Changes to Geotechnical Engineering in the Last 50 Years

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Bio: Jerry A. DiMaggio, PE, BC.GE

- B.S., M.S. Civil Engineering — Clarkson University, New York
- P.E. — Many States
- Board Certified Geotechnical Engineer
- Work Experience
  - **2024 – Present: HNTB, Pavements/Geotechnical Practice Consultant**
  - **2014 – 2024:** Applied Research Associates, Inc., Senior Principal Civil Engineer — Associate
  - **2008 – 2014:** Second Strategic Highway Research Program (SHRP2), National Academies, Implementation Coordinator and Senior Program Officer
  - **1976 – 2008:** U.S. DOT/FHWA, Principal Bridge Engineer/National Geotechnical Program Manager
  - **1974 – 1976:** New York State DOT, Junior Engineer

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Real Person: Jerry A. DiMaggio

- Pin Ball Machine Repairman – 2yr
- Country Club Maintenance Foreman – 3yrs
- Teamster Trucker– 2yrs
- Father – 46yrs
- Grandfather – 7 boys and girls
- Husband – 56yrs
- Civil Engineer (geotechnical and construction specialist) - 53yrs)

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Soil and Rock

What has Changed and Remained the Same in 50 Years?

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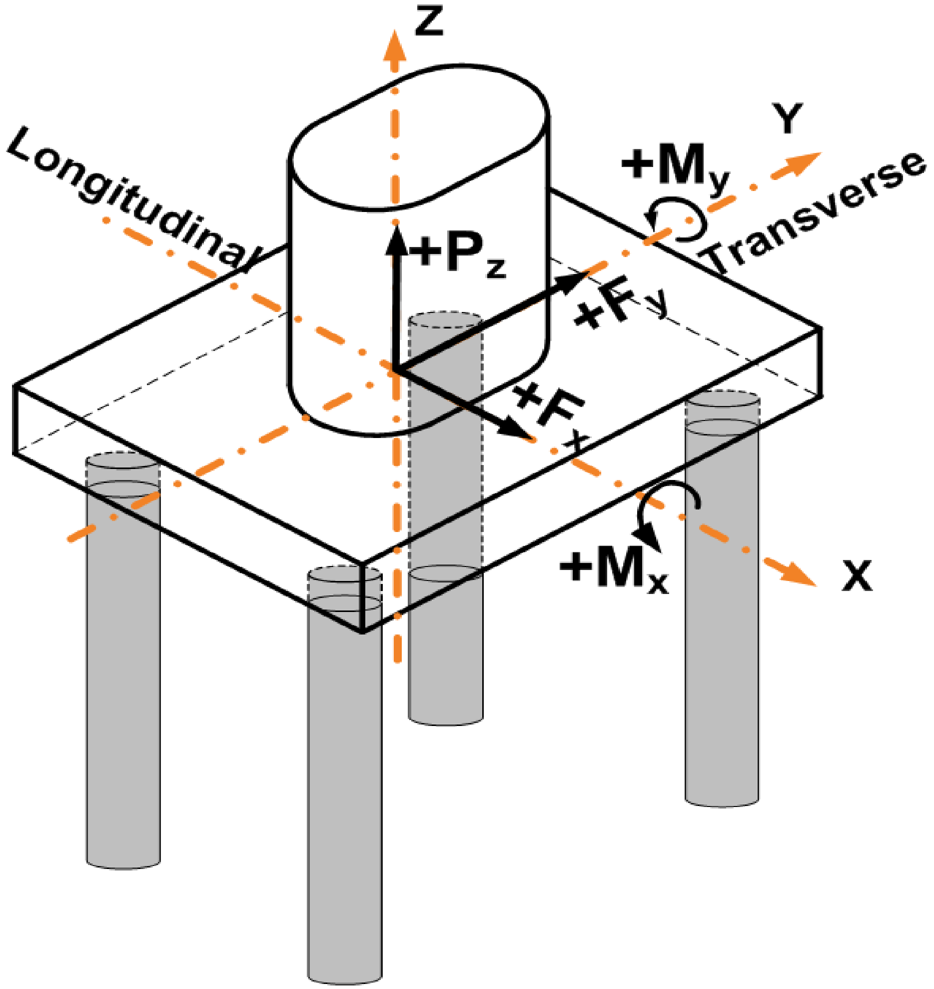
$$\Sigma \eta_i \gamma_i Q_i \leq R_r = \phi R_n$$

η_i	=	**Load modifier (eta)**
γ_i	=	**Load factor (gamma)**
Q_i	=	**Force effect**
R_r	=	**Factored resistance**
ϕ	=	**Resistance factor (phi)**
R_n	=	**Nominal resistance**

Loads Types, Magnitudes and Frequencies



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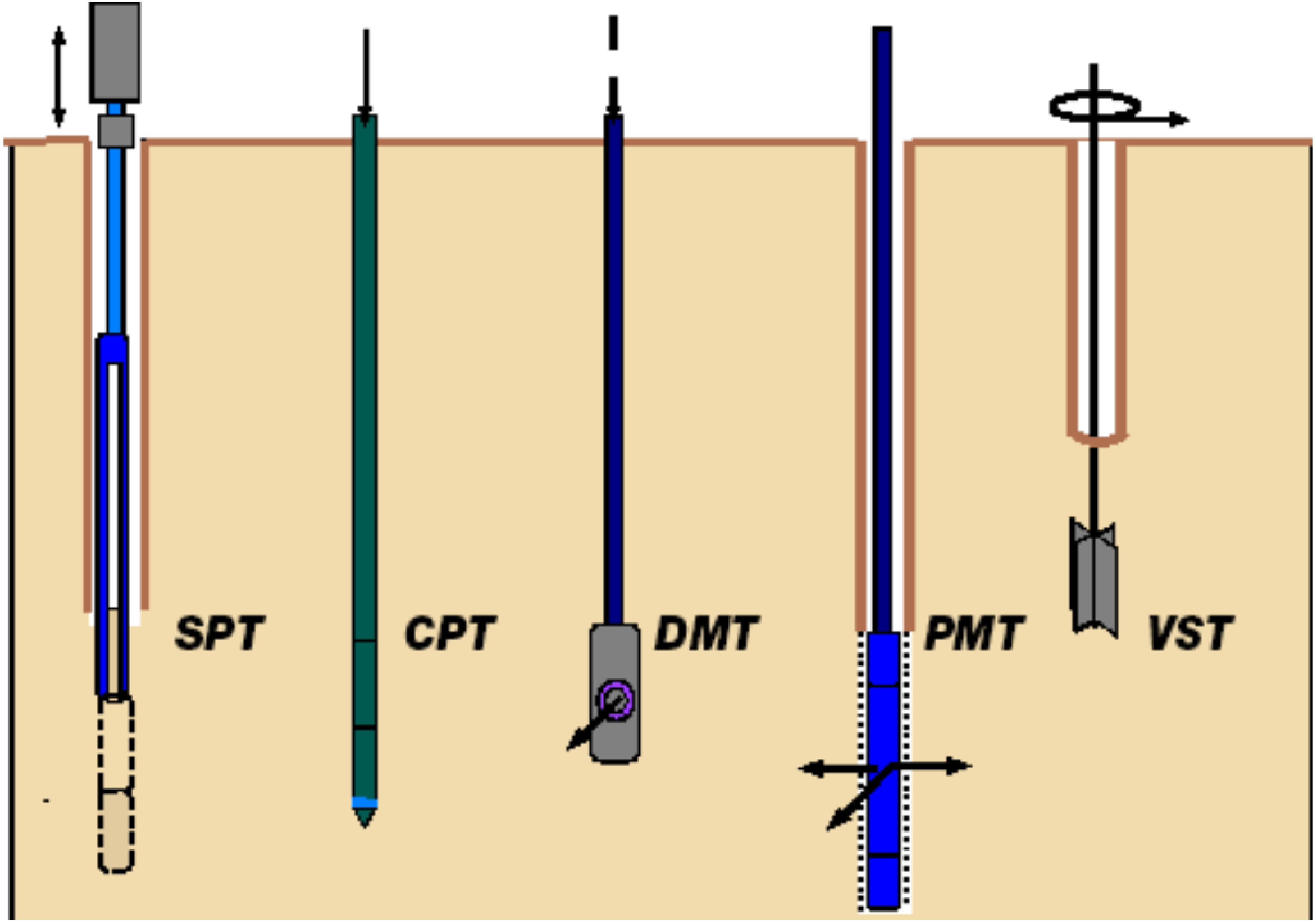
Extreme Event Loads: Seismic, Ice, Flooding, Vehicle, Vessel, Scour


