SYNOPSIS

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DYNAMIC BEHAVIOUR AND SUCTION CHARACTERISTICS OF CH COMBINATION SOIL

Combination soils possessing mixture of coarse and fine grained with varied fractions are naturally encountered in several geotechnical engineering projects. Naturally available combination soils are subjected to various types of dynamic loading including high strain (earthquake & blast loading) & low strain loading (machine vibrations & traffic loading). This leads to particle structure breakdown inducing instability within the soil mass causing severe damages to various geotechnical structures under dynamic loading conditions. Assessment of strength & stiffness degradation characteristics of such soils under dynamic loading conditions is essential for stability analysis of structures. Evaluation of dynamic behavior of soil is imperative for solving various problems involving soil-structure interaction and other geotechnical issues. Unsaturated soils comprising of three phase system (air, water & soil mass) and possessing water content less than saturation (Degree of saturation; S_r < 100%) are encountered in numerous geotechnical engineering issues especially in arid and semi-arid regions. Soil layer above hydraulic datum possess negative pore pressures frequently denoted as soil suction. Mechanical response of soil in unsaturated state remains non-consistent with conventional soil mechanics due to presence of negative pore water pressure. Current research involves the study on dynamic behavior of *CH* (Clay of high compressibility/plasticity) combination soil along with matric suction and collapsible characteristics under unsaturated state. Cyclic behavior, energy dissipation and stiffness degradation rate of *CH* combination soil is also studied under saturated state at varying amplitude and frequency under consolidated and unconsolidated testing conditions. In addition to this, the relationship of collapse potential and swelling pressure with suction measurements of expansive soils with different *DFSI* (Differential free swell index) has been evaluated.

A natural *CH* combination soil was chosen for the current research, which was collected from Ahmedabad (Gujarat, India) consisting of 1% gravel, 15% sand, 52% silt and 32% clay. Ahmedabad cohesive soil under unsaturated state was used to perform dynamic triaxial tests to evaluate the influence of matric suction and initial static loading on its hysteresis response, dynamic properties and stiffness degradation behavior. Application of initial static loading identified a unique dynamic response on compacted specimens of *CH* combination soil. Shear modulus of unsaturated combination soil increased with increase in matric suction. Soil specimens possessing higher matric suction experienced higher stiffness degradation with increasing number of loading cycles. Variation of collapse potential and cyclic degradation index with matric suction of unsaturated *CH* combination soil exhibited meta-stable behavior of specimens comprising of high matric suction indicating soil skeleton to be highly volatile and unsafe under dynamic loading conditions. Unsaturated shear strength of Ahmedabad cohesive soil was also determined by employing conventional triaxial testing and matric suction measurements. Angle of shearing resistance w.r.t matric suction was obtained to be the maximum for lower degree of saturation and higher matric suction. Ahmedabad cohesive soil under saturated conditions was used to study the influence of initial void ratio, loading frequency and amplitude on hysteresis response, dynamic properties, energy dissipation, rate and magnitude of stiffness degradation by performing dynamic triaxial tests under consolidated and unconsolidated conditions. Specimens possessing lower initial void ratio exhibited greater loss in strength and stiffness of saturated *CH* combination soil. Loading frequency and amplitude significantly impacted the hysteresis response and dynamic properties of saturated Ahmedabad soil under consolidated and unconsolidated testing conditions. Pore pressure evolution under consolidated conditions improved when subjected to dynamic loading with higher amplitude and lower frequency. Rate and amount of stiffness degradation enhanced with increment in amplitude, however negligible influence of loading frequency was attributed from the present study. Consolidated state of soil attributed higher shear modulus as compared to unconsolidated state. Energy dissipation was found to be the maximum for higher amplitude, higher frequency and first cycle of dynamic loading. The suction and collapse potential study was extended to expansive soils (shrinkage-swelling), which would exhibit large amount of matric suction at their unsaturated state. Four such *CH* combination soils with different *DFSI* ranging from 134% to 30% were explored to study the relationship of collapse and swelling with their suction parameters. Presence of large amount of Montmorillonite resulted in higher *DFSI* and higher matric suction. Higher matric suction contributed to higher affinity of water causing larger amount of crystalline swelling resulting into the greater swelling pressure. Sudden reduction of high magnitude inter-particle resistive force in the soil skeleton possessing higher matric suction might have caused excessive volume change within the soil mass leading to higher collapse.