Prevention First 2010 Symposium, Long Beach

MOTEMS Division 6 Revisions-
Geotechnical Hazards and Foundations

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History of MOTEMS Development

Approved – California State Lands Commission	August 17, 2004
Adopted – California Building Standards Commission	January 19, 2005
Published – California Building Standards Code (Title 24, Part 2, Vol. 2, Chapter 31F)	August 6, 2005
Effective (CBC 2001, CBC 2007)	February 6, 2006
First Revision in 2009 (CBC 2010)	January 1, 2011

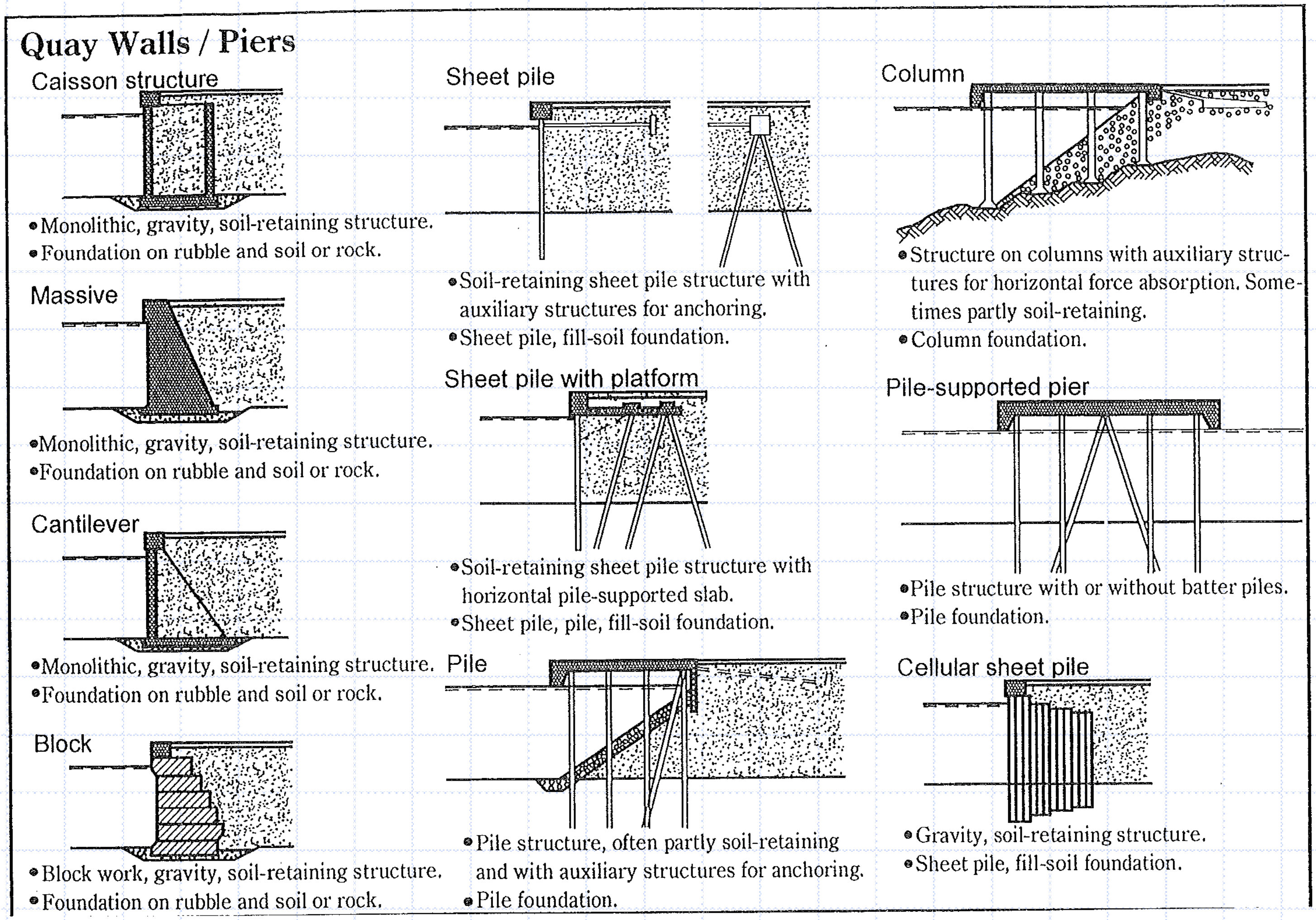
First Revision has Minimal Changes on Division 6 - Geotechnical Requirements

2010 California Building Code

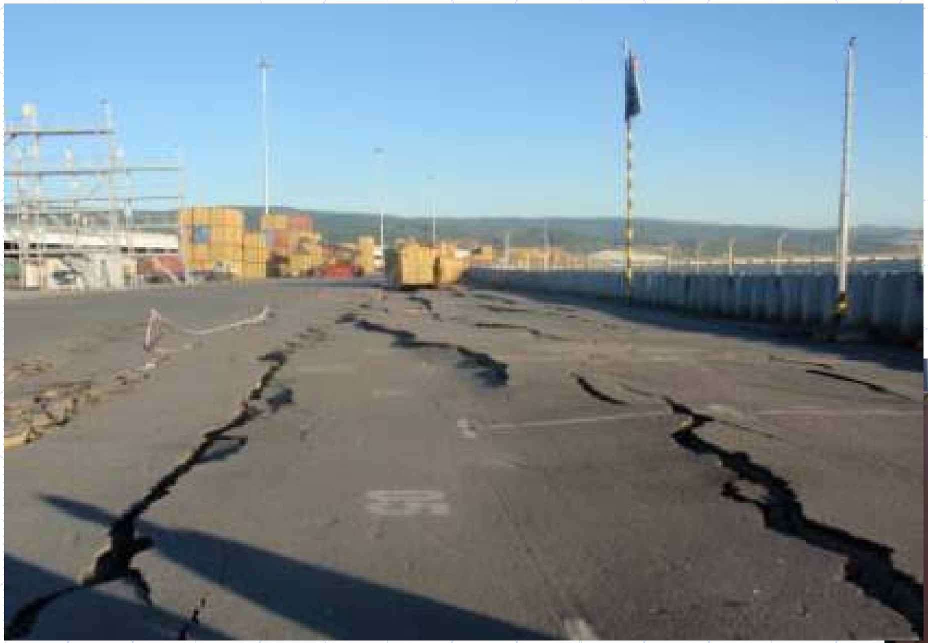
- Chapter 31F: Marine Oil Terminals

DIVISION & SECTION	TITLE
1 (3101F)	Introduction
2 (3102F)	Audit and Inspection
3 (3103F)	Structural Loading Criteria
4 (3104F)	Seismic Analysis and Structural Performance
5 (3105F)	Mooring and Berthing Analysis and Design
6 (3106F)	Geotechnical Hazards and Foundations
7 (3107F)	Structural Analysis and Design of Components
8 (3108F)	Fire Prevention, Detection and Suppression
9 (3109F)	Piping and Pipelines
10 (3110F)	Mechanical and Electrical Equipment
11 (3111F)	Electrical Systems

Some Marine Structures/Bulkhead Types



Geotechnical Hazards



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Geotechnical Hazards

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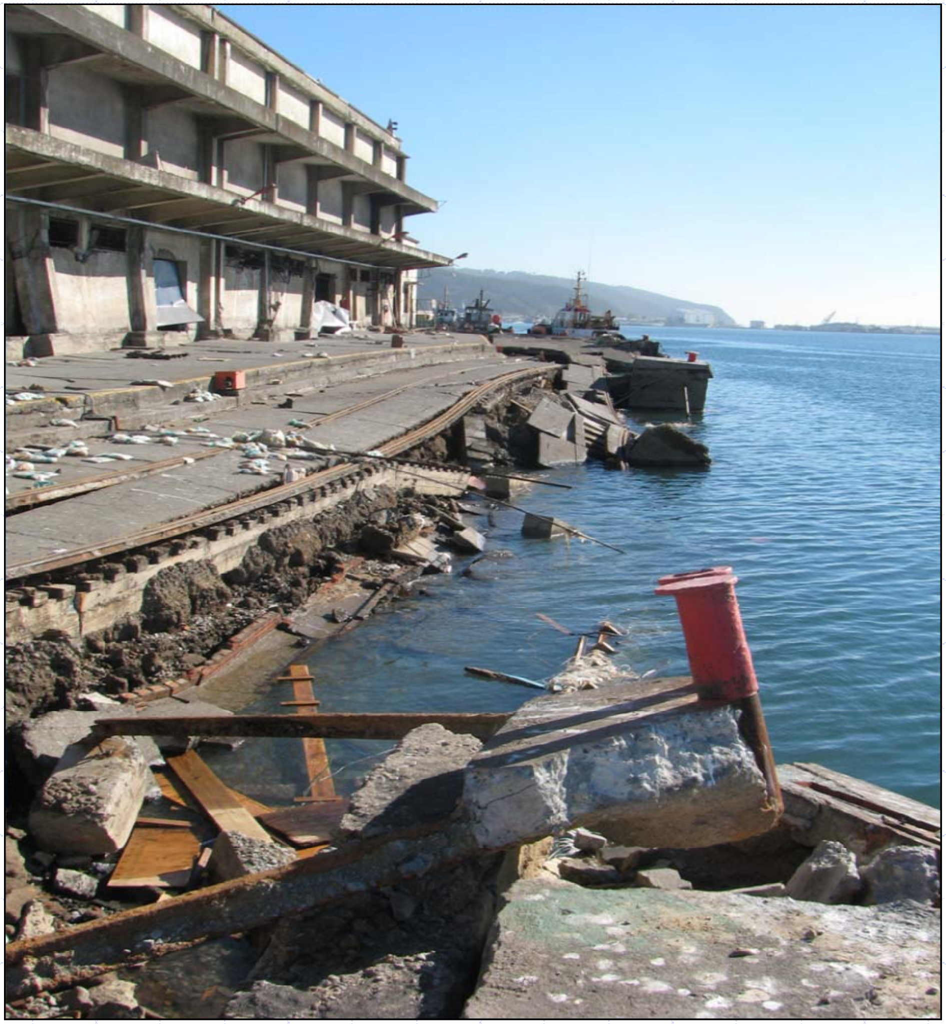