SPT
CPT
DMT
PMT
VST

AASHTO LRFD Bridge Design Specs. Section 10.4
Soil and Rock Properties

4.1 Informational Needs

4.2 Subsurface Exploration

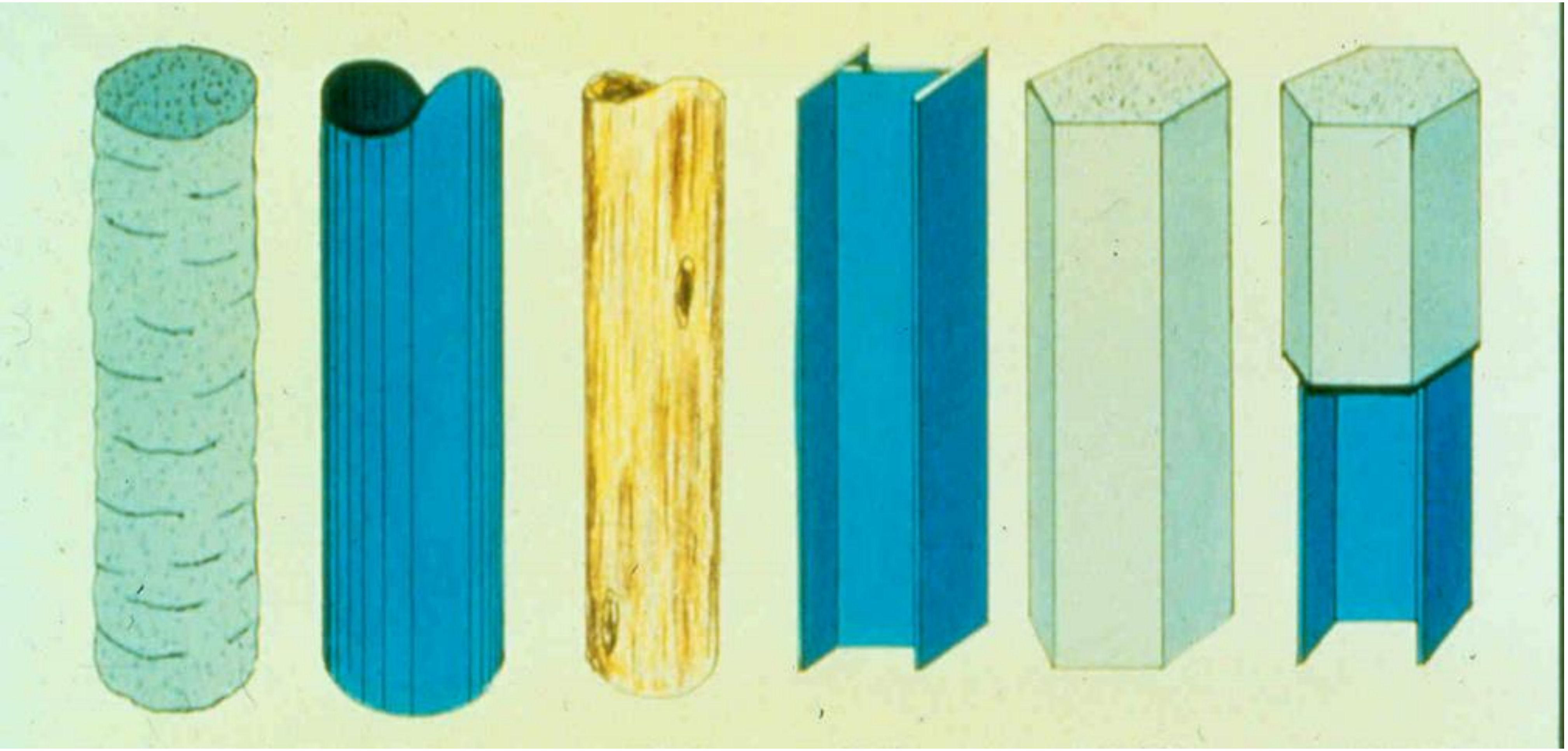
4.3 Laboratory Tests

4.4 Insitu Tests

4.5 Geophysical Tests

4.6 *Selection of Design and Construction Parameters*

TYPES OF PILING



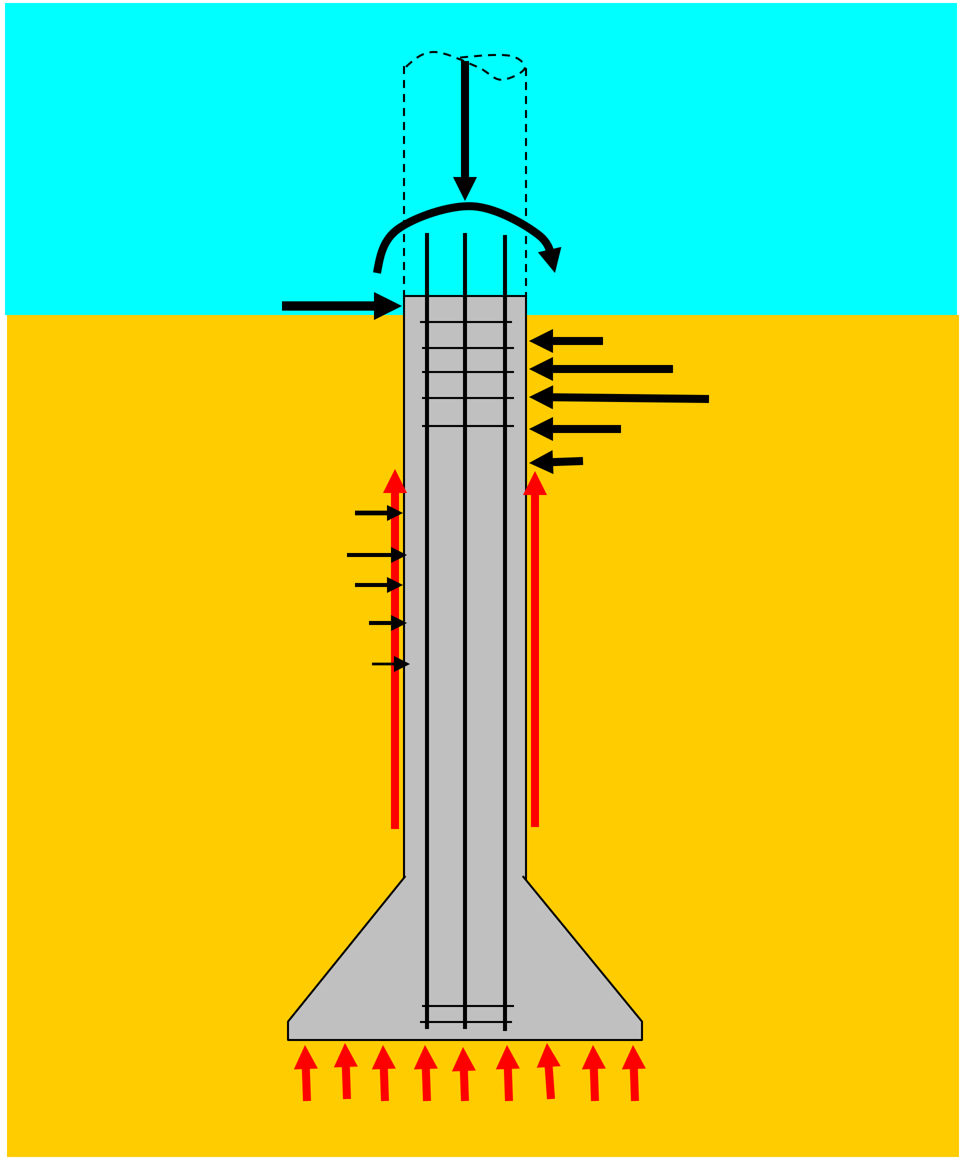
Drilled Piles | Steel Pipe | Timber | Steel H | Prestressed Concrete | Composite

Deep Foundation Selection

- Method of support
- Bearing material depth
- Load type, direction and magnitude
- **Performance Requirements** (schedule, deformations, extreme events)
- Constructability
- **Cost**
  - ➢ Expressed in $/kip resistance
  - ➢ **Include all possible costs (mobilization, time, phase construction and temporary work items)**

Steel H-Piles and Prestressed Concrete

Drilled Shafts and Augercast Piles



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Concrete

Micropiles: USA 1970s

We've Learned the Meaning of Driveability!!!!

