STRENGTH CHA ITE AND KAOLIN WITH AND W D WITH SAND

NUR SYAHIRAH ADIBA BINTI JAMSUS

A report submitted in partial fulfillment of the
requirements for the award of the degree of
Bachelor of Civil Engineering

Faculty of Civil Engineering and Earth Resources
Universiti Malaysia Pahang

JUNE 2012

ABSTRACT

The behavior of sand was found to be governed by its chemical properties rather than its physical properties. Hence, it is important to determine the geochemistry properties of sand besides its physical properties. The thermal applied on the bentonite and kaolin is one of the important external elements for changing soil mechanical characteristics based on mineralogy and stress-strain relationship. It is for considering of mineralogy and mechanical properties of bentonite and kaolin to development a better construction material. To evaluation of bentonite clay and kaolin behavior when subjected to the thermal, several laboratory tests have been conducted to analysis of bentonite characteristics. This project aimed on determining the strength of sand, mixed with 0.25%, 0.5%, 1% and 2 % of bentonite and kaolin with and without thermal added the bentonite and Kaolin for 300°C for one hour. Bentonite and kaolin, in powdered forms, was mix with sand and compacted at optimum moisture content. The strength of the compacted samples was determined from direct shear test. It was observed that the material of bentonite and kaolin increased the cohesion of sand. The result shows that 1% bentonite 300°C gives higher shear strength of sand. This shows that the bentonite can be used to increase the strength soil than kaolin. This due to the fine nature of the materials that could fill the voids in the mixture but also contribute to decrease in friction angles.

ABSTRAK

Pasir yang digunakan kebanyakannya dikawal oleh sifat-sifat kimia yang terkandung di dalamnya dan bukannya sifat fizikal. Oleh itu, adalah penting untuk menentukan sifat-sifat kimia dalam tanah selain daripada sifat fizikal. Termal yang dikenakan ke atas bentonite dan kaolin adalah salah satu cara untuk menukar ciri-ciri mekanikal yang terdapat pada bahan berdasarkan mineralogi dan gabungan tegangan-terikan. Dengan mengambil kira sifat mineralogi dan mekanikal bentonite dan kaolin kepada kepenggunaan bahan binaan yang lebih baik. Untuk menilai bentonite dan kaolin yang telah terdedah pada haba, beberapa ujian makmal telah dilakukan untuk menganalisa ciri-ciri tanah liat tersebut. Eksperimen ini bertujuan uintuk mengetahui kekuatan pasir bercampur dengan 0.25%, 0.5%, 1% dan 2 % bentonite dan kaolin dengan atau tanpa termal pada bentonite dan kaolin selama satu jam. Dalam bentuk serbuk, pasir yang bercampur dengan bentonite dan kaolin dimampatkan pada kandungan lembapan yang optimum. Kekuatan pada sampel yang telah dipadatkan telah ditentukan dengan ujian kekuatan ricih. Didapati bahawa bentonite dan kaolin telah meningkatkan kepaduan pasir. Dalam kebanyakan sampel, 1% bentonite 300°C memberikan kekuatan ricih yang paling tinggi daripada sampel yang lain. Ini menunjukkan bahawa bentonite boleh digunakan dalam meningkatkan kekuatan pasir berbanding kaolin. Ini disebabkan oleh sifat bahan yang mampu mengisi ruang-ruang kecil antara pasir tetapi menyebabkan geseran turut berkurangan.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

ASTM	American Society of Testing and Materials.
BS	British Standard
USA	United State of America
CU	Consolidated Undrained
LVDTs	Linear Voltage Displacement Transducers
MSE	Mechanically Stabilized Earth
SCPs	Sand Compaction piles
SPT	Standard Penetration Test
c	Cohesion intercept
φ	Angle of internal friction
Su	Undrained strength
u	Pore water pressure
a	Total normal stress
Qu	Unconfined compression strength
Al	Aluminium
Si	Silicon
O	Oxygen
H	Hydrogen
Na	Sodium
K	Potassium
g	gram
meq	milliequvalent
mm	millimeter
cm	centimeter
µm	micrometer
kPa	kilopascal
µ	micro

Cc	Coefficient of gradation
°C	Celsius
$kg\ m^{-2}$	Kilogram per meter square
°F	Fahrenheit

LIST OF APPENDICES

CHAPTER 1

INTRODUCTION

1.1 Background of the study

Sand, one of the most basic mineral formations on the planet, can be found some capacity in every, temperate zone, geographical region and continet around the globe. It been used in various structures in all types of civil engineering works such as low and high-rise building, infrastructure, military building, environment protection, and local or domestic developments (Limbachiya, 2004). Malaysia has seen extensive growth for the past one decade with many infrastructure projects in the construction industry. Sand create major problem in any construction of any infrastructure not just in Malaysia, but also some other country in the world. Current technology affords many ground improvement techniques to suit a variety of soil conditions, structure types and performance criteria.

