

Next Steps for NGL Consortium

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UCLA, Mong Learning Center
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NGL
NEXT
GENERATION
LIQUEFACTION

Pending Milestone

- Initial NRC contract for database development closes Dec 2018
- Databases are never 'done' ...
- ... but where will we stand at that time?

Plan for early 2019

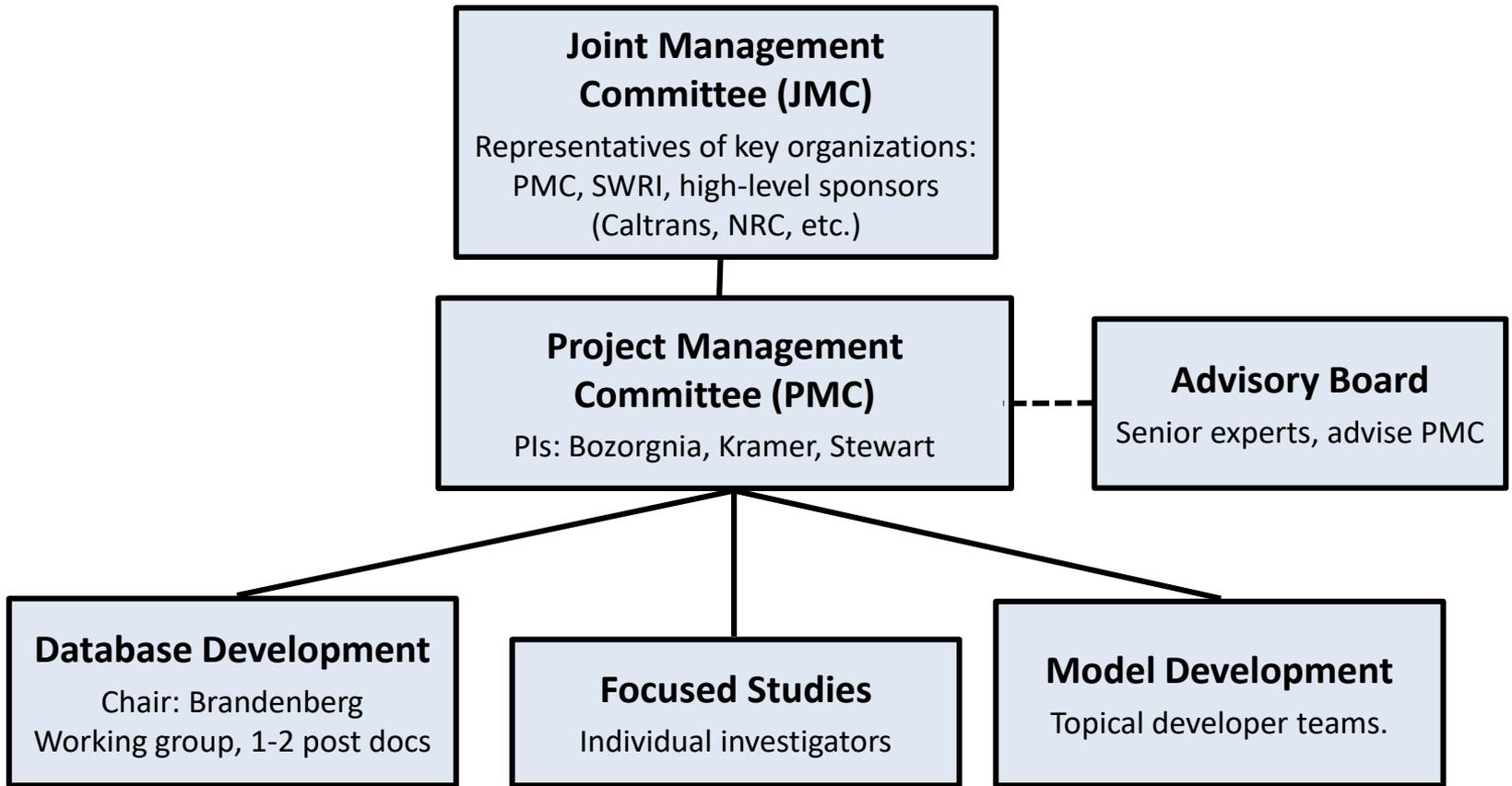
- Database working group will continue – data entry and review
- Various student projects will continue to prepare materials for case histories