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Structural Resistance Factors

10.7.3.13 Pile Structural Resistance

Concrete (5.5.4.2)

Axial Comp. = 0.75

Flexure = 0.9 (strain dependent)

Shear = 0.9

LRFD Specifications

Steel (6.5.4.2)

Axial = 0.5-0.7

Combined

- Axial= 0.7-0.8
- Flexure = 1.0

Shear = 1.0

Timber (8.5.2.2 and .3)

Compression = 0.9

Tension = 0.8

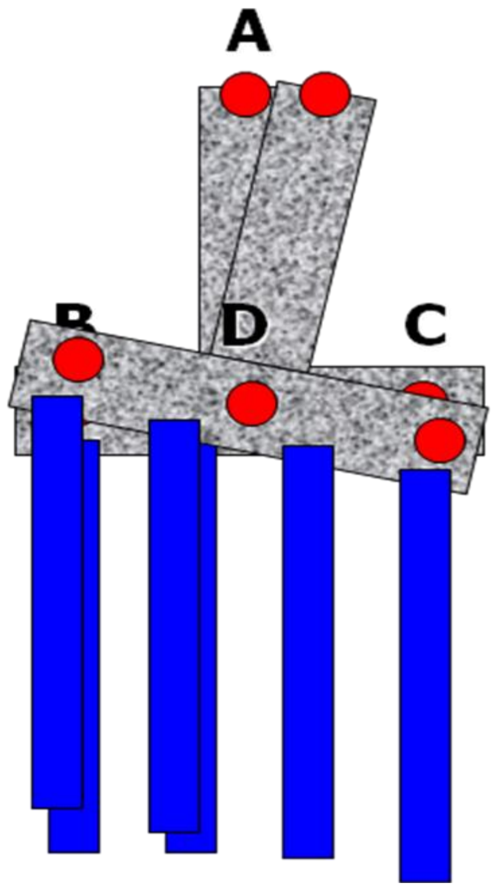
Flexure = 0.85

Shear = 0.75

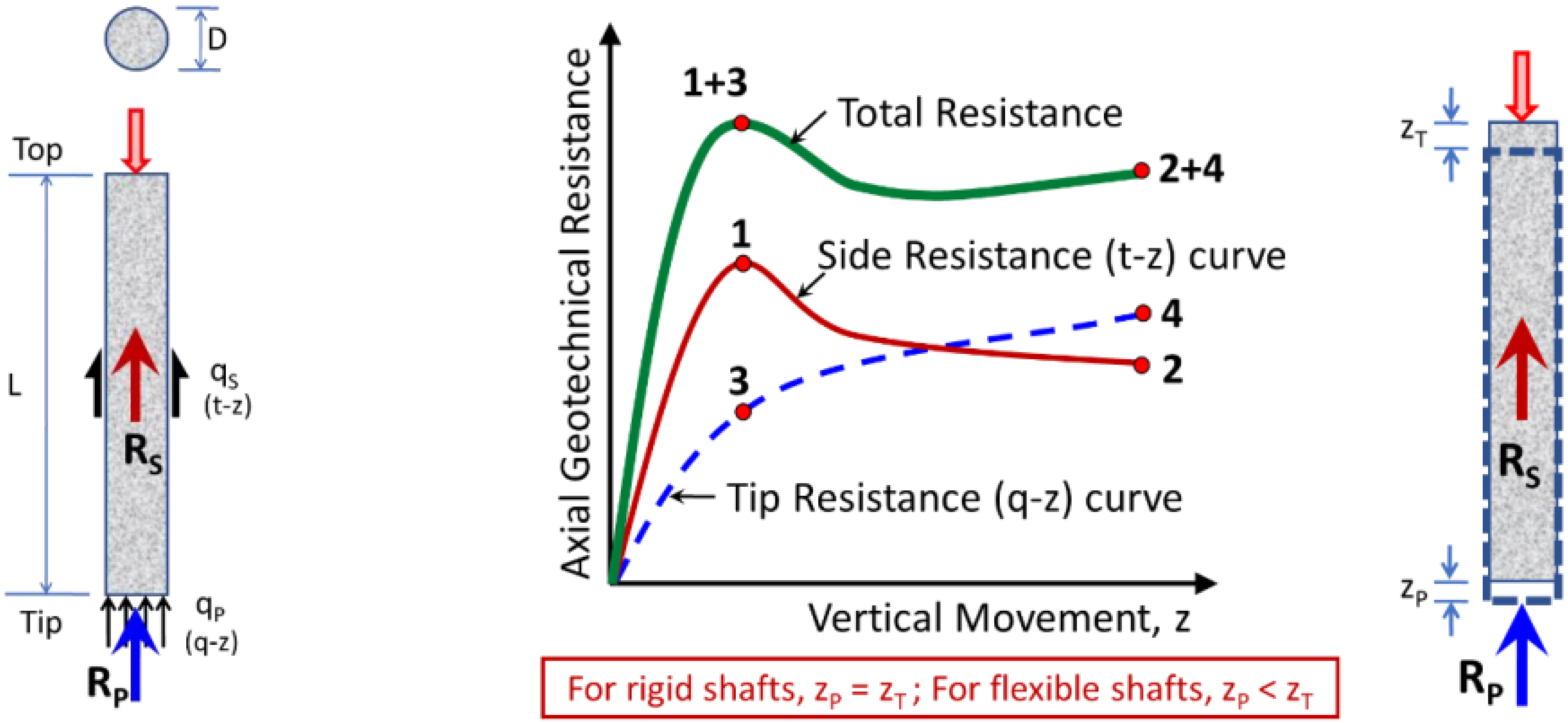
Intolerable Movements

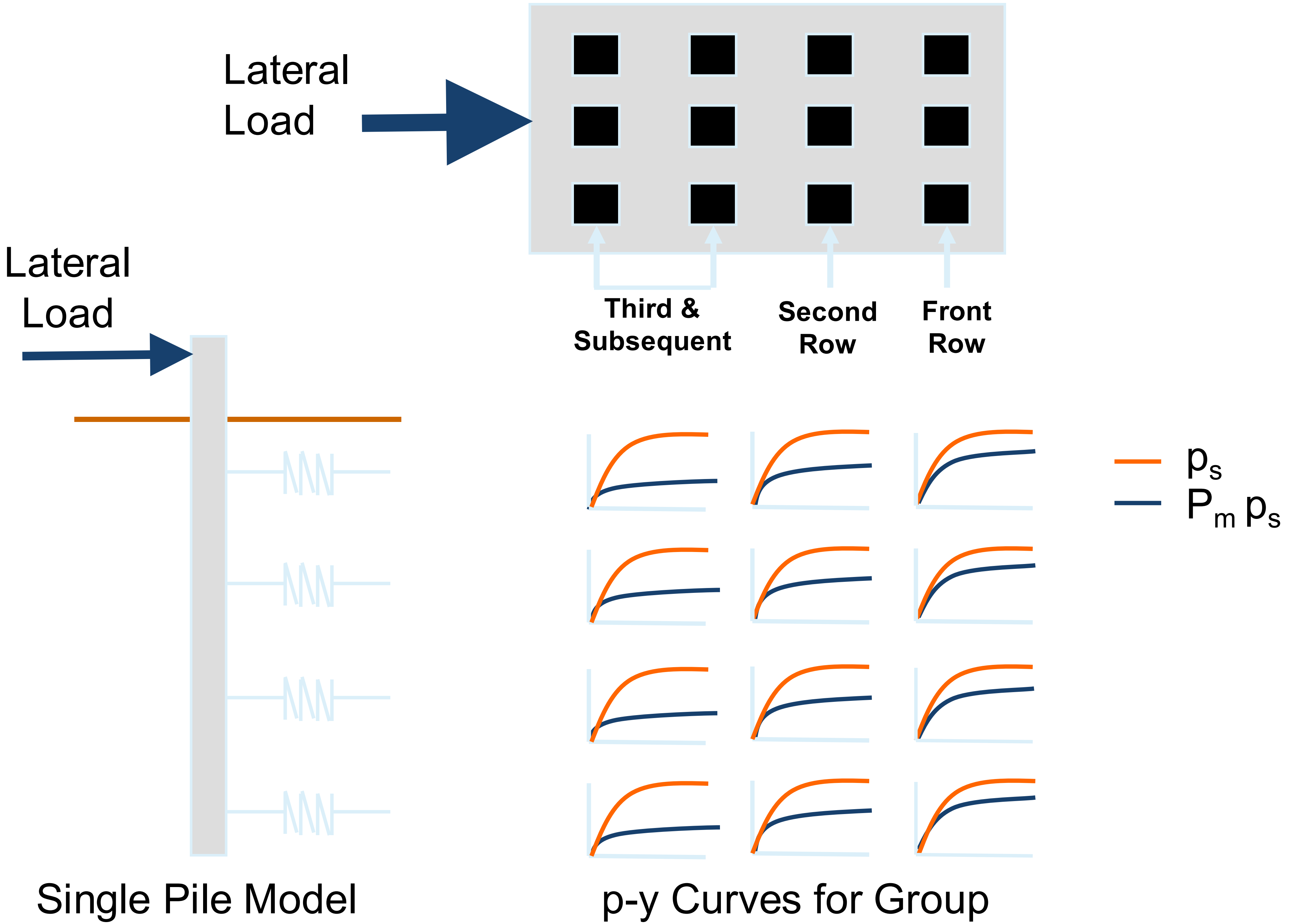
Tolerable Movements and Movement Criteria Article AASHTO 10.5.2.2

- **Service loads for settlements, horizontal movements and rotations.**
- Omit transient loads for cohesive soils
- **Reference movements to the top of the substructure unit.**
- Angular Distortion (C10.5.2.2)