MOTEMS Division 6 : Current Version

- Section 3106F – GEOTECHNICAL HAZARDS AND FOUNDATIONS
  - 3106F.1 General
  - 3106F.2 Site Characterization
  - 3106F.3 Liquefaction
  - 3106F.4 Other Geotechnical Hazard
    - Stability of Earth Structures
    - Earthquake Induced Ground Movements
  - 3106F.5 Soil Structure Interaction
  - 3106F.6 Mitigation Measures and Alternatives

Significant Revisions to “Seismic Hazards” Requirements are being Made.

Current MOTEMS Division 4 – MOT Risk Classification & Seismic Ground Motions

- Design Accelerations for Geotechnical Analyses based on Probabilistic Seismic Hazard Analyses (PSHA)
- Design Values depend on Risk Classification and Two Level Seismic Performance Requirements:
    - Level 1: Minor Damage
    - Level 2: No collapse and repairable damage

TABLE 31F-4-1
MOT RISK CLASSIFICATION

RISK CLASSIFICATION	EXPOSED OIL (bbis)	TRANSFERS PER YEAR PER BERTHING SYSTEM	MAXIMUM VESSEL SIZE (DWTx1000)
High	≥ 1200	N.A.	N.A.
Medium	< 1200	≥ 90	≥ 30
Low	< 1200	< 90	< 30

TABLE 31F-4-2
SEISMIC PERFORMANCE CRITERIA

RISK CLASSIFICATION	SEISMIC PERFORMANCE LEVEL	PROBABILITY OF EXCEEDANCE	RETURN PERIOD
High	Level 1	50% in 50 years	72 years
	Level 2	10% in 50 years	475 years
Medium	Level 1	65% in 50 years	48 years
	Level 2	15% in 50 years	308 years
Low	Level 1	75% in 50 years	36 years
	Level 2	20% in 50 years	224 years

MOTEMS Division 6 - Revisions

- Revisions are being developed under auspices of CSLC
- Will incorporate most recent practice adopted in several new Codes and Design Guidelines or Criteria:
  - Port of Long Beach Wharf Design Criteria (2009)
  - Port of Los Angeles Seismic Code for Design, Upgrade and Repair of Container Wharves (2010)
  - Proposed ASCE Standards for Seismic Design of Piers and Wharves
  - California Geological Survey Guidelines (2008)

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- California Geological Survey Guidelines

SPECIAL PUBLICATION 117A

GUIDELINES FOR EVALUATING AND MITIGATING SEISMIC HAZARDS IN CALIFORNIA

2008

THE RESOURCES AGENCY
MIKE CHRISMAN
SECRETARY FOR RESOURCES

STATE OF CALIFORNIA
ARNOLD SCHWARZENEGGER
GOVERNOR

DEPARTMENT OF CONSERVATION
BRIDGETT LUTHER
DIRECTOR

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- Site Characterization:
  - Adequate Site-Specific Borings / Cone Penetration Tests (CPT)
  - At Least One Boring Next to CPT Sounding
  - Depth Criteria Specified
  - Presence of Low Strength / Continuous Thin Soil Layers
  - Appropriate and Adequate Laboratory Tests

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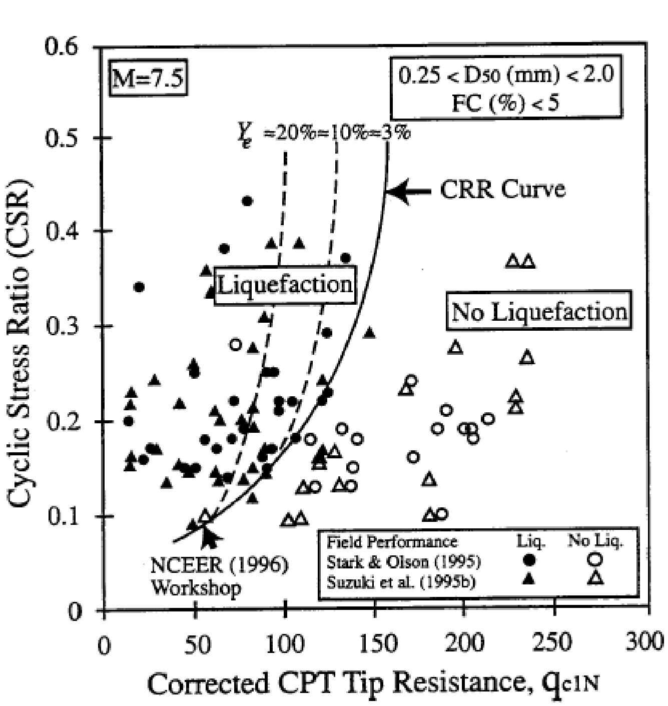
- Cone Penetration Tests (CPT) – Preferred Site Investigation Method for Liquefaction Evaluations



- Borings are always Required to Collect Soil Samples for Laboratory

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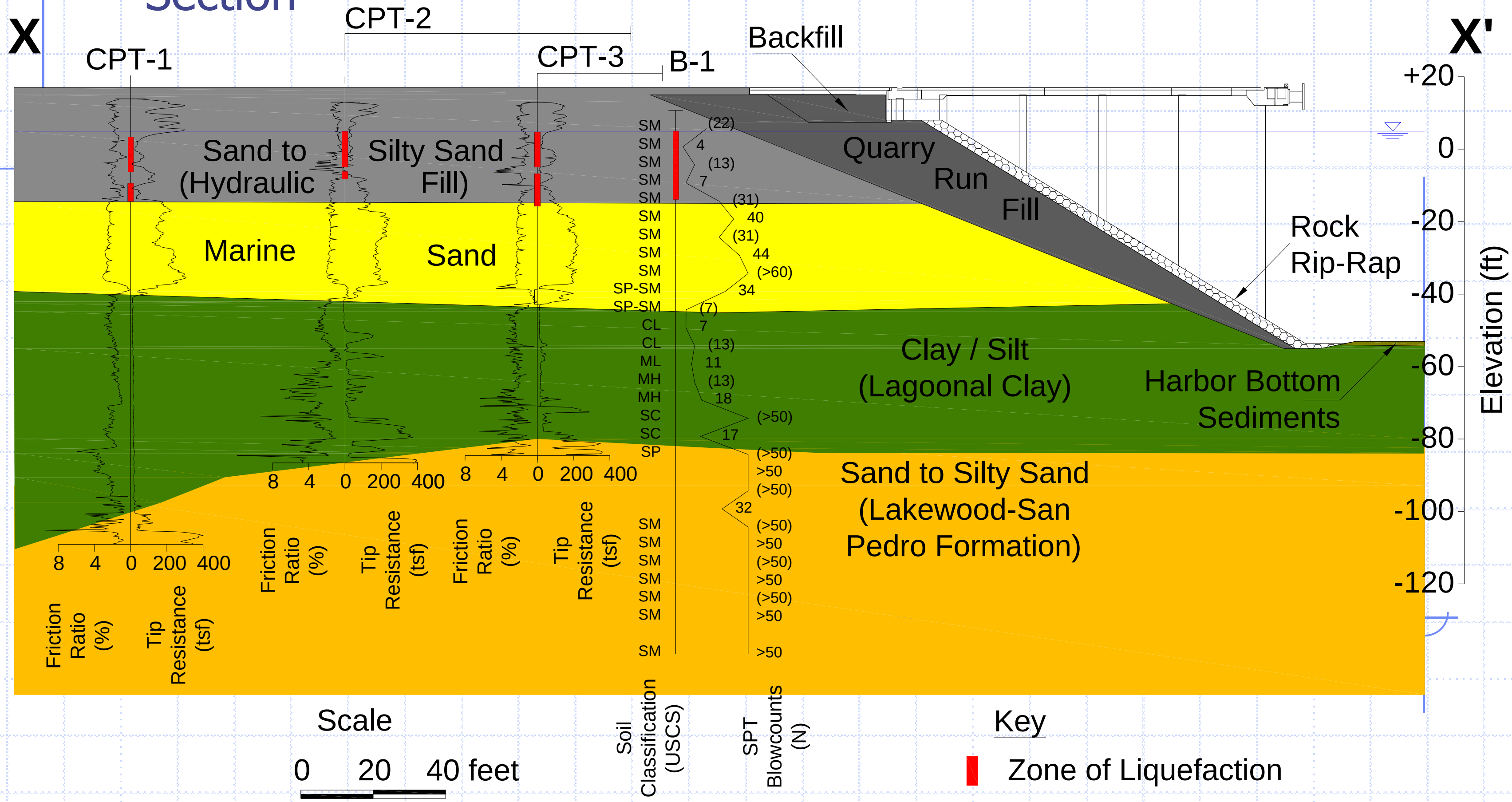
- CPT Plots and Borings Showing Liquefaction Zones on Site Cross-Section



