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Mechanical behavior of a cemented gravely sand under monotonic and cyclic loading-case study of Tehran alluvium

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Abstract

The major section of the city of Tehran has been developed on cemented coarse-grained alluvium. In order to understand the mechanical behavior of this soil, a series of undrained cyclic triaxial tests were performed on uncemented and artificially calcite-cemented samples. In this regard the effects of cement content, confining pressure and cyclic deviatoric stress were studied as well. In general by increase in the amount of cementation, maximum shear modulus increases and damping ratio show no significant variation. Also, increase in deviatoric strain results in the increase in damping ratio and decrease in shear modulus. In addition the higher confining pressures lead to higher shear modulus and lower damping ratio. Furthermore the shear modulus decreases with increase in number of cycles.

Keywords: calcite-cemented, gravely sand, shear strength, cyclic loading, Tehran alluvium

1. Introduction

Most of the alluvial deposit of Tehran, the capital city of Iran, has a soil with a cemented nature. The amount and characteristics of the cementation of the deposit varies in different parts from highly cemented in the north to non-cemented in the south. This deposit consists of gravely sand to sandy gravel with some cobbles and is dominantly cemented by calcite with carbonate origin (Haeri et al., 2002) [1]. On the other hand, Tehran is situated in a seismic region. Thus, characterization of dynamic behavior of the deposit is inevitable but undisturbed sampling from this soil for triaxial testing is virtually impossible. Therefore, a study on the dynamic behavior of Tehran deposit cemented artificially with calcite has been planned.

Previous studies conducted by Haeri and his co-workers on the static behavior of Tehran cemented gravely sand using different cementing agent like lime, Portland cement, gypsum show that cementation generally increases the static shear strength parameters and the brittleness of the soil, especially in low confining pressures (Haeri et al., 2002[1]; Haeri et al., 2005[2]; Haeri and Hamidi, 2005[3]; Haeri et al., 2007b [4]). However the influence of the cementation decreases as the confining pressure increases as a result of degradation of cemented bonds. The increase in shear strength mostly affects the cohesion and also slightly the friction angle. However, the increase in brittleness may have reverse effects as the sudden bond breakage and consequent sudden decrease in strength and increase in deformation might be unjustifiable for cuts in, or structures supported on cemented soils.

In cyclic loading, it is widely accepted that the stress–strain curve shows hysteresis and accumulation of irreversible strains with increasing number of cycles if the stress imposed during cyclic loading lies outside the true elastic range (Kokusho, 1980 [5]; Lo Presti et al., 1997[6]). Using the hysteresis loop, and applying geometrical calculations, it is possible to obtain dynamic shear modulus and damping ratio of the soil for