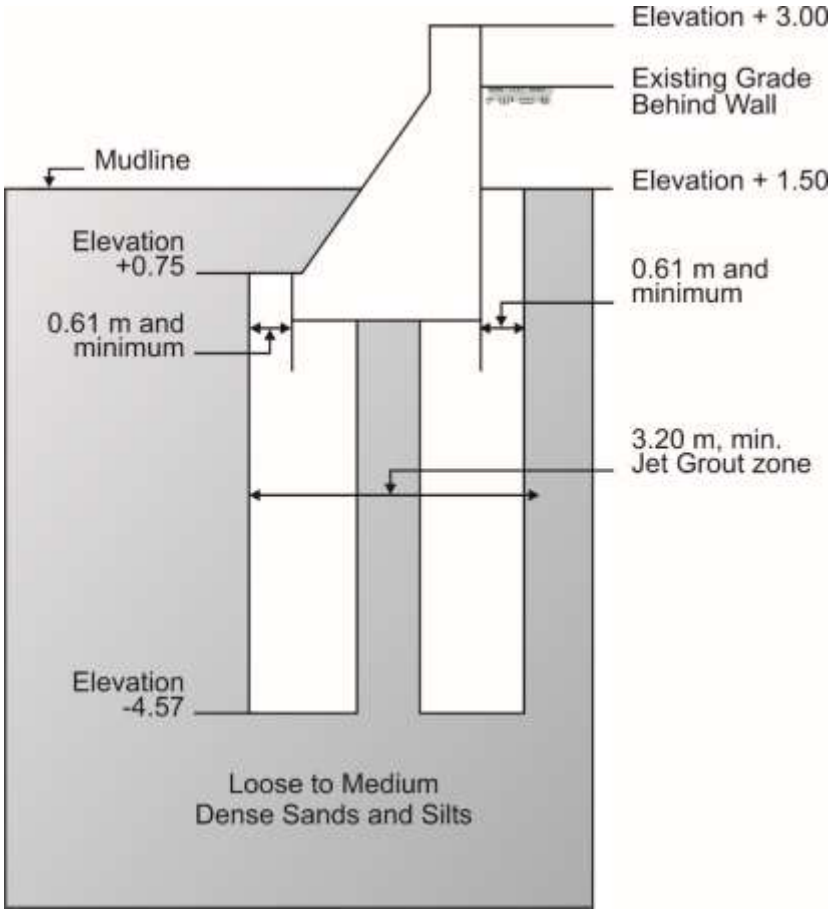
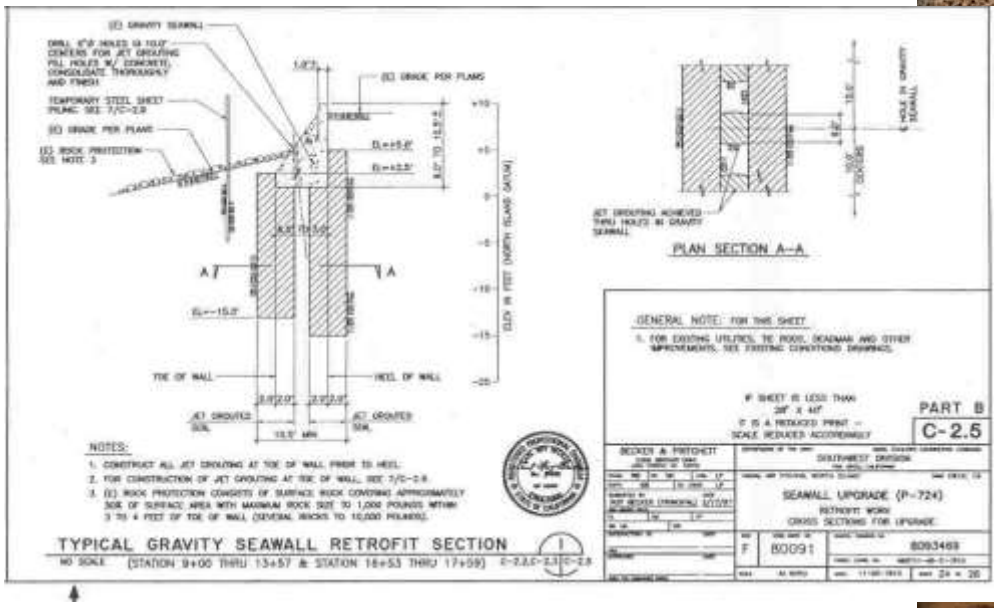
LCU 2031

NINAS San Diego - Cross Section – Repair details






ANTHONY

Jet Grouting has been used on other Port Facilities

- Piers 6 and 7 – Norfolk, VA, sealing of joints
- Millard Bulkhead – Theodore, AL, stability improvement
- Navy Pier 11A – Port Hueneme, CA, sealing of joints
- Port Bulkhead – Jacksonville, FL, sealing of joints
- Pan American Terminal – Puerto Rico, increase stability

Closing Remarks

- Soil Mixing can provide an efficient system for support of deep water bulkheads
- Soil Mixing solutions are typically more economical than stiffer deeper sheet solutions
- Jet Grouting provides an economical solution for extending the life of aging bulkheads
- Joints in concrete type bulkheads can be successfully sealed using jet grouting

The Last Slide - Thank You!! *Questions?*

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