Likely New Contracts

- NRC
- Bureau of Reclamation
- Caltrans

*via SWRI
spring 2019*

*via Lifelines
contract, fall
2019*



Potential New Partnering Organizations

- LADWP
- Japan Railway Association
- California Seismic Safety Commission
- DOE

NGL Scope Under Pending Contracts

Possible topics

Continued support for database working group

Targeted site investigations of high values sites

Supporting studies (next set of slides)

Initial modeling

Supporting Study Needs

Steven L. Kramer

Motivation for Supporting Studies

Lack of Empirical Data

Models must be applicable over range of conditions required for applications

- Stress conditions

Depths of 1-100 m

$\alpha = 0 - 0.3$

- Seismic demands

M = 5 - 9.5 (very short to very long duration)

PGA = 0 - 1.0 g

Motivation for Supporting Studies

Lack of Empirical Data

Models must be applicable over range of conditions required for applications

- Soil types

 - FC = 0 - 100%

 - Intermediate soils

 - Non-plastic to moderate plasticity

 - Interlayered soils

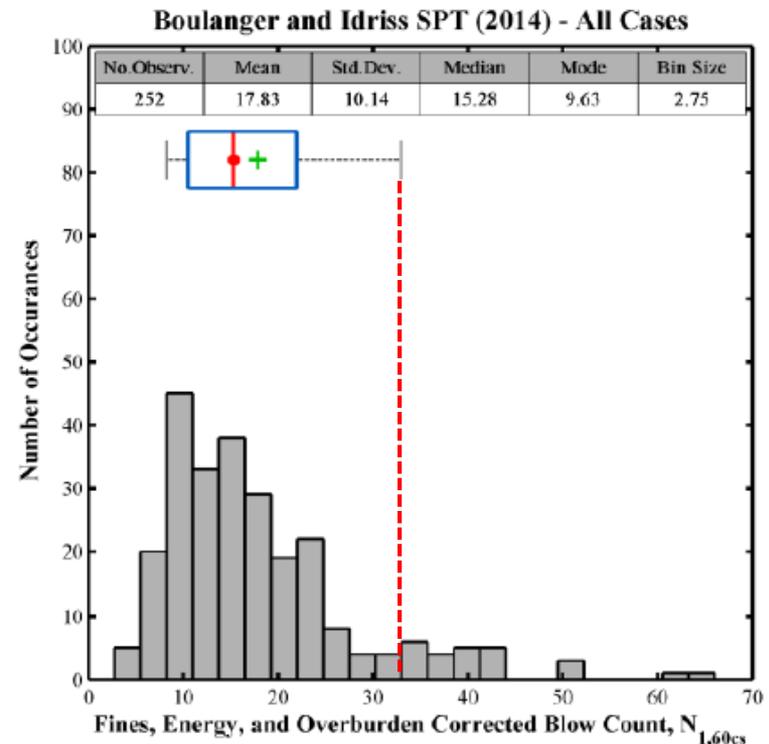
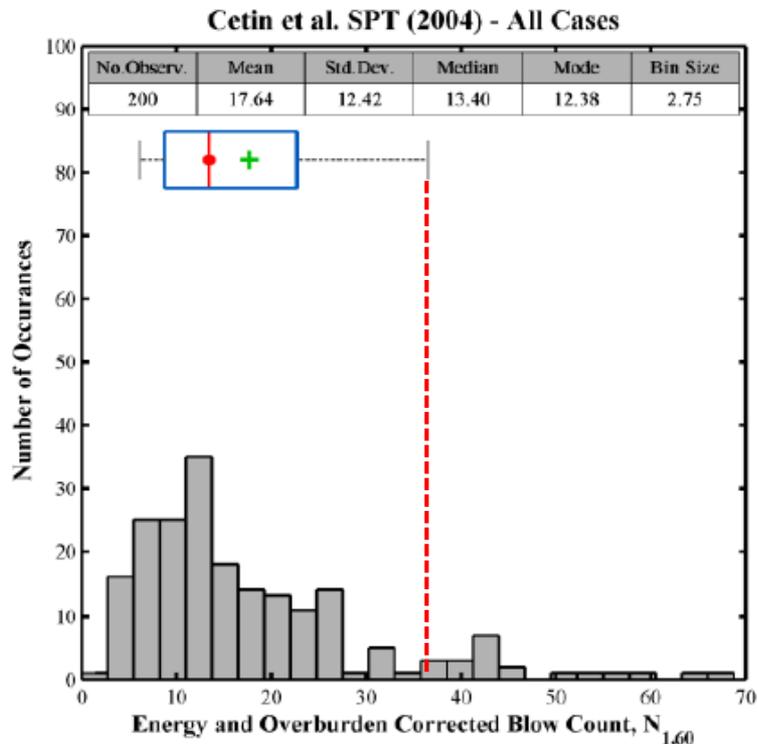
 - Gravels and gravelly soils

