

Influences on the Shear Modulus and Damping Ratio of Hydraulic Reclaimed Soil in West Taiwan

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ABSTRACT

In this study, the filled soil in the Yun-Lin offshore area in West Taiwan is adopted as testing samples. A successful hydraulic sand fill simulation method is developed in the laboratory to investigate packing properties of soil aggregates. The influence factors such as fines content, sample preparation method, relative densities and confining pressures are taken into consideration. A series of resonant column tests has been performed to study the shear modulus (G) and damping ratio (D) of the filled soil. The influence of effective confining pressure was discussed by using the K_2 value proposed by Seed and Idriss (1970). In order to evaluate the influence of fines content on the maximum shear modulus of the filled soil, an influence parameter of fines content B is defined. With this parameter and on the basis on the evaluation method suggested by Hardin and Richart (1973), the influence of fines content, effective confining pressure, void ratios and shear strain amplitudes on the maximum shear modulus of filled soil are discussed. Test results show that the predicted results agree with the experiment results. The newly proposed evaluation method can be used to predict the maximum shear modulus of hydraulic filled soil.

INTRODUCTION

Hydraulic sand fill is one of the most important reclamation methods in nearshore areas of West Taiwan. The reclaimed land is important for the development of industrial real estate (Sinotech, 1990). The materials for hydraulic sand fill were obtained from the seabed or river mouth by use of cutter and pump. According to the Sladen and Hewitt (1989) studies on the Beaufort man-made island in Canada, the relative density of hydraulic filled soil ranges from 10% to 70%. The relative density is difficult to control and is normally below 50%. Thus, by understanding the mechanisms involved, the reclamation in the coastal area can be improved. The effects of earthquake and wave forces were considered the main factors affecting the stability of the nearshore reclamation area. Therefore, the purpose of this study is to evaluate the stability of the reclamation area by investigating the dynamic properties of the reclaimed soil.

In this study, a successful hydraulic sand fill method is developed to prepare specimens and to simulate packing properties of the reclaimed soil. Resonant column tests are conducted to discuss dynamic properties of the reclaimed soil. The traditional moist tamping method and the multisieve pluviation method are used to prepare specimens. The influences of relative density (void ratio), confining pressure, specimen preparation methods are discussed.

PREVIOUS RELATED STUDIES

The dynamic properties of soil are influenced by factors such as strain amplitude, void ratio, overconsolidation ratio, fines content, effective confining pressure, soil aggregates, specimen preparation method and others. Hardin and Drnevich (1972) demonstrated that the relationship between shear stress and shear strain of sand shows the nonlinearity, namely the shear modulus decreases non-

linearly as the strain amplitude increases. Hall and Richart (1973) showed that the damping ratio increases as the shear strain amplitude increases for Ottawa sand.

Seed and Idriss (1970) proposed an equation for the relationship between shear modulus and confining pressure as follows:

$$G = 1000 \cdot K_2 \cdot (\sigma'_m)^{0.5} \quad (1)$$

where σ'_m is effective confining pressure (psf) and K_2 is a parameter.

Hardin and Richart (1963) demonstrated that when the shear strain is below $10^{-3}\%$, the shear modulus of sand keeps almost constant maximum value. The relationships among shear strain, void ratio and maximum shear modulus are shown by the following:

$$G_{max} = A \cdot F(e)(\sigma'_m)^n \quad (2)$$

$$\text{where } F(e) = \frac{(2.97-e)^2}{1+e} \quad (3)$$

for angular grained sand, and

$$F(e) = \frac{(2.17-e)^2}{1+e} \quad (4)$$

for round grained sand. σ'_m is effective confining pressure (psf), A is a dimensionless parameter of the soil and n is a parameter.

Iwasaki and Tatsuoka (1977) obtained a formulation of the maximum shear modulus for different clean sand as follows:

$$G_{max} = 900 \cdot F(e) \cdot (\sigma'_m)^{0.5} \quad (5)$$

$$\text{where } F(e) = \frac{(2.17-e)^2}{1+e}$$

The above equation shows that the shear modulus increases as effective confining pressure increases.

In recent studies, Robertson et. al. (1992) investigated the relation between shear wave velocity and void ratio based on a series of triaxial test with bender element. The results demonstrated that the steady state parameter of soil can be discussed by shear wave

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Received January 28, 1997; revised manuscript received by the editors April 13, 1998. The original version (prior to the final revised manuscript) was submitted directly to the Journal on January 28, 1997.

KEY WORDS: Reclaimed soil, fines content, shear modulus, damping ratio.