2019 UDOT RESEARCH PROBLEM STATEMENT

**** Problem statement deadline is Feb. 6, 2019. Submit statements to UTRAC@utah.gov. ****

Title: Probabilistic liquefaction assessment in gravels using DPT Testing. **No. (Office Use):** 19.04.02

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Select ONE Subject Area ☐ Materials/Pavements ☐ Maintenance ☐ Traffic Mgmt/Safety ☒ Structures/Geotech ☐ Planning ☐ Perf Mgmt/Data Analytics ☐ Public Transportation ☐ Other

1. Describe the problem to be addressed:

The technical literature now indicates that gravelly soils have liquefied in at least 20 earthquakes over the past 20 years including three well-documented case histories in the past 5 years. Standard procedures for assessing liquefaction hazard in sands (CPT and SPT) are unreliable in gravelly soils while alternative procedures (Becker test) are unrealistically expensive for routine geotechnical investigations. The 3-inch diameter Dynamic Cone Penetration Test, that is driven with a 340 lb weight, instead of a conventional 140 lb weight, can penetrate gravelly soils and has been correlated with liquefaction resistance for a major earthquake (M7.9) in China. However, validation of this method requires additional data from multiple earthquakes at sites where gravels did and did not liquefy. This effort is underway with funding from USGS and NSF, but additional testing at non-liquefied sites is required. This will allow the DPT liquefaction assessment procedure for gravels to be validated and refined.

2. Write the project objective (25 words or less):

The project objectives are: (1) develop probabilistic liquefaction triggering curves for gravelly soils based on the penetration resistance from the Dynamic Cone Penetration Test (DPT) and (2) evaluate the sensitivity and reliability of the blow counts as the mean grain size of gravel increases.

3. Explain why this research is important:
(In response, consider addressing specific UDOT goals, applicability in Utah or other states, etc.)

Roadways and bridges in Utah often traverse soil profiles containing gravelly soils. Because conventional approaches for assessing liquefaction are not reliable for gravels, decision makers may err on the side of conservatism and specify costly ground improvement remedies that are unnecessary. Alternatively, engineers may see artificially high blow counts and mistakenly assume the layer is not liquefiable leaving the structure vulnerable to damage in an earthquake. Bridges and roadways are essential lifelines for economic and public safety and should be designed in a safe, but cost-effective way.

4. List the major tasks:

1. Conduct companion dynamic cone penetration tests (DPT) with two hammer energies at four sites near L'Aquila Italy where gravels did not liquefy in multiple earthquakes.
2. Conduct companion DPT tests with two hammer diameters in stockpiles at Geneva Rock with different mean grain-sizes.
3. Add CSR-DPT blow count data points to previously collected field case histories and develop revised probabilistic liquefaction triggering curves for gravels.
4. Evaluate the effect of mean grain size on DPT penetration resistance and define ranges of applicability based on cone diameter.
5. Prepare final report and provide implementation training.
6. Prepare papers for ASCE J. of Geotech. & Geoenviron. Engrg. and conference papers

5. List the expected deliverables (reports, manual, specification, design method, training, etc.):

1. Final report with test results, interpretations, and limitations of DPT for mean grain size.
2. Probabilistic liquefaction assessment curves for gravels with world-wide data set from multiple earthquakes.
3. Training session to describe dynamic cone testing procedure and liquefaction assessment procedure to UDOT & Consultants

6. Describe how the research results will be implemented:
(In response, consider addressing UDOT leader support, process or standard improvement, etc.)

After training, the DPT-based liquefaction assessment procedure can be incorporated in the UDOT Geotechnical Manual of Instruction. This procedure can then be employed to provide realistic assessments of gravel layers encountered in geotechnical investigations for roadways and bridges.

7. Requested from UDOT: $25k **Other/Matching Funds:** $25k **Total Cost:** $50k
(or UTA for Public Transportation)

8. Outline the proposed schedule, including start and major event dates:

The DPT testing will likely begin in June of 2019 at gravel liquefaction sites in L'Aquila, Italy that have been subjected to 5 major earthquakes in the past 10 years. Dr. Rollins and students will already be in Italy as part of their NSF-supported research which will pay for travel expenses, while UDOT money will pay for soil investigation. DPT tests at the Geneva Rock stockpiles at the point of the mountain will follow in August of 2019. Dr. Rollins and his students will analyze the test results and develop revised triggering curves in the fall of 2019 primarily using NSF funds. Reports and presentation materials will be developed in Jan-April 2020 and implementation presentations will take place in May-June 2020.