 - Non-quartz mineralogies of coarse particles

Empirical Data

Where is it?

Penetration resistance

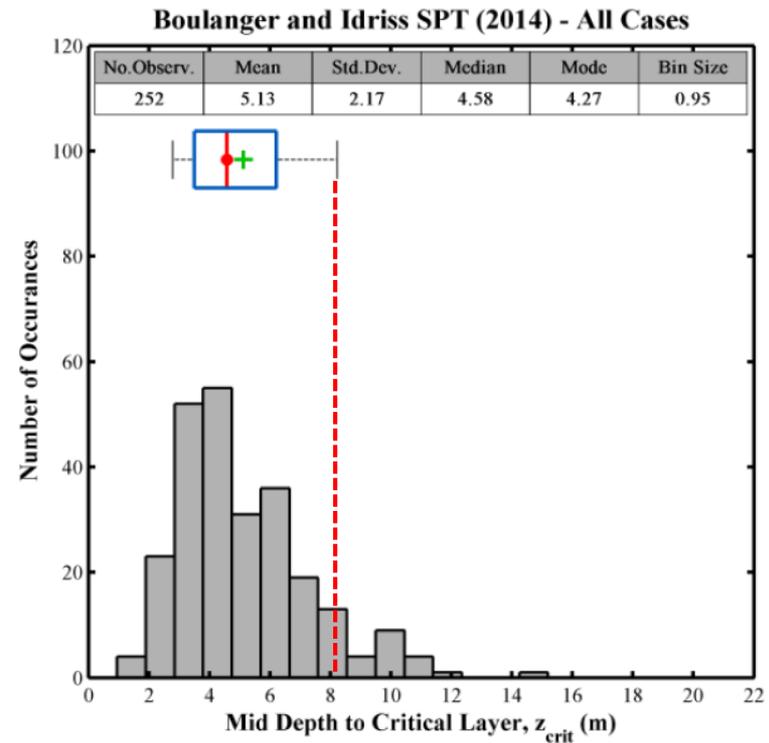
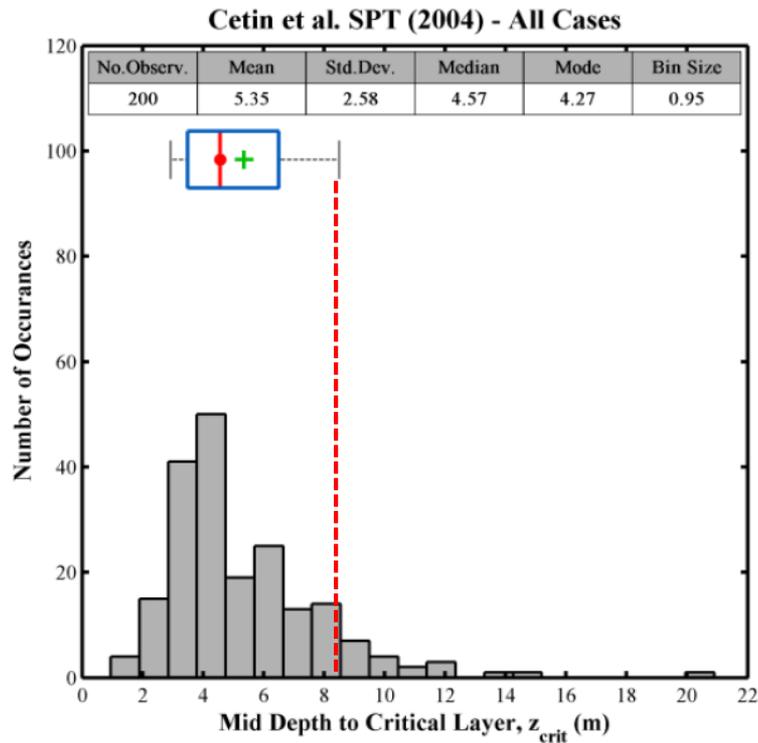