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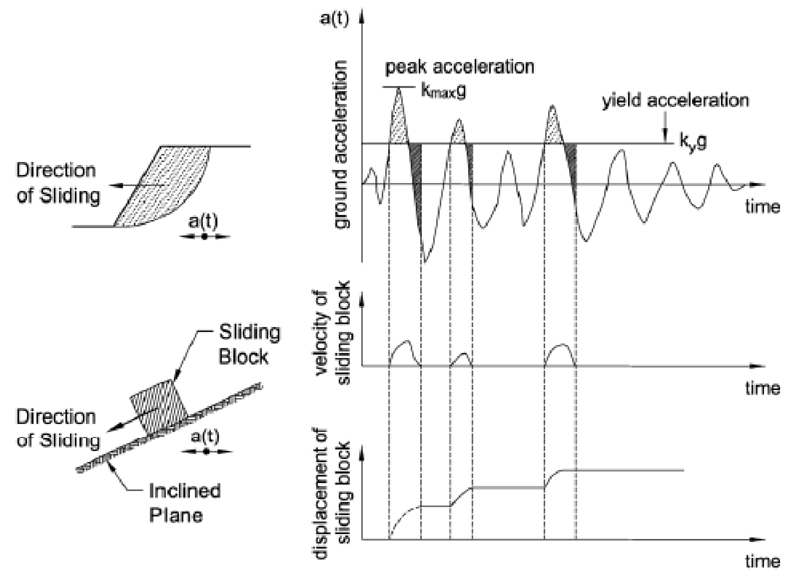
- Slopes or Embankments – Seismic Stability
  - Displacement Based Approach using Newmark Sliding Block Method
  - Assumed Rigid Sliding Block on Critical Failure Surface
  - Firm Ground Time History Input at Base of Block
  - Yield Acceleration from Pseudo-Static Stability Analysis



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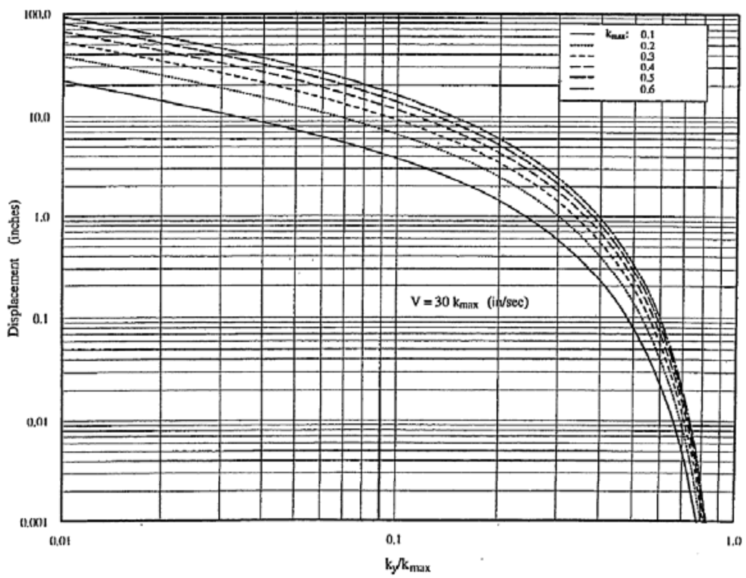
- Slopes or Embankments – Seismic Stability
  - TRB Report 611 – Seismic Analysis and Design of Retaining Walls, Buried Structures, Slopes, and Embankments (2008)
  - Analytical studies based on regression analyses of large data base of WUS Accelerations (Over 1,800 records)



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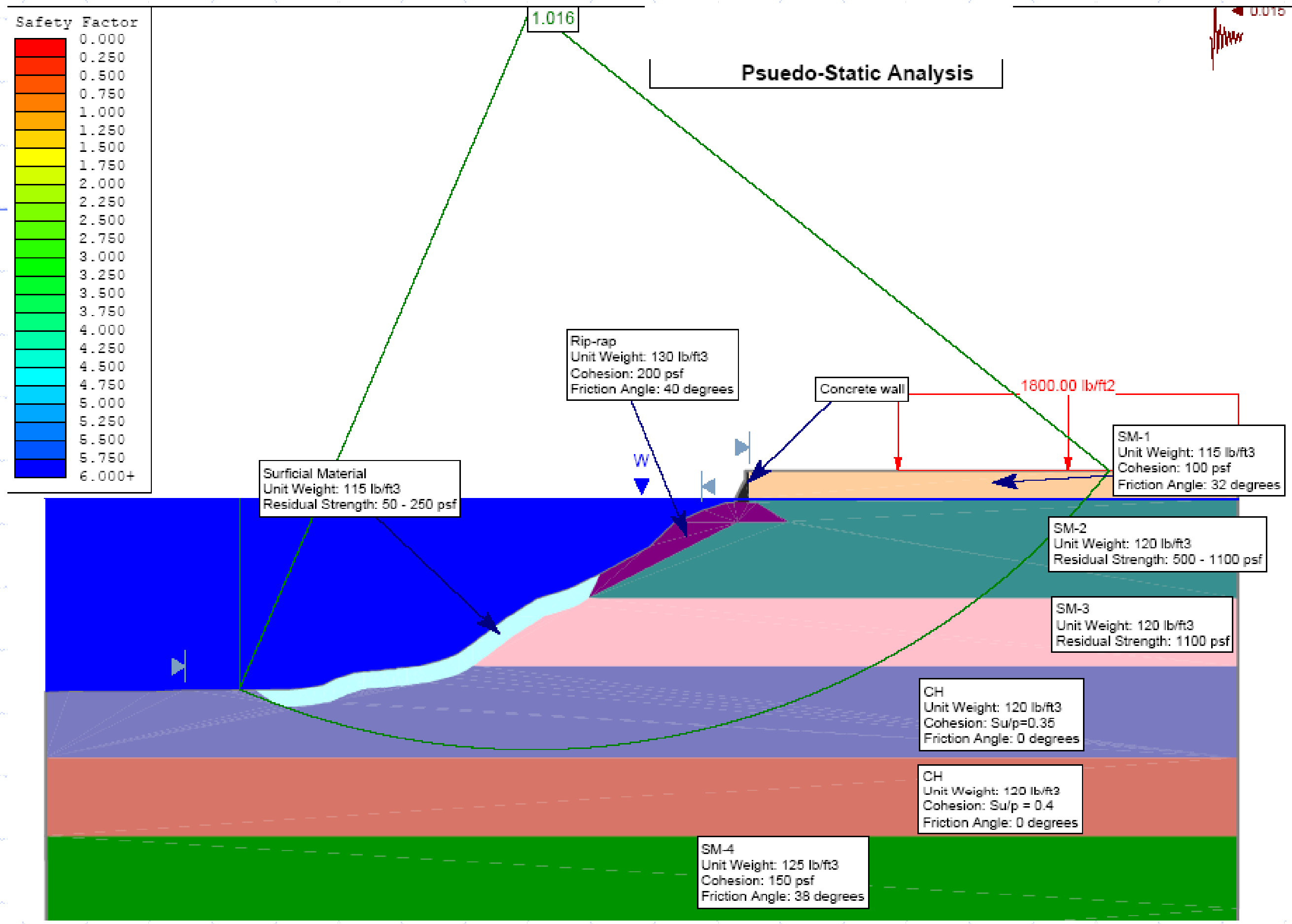
- Slopes or Embankments – Seismic Stability – Yield Acceleration



