



Pacific Earthquake Engineering Research Center

Implementation of *OpenSEES* Soil Modeling Capabilities

Pedro Arduino (U. of Washington)

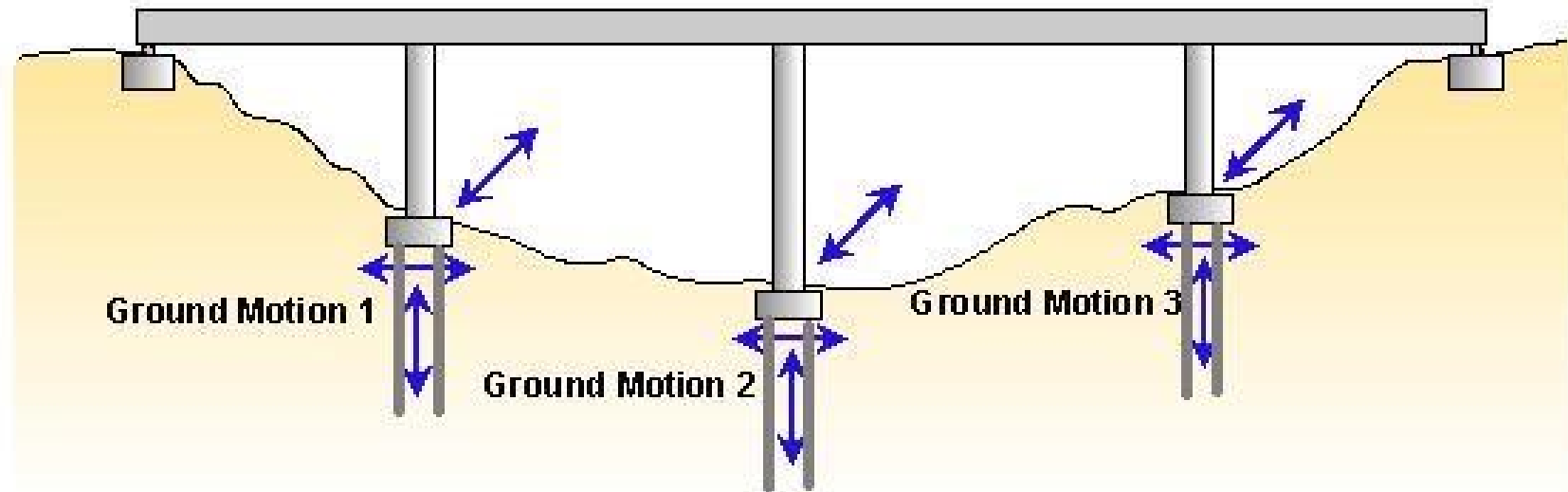
Ahmed Elgamal (UCSD)

Boris Jeremic (UC Davis)

Zhaohui Yang (UCSD)

PEER Annual Meeting, Oakland, California

January 26, 2001



a) Computer Model

Our Mission: May 2000

Include SOA:

Soil-structure interaction

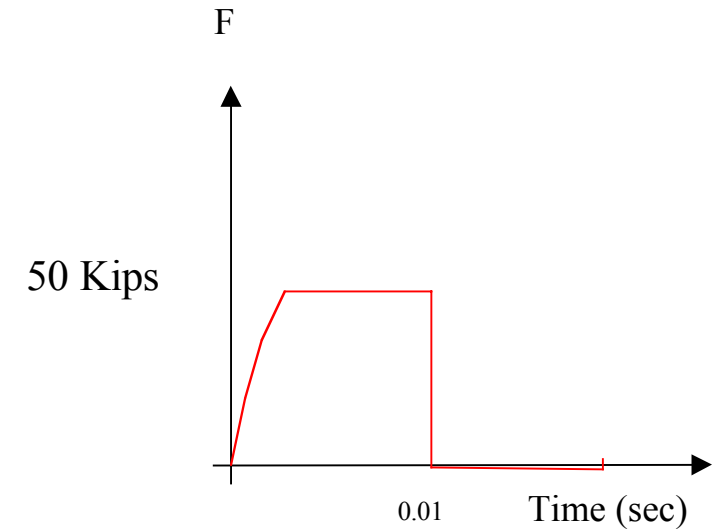
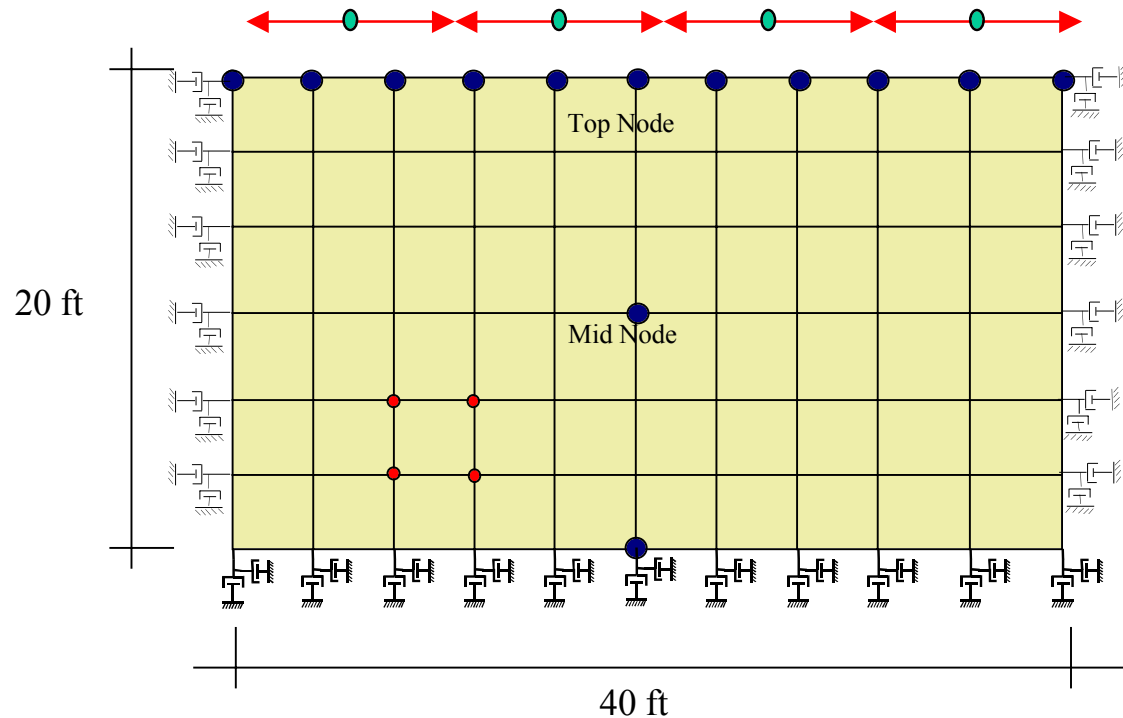
Soil models

