Liquefaction Potential Evaluation of Sands with Fines using Variable Rate Cone Penetration Testing (VRCPT)

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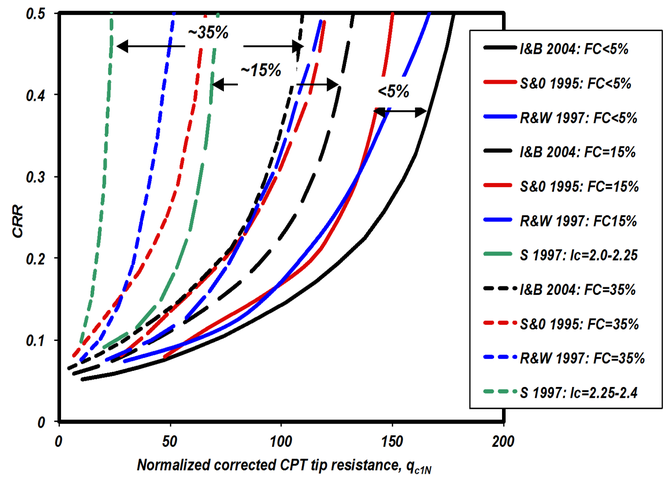
OBJECTIVE

Intermediate soils (sands w/ fines) at documented liquefaction sites require correction of CPT tip resistance as part of conventional liquefaction assessment procedures. We hypothesize that this correction is due to fines creating partially drained conditions during cone penetration, resulting in decreased tip resistance and increased excess pore pressure. Historically the potential effect of partially drained cone measurements has not been considered.

This research project uses a new Variable Rate Cone Penetration Test (VRCPT) system to control drainage around an advancing cone. Testing is being performed at documented liquefaction sites to validate this hypothesis.

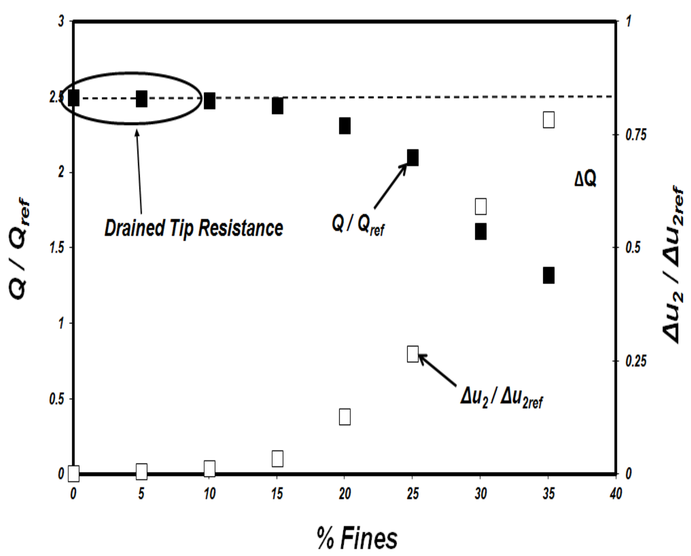
BACKGROUND

• Current practice compares in-situ tip resistance with an established triggering curve, adjusting for fines content to evaluate liquefaction potential.



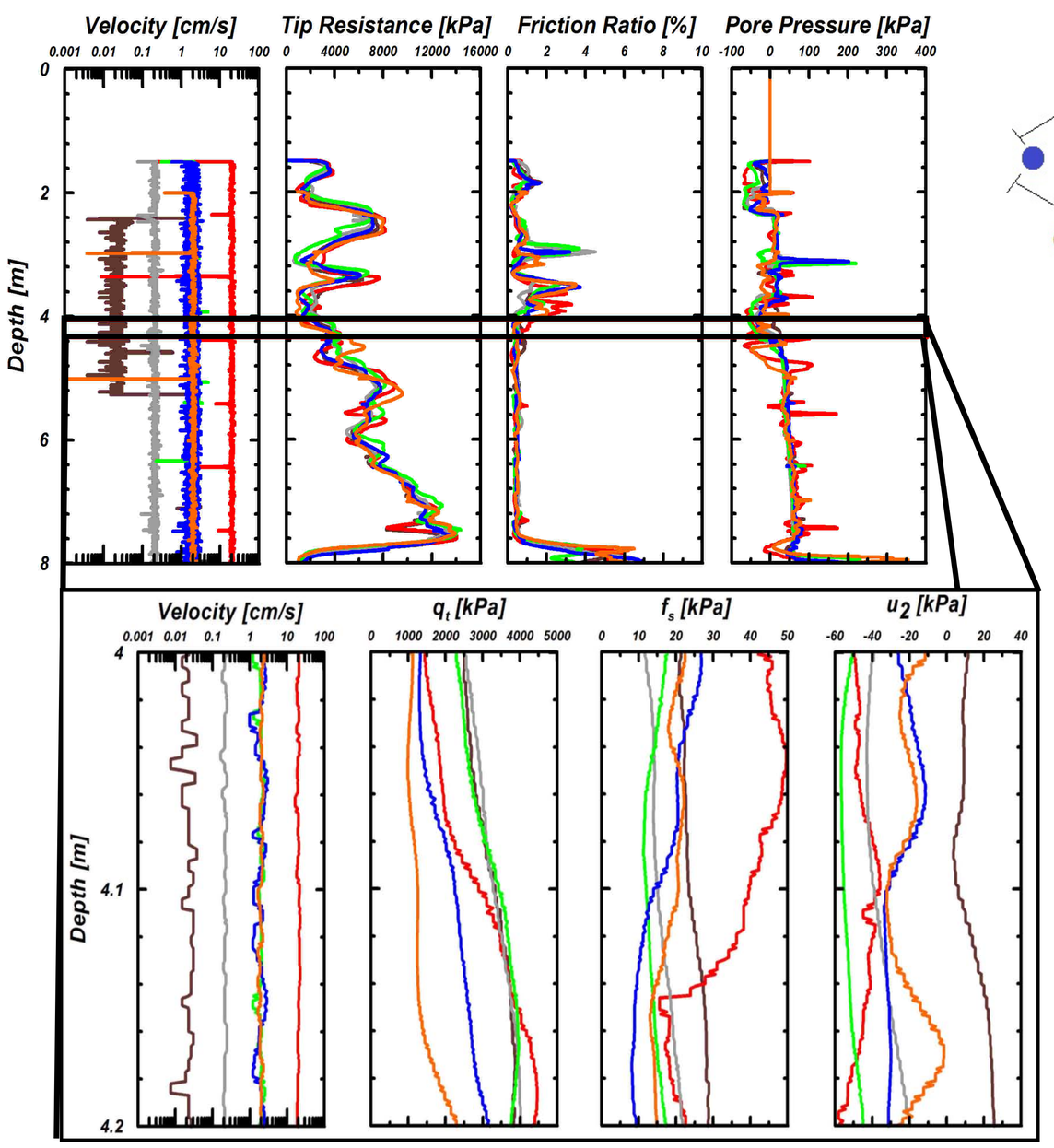
• Fully drained conditions exist for clean sands at the standard penetration rate of 2 cm/s.