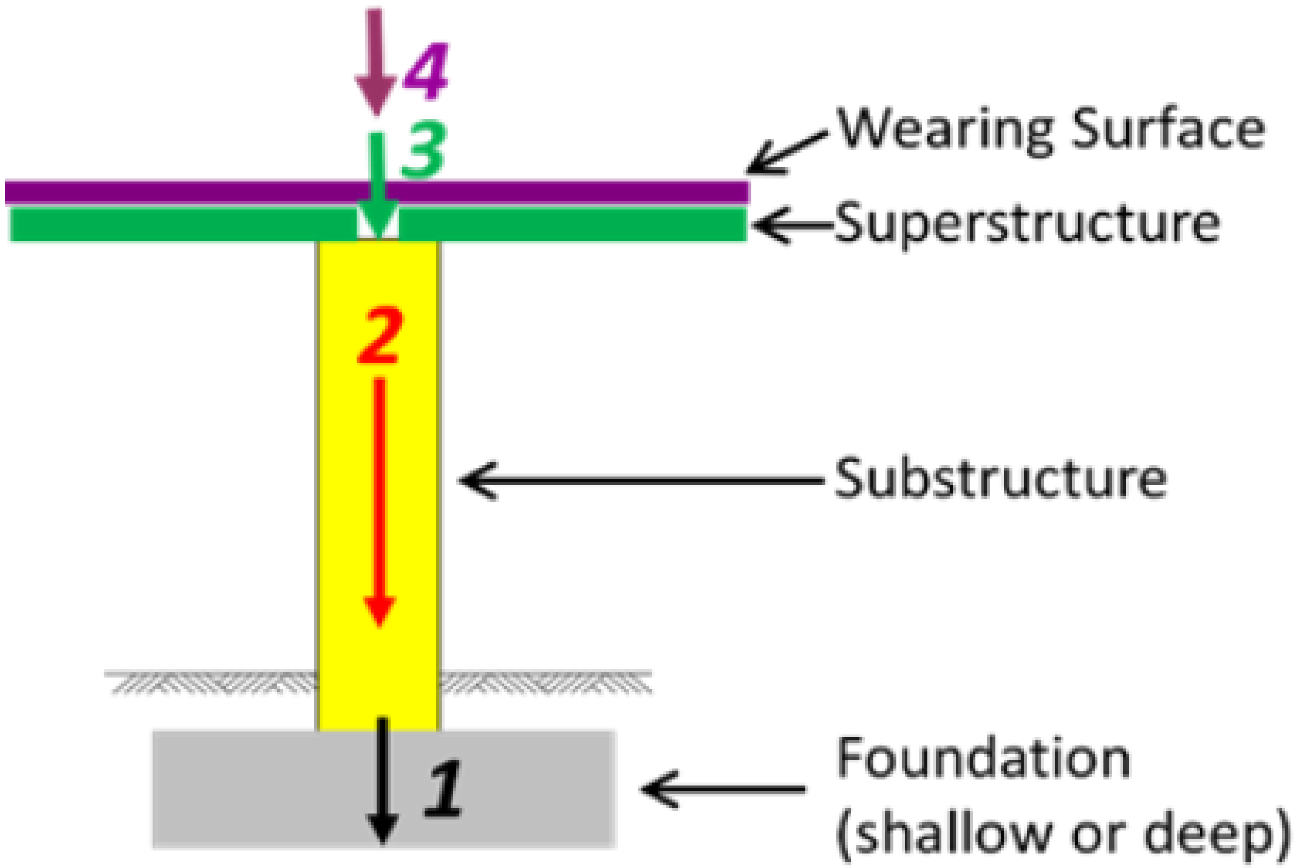


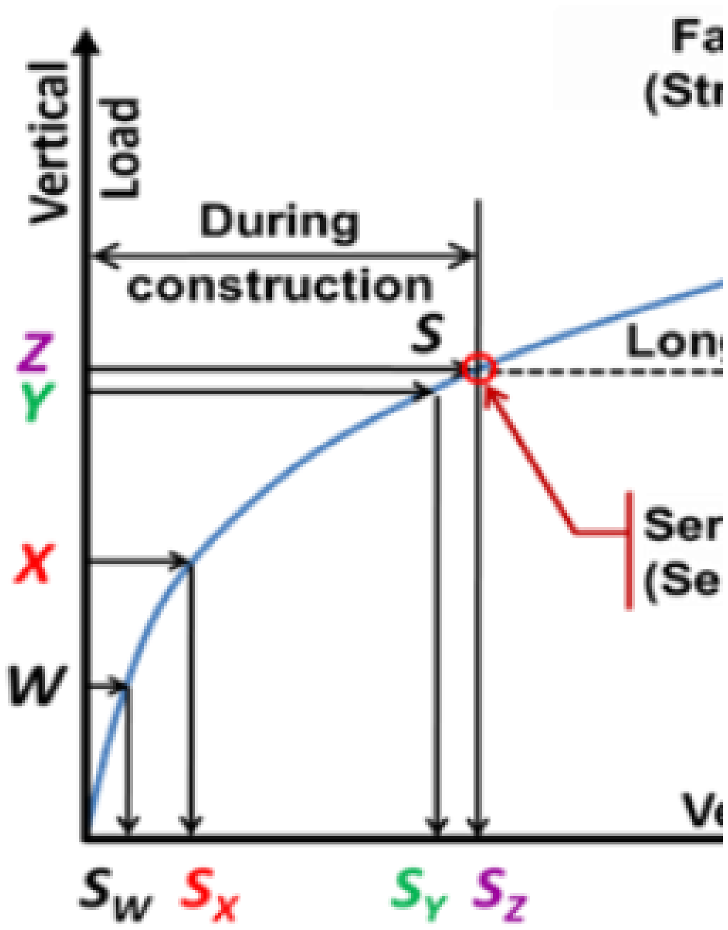
Concept of Mobilized Resistance



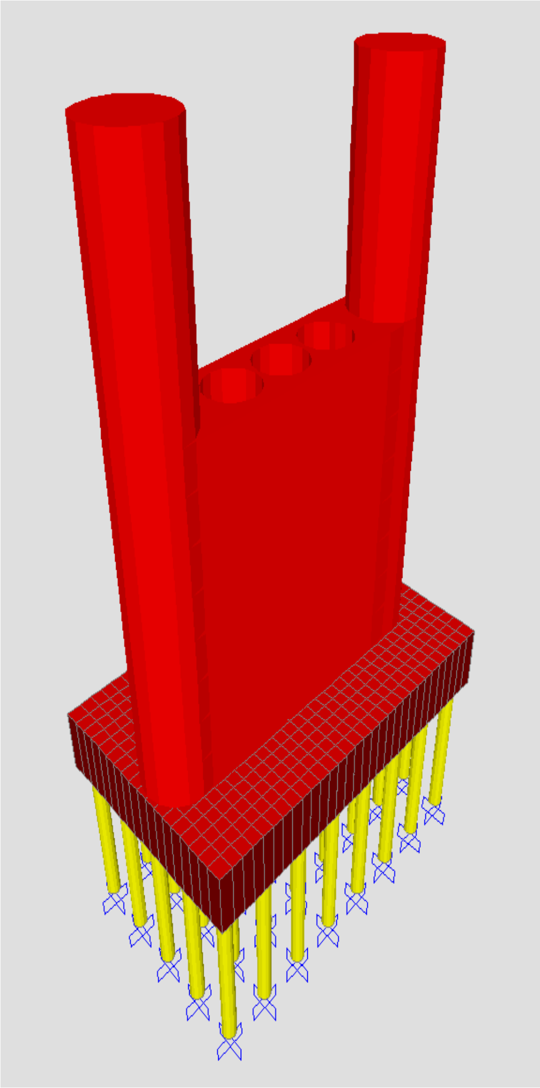

Lateral Load
Lateral Load
Third & Subsequent
Second Row
Front Row
p_s
$P_m\, p_s$
Single Pile Model
p-y Curves for Group

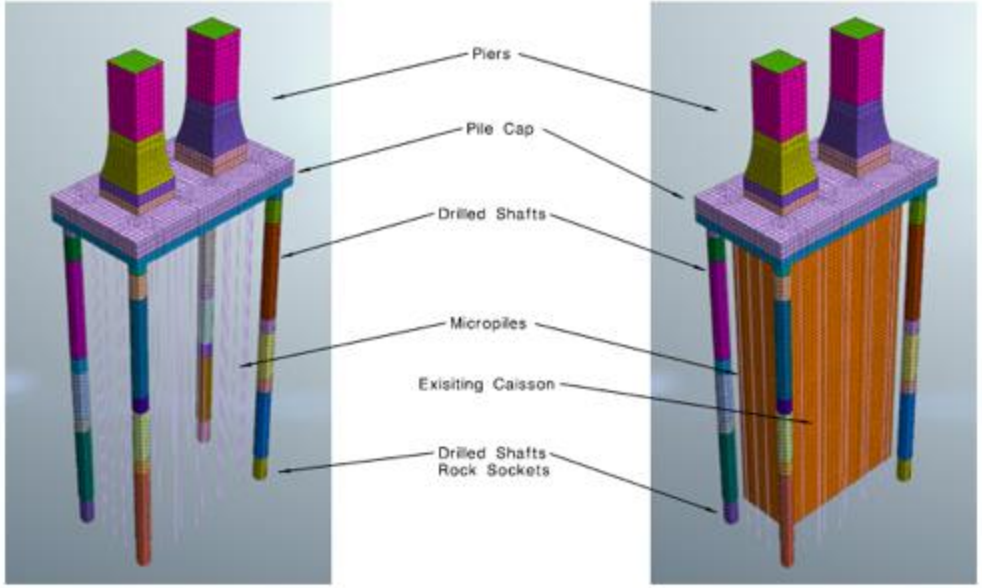
Construction Point Concept

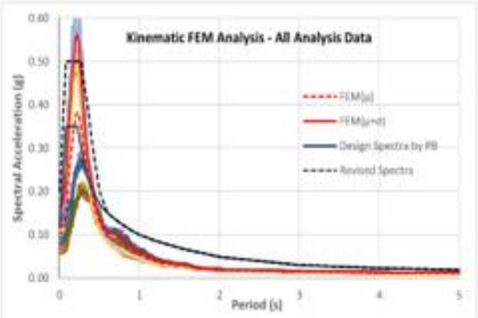


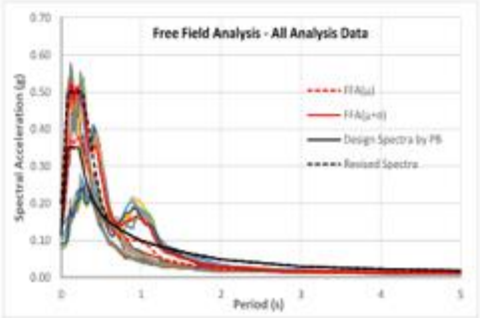


Foundation Engineering Software









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Risk Mitigation, Claims Support, Forensic Engineering

- Elements of Risk Management.
- Expectations Management.
- Appropriate Scope, Fee and Schedule Development.
- Construction Observation by Geotechnical Staff.
- Decreased Liability.
- HNTB is exposed to risk even if services are subcontracted.
- Quickly respond to issues.
- Commitment to success of firm.
- QA/QC Role.
- Minimize construction claims / issues.

Oscillator/Rotator Systems


5. 8. 2000

Pile Testing Methods

Analysis Method	Resistance Factor (f)
Dynamic formula	0.10 (EOD) or 0.40 (EOD)
Wave equation	0.50 (w field confirmation of hammer)
Dynamic testing	0.65 (2%) or 0.75 (100%) (0.5 uplift)
Static load test	0.75 to 0.80 (wo/w dynamic) (0.6 UPLIFT)