90% less than $(N_1)_{60cs} \sim 35$

Empirical Data

Where is it?

Depth of critical layer

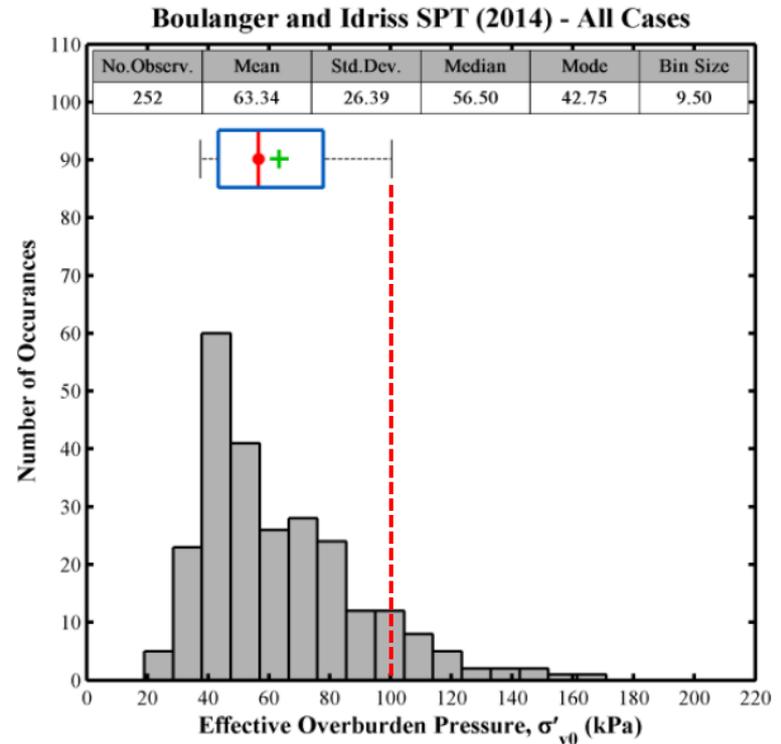
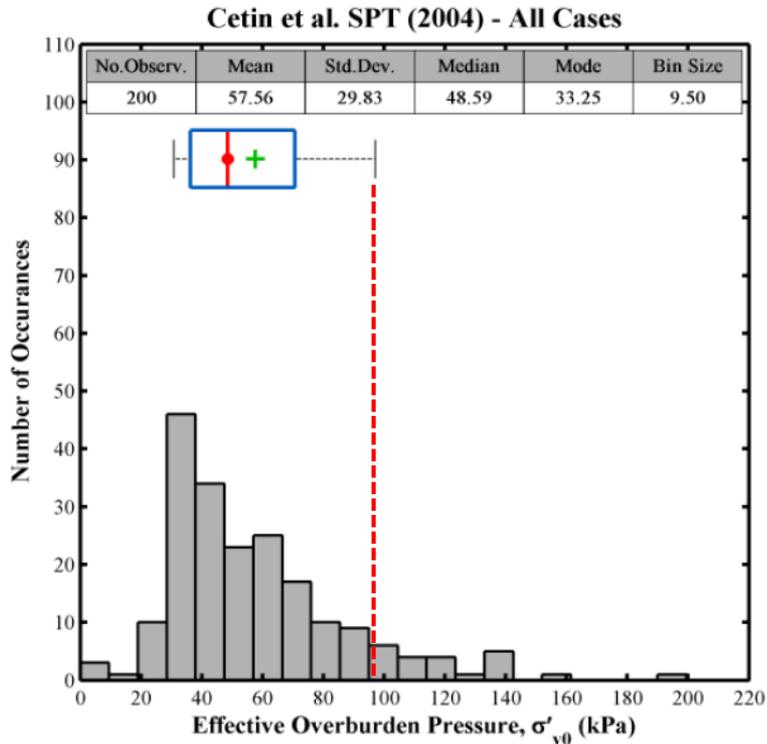


90% less than 8-9 m

Empirical Data

Where is it?