• Partial drainage may occur with fines content >20%.

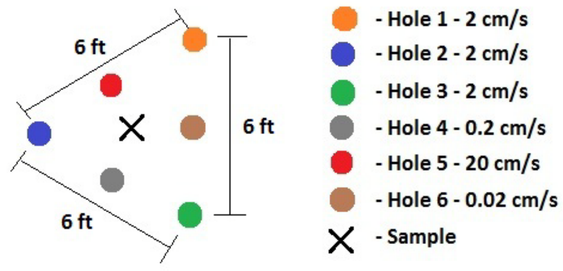


EXAMPLE RESULTS: Lenordini Farms, Castroville, CA

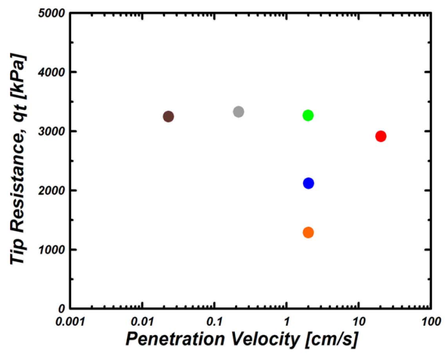
Sounding Results:

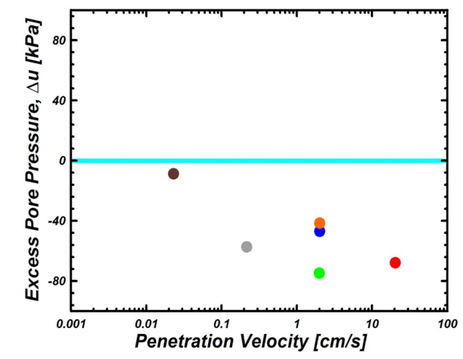


Typical Test Site Layout:

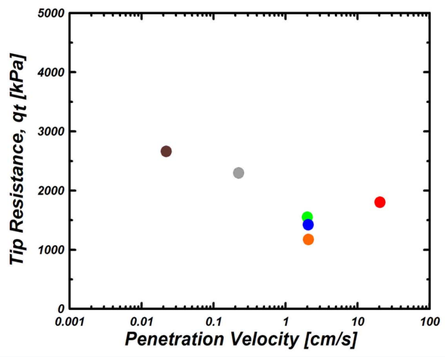


Depth Interval: 4.0-4.2 m
%FC = 63, PI = 1

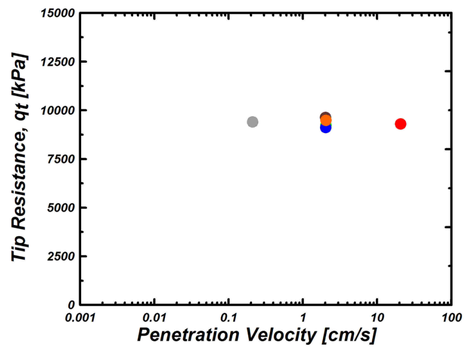




Depth Interval: 3.5-3.7 m
%FC = 30, PI = NP



Depth Interval: 6.5-6.7 m
%FC = 11, PI = NP



Observed Trends:

- Variation in q_t with penetration rate dependent on fines content.
- Magnitude of variation must be considered with respect to spatial variability evident between 3 control soundings.

TESTING PROCEDURE

Site Selection:

- Observed damage due to liquefaction in past earthquake
- Fines content of 5-50%
- Site used in popular CPT liquefaction databases (e.g. Moss et al 2006, Idriss and Boulanger 2004, Stark and Olson 2004)

Procedure:

- Six soundings in a triangular grid (Fig. 2)
- Confirm site uniformity/evaluate spatial variability
- Perform Variable Rate soundings

FUTURE WORK

- Account for spatial variability in analysis
- Resolve $-\Delta u$ with low qc observations
- FLAC Modeling with MIT-S1 constitutive model
- Reanalyze case histories to evaluate the effects of drained conditions on original site evaluation

ACKNOWLEDGEMENTS

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