2D and 3D solid (soil) elements

Transmitting Boundary



Transmitting Boundary

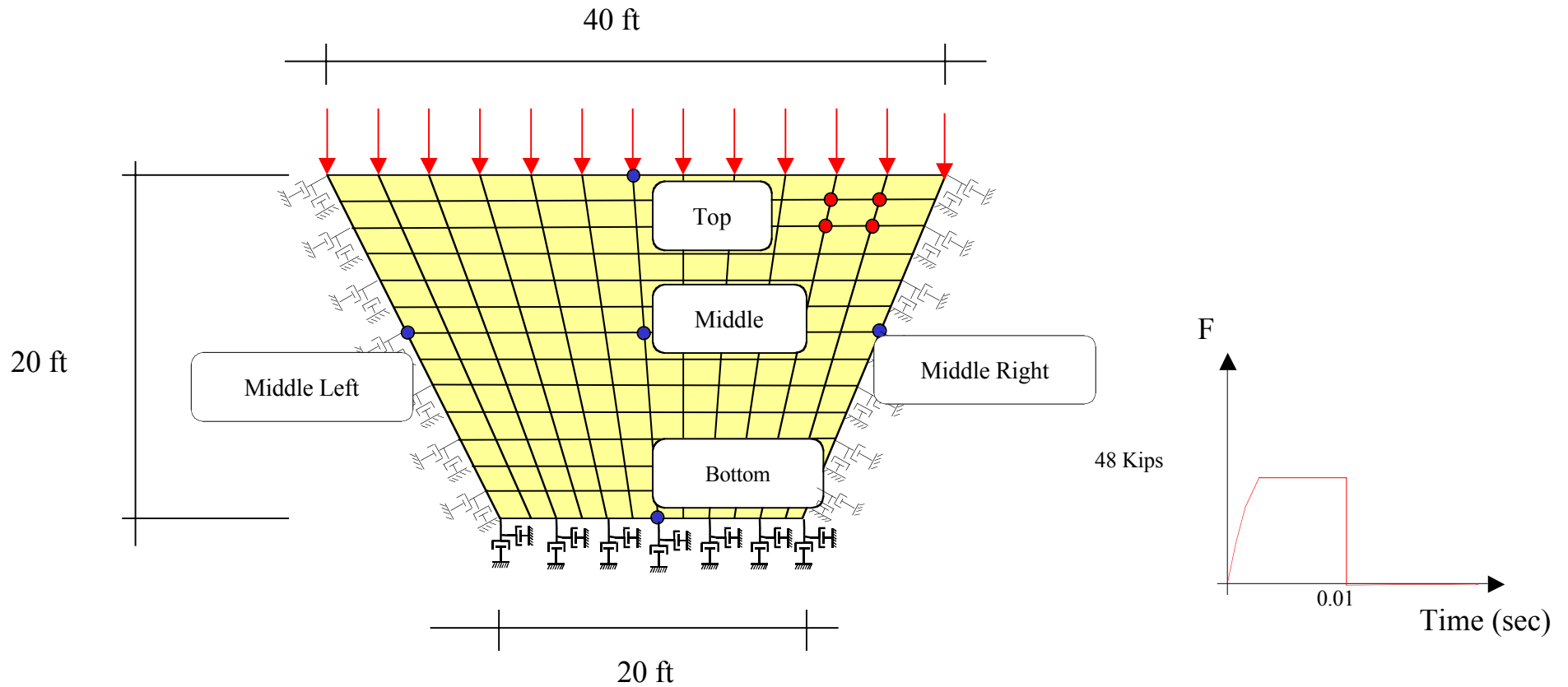


Surface Shear Pulse

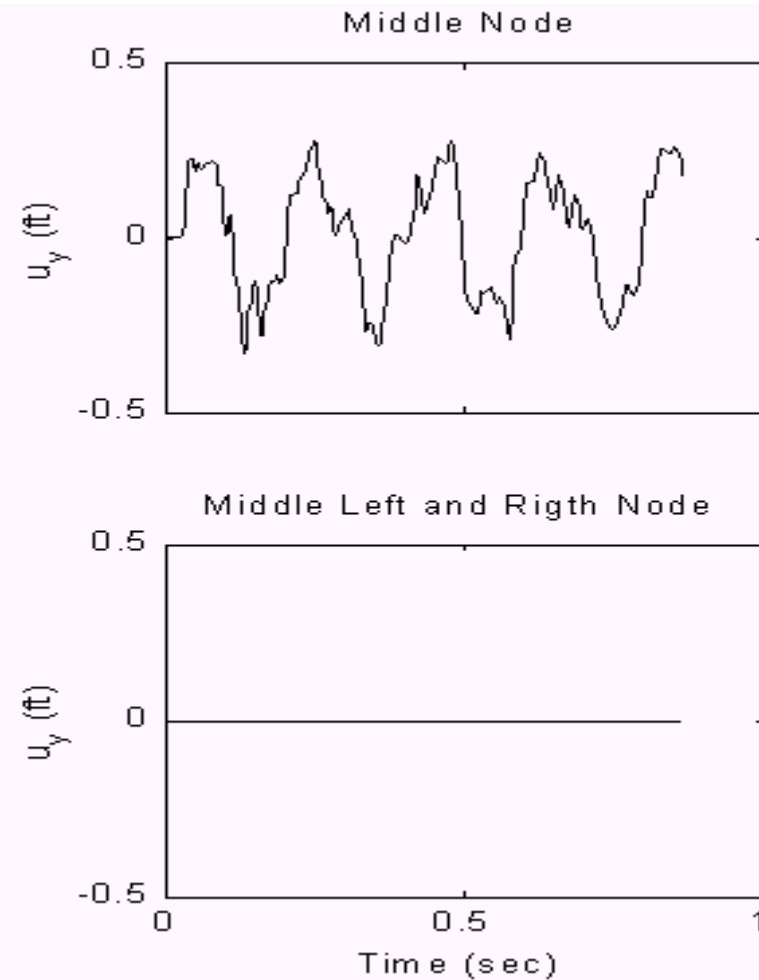
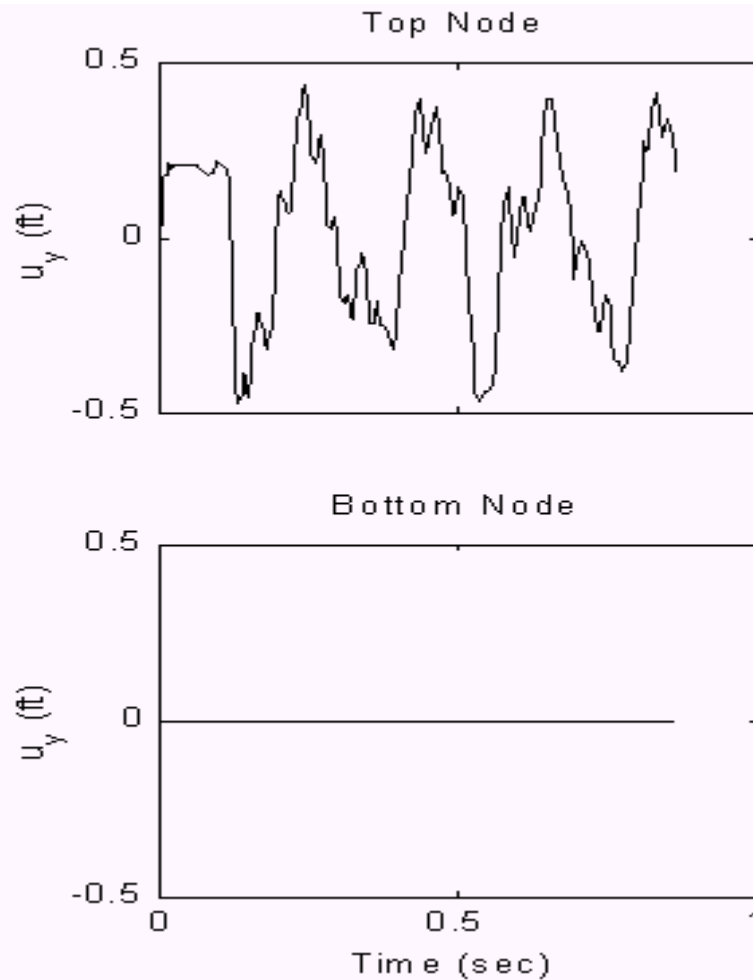
Pedro Arduino, University of Washington

