ABSTRACT

Dawood, Sulaiman. MSCE, Purdue University, May 2014. Small Strain Stiffness of a Carbonatic Clay. Major Professors: Antonio Bobet and Maria C. Santagata.

This research is part of an ongoing project aimed at the characterization of the engineering properties, microstructure and mineralogy of a soft fine-grained carbonatic soil deposit in Southwestern Indiana (Daviess Co.). The specific focus of this thesis is the characterization, through both field and laboratory measurements, of the small strain behavior of this soil, commonly referred to as a "marl."

Index tests indicate that the 6 m marl layer present at the site is characterized by two soil types alternating in small layers: a high plasticity silt (soil *M*) with w_n~60% and $CaCO_3$~60%, mostly in form of shells, and a low plasticity clay (soil *C*) with lower water (~45%) and $CaCO_3$ (~40%) contents, and no shells. Resonant column tests conducted on high quality samples are used to measure the shear modulus of isotropically consolidated specimens of both soil *M* and soil *C* as a function of stress level (70-650 kPa) and OCR (1-4) for shear strains between 10^{-4}% and 0.1%. The G_{MAX} data for the two soil types fall on distinct bands, with the modulus of soil *M* consistently greater than that of soil *C* soil at any stress level. Differences are also observed in the stiffness degradation behavior, with soil *C* exhibiting greater non-linearity at the same stress level and OCR. Finally, measurements of G_{MAX} over time provide values of the aging parameter N_G, which for both soils falls in the range typically reported for clays.

The shear wave velocity (V_s) profile of the site, obtained from two seismic cone penetration tests, indicates that the marl layer is characterized by values of V_s in the 110-160 m/s range, significantly lower than those of the layers above and below it. However,

these measurements do not allow resolution of the *C* and *M* sub-layers. Values of V_s derived from these measurements are 25-30% greater than those measured at the same stress level and OCR in the laboratory. This difference can be attributed to sample disturbance and anisotropy effects, and, most importantly, to the impact of aging in the field. Consideration of the increase in modulus associated with the age of the deposit yields a closer match between laboratory and field results.