Liquefaction potential of South Carolina Coastal Plain soils using dilatometer data

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Abstract:

In recent years much research has been focused on developing the flat plate dilatometer (DMT) as a tool to estimate the liquefaction potential of soils. Currently the DMT is over shadowed by the more accepted methods of estimating liquefaction potential which utilize test data from either the standard penetration test (SPT), cone penetration test (CPT), or shear wave velocity test (Vs). The SPT, CPT, and V_s tests are all well-developed methods of estimating liquefaction potential and are supported by extensive databases; however, the DMT is believed by many researchers to be the superior alternative. Due to the DMT's minimal amount of soil disturbance the test is able to detect minor changes in soil fabric and thus is sensitive to stress history, cementation, bonding, and aging, all factors which increase liquefaction resistance.

Aging is a critical factor that needs to be considered in liquefaction analysis. The current methods of estimating liquefaction potential were developed based on data from relatively young soil deposits of the Holocene era (<10,000 years); whereas the soil deposits of the South Carolina Coastal Plain (SCCP) range in age from 200,000 to 1.6 million years old. The current SPT and CPT based methods of estimating liquefaction potential, which do not account for the effects of aging, underestimate SCCP soil's resistance to liquefy (e.g. cyclic resistance ratio (CRR)) by as much as 60%.

Given the importance of accounting for aging of soils in liquefaction analysis and the recent developments of the DMT as an in situ tool that is sensitive to aging, this thesis aims to 1) expand the limited DMT data base by adding data from five research sites in the SCCP and 2) develop new relationships between DMT data and CRR that can be used as first approximations for evaluating the liquefaction

potential of soils in the SCCP. The five research sites studied herein are part of a larger study to evaluate the geotechnical properties and liquefaction potential of soils at sites in the SCCP where evidence of paleoliquefaction has been identified through the discovery of sandblows. These sites include Sampit, Gapway, Fort Dorchester, Hollywood, and Four Hole Swamp.

At each site, DMT, SPT, and CPT tests were performed side by side. Laboratory index testing consisting of visual-manual identification, grain size distribution, Atterberg limits, and specific gravity were also performed on SPT samples from each site. The field and laboratory test data was used along with the in situ test parameter upper limits for liquefaction presented in the literature to identify the source sand zones, or the layers that are most prone to liquefy, at each site. The field test data from within the source sand zones was analyzed and correlations between DMT-SPT and DMT-CPT test parameters that are specific to SCCP soils were developed. In analyzing the field test data, the K_D and E_D values of the SCCP soils were found to be higher than the values of Holocene soils of other published data and the K_D upper limit of liquefaction presented in the literature considered the majority of the SCCP soils unliquefiable.

The correlations between DMT-SPT and DMT-CPT test parameters in SCCP soils were used to transform the CRR-SPT and CRR-CPT relations that account for aging into new first approximation CRR-DMT relationships. The first approximation CRR-DMT relations are supported by CRR-DMT relations with CRR obtained from cyclic triaxial tests on high quality undisturbed samples from each site. The first approximation CRR-DMT relations presented herein are shown to be in good agreement with the SCCP data and serve as appropriate boundaries between unliquefiable soils and soils that are prone to liquefaction.

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