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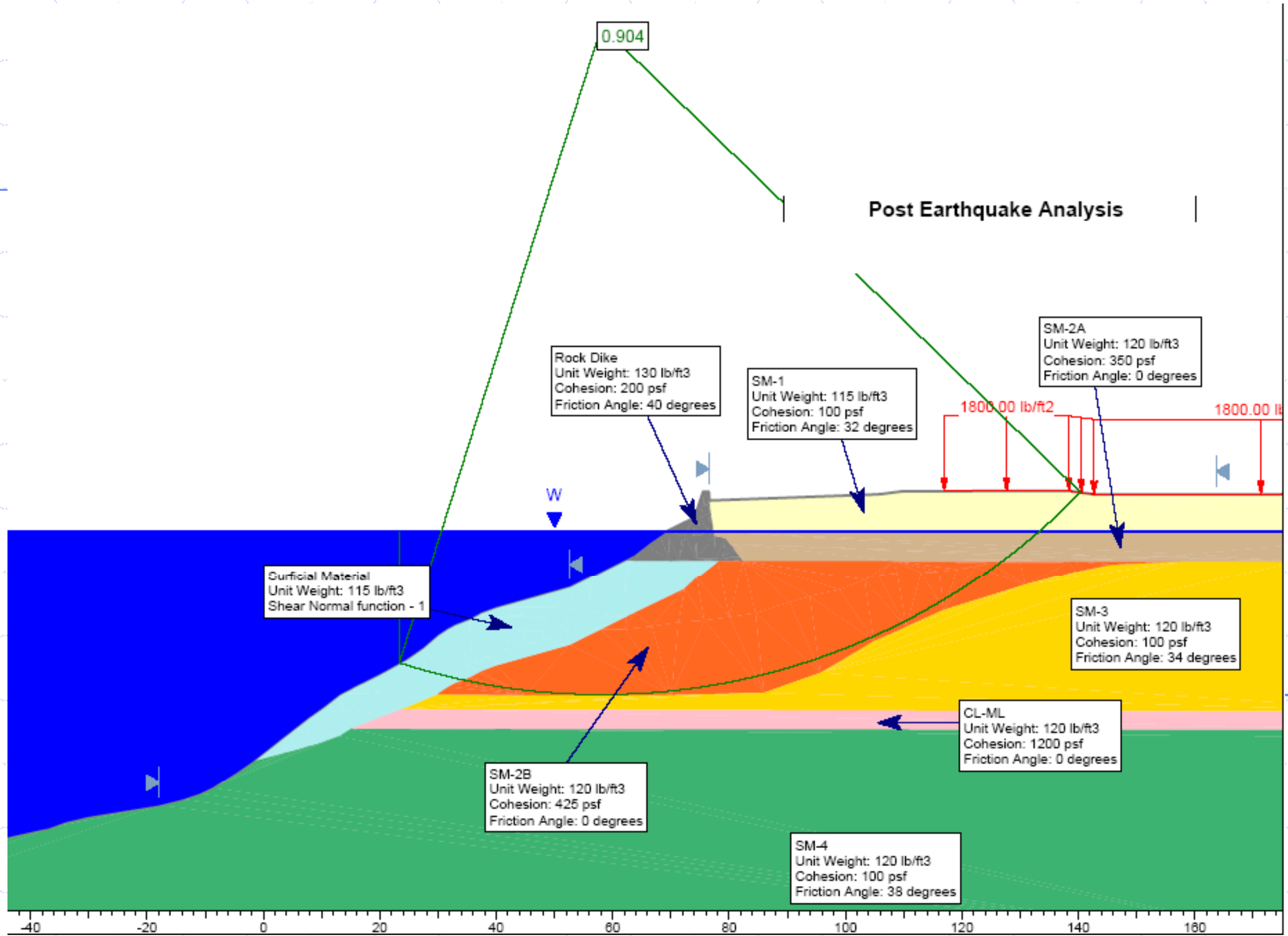
- Slopes or Embankments – Post Earthquake Static Stability ≥1.1



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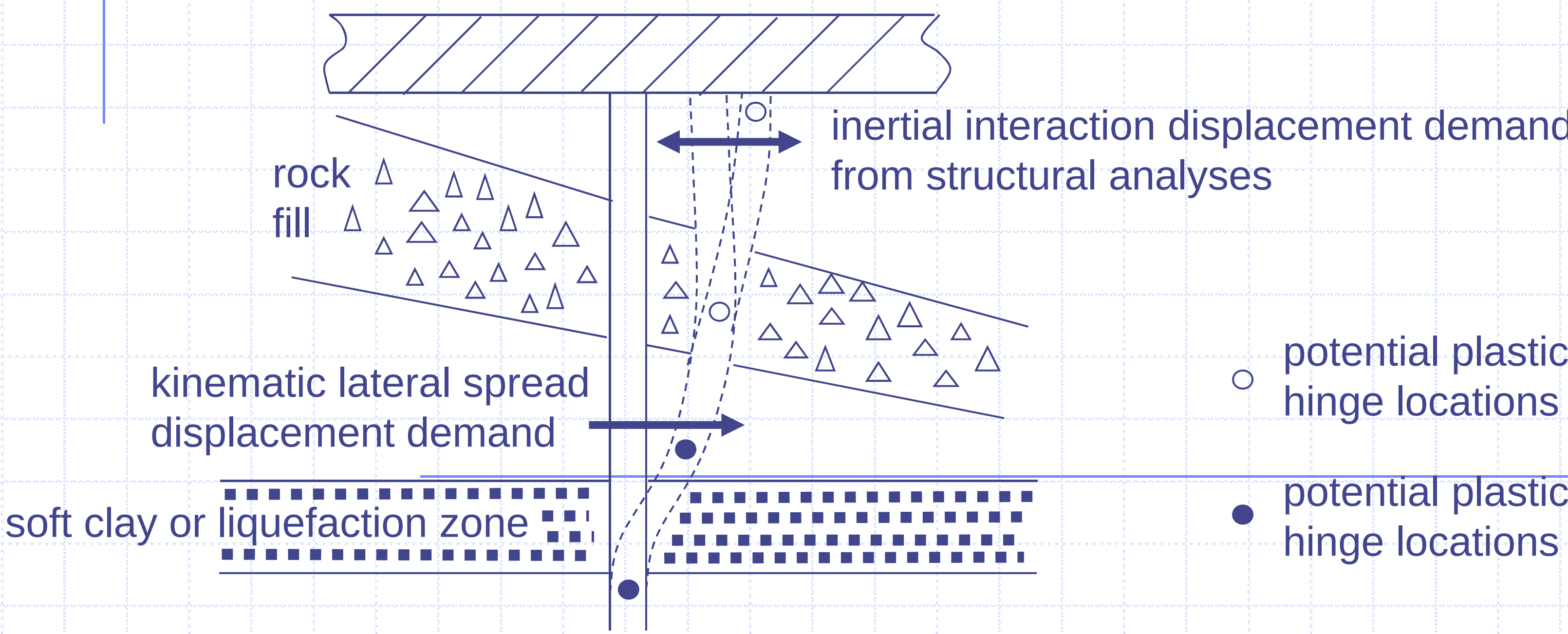
- Soil-Pile-Structure Interaction
  - Inertial Loading (Structure Pushing the Pile => Pile Pushing the Ground)
  - Kinematic Loading (Slope Movement => Ground Pushing the Pile)