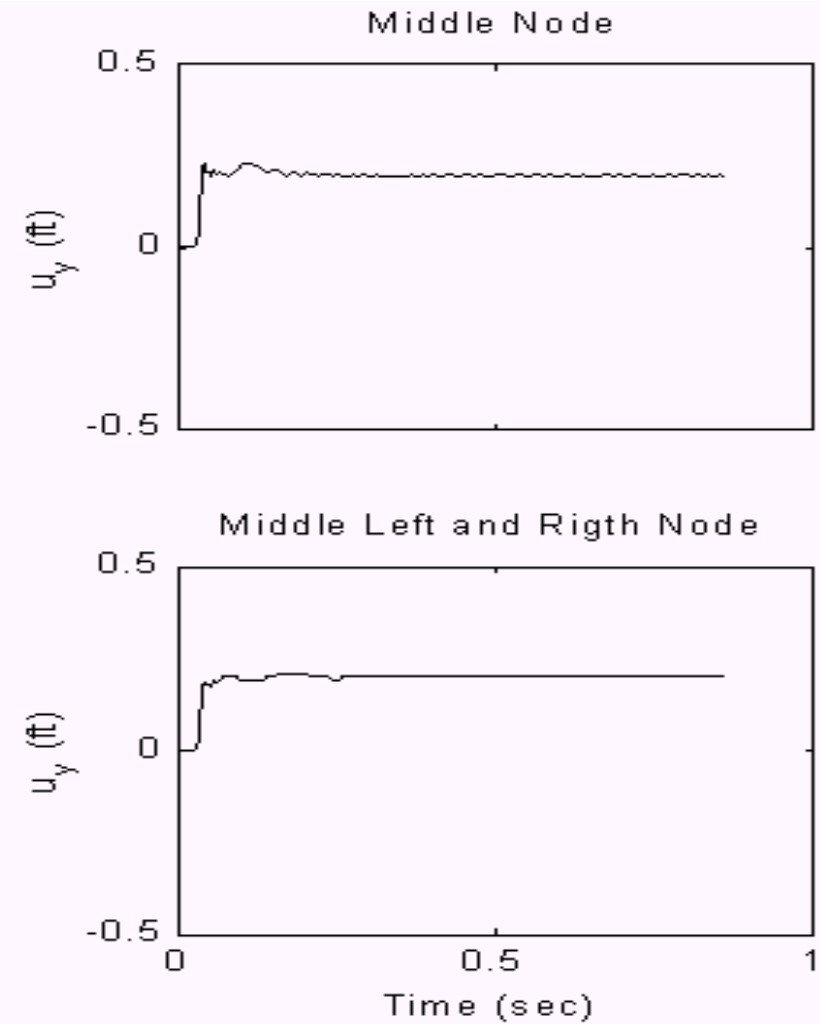
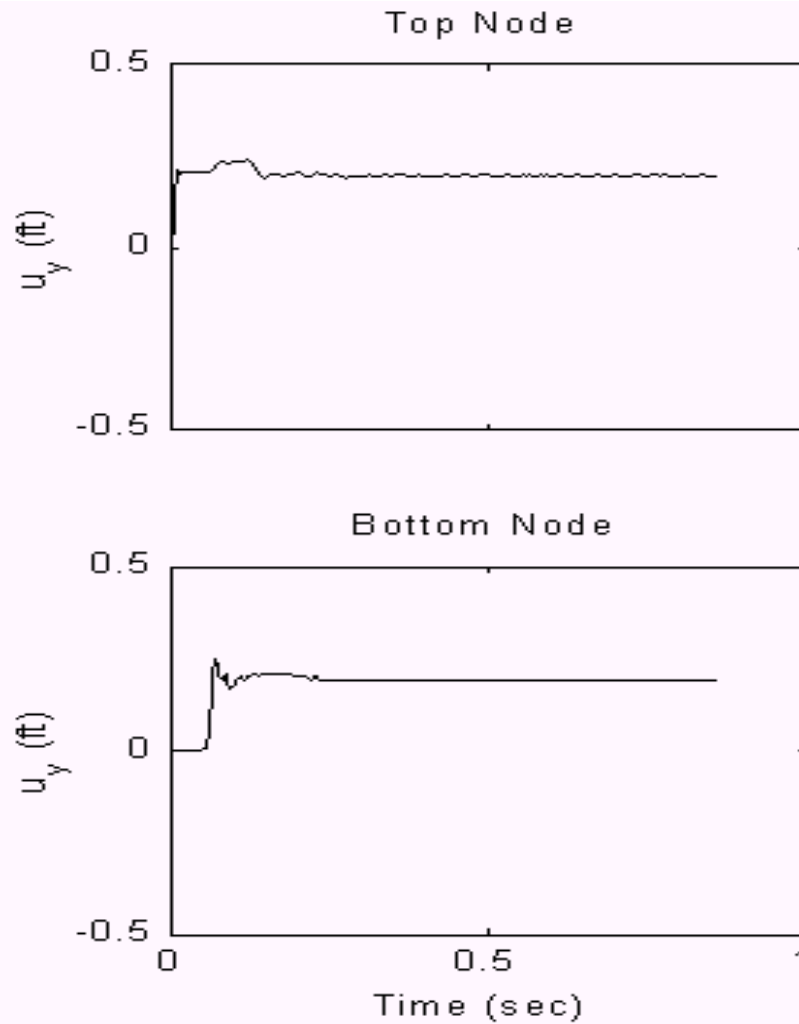


Transmitting Boundary: Vertical load Pulse



Pedro Arduino, University of Washington

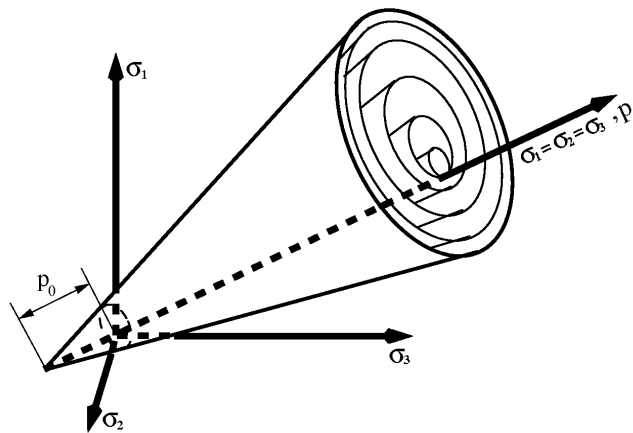




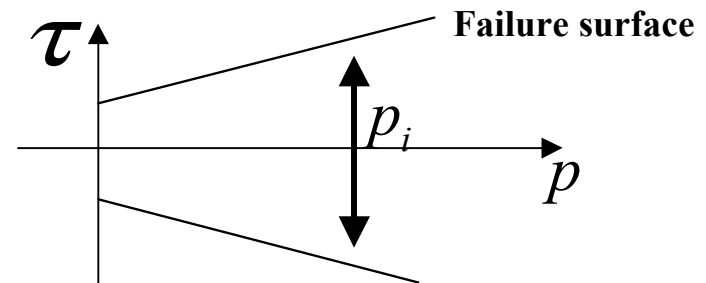
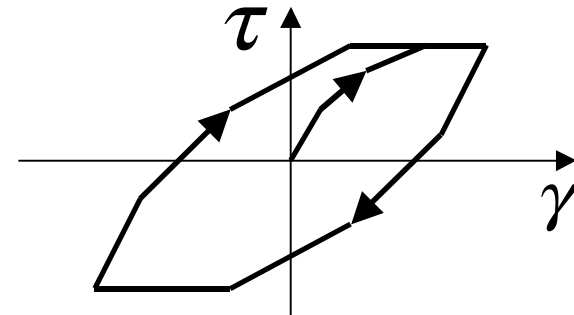
Pedro Arduino, University of Washington



Clays: Pressure-independent multi-yield-surface model for general 2D and 3D elasto-plastic hysteretic behavior