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LINK

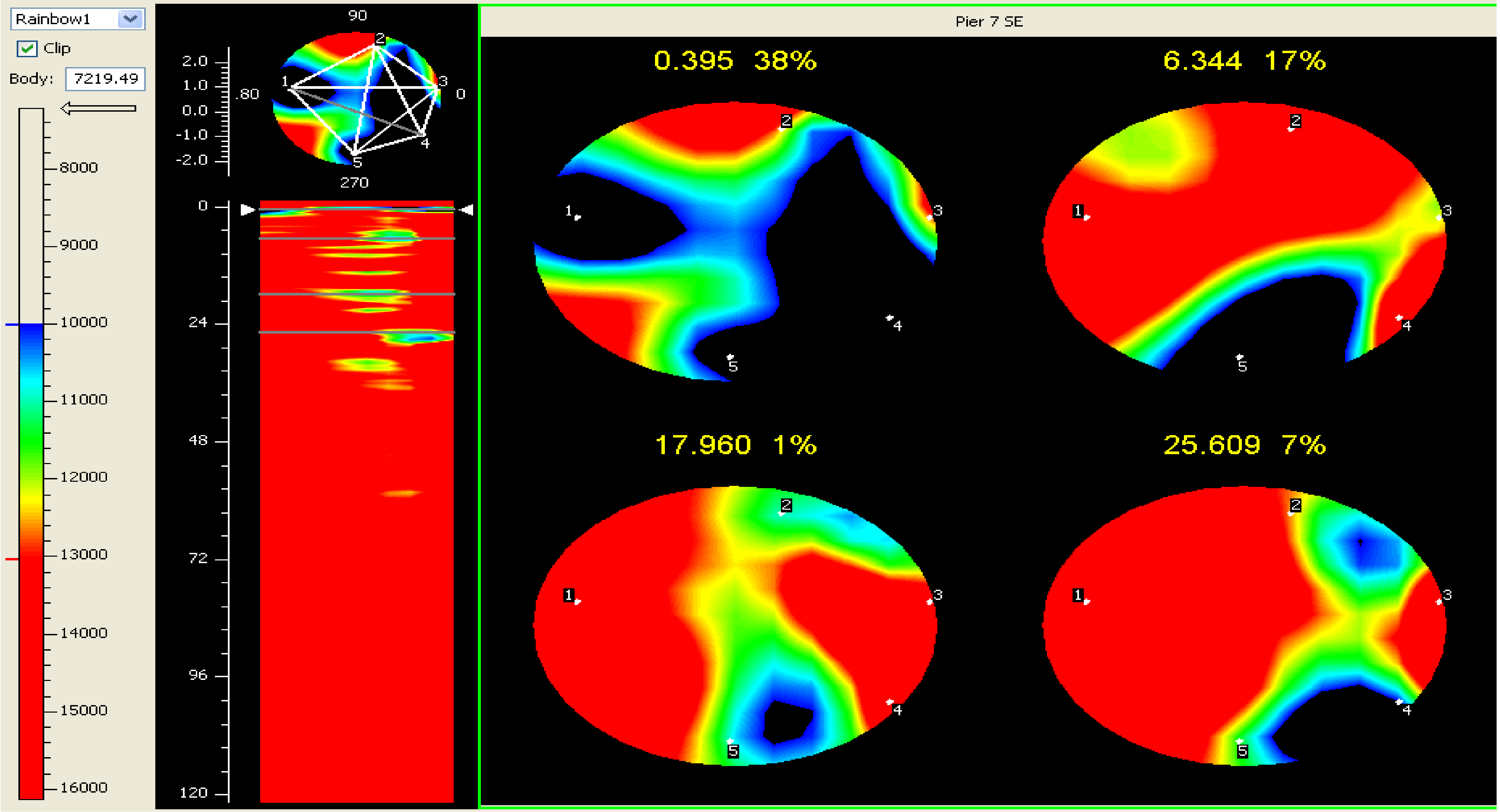
Dynamic Load Test (PDA) ASTM D4945

Pomeroy-Mason Bridge
Pomeroy County Ohio

8' Dia. Shafts for Support of Bridge River Piers

Statnamic Load Tests

NDT Testing and Analysis



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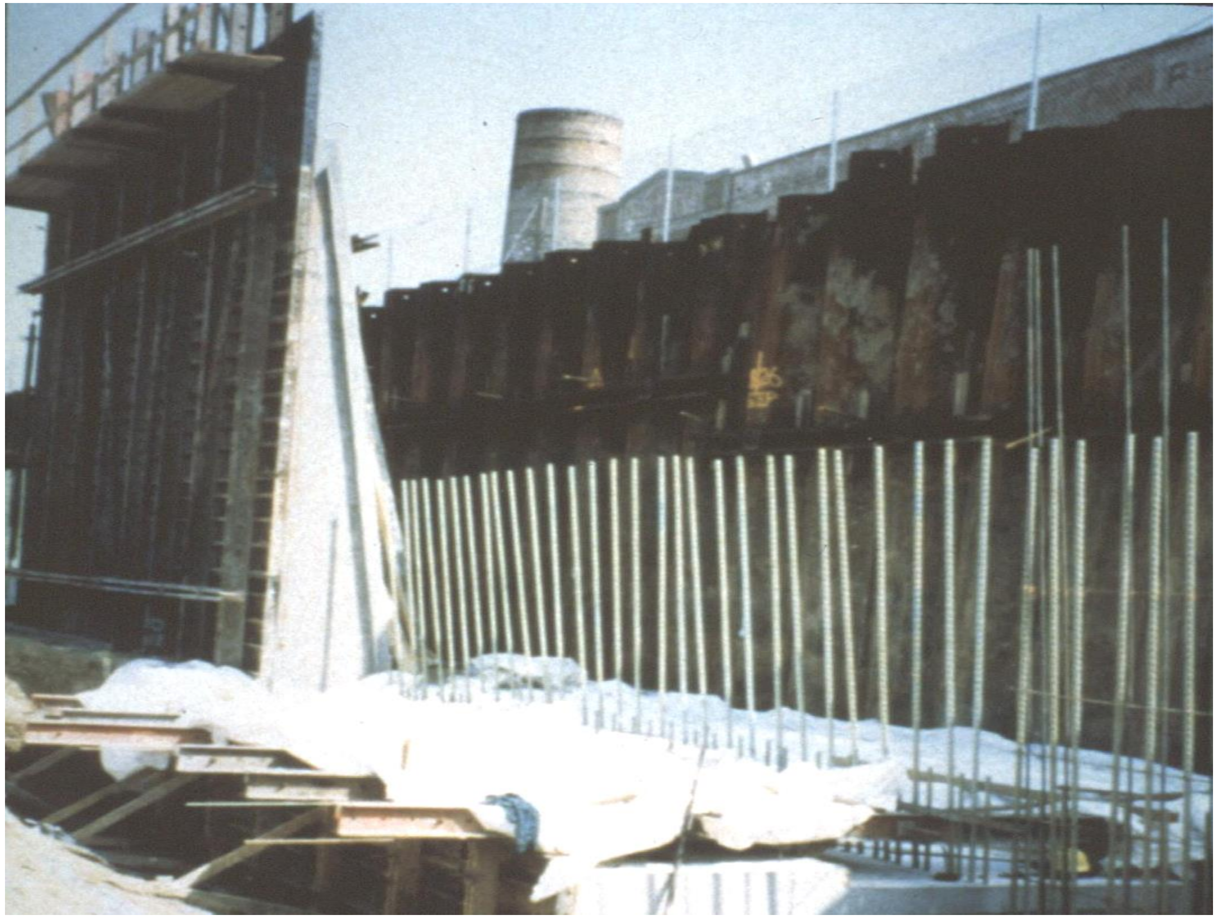
Earth Retaining Structures



Earth Retaining Structure Families

EARTH RETAINING STRUCTURES

- Externally Stabilized
  - In situ walls
    - Structural (Cut Walls)
      - Sheet-pile*
      - Soldier pile-lagging*
      - Cast-in-situ
        - Slurry walls
      - Bored pile
        - Contiguous
          - Tangent pile
          - Secant pile
      - Non-contiguous
    - Chemical (Cut Walls)
      - Jet grout
      - Deep Soil Mix
    - Braced
      - Cross-lot
      - Rakers
    - Anchored
      - Augured
      - Belled
      - Pressure injected
  - Gravity walls
    - Cast-in-place Concrete (Fill Walls)
      - Cantilever
      - Counterfort
      - Buttress
    - Modular Gravity (Fill Walls)
      - Masonry
      - Crib
      - Bin
      - Gabion
      - Concrete Module
- Internally Stabilized
  - Mechanically Stabilized (Fit Walls)
    - Metallic and polymeric reinforcing strips, grids, and sheets
    - Anchored Earth Reinforced Soil Slopes
  - In situ Reinforced (Cut Walls)
    - Soil Nailing
    - Reticulated Micro Pile
- Hybrid Walls (Modular Gravity + Mechanically Stabilized)
  - Tailed Segmental
  - Low density Fills