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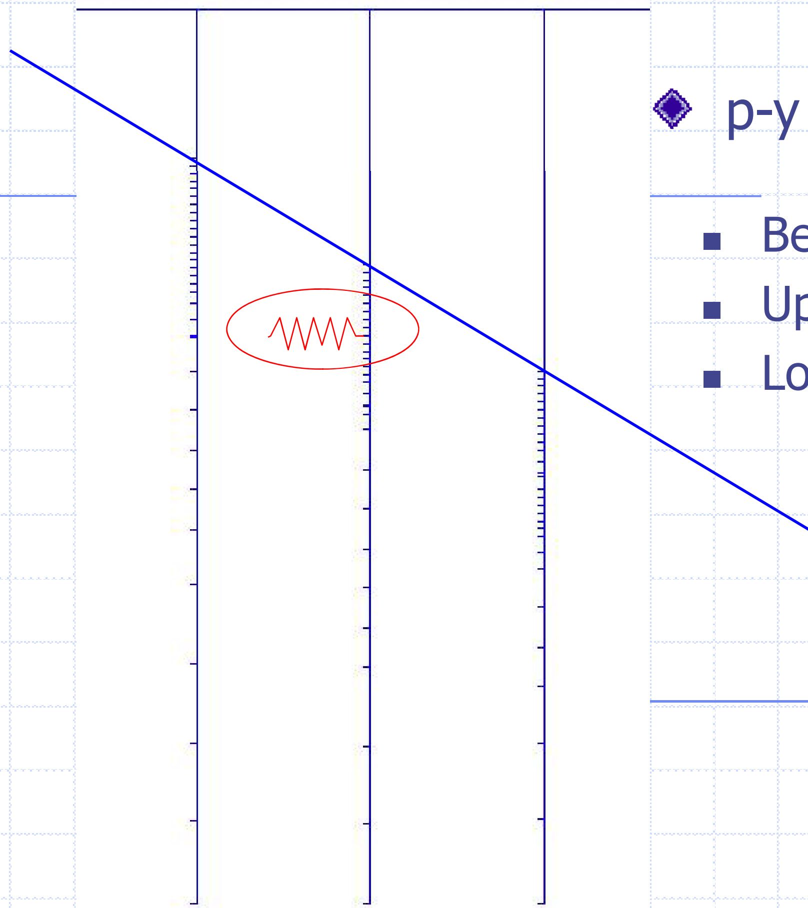
- Inertial Loading



- p-y Springs
  - Best-Estimate (Level Ground)
  - Upper Bound
  - Lower Bound

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- Kinematic Loading

Courtesy – Bill Bruin of Halcrow

Was a Battered Pile NOW Plumb!

Was a Plumb Pile NOW Battered!

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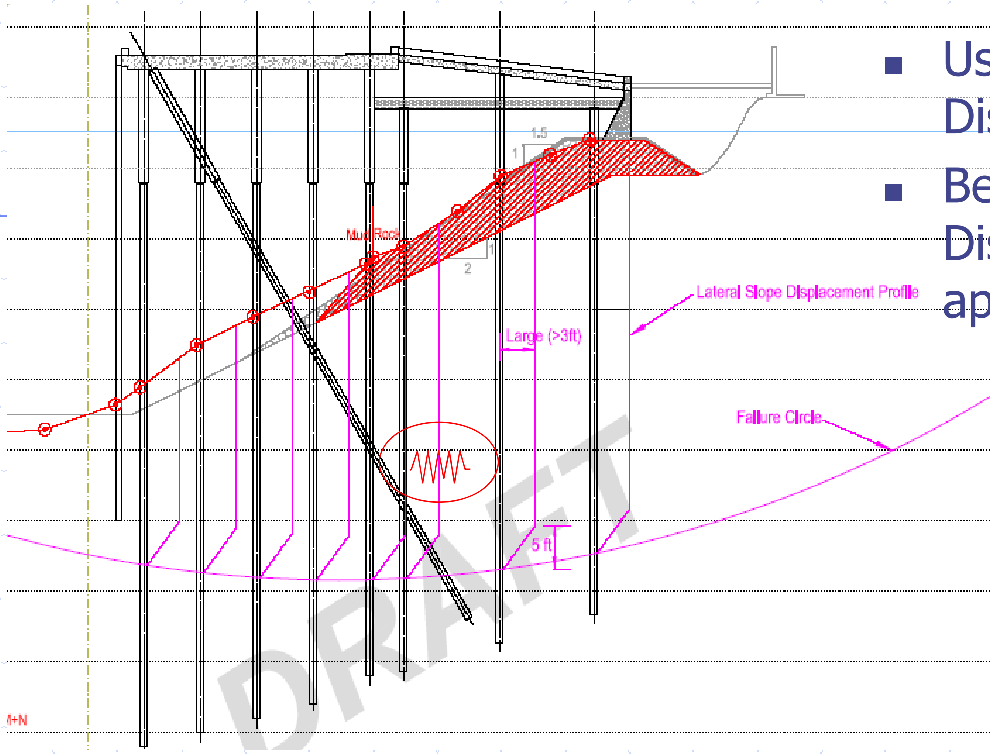
- Kinematic Loading



- Use Consistent Ground Displacement and p-y Springs
- Best-Estimate Ground Displacement and p-y Springs are appropriate

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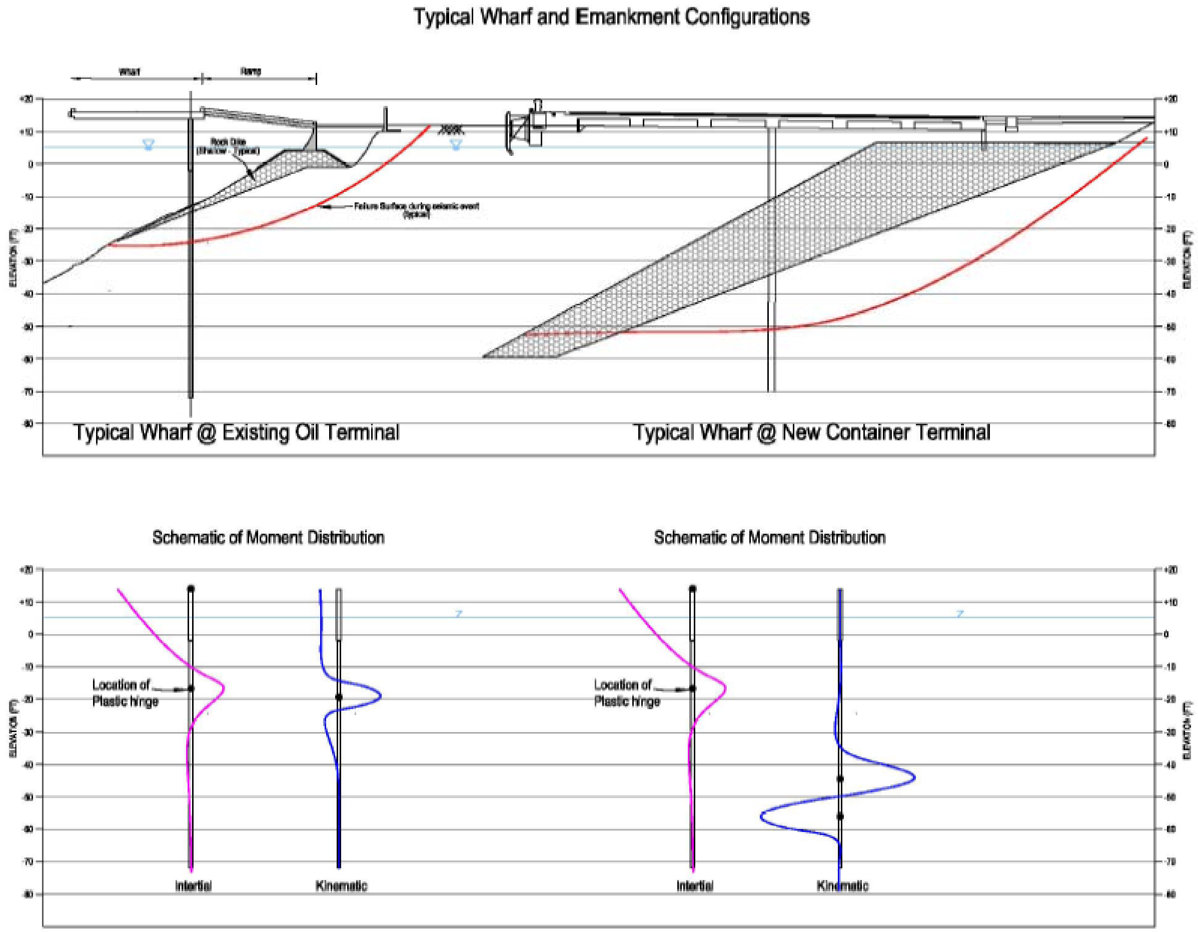
- Combination of Inertial and Kinematic Loadings