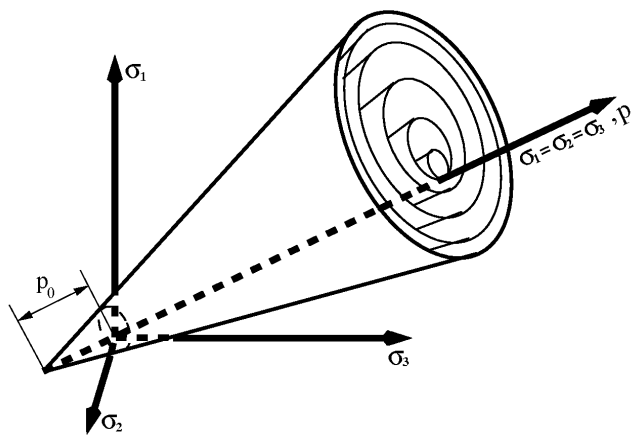


Principal effective stress space

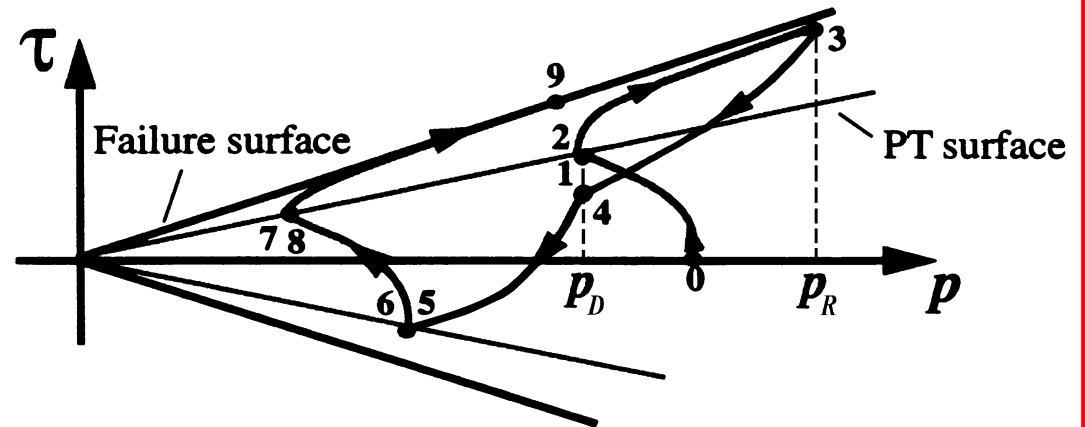
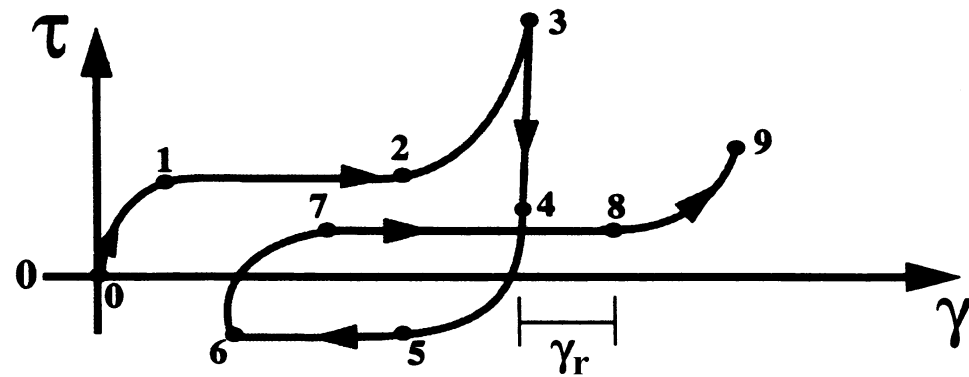


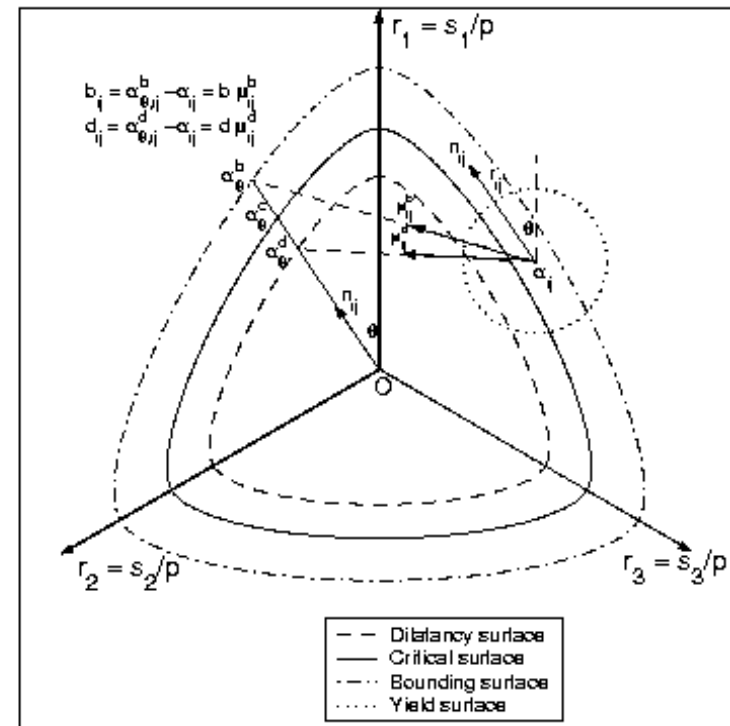
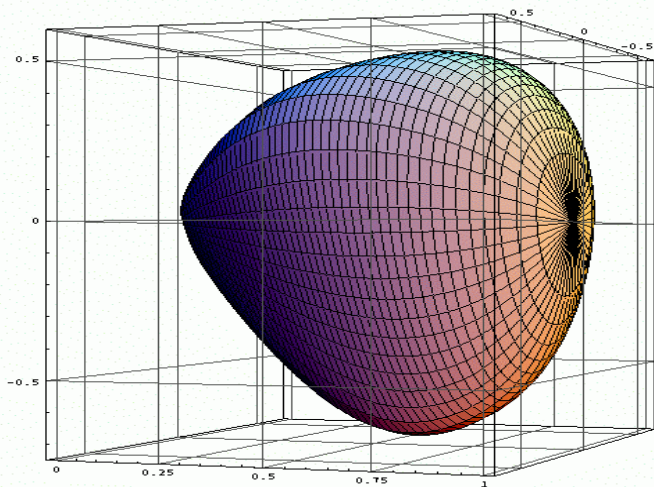


UCSD pressure-dependent multi-yield-surface model (for gravel, sand, and silt), with **liquefaction** capability.



