SAND BEHAVIOR CHARACTERIZATION FOR VARIOUS GRAIN SIZE DISTRIBUTIONS

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A thesis submitted in fulfillment of the requirement for the award of the degree of Master of Engineering (Civil – Geotechnics)

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APRIL 2010

Dedicated to my beloved father and mother, Abd Rahman Bin Alias and Zainap Binti Abdul Ghani, All my sisters and brother (Monnaliza, Norsuriya and Mohd Rizal).

ACKNOWLEDGEMENT

First and foremost, I would like to thank Allah the Almighty for His guidance and help in giving me the strengths to complete this thesis. In particularly, I would like to express my sincere appreciation to my supervisor, Dr Mokhammad Farid Ma'ruf for the encouragement, knowledge, motivation, patience and time in helping me along the preparations of this thesis.

Thank are due to all the staff of Geotechnical Laboratory, Faculty of Civil Engineering, UTM, especially to Mr. Zulkifli , who are willing to provide assistance at various occasions.

Last but not least, I warmly thank my family and close friends of mine for their love, patience and encouragement during those stressful times. Their views and tips are useful indeed. Without their continued support and interest, this project would not have been the same as presented here. A lot of thank for all parties have been contributed directly and indirectly.

ABSTRACT

The enormous amount of work done so far do not much elaborate the relationships both density and fabric to grain size distribution. The main objective of this study is to investigate sand behavior characterization for various grain size distributions. Grain size distribution curves are develop from the sieve analysis. A series of laboratory test has been carried out shows that grain size distributions make an effect on sand behavior characterization. 2 sample of well graded and 1 sample of uniform sample have been tested under wide range of laboratory conditions. Consolidated undrained triaxial test on granular soils have been systematically carried out. The various of stress-strain relationship has been develop during this study. Results of the test clearly indicate that, well graded soil sample have higher strength value than the uniform soil sample. Liquefaction strength of coarse grains may be roughly evaluated by the index of relative density (Dr). despite large different in particle gradations. One of most important mechanisms in the deformation of coarse grains is the relative sliding between particles.

ABSTRAK

Sejumlah besar kerja yang dilakukan tidak banyak menjelaskan hubungan antara kepadatan dan bentuk agihan butiran. Tujuan utama kajian adalah untuk mengetahui hubungan antara ciri pasir berdasarkan kepada agihan pelbagai saiz butiran. Graf agihan butiran dapat dilakukan berdasarkan kepada analisis ayakan kering. Ujian makmal dilakukan untuk mengetahui bahawa agihan saiz butiran menberi kesan kepada ciri pasir. Dua jenis sampel dihasilkan untuk menjalankan projek ini iaitu sampel yang mempunyai saiz butiran yang berbeza dan sampel yang mempunyai saiz butiran yang seragam. Ujian CU dilakukan dengan bersistematik untuk mendapatkan keputusan yang baik. Hasil daripada ujian yang dilakukan pelbagai hubungan tegangan-regangan dapat dihasilkan. Keputusan ujian jelas menunjukkan bahawa sampel yang mempunyai saiz butiran yang berbeza mempunyai kekuatan yang lebih tinggi daripada sampel yang mempunyai saiz yang seragam. Likuifakasi kekuatan butiran yang kasar boleh dinilai dengan indeks relatif (Dr) . salah satu mekanisme penting dalam deformasi butiran adalah sifat butiran dan gelongsoran antara zarah.

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ρ_b	=	Bulk density
ρ_d	=	Dry density
γ_w	=	Unit weight of water
γ_d	=	Dry unit weight
C_u	=	Uniformity coefficient
C_z	=	Curvature coefficient
V_s	=	Void of soil
ε_a	=	Axial strain
q	=	Deviator stress
p	=	Effective Stress Path
e	=	Void ratio
Dr	=	Relative density
Gs	=	Specific gravity

ρ_s	=	Particle density
μm	=	micrometer

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CHAPTER 1

INTRODUCTION

1.1 Background of the Study

Sand, one of the most basic mineral formations on the planet, can be found in some capacity in every country, temperate zone, geographical region and continent around the globe. Sand is defined as a naturally occurring granular material composed of finely divided rock and mineral particles.