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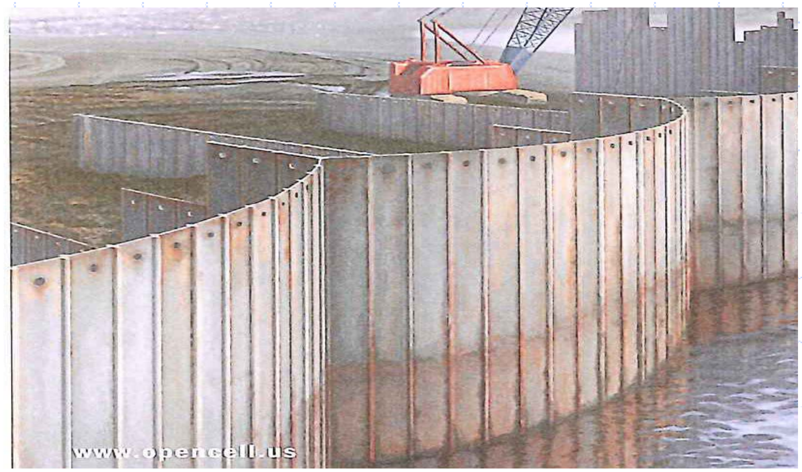
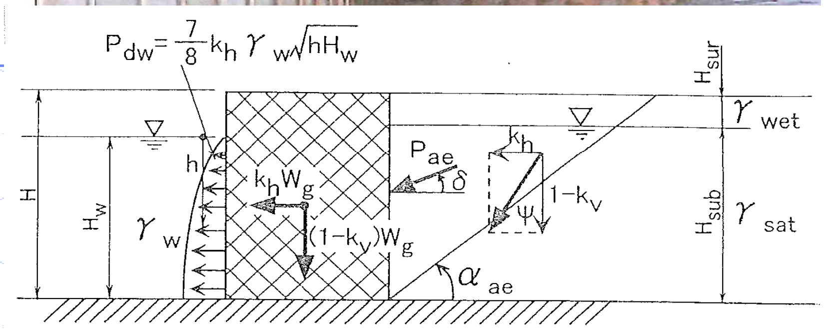
- Earth Pressures on Retaining Structures
  - Current Version, 3107F.4 Provides Some Guidance
  - Text Complementing 3107F.4 will be added in Division 6
  - Will address design issues for cellular structures





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- Ground Improvement
  - Densification Techniques
    - Vibro Compaction
    - Vibro Replacement
    - Deep Dynamic Compaction
    - Compaction Grouting
  - Hardening (Mixing) Techniques
    - Permeation Grouting
    - Deep Soil Mixing
    - Jet Grouting

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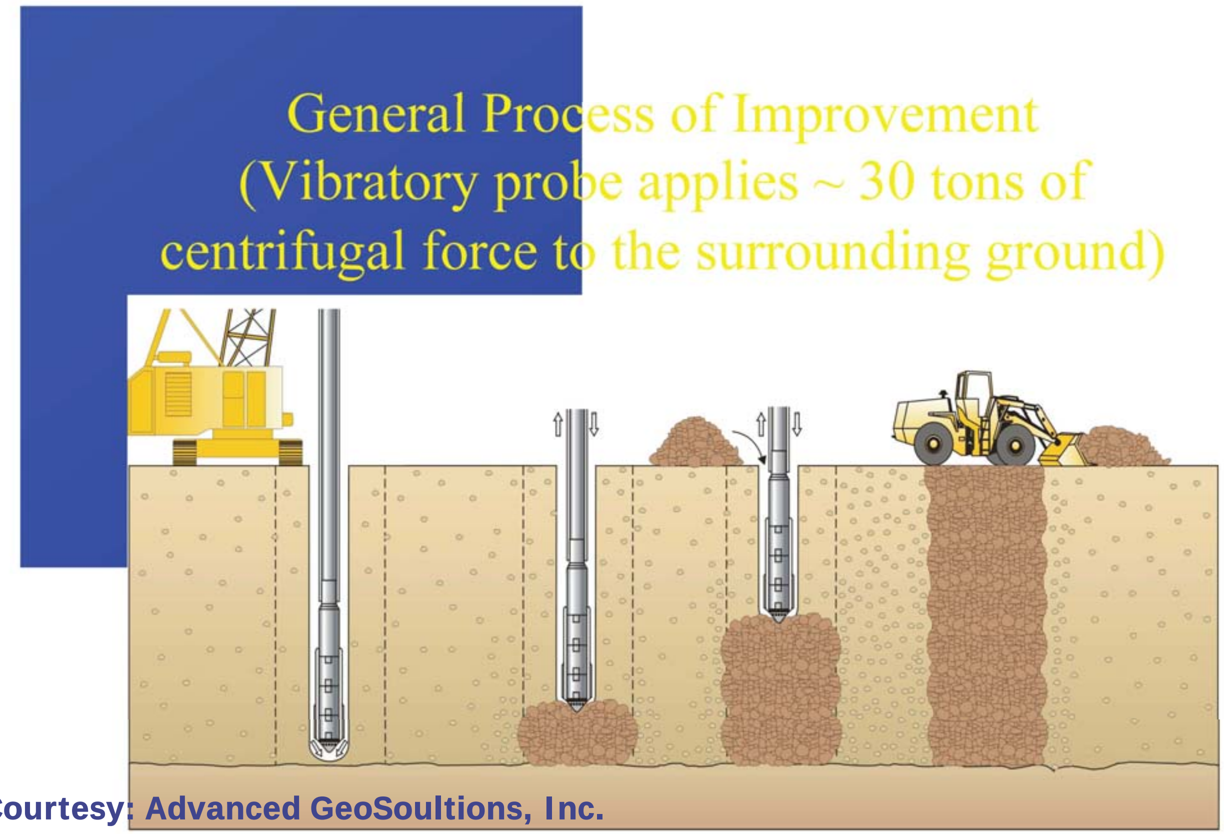
- Ground Improvement – Stone Columns



Courtesy: Advanced GeoSoultions, Inc.

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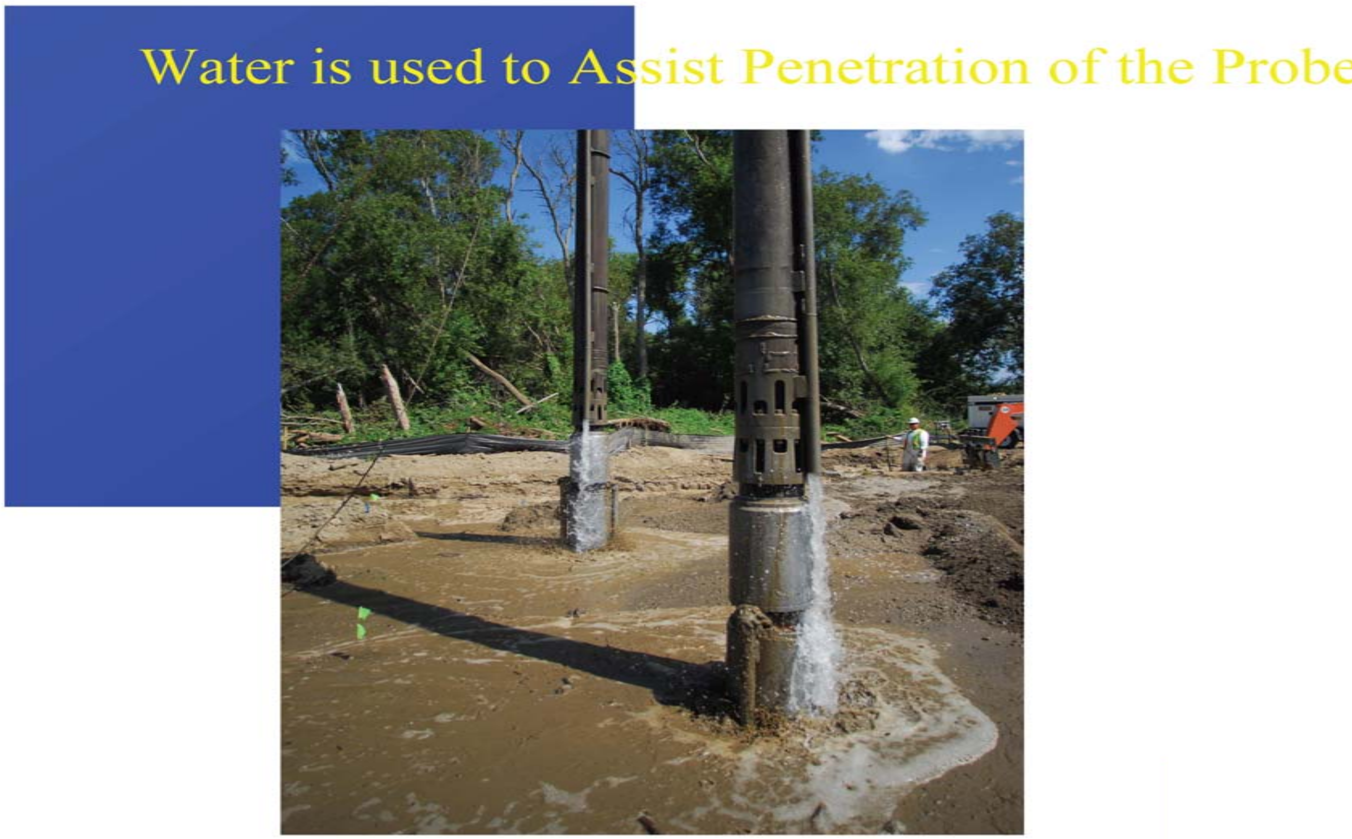
- Ground Improvement – Stone Columns



Courtesy: Advanced GeoSoultions, Inc.