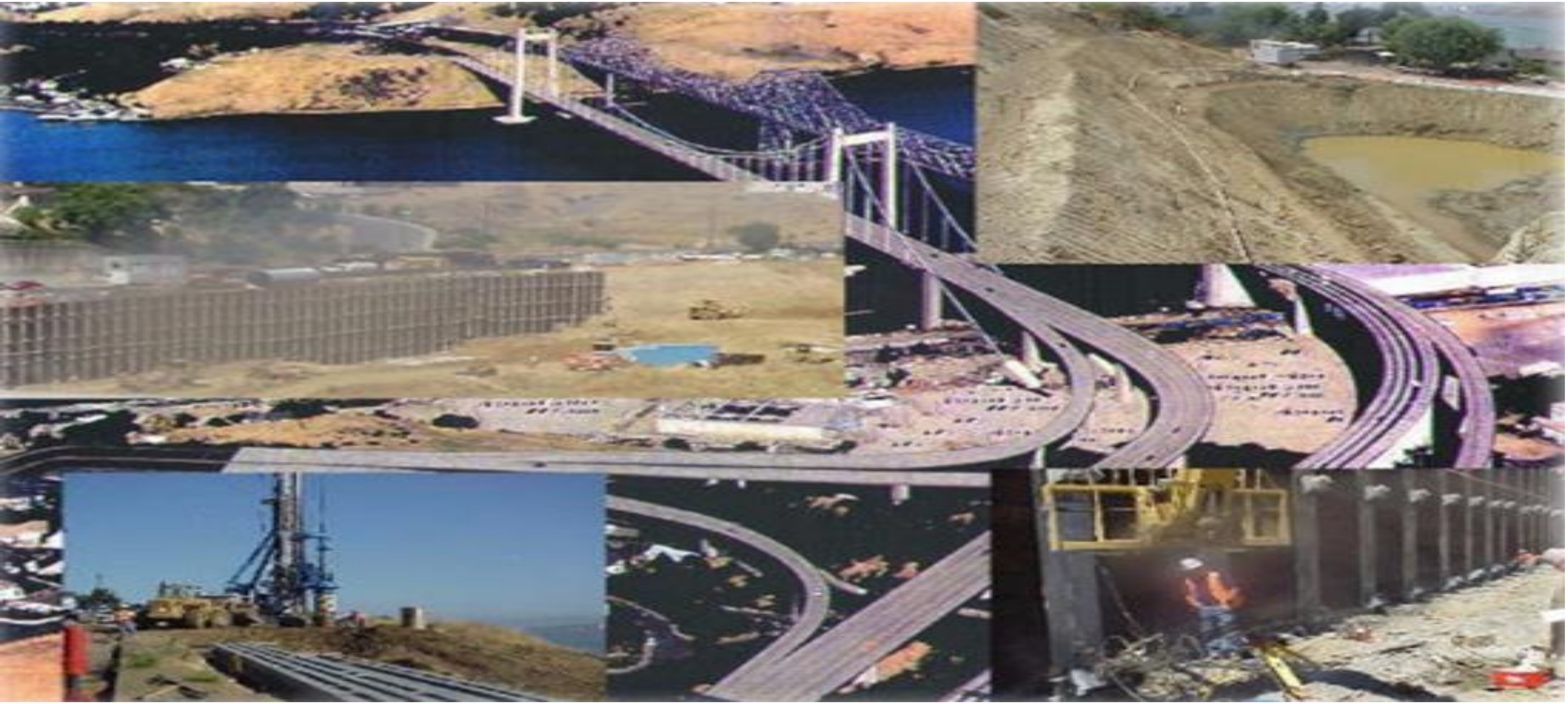
can also be used in fill conditions

Ground Improvement Methods

- Staged fills.
- Lightweight fill material.
- Grouting.
- Column supported embankments.
- Surcharge with prefabricated vertical drains.
- **More than 50 materials and Techniques!**

Geosynthetic Types

Geotechnical Asset Management



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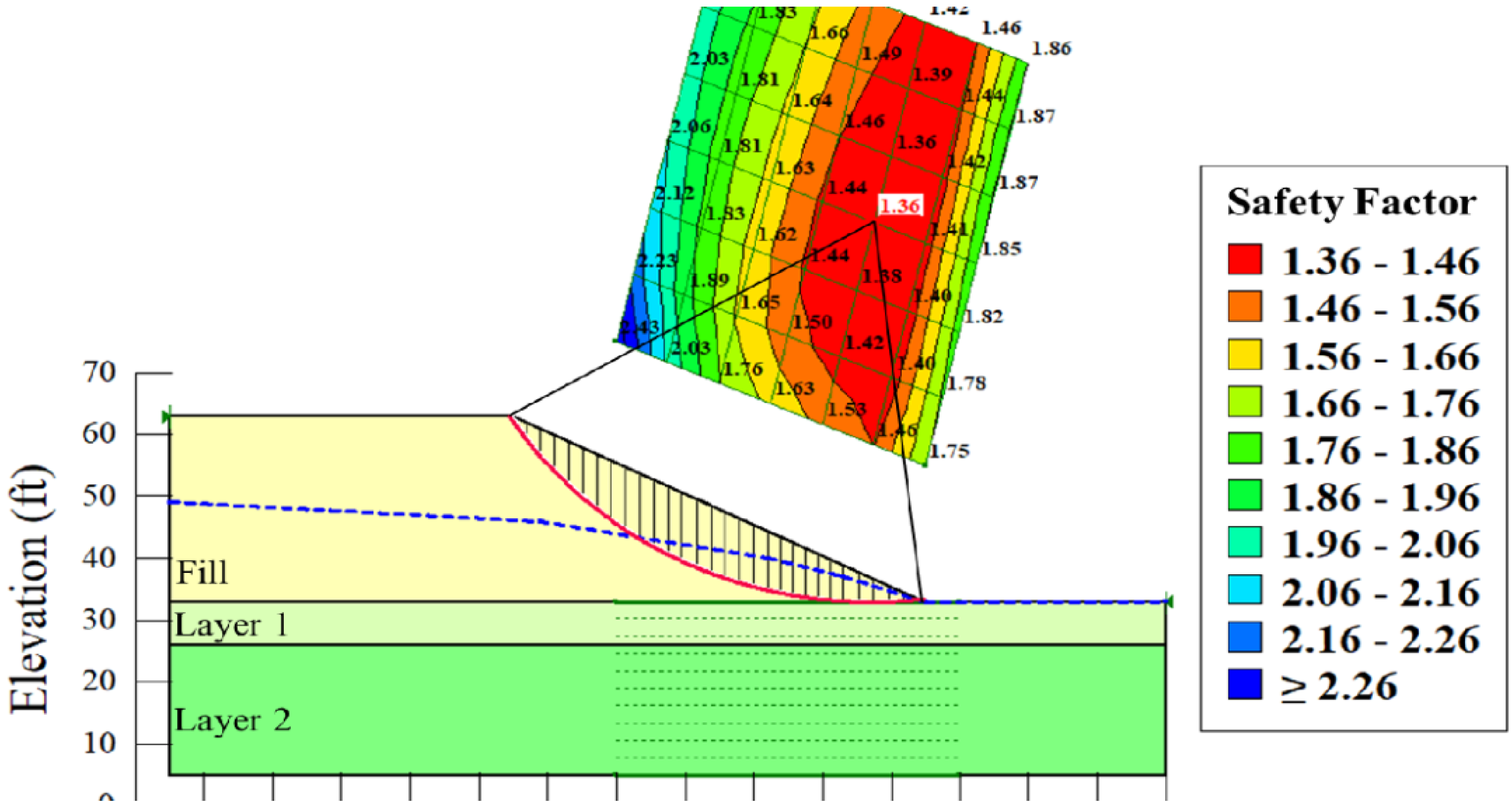
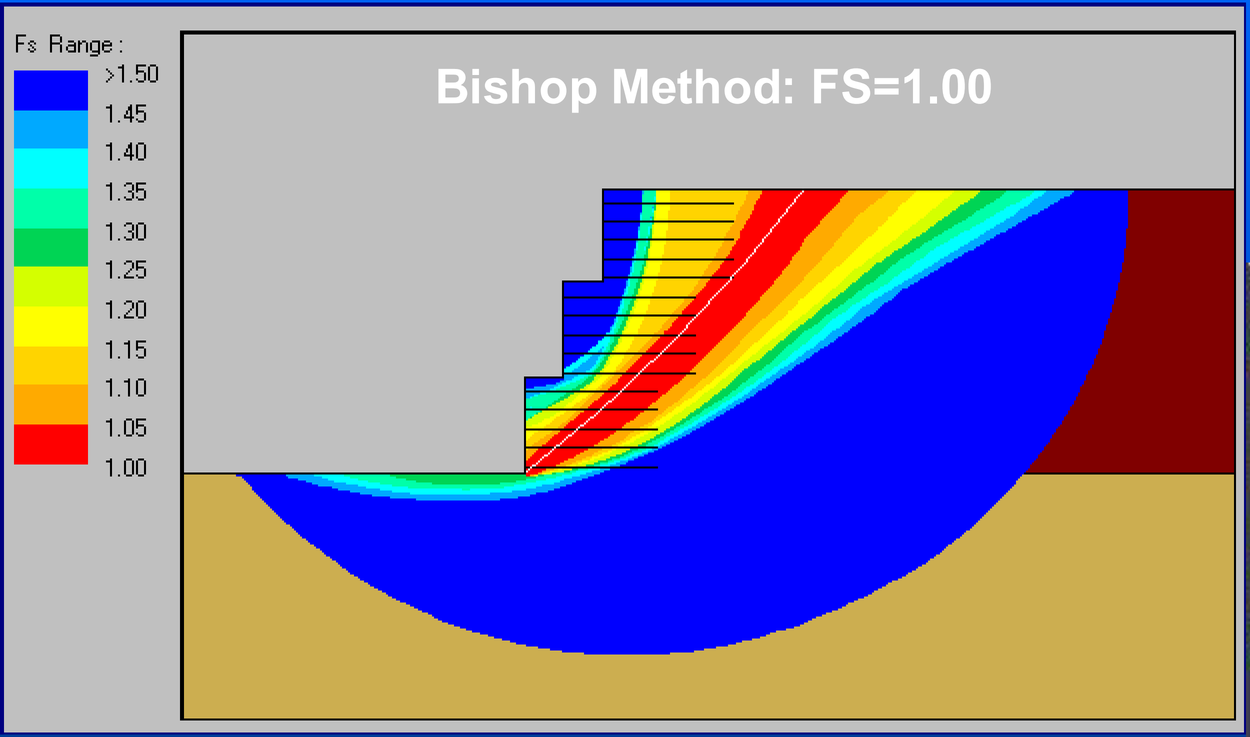
Slope Stability Issues