Effective overburden pressure

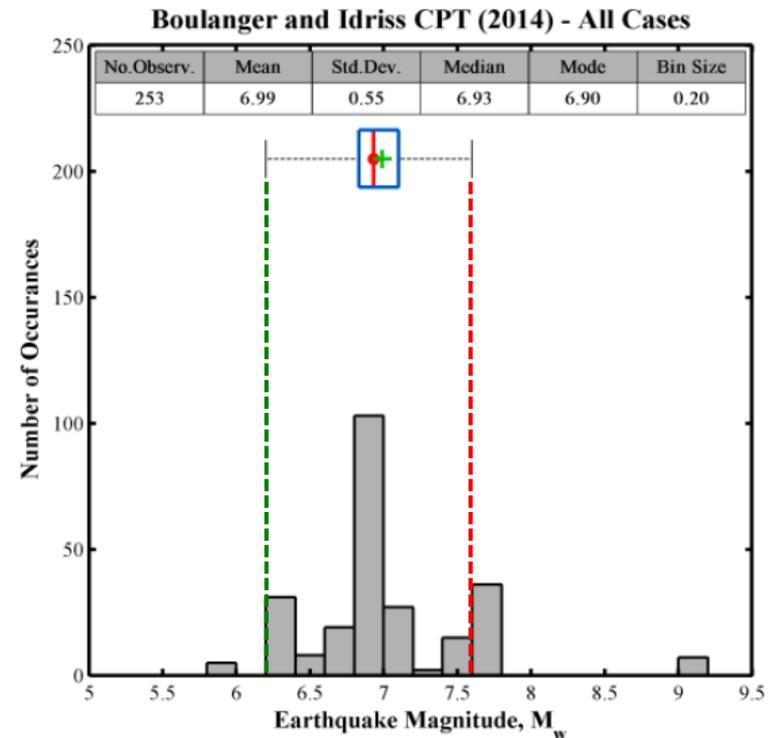
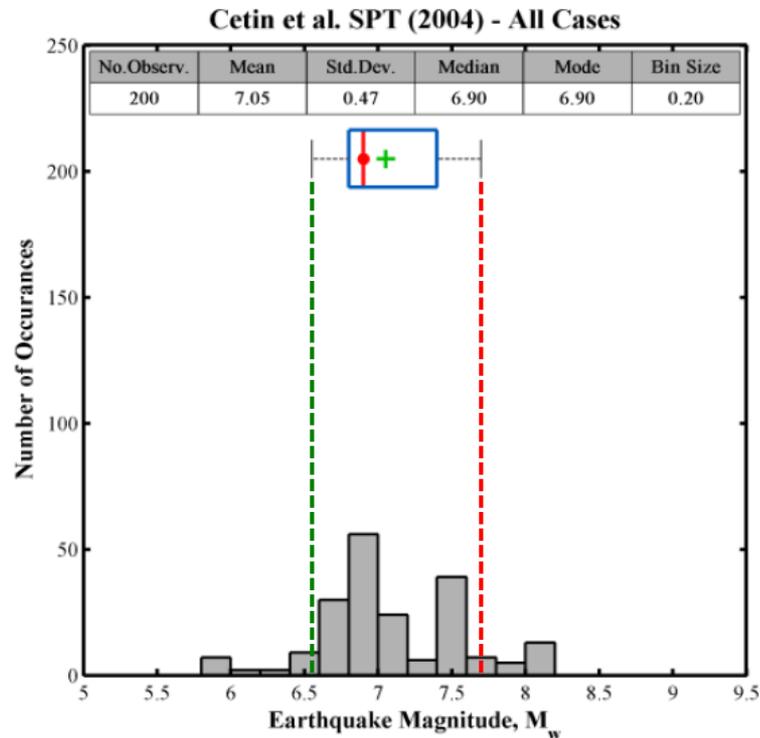


90% less than 90-100 kPa

Empirical Data

Where is it?