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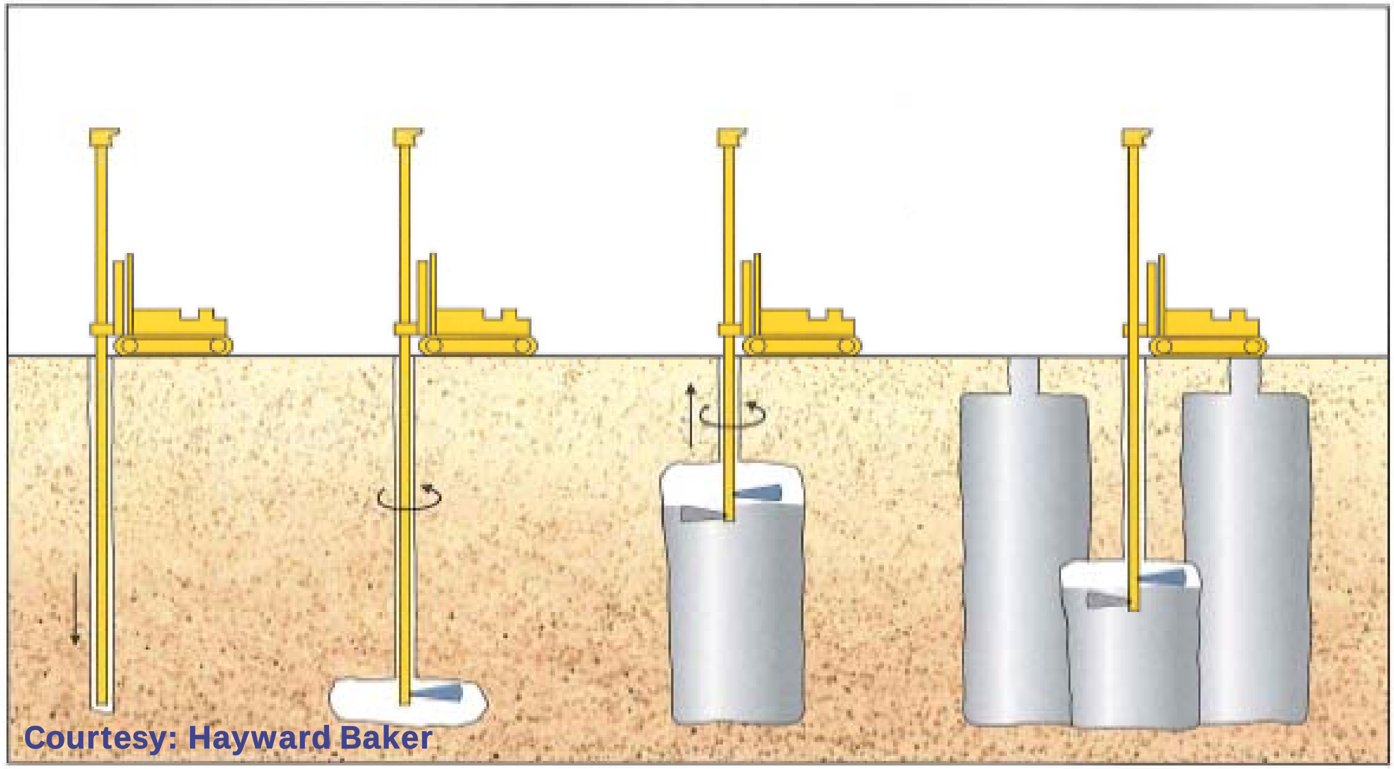
- Ground Improvement – Jet Grouting



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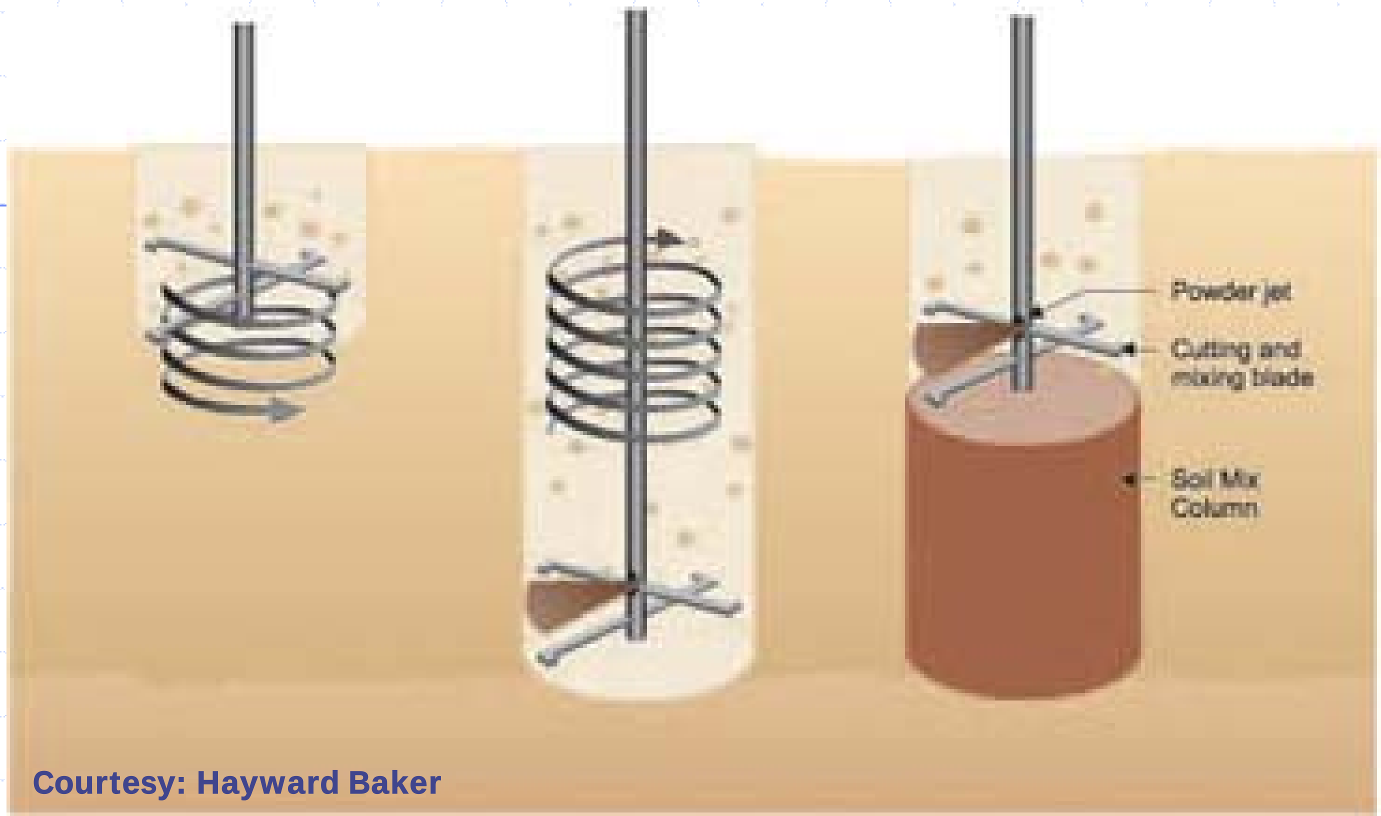
- Ground Improvement – Deep Soil Mixing



