

On the Steady State of Granular Soils in Undrained and Drained Conditions

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1. Introduction

The existence of a unique steady state for granular soils at large strains still remains unclear. It is often reported that the steady state of granular soils is dependant on the initial density, loading path, drainage condition and mode of shearing. Recent research advocates for the importance of strain localization in the shear bands in medium dense to dense samples and the measurement of local void ratio evolution, questioning the validity of critical void ratio based on global volume change measurements. Consequently, it is reported that the steady state is usually reached within the intense shear zone.

Observation has shown a strong localization of strain into the shear zone, during ring shear testing. Research results are presented from undrained and drained tests of very loose to dense sands in an effort to examine the existence of the steady state within the shear zone in a place of strain localization.

2. Testing Apparatus and Testing Materials

The ring shear apparatus employed in this research was DPR1 No. 5, with an outer diameter of the shear box 18.0 cm and the inner diameter is 12.0 cm. The samples employed were sandy soils with $D_{50} = 1.1$ and $U_c = 2.3$. Sample no.1 is silica construction sand and sample no. 2 is a feldspathic sand. The saturation parameter B_D was above 0.95 for all tests. All the samples were normally consolidated. After consolidation load controlled shearing stress was applied at a very low rate of 1 kPa /sec.

3. Test Results

Undrained test results of very loose to dense specimens ($R_d = 6 - 65\%$) are presented in Figure 1. The results show a strain softening behaviour as the samples were sheared further. Figure 2 shows test results of very loose to loose drained specimens subjected to normal stresses of 100 - 300kPa. Unlike the undrained tests all the specimens seem to obey the steady state theory. Albeit a highly strain localized apparatus, the undrained tests do not appear to reach their steady state even at higher shear displacements, but rather do strain soften progressively.

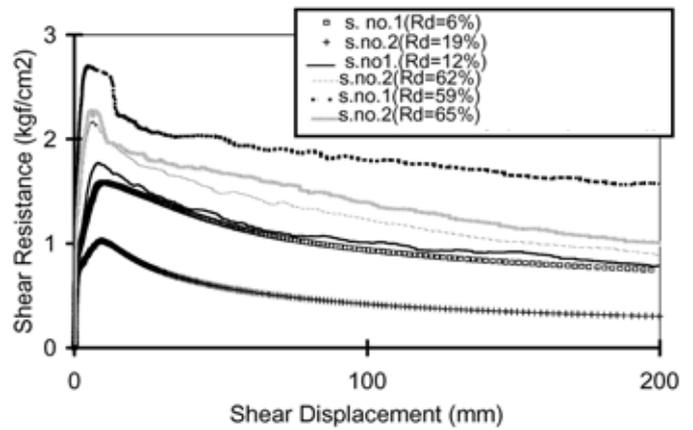


Fig-1 Undrained test results

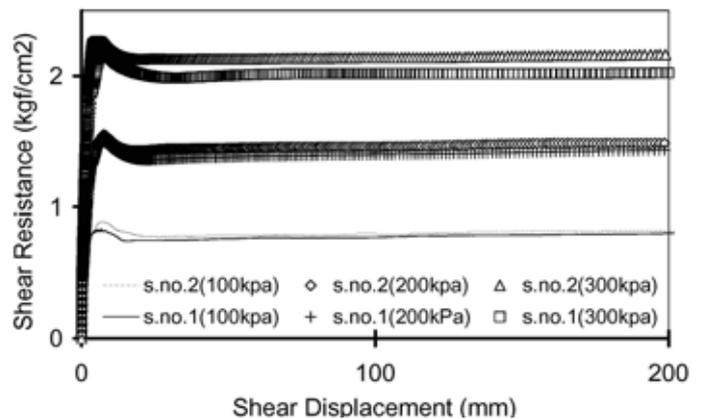


Fig-2 Drained test results