A NEW COMPRESSION APPARATUS FOR PEAT AND ORGANIC SOIL

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This project report entitled "A New Apparatus For Peat And Organic Soil" was prepared by Norini Shamsudin as a partial fulfillment for the Bachelor of Engineering (Hons.) Civil Engineering degree programme is hereby read and approved by:

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A New Compression Apparatus For Peat and Organic Soil

by

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This report is submitted in partial fulfillment of the requirement for the degree of

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Dedicated to my father Hj. Shamsudin Napis

and mother Hjj. Aisah Othman

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Abstract

In most soil analysis cases, the soil at a given site such as peat or organic are often less than ideal for the proposed construction. They may be weak, highly compressible, or have a higher permeability than desirable from engineering or economic point of view. The most economical solution to the problem is to stabilize or improve the engineering properties of the soil. Stabilization is usually done by mechanical or chemical methods. Mechanical stabilization or compaction is the process of packing soil particles more closely together, usually by rolling, tamping or vibrating. Thus, it will increase the dry density of the soil. Generally, laboratory compaction is carried out by Standard Proctor Test. However, the new compression apparatus was developed as alternative for the compaction test. This study is mainly concerned with checking of the suitability of the new compression apparatus for peat soil. The data obtained were analysed and were compared with the data obtained from standard Proctor test. It was observed that the result from the new compression test is a bit different from the standard Proctor. Thus, the recommendation is also included in the end of this study for further work in future.

Abstrak

Dalam kebanyakkan analisis tanah, tanah yang terdapat dalam sesuatu tapak projek seperti tanah gambut selalunya tidak sesuai untuk tujuan tersebut. Tanah-tanah tersebut mungkin lemah, mempunyai kadar kebolehmampatan dan kebolehporosan yang tinggi daripada standard yang optimum dari segi kejuruteraan atau ekonomi. Cara penyelesaian yang berorientasikan ekonomi untuk menyelesaikan masalah ini ialah dengan menstabilkan atau meningkatkan ciri-ciri kejuruteraan tanah. Penstabilan biasanya dilakukan secara mekanikal atau secara kimia. Penstabilan mekanikal atau dikenali sebagai pemadatan ialah merupakan suatu proses, mengumpul elemen-elemen tanah secara kumulative selalunya dengan cara digelek, getaran atau dihentak. Dengan ini ianya berupaya meningkatkan ketumpatan kering tanah tersebut. Secara amnya, proses pemadatan tanah di makmal dilakukan dengan menggunakan ujian *standard Proctor*. Tetapi, satu alat pemampat telah di[erkenalkan sebagai alternative untuk dalam ujian pemadatan tanah. Dalam kajian ini, kesesuaian alatan baru ini ke atas tanah gambut difokuskan. Maklumat yang diperolehi dianalisa dan dibandingkan denga maklumat yang diperolehi melalui ujian *standard proctor*. Didapati di dalam ujian yang telah dijalankan ke atas alatan baru ini menghasilkan keputusan yang agak berlainan daripada ujian standard proctor. Oleh yang demikian, beberapa cadangan turut disertakan pada akhir kajian ini sebagai langkah untuk mempertingkatkan kebolehan alat baru ini.

CHAPTER 1

INTRODUCTION

Peat and organic soils are well known for their high compressibility, long settlement, low strength, high plasticity, high shrinkage and low hydraulic conductivity. They are composed of dead hygrophyte, which have been deposited over a long period of time without fully decomposing. In former day, peat was removed from geotechnical design when ever possible. However, in regions with very thick peat layers, removal remained economically unattractive and practically impossible (Molenkamp & Hesmati, 1997).

Thus, these soils need to be treated or improved before going for any geotechnical activities with them. The most common technique for soil treatment and improvement were mechanical and chemical method. The basic principle of all these methods are either to closing the soil particles together thus reducing the voids with some finer particles or chemically to change the properties of soil by the inclusion of other material.