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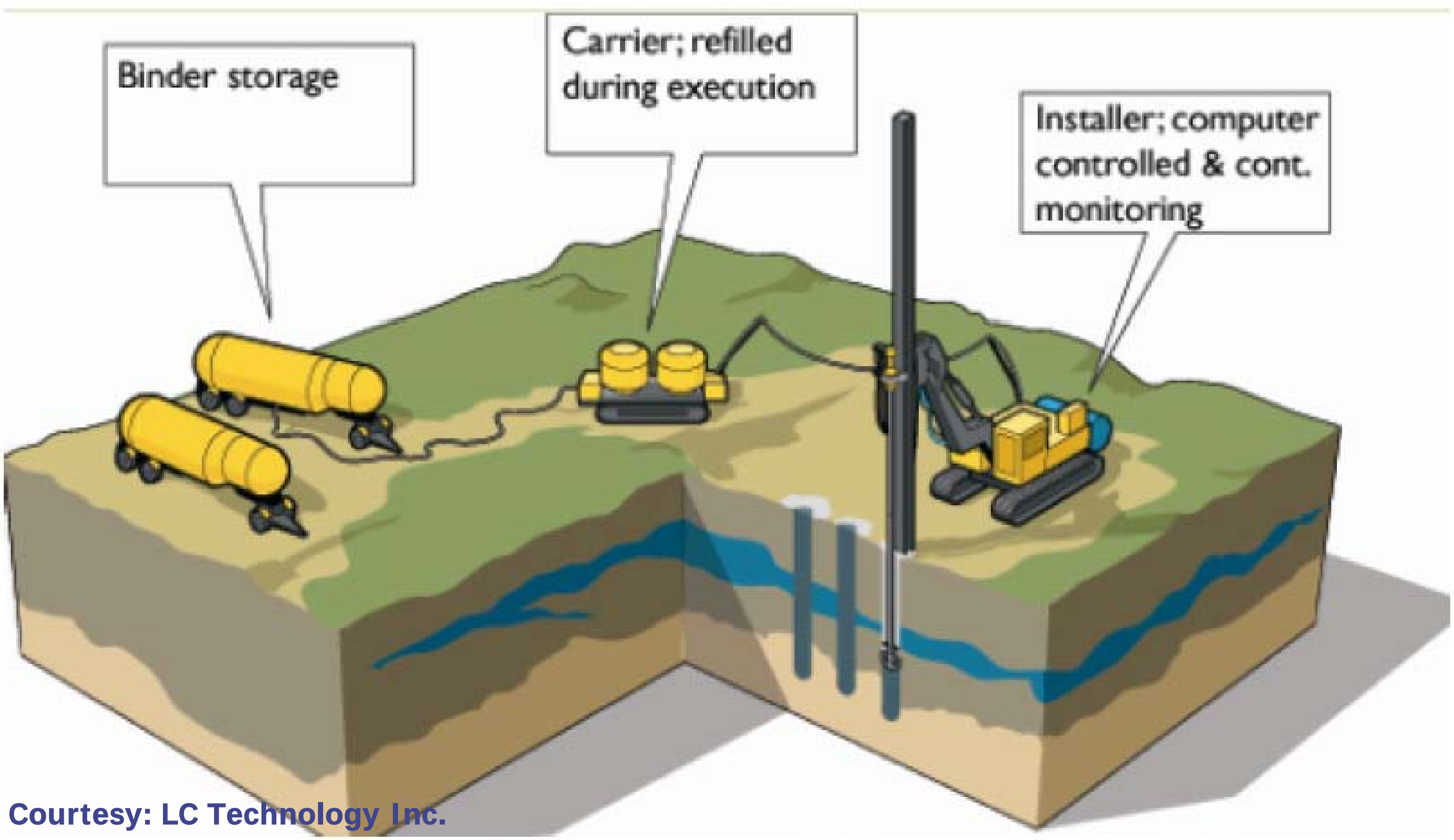
- Deep Soil Mixing – Site Logistics



Courtesy: LC Technology Inc.

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- Deep Soil Mixing – Site Logistics

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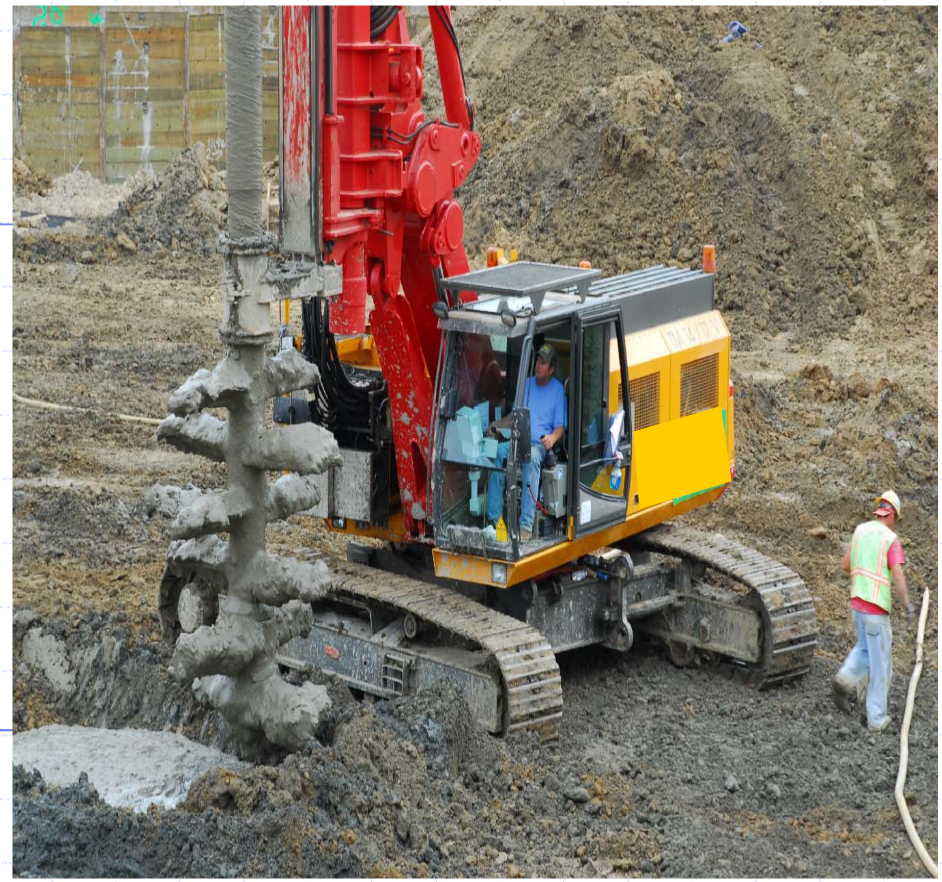
- Deep Soil Mixing – Site Logistics



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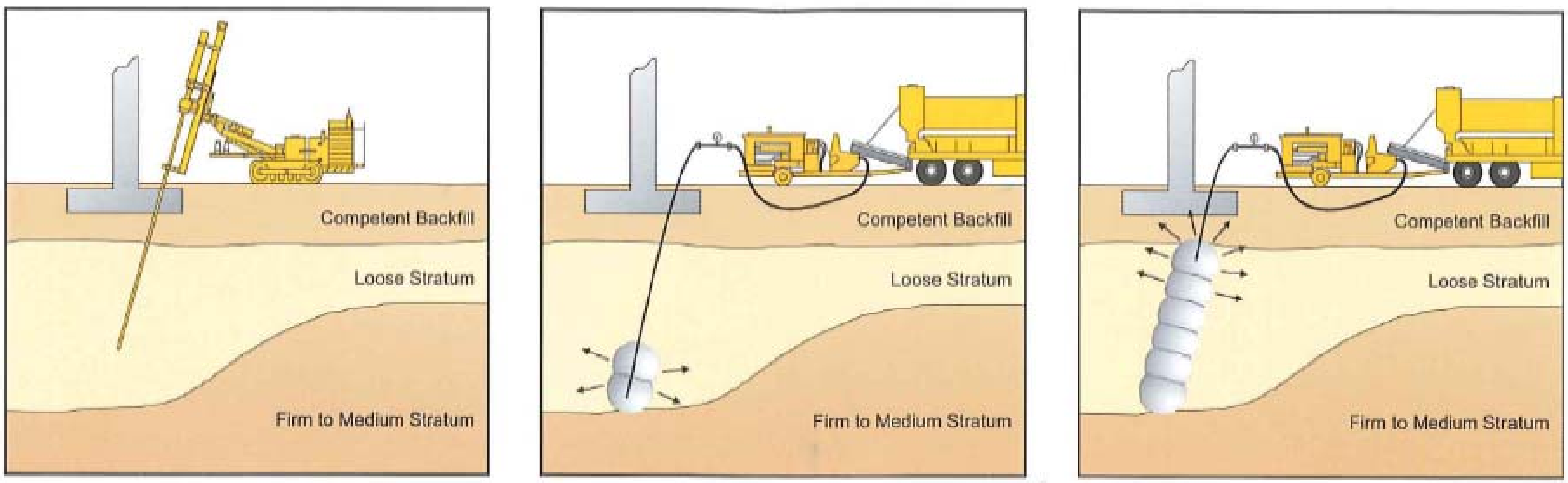
- Ground Improvement – Compaction Grouting



Installation of grout pipe:

- *Drill or drive casing*
- *Location very important*
- *Record ground information from casing installation*

Initiation of grouting:

- *Typically bottom up, but can be top down*
- *Grout quality important*
- *Pressure and/or volume of grout is usually limited*
- *Slow, uniform stage injection*

Continuation of grouting:

- *On-site batching can aid control*
- *Grout quality important*
- *Pressure, grout quantity and indication of heave are controlling factors*
- *Sequencing of plan injection points very important*

Courtesy: Hayward Baker

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- Anticipated Schedule
  - Draft to be Completed by Q1 2011
  - Incorporate into Draft Revised MOTEMS by Q3 2011
  - Public Comments by Q4 2011
  - Adoption by CBSC by Q1 2012

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- Geotechnical Hazards and Foundations

QUESTIONS?