Effect of Fines and Plasticity on Evaluating Sample Disturbance

PEER Internship Program – Summer 2013

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Introduction

Ground failure due to earthquake loading has occurred over a broad range of low plasticity clays and silts, indicating the need for direct data that identifies the properties and strengths of intermediate soils (see Figure 1). However, practical, scientific characterization of sample disturbance criteria for intermediate soils still needs to be developed.

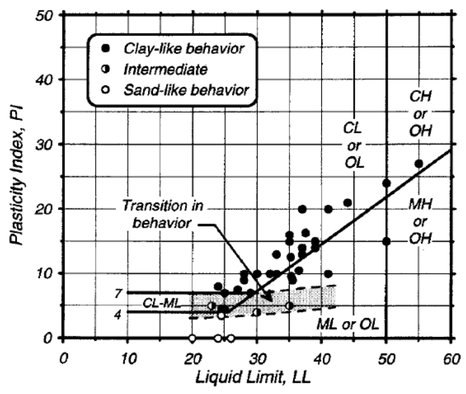

Figure 1: Atterberg limits chart of soils prone to sand-like liquefaction, clay-like cyclic softening, or intermediate behavior [Boulanger and Idriss 2006].

The objective of this study is to establish a relationship between fines, plasticity, and level of sample disturbance for intermediate soils.

Methods

This study performs controlled rate of strain (CRS) consolidation tests (see Figure 2) on samples of silica silt or nevada sand with varying amounts of kaolin clay. Each mixture experiences different levels of induced sample disturbance.

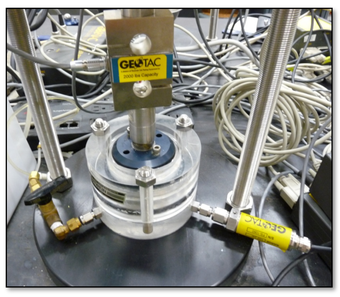

Figure 2: Soil sample loaded in the GEOTAC automated consolidation system.

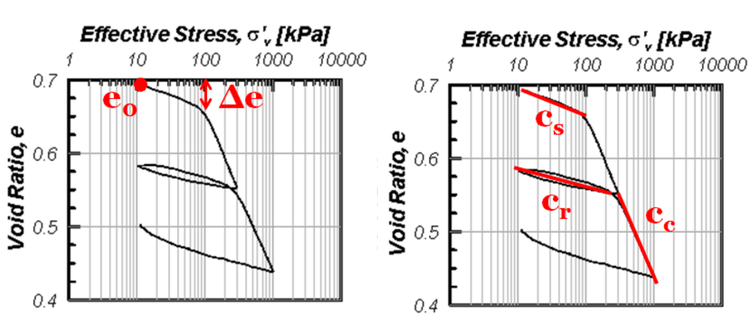

Figure 3: The evaluated consolidation curve parameters are: $\Delta e/e_0$, swell index (C_s), recompression index (C_r), and compression index (C_c).

Results

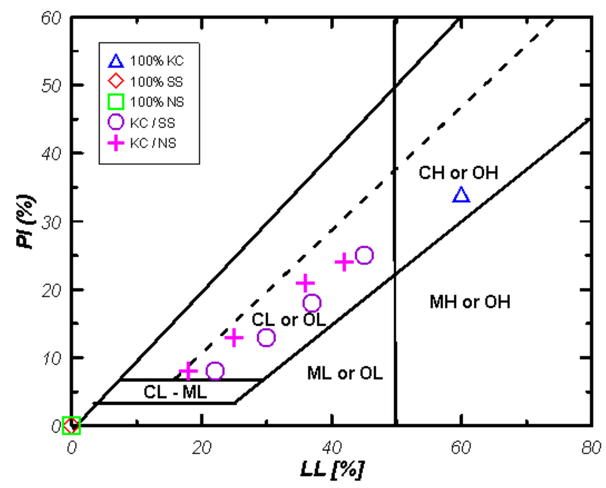

Figure 4: The tested intermediate soil samples exhibit low plastic behavior.

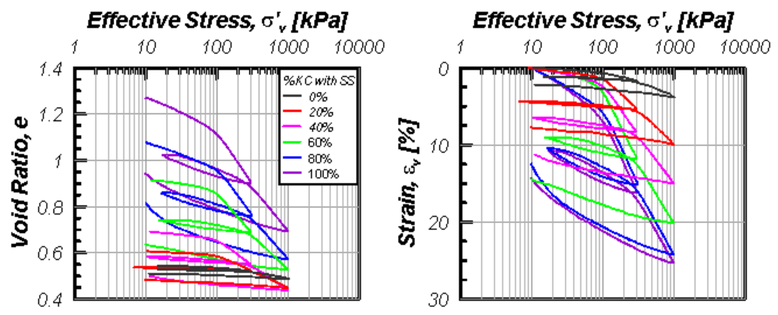

Figure 5: Increasing the level of plasticity increases strain, C_s, C_r, and C_c.