Sands behavior under loading is susceptible to deal with the failures of earth related structures. The investigation of upper and lower San Fernando Dams failure (Seed at al.1975; Ming and Li, 2004), Immogawa river dams landslide (Marui and Yoshimatsu, 2007), landslide at Chuetsu Region during Mid-Niigata earthquake (2004), Macchu Pichu World Heritage landslides (Sassa et al. 2005) and El Salvador landslide hazard (Rodriguez et al, 2006) were

revealed better knowledge regarding factors behind the failures. These failures were triggered either by earthquake or by monotonic loading. However, a salient outcome from these investigations was that the sands responsible to develop these earth related structures failures.

Sands behavior during loading extends several phenomena. Flow deformation, dilatancy, critical state and steady state condition, transformation phase are the important ones that have to be concerned. In fact, it is well known that sands behavior depend on density, initial pressure, initial fabric and stress history. The evidence of close relation of sand shear strength to its initial density, initial pressure and stress history was identified by many researchers (Bopp and Lade, 2005; Verdugo and Ishihara, 1996; Yoshimine et al., 1998). Moreover, Cubrinovski and Ishihara (1998) revealed dilative and contractive behavior when applied loading to various combination of initial density and initial pressure.

The density of sands has correlation with its gradation. Recent works of Aberg (1996a);Aberg (1996b); Ng et al. (2006); Aberg (1992); Santamarina and Cho (2004) and Ozgurel et al. (2004) are among others who succeed to explore this correlation. Miura and Toki (1982) and Tatsuoka et al. (1986) did similar works to investigate the effects of sample preparation on shear strength and deformation of several types of natural sands having different grain size distribution. They concluded that various sample preparation will produce various porosity and fabric to develop completely different response during loading for each gradation. However, the relation of gradation and initial density to its fabric remained unclear. The works of Sulaiman et al. (2007) and Sulaiman (2008) modeled void ratio sediment based on its gradation.

The enormous amount of work done so far do not much elaborate the relationships both density and fabric to grain size distribution. Better knowledge on the relationships among them helps one to predict sands behavior during loading. In the proposed research work, the influence of gradation to sands behavior phenomena such as dilatancy, steady state, transformation phase and flow deformation will be clarified through the direct shear and triaxial test at wide spread condition. The result of this work will present better guidance for geotechnical engineer to interpret properly when they deal with soil, especially sands.

1.2 Problem Statement

The differentiation among different kind of soil is necessary in order to help geotechnical engineers to judge properly when dealing with soils because soils has wide spread behavior. However, relative density alone is not a good parameter from engineering view since it neglect to pressure state (Alarcon-Gusman et al. 1998, Konrad 1991)[1].

Since then the attempt to find a single parameter to take account the effect of relative density and confining pressure has been started. Been and Jefferies (1985) introduced a scalar parameter called state parameter ψ that consider the

[1] Alarcon-Gusman et al. 1998, Konrad 1991

effect of the relative density and confining pressure using steady state line (SSL). The state parameter is a measure of vertical distance of current void ratio from the steady state line in the e − I1 line. The definition of state parameter postulates that sands will have similar behavior if the different between the current void ratio and its corresponding steady state void ratio is identical. The state parameter was the remarkable parameter in characterizing sands behavior.

1.3 Objectives

The main objective of this study is to carry out a comprehensive study on the sands behavior due to various gradations. This includes the evaluation of flow deformation, dilatancy, phase transformation and steady state phenomena. Clarification of the relation among gradation, porosity and sands behavior during loading is also included. The specific objectives of the study are:

i. To evaluation of the grain size distribution effects on sands behavior under loading
ii. To clarification of the relation among grain size distribution, porosity and sands behavior
iii. To characterization of sands behavior based on grain size distribution and porosity.

1.4 Scope of Study

This study is focus on the sand behavior characterization for various of grain size distributions. The sand sample is industrial sands composed of natural grains. Triaxial test will be conducted to achieve the research objectives.