Principal effective stress space

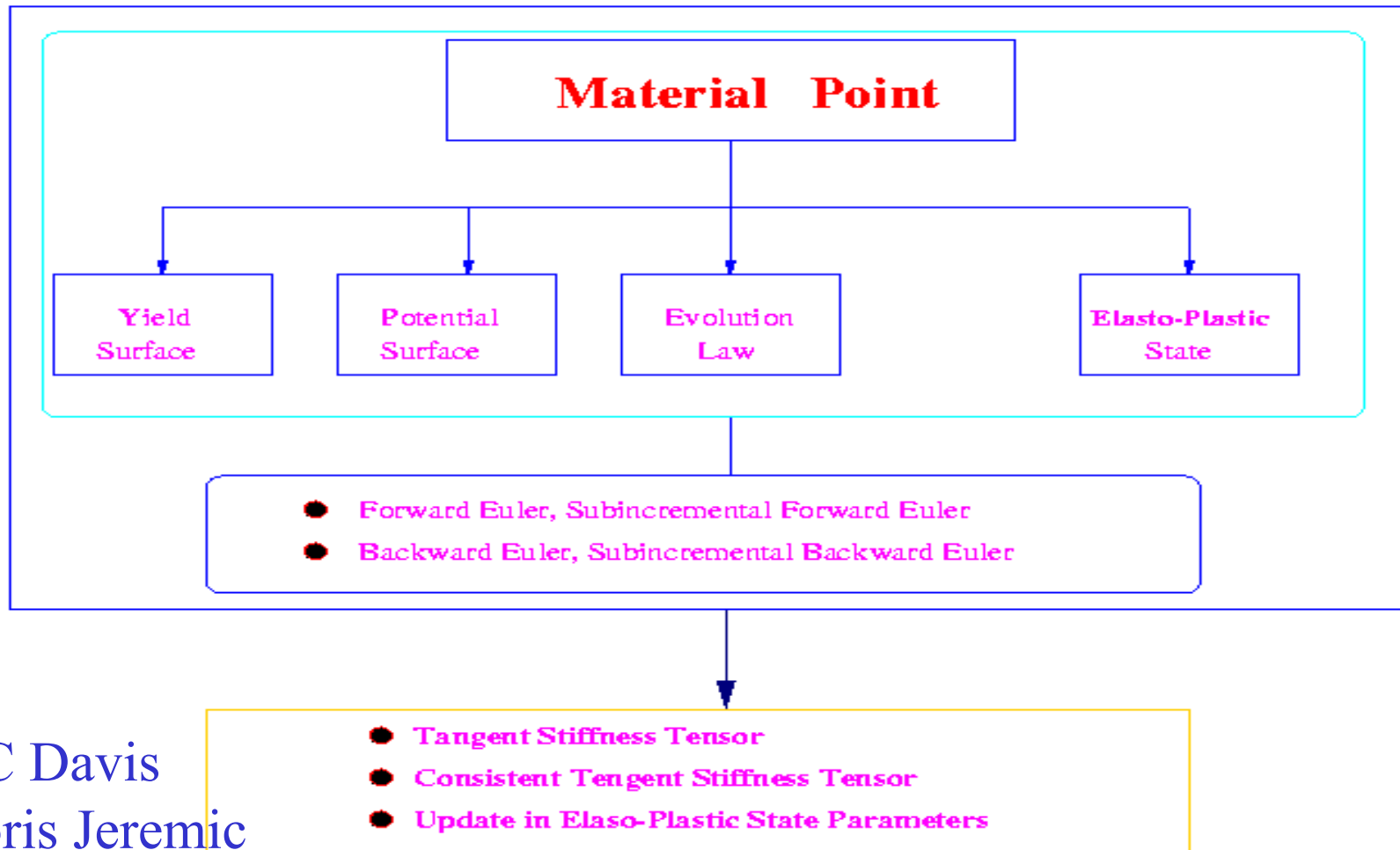




Soil Modeling at UC Davis, Boris Jeremic

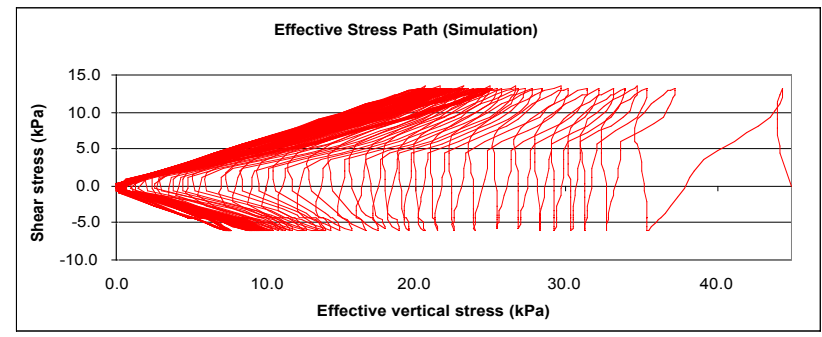
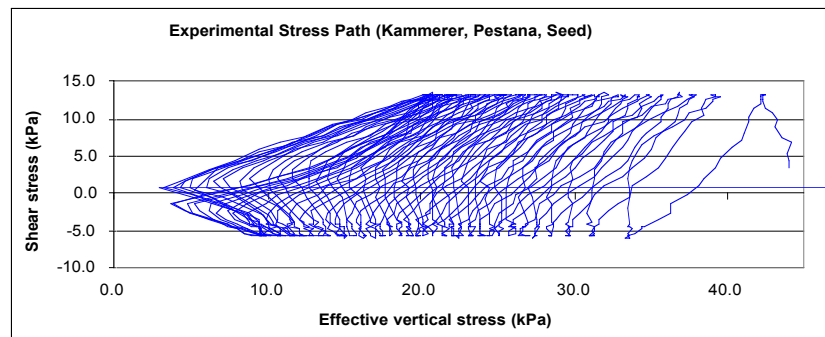
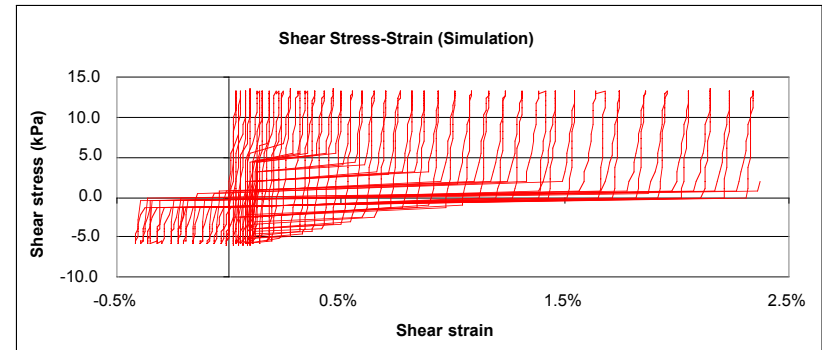
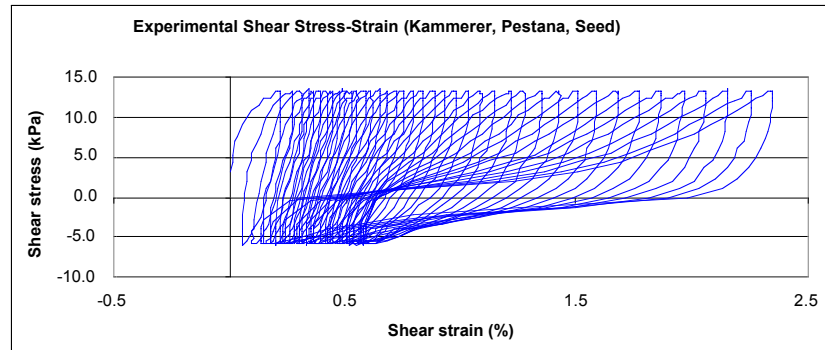
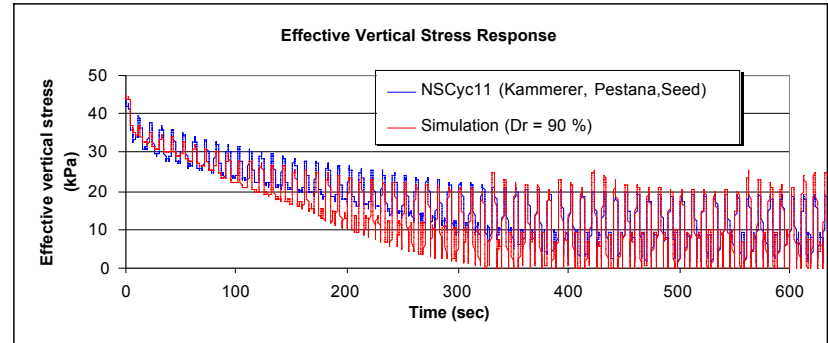
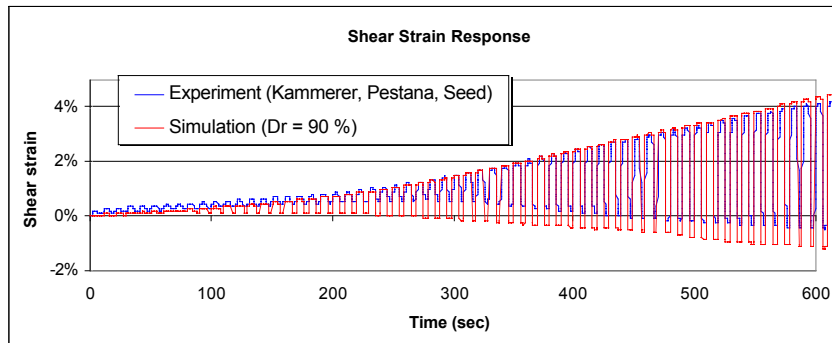


- Objected-oriented design of the Template Elastic-Plastic Framework
- Easy implementation and Applicable to Soils, Concrete, Steel, ..