Earthquake magnitude

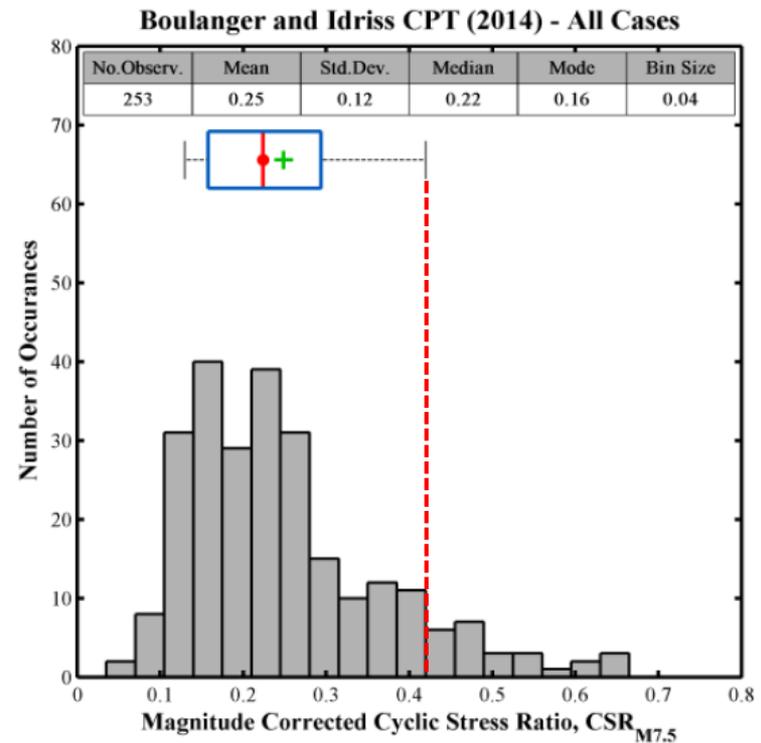
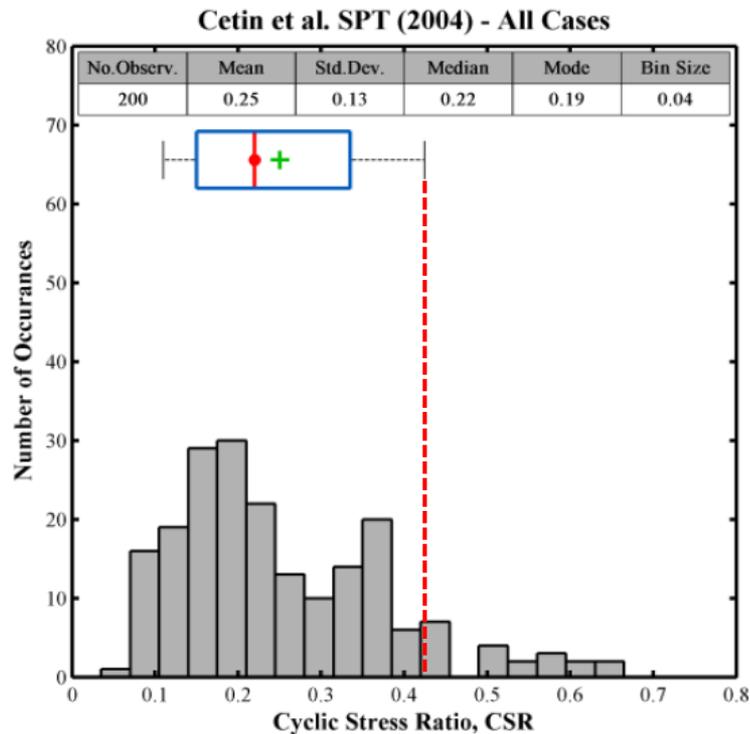


90% less than **M7.6-7.7**

Empirical Data

Where is it?