Sand is a naturally occurring granular material composed of finely divided rock and mineral particles. The composition of sand is highly variable, depending on the local rock sources and conditions, but most common constituent of sand in land continental settings and non-tropical coastal setting is silica (silicon dioxide) usually in form of quartz. Sand is usually a fine grained and poorly graded material with small amounts of silt. These soils are characterized by a loose fabric structure and are susceptible to erosion by wind and rain (Al-Khanbashi et al., 2000). Sands are also not suitable for support structure and roads, because they are loose and vulnerable to collapse upon wetting (Elsharief et al. 1999). Bentonite attracts and neutralizes poisons in the intestinal tract. It can eliminate food allergies, food poisoning, mucus colitis, spastic, viral infections, stomach flu, and parasites (parasites are unable to reproduce in the presence of clay). There is virtually no digestive disease that clay will not treat. Sands are also not suitable for dam construction because of it relatively in high permeability and low in shear strength. For the same reason, sands also not suitable for any construction for landfill liner and covers.

Mixing sand with other material like bentonite, natural clays, cement, cement by-pass dust and incinerator ash can be considered to produces a new mixture that can be used to support structure, road construction and as a water barrier (Mohamedzein et al. 2003).

The first step in stabilizing sand is temporary stabilization by any material that stops surface sand movement. The second step is biological stabilization, which consists of establishing a permanent vegetative cover (TROEH et al. 1980). Another reason for stabilizing sandy areas is to maintain the quality of the environment. (ARMBRUST 1977, TROEH et al. 1980).

Better knowledge on the relationship among them helps one to predict sands behavior during loading. In previous research work, most research shows only on natural soil stabilization. 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

Bentonite is a yield which greatly found in Malaysia. Bentonite is an absorbent aluminum phyllosilicate, essentially impure clay consisting mostly montmorillonite. There are different types of bentonite, each named after the respective dominant element, such as potassium (K), sodium (Na), calcium (Ca) and aluminum (Al). Usually come out with two types of bentonite, sodium bentonite and calcium bentonite.

Kaolinite is a clay mineral, part of the group of industrial minerals, with the chemical composition $Al_2Si_2O_5(OH)_4$. It is a layered silicate mineral, with one tetrahedral sheet linked through oxygen atoms to one octahedral sheet of alumina octahedral. Rocks that are rich in kaolinite are known as kaolin or china clay. Kaolinite has a low shrink-swell capacity and a low cation exchange capacity (1-15 meq/100g). It is a soft, earthy, usually white mineral (dioctahedral phyllosilicate clay), produced by the chemical weathering of aluminums silicate minerals like feldspar.

Kaolin commonly has highly polar hydrophilic surfaces, whereas the polymers (e.g., polypropylene) into which they are introduced are often non-polar and hydrophobic. Consequently, poor adhesion occurred between the filler surface and the matrix. In addition, achieving uniform dispersion of the fillers tended to be difficult. Filler coating improved filler dispersion, which resulted in enhanced mechanical properties and easier process ability.

During now a day's lifestyle, human always create something out of box. Mega structure, high tech- increase life style and etc. playing a lot of space in land. As heavy load transfer to the earth, soil play main role to make the structure stabil. Sand's many uses require a significant dredging industry, raising environmental concerns over fish depletion, landslides, and flooding. Countries such as China, Indonesia, Malaysia and Cambodia ban sand exports, citing these issues as a major factor. The problem with soft clay is large settlement and low bearing capacity. With more research being conducted, various techniques are available to reduce the settlement and increase the bearing capacity of soft clays. Bentonite and Kaolin both can stand alone as clay when it comes with soil.

1.3 Objectives

The main objective of this study is to carry out a compressive on the sand behavior due to various type of clay.

i. To evaluating the properties of given sand.

ii. To determine changes in basic properties of Sand mixed with various percentages of kaolin and bentonite. Only unheated and 300°C bentonite and kaolin are used. The percentages of mix are 0.25%, 0.5%, 1% and 2% by weight of bentonite and kaolin.

iii. To determine soil shear strength in the expression of normal stress, friction angle and cohesion.

1.4 Scope of Study

In this research will focus on to evaluate the soil shear strength behavior of sand + bentonite and sand + kaolin. It is based a total stress analysis and an effective stress analysis. This type of bentonite and kaolin will be mix separately and together by using thermally processed. Because lack of time needed, only 300°C heat for bentonite and kaolin are used to show the different of their properties in doing the experiment. Mix of proportion as illustrated in Table 1.1.

Table 1.1: Sand-Bentonite and Sand-Kaolin mixture ratio, bentonite subjected to the heat in different level for 1 hour.