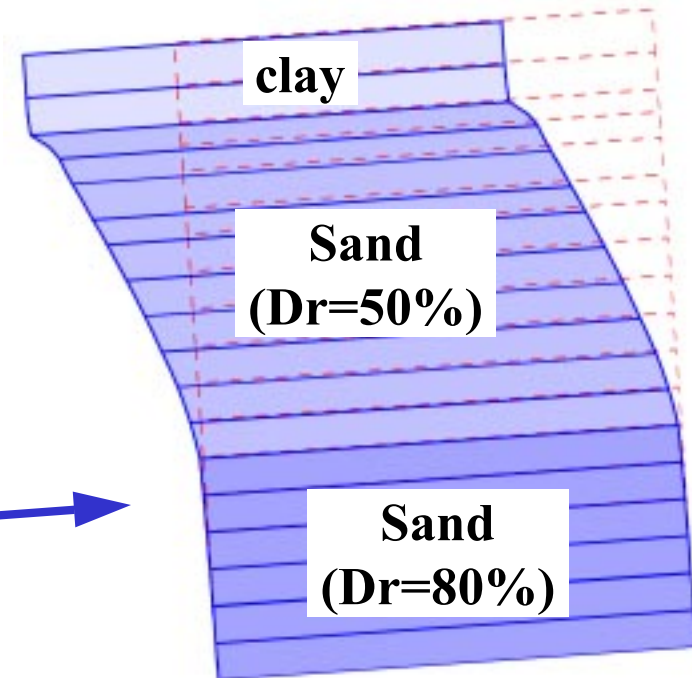
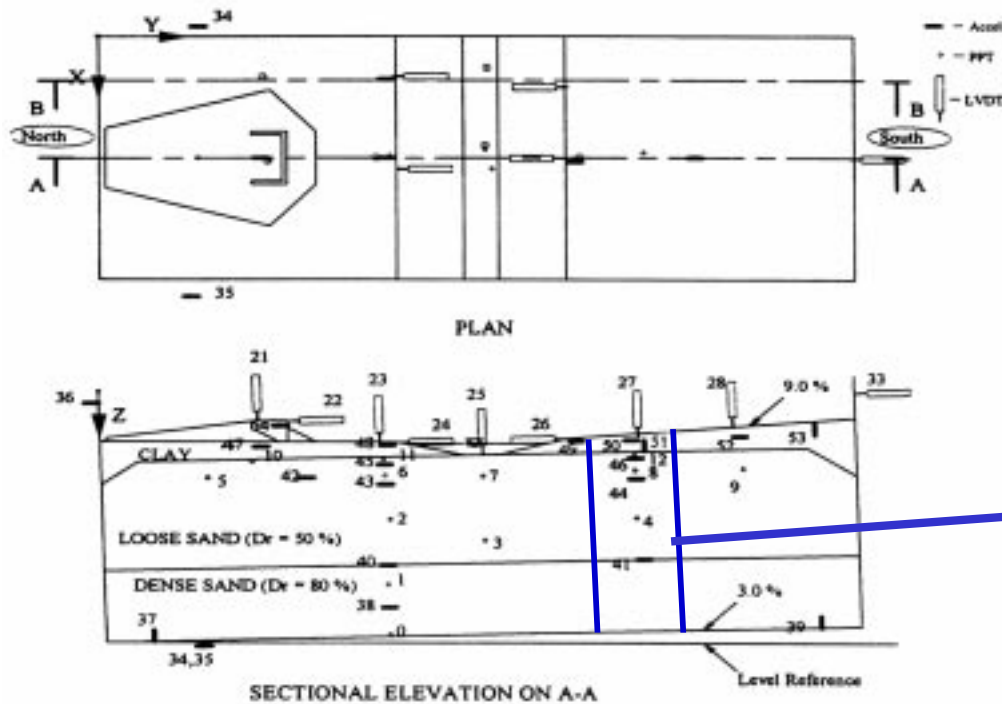
UC Davis
Boris Jeremic

