SLOW AND FAST CYCLIC LOADING EFFECTS ON SHEAR MODULUS AND DAMPING RATIO OF NORMALLY CONSOLIDATES UNSATURATED KAOLIN

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Development of appropriate equipment to perform tests on unsaturated materials in recent years has led to significant progress in various branches of this field. One of these branches is cyclic and dynamic behavior of unsaturated materials. Several researchers have investigated the dynamic parameters of this kind of materials, especially small-strain shear stiffness (Mancuso et al., 2000; Mendoza et al., 2005; Ng et al., 2009; Biglari et al., 2011).

In this field the discussion of the effects of cyclic loading speed on dynamic parameters of such materials has less attention. In materials which equalized in certain suction level, changes in the loading speed can disturb the suction conditions and thus may change the results of the test. So with knowledge about this subject help us to correctly interpret the results and to identify more precisely the behavior of unsaturated soils.

In this research the results of two series of cyclic triaxial tests are presented which were done on a kind of fine grained trade soil (Zenuz Kaolin) in unsaturated condition and two mode of slow and fast loading, using suction control triaxial equipments improved in IIEES geotechnical laboratory. Using this apparatus can be able to test unsaturated samples in a wide range of suction and mean net stress levels. Sample construction and initial conditions of the samples, including the initial water content and initial density were the same in every test. These tests were done in mean net stress of 100 kPa and three suction level of 0, 150 and 300 kPa and three amplitudes of cyclic deviatoric stresses too. The stress paths of the slow and fast tests are shown in Figure 1.

In the slow tests, loading speed was in a way that suction equalization condition of the samples did not change during all paths of the test. But in fast tests, up to achieve mean net stress of 100 kPa and also before applying deviatoric stress cycles, the condition of suction equalization was established. In fast tests, during applying load cycles due to fast loading, pore water and pore air pressures change in the sample and so suction condition will change.

Shear modulus and damping ratio obtained from the tests are presented in Figures 2 and 3. In this figures the results of each test are presented in a term like '$S_{(Number)} D_{(Number)}$' (for example S300D81 means the test is done in final suction level 300 kPa and cyclic deviatoric stress 81 kPa). Also the results of the first cycles are connected with dotted line (for suction level 0 kPa), grey line (for suction level 150 kPa) and black line (for suction level 300 kPa). The results show that in the same suction level and equal strain level, shear modulus in fast tests are bigger than slow tests. But there is not considerable difference between the values of damping ratio in the slow and fasts.
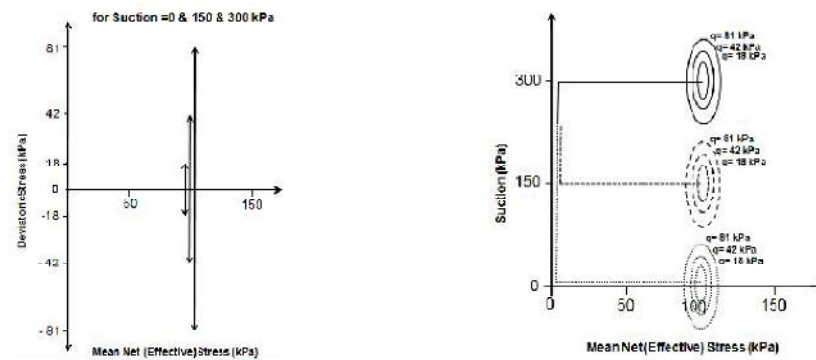
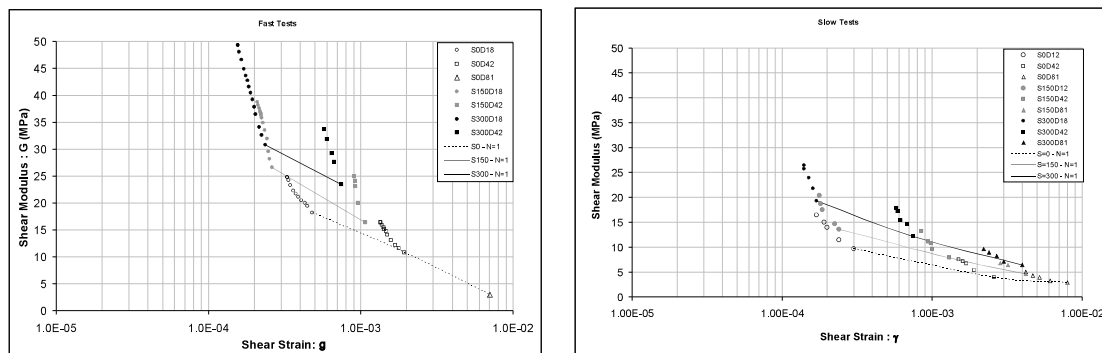Figure 1. The stress paths of the slow and fast tests

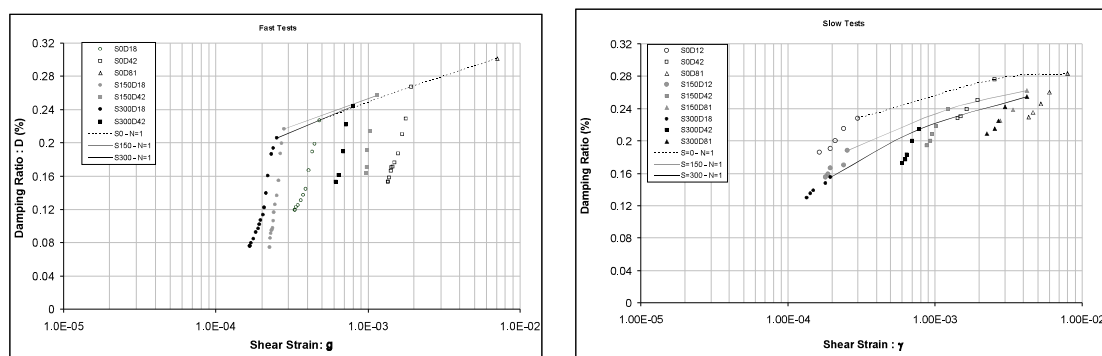Figure 2. Changes of shear modulus in slow and fast cyclic tests

Figure 3. Changes of damping ratio in slow and fast cyclic tests

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