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Effect of physical parameters on static undrained resistance of sandy soil with low silt content

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ABSTRACT

Previous researches concerning the behavior of sand mixed with non-plastic fine show that the void ratio related to sand grains (e_c) plays a more important role in comparison with the total void ratio, where soil undrained resistance will be improved due to increase in *FC* at the constant e_c. In spite of this fact, the recent works indicate that e_c is unable to show perfectly the role of the non-plastic fines that are in voids between sand grains. For this reason, an equivalent void ratio $(e_c)_{eq}$ has been defined that takes into account the non-plastic fine participation ratio in the soil bearing skeleton. In the present work, the generality of the expression of $(e_c)_{eq}$ is verified. For this, a set of static undrained triaxial tests were performed. The results of tests indicate that the undrained behavior of a given sand mixed with different percentages of non-plastic fine can be described by $(e_c)_{eq}$. But if the grading curves of sand change, we cannot find a logic retention between $(e_c)_{eq}$ and undrained resistance of soil, unless the physical and mechanical characteristics of soil are well introduced in expression of $(e_c)_{eq}$.

1. Introduction

It is more than 60 years that the focus of the researches has been on the phenomenon of liquefaction, but large part of these researches has been done on the clean sands, assuming that the behavior of clean sand can be generalized to the natural sands such as silt sand. In fact, most of these researchers believed that firstly plastic fines in sand lead to the increase of the undrained shear resistance [1,2] and secondly existence of the silt in sand does not affect the sand residual resistance, because silt fines are similar to sand grains and do not have magnetic forces on their surfaces [3]. Various tests on different sands have confirmed the first part of idea mentioned above which is based on shear resistance of sand improved by increased amount of plastic fines in sand. The reason behind this issue is due to the fact that liquefaction is so state that increase of pore water pressure causes grains to separate and also sand grains are suspended, but the existence of plastic fines in the soil with magnet forces in their surface causes to situation of almost constancy of grains. Hence, more amount of plastic fines in sand causes the improvement of the undrained shear resistance. However, researches have not confirmed the second part of idea mentioned above; these researches showed that the behavior of clean sand in comparison with sand–silt mixtures is completely different. Yet, there is a disagreement over this difference so that some believed silt in the sand reduces undrained resistance of sandy-soil mixtures [4], while others had dissenting opinion [5,6], but Yamamuro and Lade [7] obviously showed, having performing the tests, that the increase of silt in sand remarkably leads to the decrease in undrained resistance of sand–silt mixtures at constant total void ratio. They justified their reasoning by saying that when an amount of silt is added to sand, a part of silt will be placed in void within the grains, so this amount of silt does not have considerable effect on soil behavior. On the other hand, a part of silt that is placed in contact surfaces of sand grains leads to separation and sliding the grains during loading. This leads to the increase of soil compressibility and the decrease of soil undrained resistance (Fig. 1). They suggested, therefore, that sand skeleton void ratio (e_c) probably can control undrained resistance of silt–sand mixtures. In fact, e_c represents the space within sand grains in the sand–silt mixture. This parameter is calculated by

$$e_c = (e + fc)/(1 - fc) \quad (1)$$

where e is the total void ratio and fc is the ratio of silt weight to total sample weight. According to this relationship, for a given total void ratio, the e_c increases due to the increase in fc that creates more distances between sand grains.

Polito [8] modified viewpoint of Yamamuro and Lade [7] showing that the increase of silt in sand to the threshold value ($FC_{th} \approx 35\%$) reduces undrained resistance of silt sand, but after this the increase of silt improves undrained resistance at constant void ratio (Fig. 2). Thevanayagam et al. [9] stated that silt fines have the main role in determining the behavior of soil at the state of $FC > FC_{th}$. In this case, silt fines are close to each other and sand grains break away. This means that silt fines play the main role in

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