Simulation of UC Berkeley Shear Test, Pestana and Seed





Simulation of UC Davis Centrifuge Test



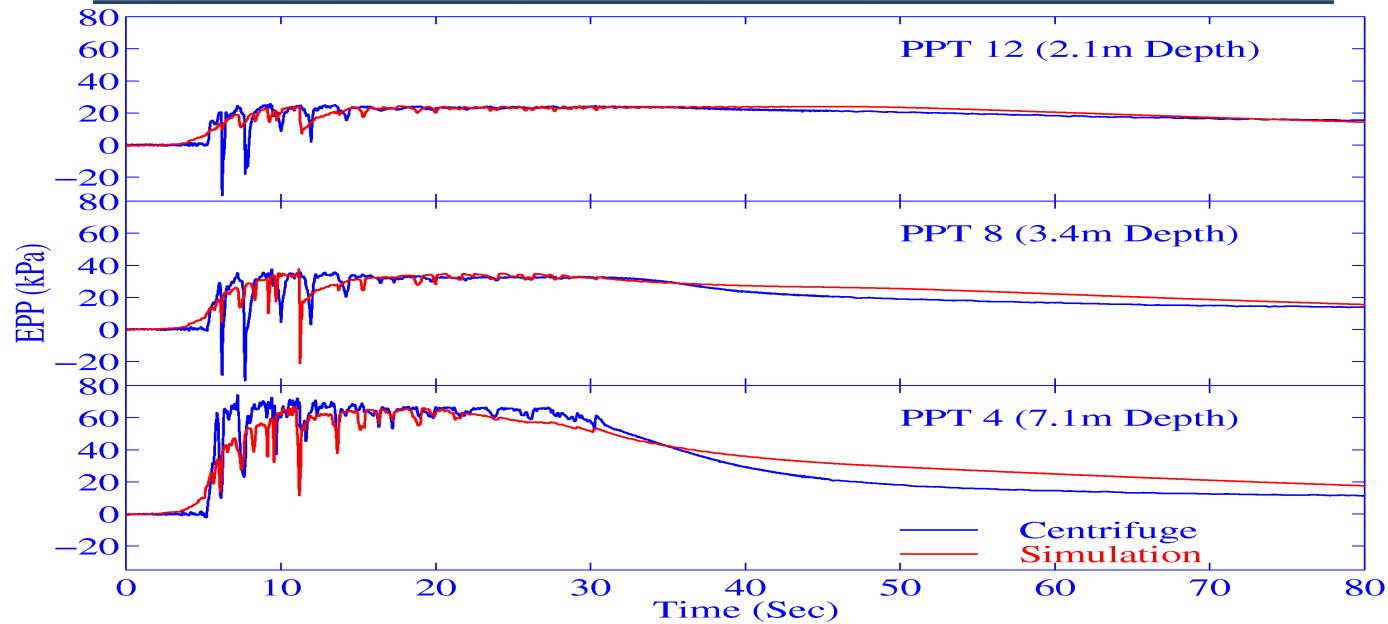
Centrifuge model setup

Simulated 1D response

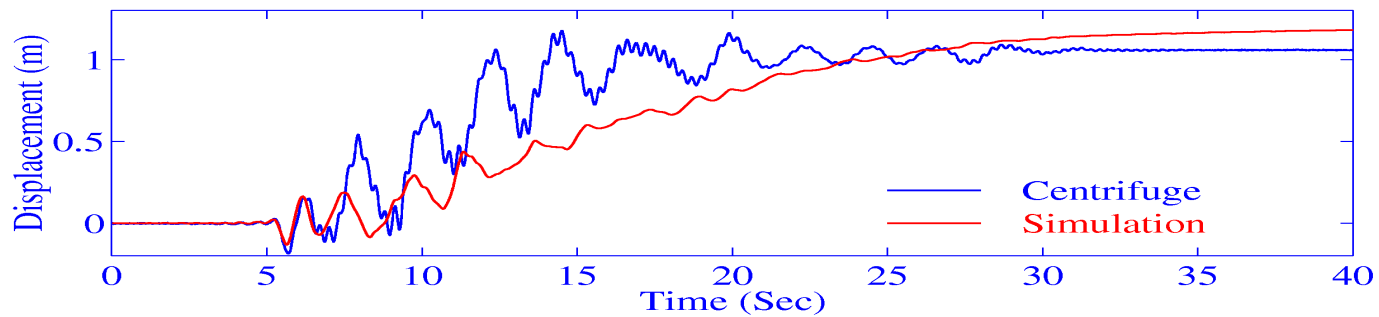
Kutter, Boulanger, Idriss, and Wilson



Pacific Earthquake Engineering Research Center



Excess pore pressure



Lateral displacement at surface



Nothing like the real thing!
Humboldt Bay Bridge



Caltrans

C. Sikorsky

F. Allamuddin

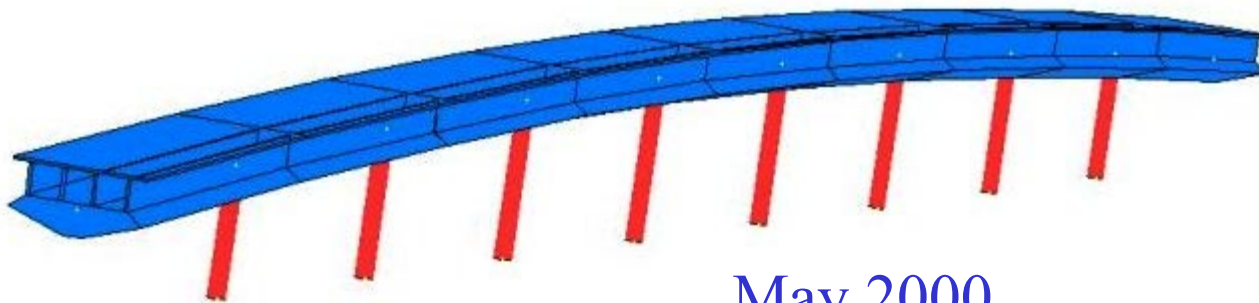
A. Abghari

UCSD

F. Seible

D. Zonta

M. Fraser



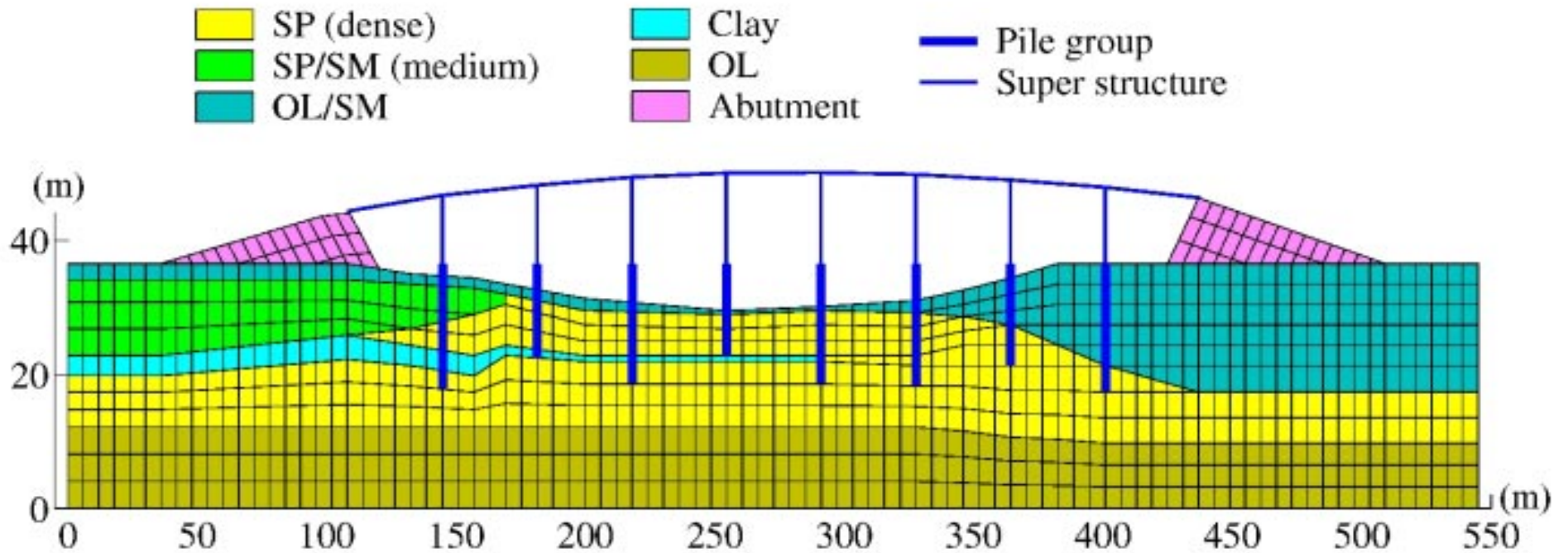
May 2000

UCLA

J. Conte



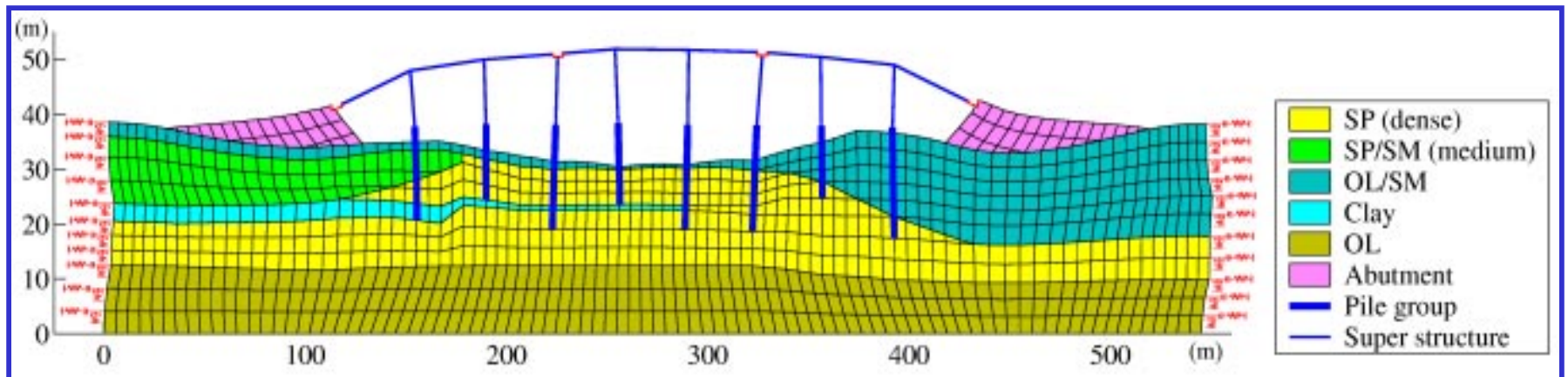
Humboldt Bay, Middle Channel Bridge



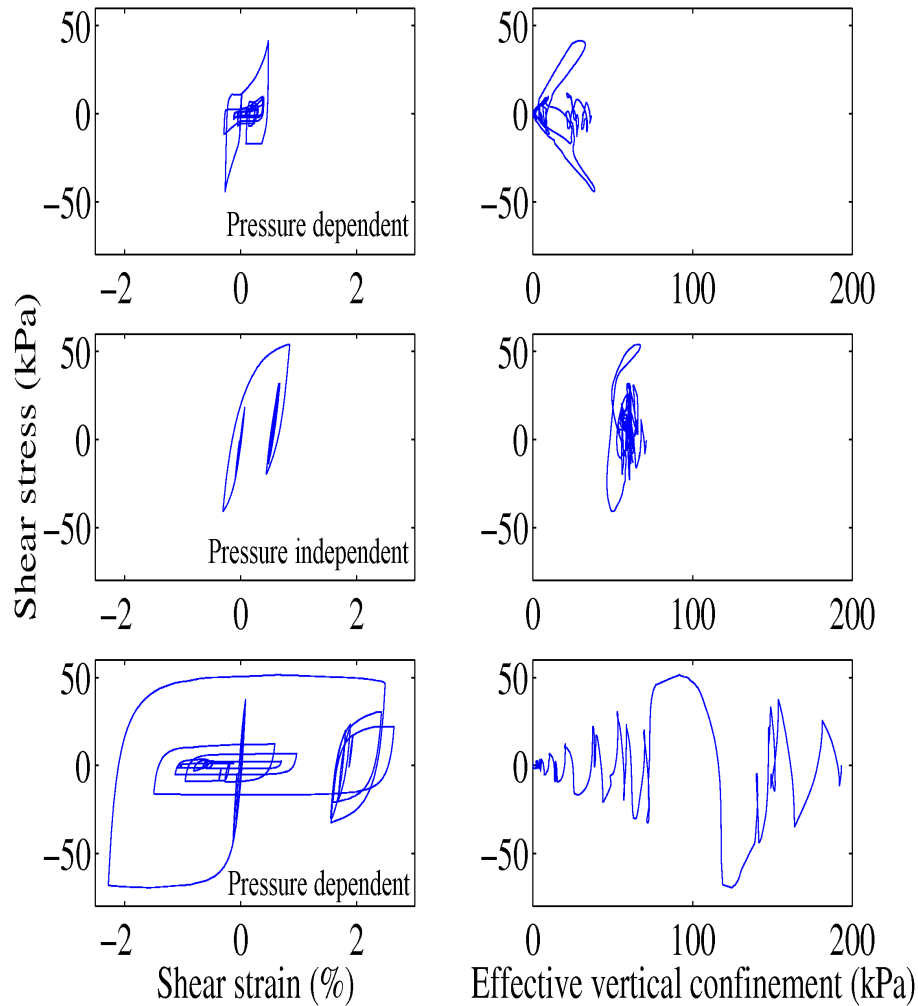
January 2001



Modeling of Actual Bridge Site with *OpenSEES*
Middle Channel bridge at Humbolt Bay (Eureka, CA)