Specimen no.	Sand (%)	Unheated bentonite (%)	Bentonite 300°C (%)	Unheated Kaolin (%)	Kaolin 300°C (%)
1	100	-	-	-	-
2	99	1	-	-	-
3	98	2	-	-	-
4	99	-	1	-	-
5	98	-	2	-	-
6	99	-	-	1	-
7	98	-	-	2	-
8	99	-	-	-	1
9	98	-	-	-	2
10	99	0.25	0.25	0.25	0.25
11	98	.5	0.5	0.5	0.5

1.5 Expected Result

a) The goal of soil stabilization is to provide a solid stable foundation when sand soils are used.

b) Voids per volume of uniformly graded material will be dense enough to avoid loose sand with the small amount of additives.

CHAPTER 2

LITERATURE REVIEW

2.1 Introductions

Granular materials are made up of many small pieces that can move either separately or together. Some examples of different granular materials are sand, soil, grain, corn, plastic pellets, powders, and pills. These materials tend to have many different physical properties. They appear both liquid- or solid-like. For example, a pile of sand is more like a solid, while a vibrated or fluidized bed of sand can be more like a liquid like quicksand. This is important in life and industry.

Sand means different thing to a different people. A general, non-technical dictionary the definition of sand is a loose particle of hard broken rock. More restrictive definitions also exist which depend upon the frame of reference or academic discipline to which the meaning of sand is to be applied.

Soil stabilization refers to the process of changing soil properties to improve strength and durability. There are many techniques for soil stabilization, including compaction, dewatering and by adding material to the soil. Mechanical stabilization improves soil properties by mixing other soil materials with the target soil to change the gradation and therefore change the engineering properties.

The sands form the outer shape of the mold cavity. These sands normally rely upon a small amount of Bentonite clay and Kaolin clay to act as the binder material. Chemical binders are also used to create sand 'cores'. Depending upon the geometry of the casting, sands cores are inserted into the mold cavity to form internal passages for the molten metal. Once the metal has solidified, the casting is separated from the molding and core sands in the shakeout process.

2.2 Ground Improvement method (General)

In general, the term soft ground includes soft clay soils, soils with large fractions of fine particles such as silts, clay soils which gave high moisture content, peat foundations and loose sand near or under the water table (Kamonand Bergado 1991). For clayed soils, the softness of the ground can be assessed by its undrained strength, Su, or by it unconfined compression strength, qu. On the other hand, the SPT N-values are utilized to ascertain the consistency of the ground and its relative density. Where poor ground conditions make traditional forms of construction expensive, it may be economically viable to attempt to improve the engineering properties of the ground before building on it. This can be done by reducing the pore water pressure, by reducing the volume of voids in the soil, or by adding stronger materials. For soft and cohesive soils in subsiding environments, ground improvement by reinforcement (i.e. sand compaction piles), by admixtures (i.e. deep mixing method), and dewatering (i.e. vertical drains) are applicable. For loose sand deposits, various in-situ compaction methods are applicable such as dynamic compaction, resonance compaction and vibroflotation. Above the ground, such techniques as earth reinforcement or mechanically stabilized earth (MSE) and the utilization of lightweight synthetic materials are applicable.

The risk of liquefaction and ground deformation can be reduced by the following types of ground improvement: densification, solidification, drainage, dewatering and reinforcement (Ledbetter, 1985; National research Council, 1985; Kramer and Holtz, 1991; JSSFME, 1995)

2.3 Sand

2.3.1 Properties of Sand

The internal pore characteristics are very important properties of aggregates. The size, the number, and the continuity of the pores through an aggregate particle may affect the strength of the aggregate, abrasion resistance, surface texture, specific gravity, bonding capabilities, and resistance to freezing and thawing action. Absorption relates to the particle's ability to take in a liquid. Porosity is a ratio of the volume of the pores to the total volume of the particle. Permeability refers to the particle's ability to allow liquids to pass through. If the rock pores are not connected, a rock may have high porosity and low permeability.

Surface texture is the pattern and the relative roughness or smoothness of the aggregate particle. Surface texture plays a big role in developing the bond between an aggregate particle and a cementing material. A rough surface texture gives the cementing material something to grip, producing a stronger bond, and thus creating a stronger hot mix asphalt or portland cement concrete. Surface texture also affects the workability of hot mix asphalt, the asphalt requirements of hot mix asphalt, and the water requirements of portland cement concrete.

Some aggregates may initially have good surface texture, but may polish smooth later under traffic. These aggregates are unacceptable for final wearing surfaces. Limestone usually falls into this category. Dolomite does not, in general, when the magnesium content exceeds a minimum quantity of the material.

Figure 2.1: Sand

2.3.1.1 Specific gravity and Water Adsorption

Density is the weight per unit of volume of a substance. Specific gravity is the ratio of the density of the substance to the density of water. 3-3 The following chart illustrates these relationships for some common substances.