Slope Stability Safety Map

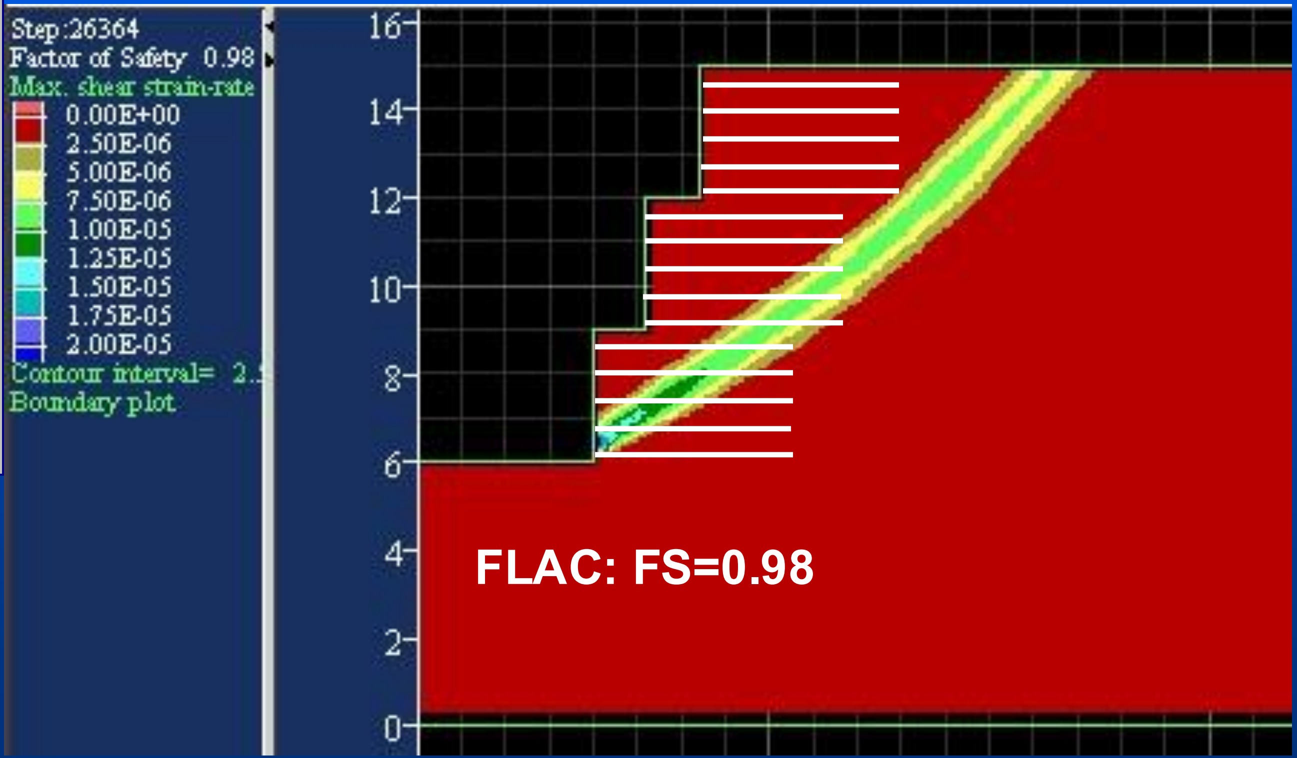


Example: LE&FD (Leshchinsky & Han, 2004)



LE

FD

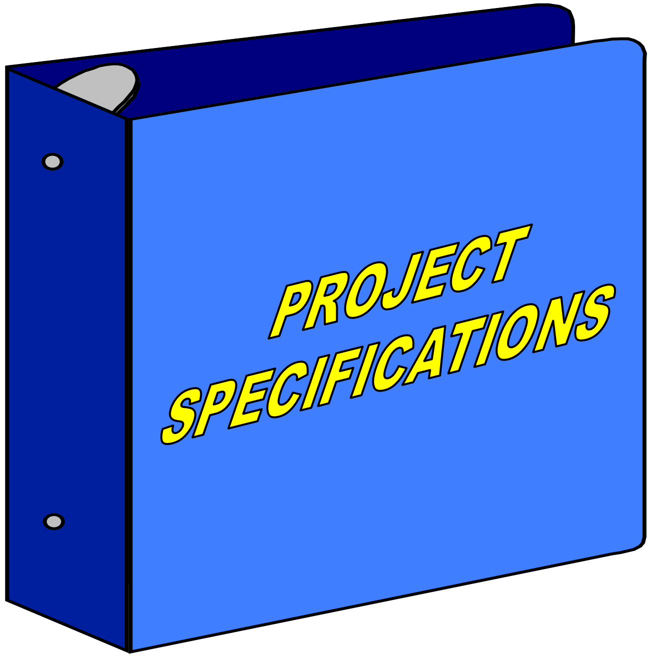


Improved Foundations Extend Pavement Life and Condition

- Despite their significant impact, foundations are not integrated efficiently with pavement engineering.
- The BEST approach is to build on connecting all components from the bottom to the top and focus on long-term performance.

CONTRACT DOCUMENTS

importance, complexity, performance based



PLANS

SPECIFICATIONS

Grand Challenges or GREAT OPPORTUNITES

- Poor understanding of tolerable deformations
- Mainstream application of soil/ structure interaction
- Marginal quality of construction and quality assurance
- Quality/use of lab and field subsurface information
- Definition of recommended soil/ rock parameters
- Demonstrating value added service to clients
- Communications oral and written
- OTHERS? Certainly, there are more.

Geocommunity NEEDS: Research / Innovation Deployment

- Mainstream use of practical cost-effective innovations
- Deterioration and remaining service life models based on REAL performance
- Practical long-term monitoring of pertinent geo-feature conditions
- Improved reliability of deformation predictions and relevant application to transportation features
- Cost EFFECTIVE application of resilience and climate change considerations to geotechnical feature design and construction
- Processes to define short and long-term performance criteria for specific geotechnical features
- Develop and apply ROI and life cycle cost models to geotechnical features

Thank You!

Jerry D. "Alias Joe D' Cousin"
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