A Caltrans Retrofit Project



January 2001



Soil

Currently:

Undrained elasto-plastic material.

Future:

Solid-fluid coupled medium!



Ongoing Research

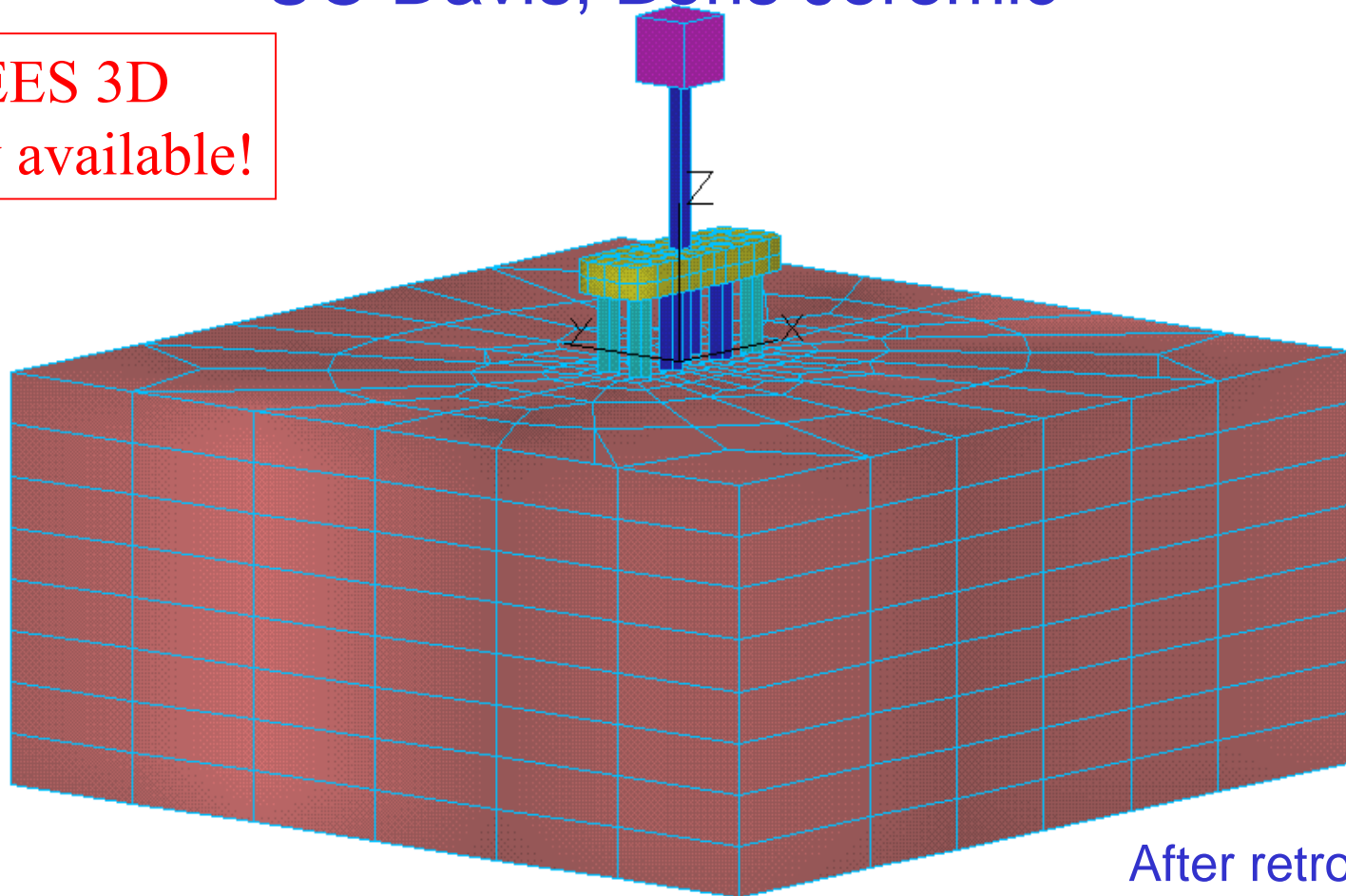
1. Continued calibration and verification of soil models through:
 - Simulation of laboratory tests and centrifuge experiments.
 - Definition of input motions.
 - Modeling of other existing bridge sites (PEER Field Labs.)

2. Interaction with other researchers:
 - *OpenSEES* SOA Structural modeling + SOA soil modeling
 - Probabilistic Analyses for PBEE, and Decision Making tool.



Humboldt Bay Bridge Seismic Retrofit Analysis using OpenSees UC Davis, Boris Jeremic

OpenSEES 3D
Already available!



After retrofit

Expansion Joints / Shear Keys

Currently: modeled as elastic-perfectly-plastic gap elements.

Future: element calibration using UCSD experimental data.