Cyclic stress ratio

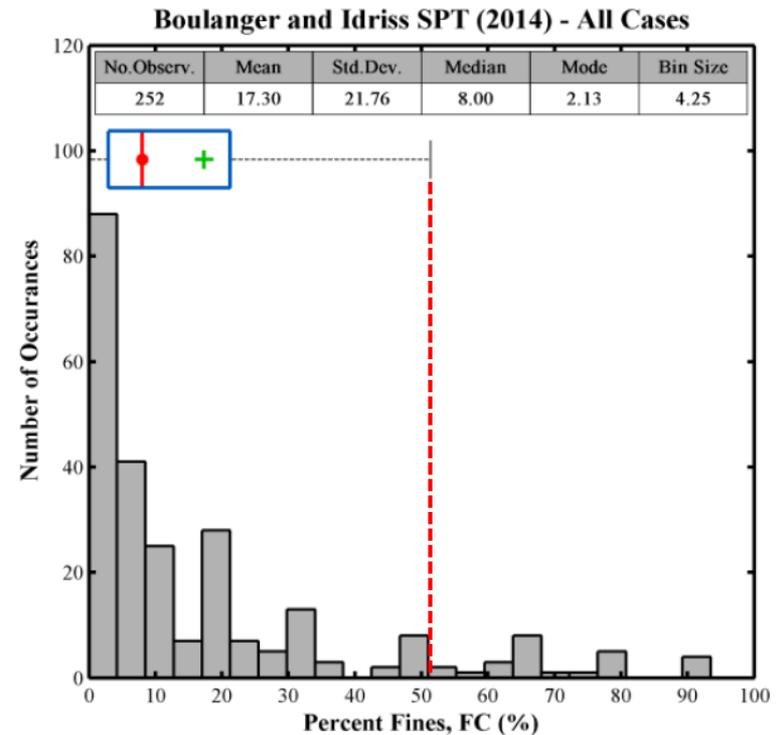
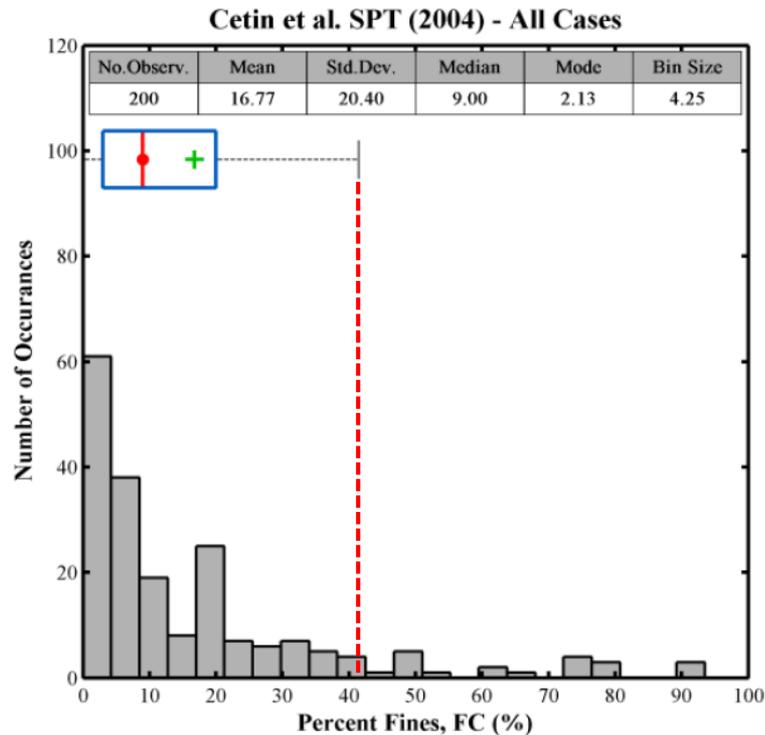


90% less than ~0.42

Empirical Data

Where is it?

Fines content



90% less than ~40-50%

Issues for Supporting Studies

Current Studies

Ageing – Ron Andrus (Clemson)

Identification of critical layer(s) – Russell Green (VPI)

Residual strength – Robb Moss (Cal Poly SLO)

Issues for Supporting Studies

Potential Studies

- Intermediate soils – susceptibility, triggering, effects

Can they liquefy?

What is required to trigger them (relative to clean sand)?

How do they deform (in shear, volumetrically)?

