# NEES Workshop Panel Discussion

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Are we making the right observations to improve our ability to simulate site response behavior? What type of sites are lacking in observations?

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From engineering standpoint, most pressing need is w/r/t strongly nonlinear response

- Nonlinearity due to large strains
  - Soft, weak soils NC clays, organic soils
  - Strong shaking large amplitudes, long periods/durations
- Nonlinearity due to pore pressure generation
  - Potentially liquefiable soils
    - Level ground evolving freq. content, permanent settlement
    - Sloping ground permanent lateral deformations
  - Sand vs. silt behavior "clay-like" and "sand-like"

Are we making the right observations to improve our ability to simulate site response behavior? What type of sites are lacking in observations?

Sloping sites

- One-dimensional infinite slope cases
  - Asymmetric response
  - Permanent deformations
  - Simple modification of existing one-dimensional codes
- Two-dimensional embankment or river bank
  - Multiple vertical arrays perpendicular to slope
  - Horizontal and vertical motions
    - Dynamic
    - Permanent

Are we making the right observations to improve our ability to simulate site response behavior? What type of sites are lacking in observations?

Need to focus on nonlinear layers

- Need to measure motions above and below layer(s) of interest
  - Extremely deep downhole instruments may not be helpful
  - Need reliable pore pressure measurements in appropriate soils
- Need to measure permanent deformations
  - Lateral deformations
    - inclinometers
    - shape arrays
  - Vertical deformations
    - Sondex tubes

#### **Question 2**

What are the important geotechnical site characterization parameters needed to simulate and predict site response behavior?

Shear wave velocity profile

Soil

- all layers
- Rock define reference layer
  - weathered zone
  - rock layers (sedimentary / igneous)

Liquefiable soil profiles

- Permeability profile void redistribution effects
  - Position / continuity of impermeable layers
  - Connectivity of permeable layers
- Plasticity profile

#### **Question 3**

## Advantages and disadvantages to the various methods for computing site response behavior especially at large strain levels?

#### Equivalent linear

- Good approximation for low strain levels
  - Familiar
  - Simple, readily available material properties
  - How low is low?
  - What is nature of "error" relative to nonlinear?
- Soil has infinite strength
  - Modulus reduction  $(G/G_{max})$  curves validated up to ~1% strain
  - Can trick into limiting shear stress by modifying  $G/G_{max}$  curve

#### **Question 3**

Advantages and disadvantages to the various methods for computing site response behavior especially at large strain levels?

#### Nonlinear

- More "correct" representation of behavior at low <u>and</u> high strains
- Can predict permanent deformations
- Can accommodate pore pressure generation
- Stress-strain models are more complicated
  - Unfamiliar
  - Material properties not readily available
  - Low-strain damping can be problematic
  - Large-strain damping may be incompatible w/ laboratory results
- Numerical issues more prevalent
  - Stability, numerical damping