Table 2.1: Typical values

Substance	Specific gravity	Density (lb/ft^3)
Water	1.0 (73.4°F)	62.4 (73.4°F)
Limestone	2.6	165 to 170
Lead	11.0	680 to 690

The density and the specific gravity of an aggregate particle is dependent upon the density and specific gravity of the minerals making up the particle and upon the porosity of the particle. These may be defined as follows:

1) All of the pore space (bulk density or specific gravity)
2) Some of the pore space (effective density or specific gravity)
3) None of the pore space (apparent density or specific gravity)

Determining the porosity of aggregate is often necessary; however, measuring the volume of pore space is difficult. Correlations may be made between porosity and the bulk, apparent and effective specific gravities of the aggregate. As an example, specific gravity information about a particular aggregate helps in determining the amount of asphalt needed in the hot mix asphalt. If an aggregate is highly absorptive, the aggregate continues to absorb asphalt, after initial mixing at the plant, until the mix cools down completely.

This process leaves less asphalt for bonding purposes; therefore, a more porous aggregate requires more asphalt than a less porous aggregate. The porosity of the aggregate may be taken into consideration in determining the amount of asphalt required by applying the three types of specific gravity measurements. In the example in Figure 3-1, the bulk specific gravity includes all the pores, the apparent specific gravity does not include any of the pores that would fill with water during a soaking, and the effective specific gravity excludes only those pores that would absorb asphalt. Correlation charts and tables provide guidance to asphalt quantities or acceptability of the aggregate.

The standard method of soil water content measurement involves taking a physical sample of the soil, weighing it before any water is lost, and drying it in an oven before weighing it again. The mass of water lost on drying is a direct measure of the soil water content. This measure is normalized either by dividing by the oven-dry mass of the soil sample, in which case the units are Mg Mg^{-1}, or by converting the mass of water to a volume (by dividing the mass of water by the density of water) and dividing this volume of water by the volume of the sample, in which case the units are m^3 m^{-3}. This method is standard and reliable but there are some problems to look out for (Dane and Topp, 2002, p. 419) if high accuracy is required. Because the water content is determined by direct weighing, this method is called gravimetric.

2.3.1.2 Gradation

A sieve analysis (or gradation test) is a practice or procedure used (commonly used in civil engineering) to assess the particle size distribution (also called gradation) of a granular material. Theoretically, it is difficult (Senov 1987, Aberg 1996) to predict the aggregate volumetric parameters, even the resultant void ratio, when the gradation curve is known. The Fuller's experimental study for minimum void distribution (Fuller and Thompson 1907) still forms the basis of these exercises.

The size distribution is often of critical importance to the way the material performs in use. A sieve analysis can be performed on any type of non-organic or organic granular materials including sands, crushed rock, clays, granite, feldspars, coal, and soil, a wide range of manufactured powders, grain and seeds, down to a minimum size depending on the exact method. Being such a simple technique of particle sizing, it is probably the most common.

2.2.1.3 Compaction

The mechanics of compaction has been approached from two different viewpoints for a long time i.e., that of the geologist-sedimentoligist and that of the soils engineer. The largest body of knowledge on properties affecting the sediment compaction undoubtedly has been accumulated in the field of soil mechanics. In as much as the terms compaction and consolidation are used by both disciplines, but with different connotations, it is necessary to present various definitions as used in each fields. In the field of soil mechanics, compaction means a density increase caused by mechanical or hydraulic means such as tamping, vibrating, loading or wetting, whereas in the geological science, compaction means the lessening of sedimentary volume owing to overburden loading, grain rearrangement, etc.

Table 2.2: Definitions of compaction and consolidation as used in the fields of geology and soil mechanics.

Geology-Sendimentology usage	Soils Engineering usage
Compaction	
A lessening of sedimentary volume owing to overburden loading, grain rearrange, etc.	An increase in bulk specific weight (or bulk specific gravity) caused by mechanical or hydraulic means such as vibrating, loading or wetting.
Consolidation	
The acquisition of structural competency by a sediment owing to reduction in volume, induration, cementation, etc.	The lessening of volume of a porous material (such as clay) by the expulsion of pore upon the application of the load.

Sand compaction piles (SCPs) are commonly used for rapid stabilisation of soft seabeds in near-shore construction works (Aboshi & Suematsu, 1985).

2.3.1.4 Soil Texture

Soil texture refers to the relative proportions of various size particles in a given soil. Particle size analysis enables to fix adequately the percentages of the various constituents of the soil. This soil characteristic has an important impact on the soil moisture status and aeration, as well as on other qualities like workability, root penetration and anchorage, cation retention, etc. Sandy soils are considered as "light", clayey soils as "heavy" since they are either easy or more difficult in tilling and cultivation.