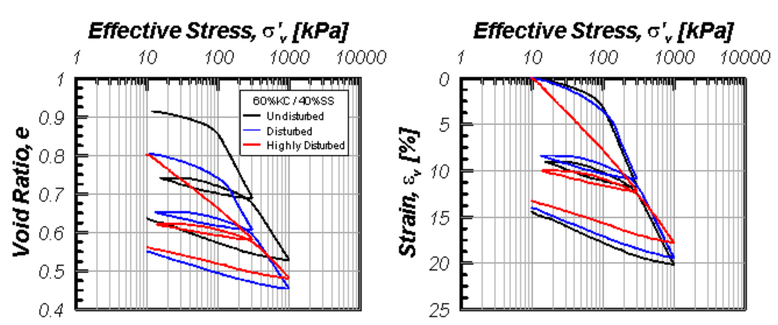

Figure 6: Only $\Delta e/e_0$ and C_s are subject to sample disturbance.

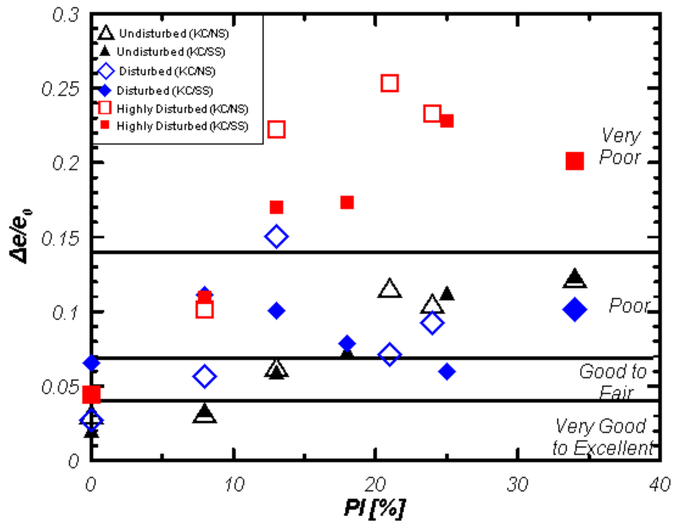

Figure 7: The $\Delta e/e_0$ index is a sample disturbance criteria developed for pure clays. Applying the $\Delta e/e_0$ index to intermediate soils shows that the $\Delta e/e_0$ ratio is not only dependent on level of sample disturbance, but also level of plasticity.

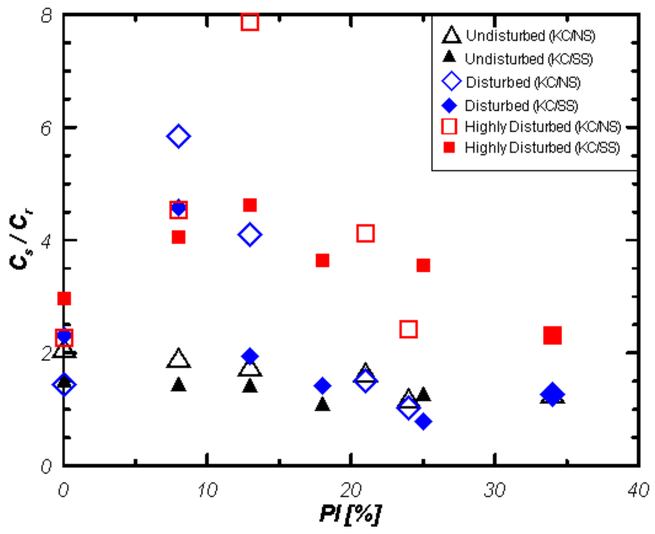

Figure 6: The C_s is susceptible to sample disturbance, while the C_r does not change with disturbance. The C_s/C_r ratio is more dependent on level of sample disturbance than level of plasticity.

Conclusions

- Increasing the amount of fines and level of plasticity should increase $\Delta e/e_0$, C_s, C_r, and C_c
- Sample disturbance increases $\Delta e/e_0$ and C_s, but does not affect C_r and C_c
- The $\Delta e/e_0$ index decreases as a function of function of plasticity and should not be used to classify soils with PI values less than 15%
- From the samples tested, the C_s/C_r ratio appears to provide a better sample disturbance classification for intermediate soils than the $\Delta e/e_0$ ratio
- Although the C_s/C_r ratio seems to be a viable alternative for classifying sample disturbance for intermediate soils, more research must be performed to confirm

Acknowledgements

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References

Boulanger, R. W. and Idriss, I. M. (2006). "Liquefaction Susceptibility Criteria for Silts and Clays." *J.* Geotech. Eng., 132(11), 1413-1426.

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