Residual strength

Post-triggering stress-strain (dilation, fabric degradation)

Response to transient loading

Issues for Supporting Studies

Potential Studies

- Intermediate soils – susceptibility, triggering, effects
- Gravels/gravelly soils – characterization, triggering, effects

BPT
iBPT
Foundex BPT
Vs
Other?

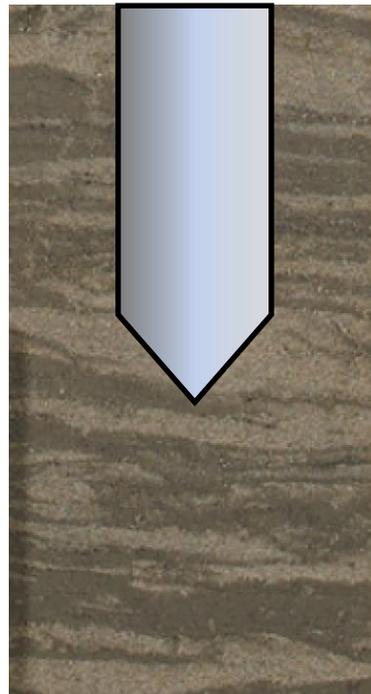
Permeability
Capping layer

Shear and
volumetric
behavior
Residual strength
Permeability
effects

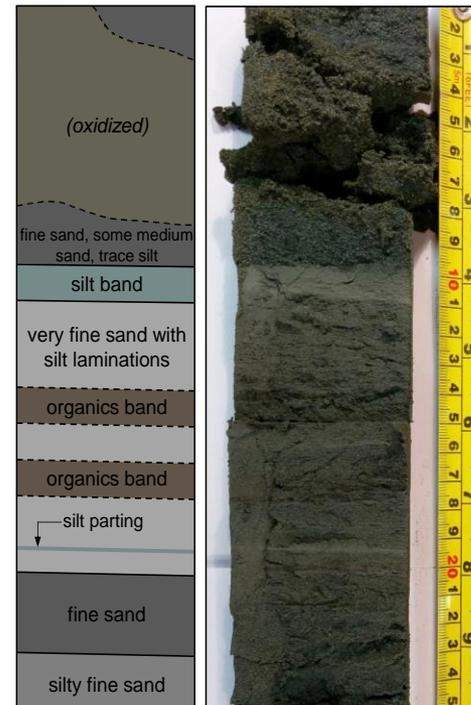
Issues for Supporting Studies

Potential Studies

- Intermediate soils – susceptibility, triggering, effects
- Gravels/gravelly soils – characterization, triggering, effects
- Inter-layered soils – characterization, triggering, effects



Fugro (2017)



Beyzaei et al. (2017)

Issues for Supporting Studies

Potential Studies

- Intermediate soils – susceptibility, triggering, effects
- Gravels/gravelly soils – characterization, triggering, effects
- Inter-layered soils – characterization, triggering, effects
- Depth (confining pressure) effects – C_N , r_d , K_σ

All affect triggering

Issues with uniqueness

Depth effect on lateral spreading

post-triggering settlement

residual strength

Issues for Supporting Studies

Potential Studies

- Intermediate soils – susceptibility, triggering, effects
- Gravels/gravelly soils – characterization, triggering, effects
- Inter-layered soils – characterization, triggering, effects
- Depth (confining pressure) effects – C_N , r_d , K_σ
- Duration effects – high/low M , alternatives to MSF



Subduction
zone
earthquakes

Induced
seismicity

Evolutionary IMs
(Arias intensity,
CAV, ...)

Issues for Supporting Studies

Potential Studies

- Intermediate soils – susceptibility, triggering, effects
- Gravels/gravelly soils – characterization, triggering, effects
- Inter-layered soils – characterization, triggering, effects
- Depth (confining pressure) effects – C_N , r_d , K_σ
- Duration effects – high/low M , alternatives to MSF
- Ground motion estimation – spatial correlation, alternate IMs
- Initial shear stress – K_α
- Continuity/spatial variability – triggering, effects
- Geologic environment – triggering, effects, quantification
- Void redistribution – triggering, effects, residual strength
- Residual strength – effects of fines
- Other suggestions ???