Compaction is the densification of soil by the application of mechanical energy. In other words it refers to the process by which soil particles are packed more closely due to a reduction in the volume of void space; resulting from the momentary application of loads such as rolling, tamping or vibration. Its also involve the expulsion of air from the voids without the moisture content being changed significantly. Compaction is actually rather cheap and effective way to improve the properties of soil. It is performed to determine the optimum moisture content at which a given soil has to compact in order to achieve the maximum dry density. In the laboratory compaction test, a hammer is dropped several times on a soil sample in a mould. The mass of hammer, height of drop, number of drops, number of layers and the volume of mould are specified. During the compaction, the small amount of water draws off from the mould and flows to the other side. In addition, some amount of water may be observed by fibre. As a certain portion of the soil is impacted, the other remainder of the soil expands. As a result, the soil is not really compact.

The intention of this research is to use the static compressive load rather then the impact compaction in a new compaction apparatus. The objective of the present research are:-

- To check the suitability of the compression apparatus for the compaction test
- To investigate the effect of compactive effort of the peat and organic soil.

CHAPTER 2

LITERATURE REVIEW

2.1 General

Usually the soil at a site to be developed is not ideal from the viewpoint of soil engineering. In some cases, the engineer can avoid potential soil problem by choosing another site or by removing the undesirable soil and replacing it with desirable soil. In the early days, this procedure was widely employed. As time went on, decision to avoid bad soils was made frequently. Increasingly, the soil engineer has been forced to construct at site selected for reasons other than soil condition.

A second approach to the problem of bad soil is to adapt the design for the conditions at hand. Another approach is to improve the soil. This approach is becoming more feasible and more attractive. Soil improvement is frequently termed soil stabilization, which in its broadest sense is the alteration of any property of soil to improve its engineering performance.

In these chapter we are primarily concerned with mechanical stabilization or densification, also called compaction. Compaction and stabilization are very important when soil is used as an engineering material; that is the structure itself is made of soil. Besides, compaction is actually a rather cheap and effective way to improve the properties of soil

Compaction is one of the most widely used and the oldest technique of soil improvement. If the depth to be improved is less, then compaction on the surface of the soil may alone solve the problem. In the construction of road bases, runaways, earth dams and embankment, the soil is placed in layers of specified thickness, each layer being compacted to a specification relating to the type of plant in use. Surface compaction needs less skilled labor and is usually the most economical of the technique. There are several important advantages that occur through compaction: -

- detrimental settlements can be reduced or prevented
- soil strength increase and slope stability can be improved
- bearing capacity of pavement subgrade can be improved
- undesirable volume changes, for example caused by frost action, swelling and shrinkage may be controlled.
- decrease in its permeability.

These effects are beneficial for various types of earth construction, such as highways, airfields, earth dams and filling in building floors. As a general rule, the greater the compaction the grater the benefits will be.

The increased shear strength is achieved by the increase in the values for unit weight and shear strength parameters. Reduction in void ratio may achieve by particle reorientation subsequent to

- alteration of the soil structure
- crushing and changing in the geometry of the soil grains
- distortions of the grains

The reduced swelling, shrinkage and frost heave benefits come as a result of higher resistance to deformation and of a smaller void ratio. When considering the compaction of soils, two broad classifications of soils can be considered separately: (i) cohesive soils, and (ii) cohesionless soils. Cohesive soils are those that contain sufficient quantities of silt or clay to render the soil mass virtually impermeable when properly compacted. Such soils include all varieties of clays, silts, silty or clayey sands and gravels. In Unified Soil Classification Groups, they fall in CH, CL, MH, ML, SC, SM, GC, GM and boundary groups of any two of these. On the other hand, cohesionless soils are the relatively clean sands and gravels that remains pervious even when well compacted. Soils groups SW, SP, GW, GP and boundary groups of any two of these represent such soils (Fang, 1991)

2.2 Type of Compaction

The earliest and most common type of compaction test consist of placing soil in a mold and then dropping a hammer on the soil a specified number of times. This type of test is frequently termed a *dynamic or impact* compaction test. The mass of the hammer, height of drop, number of drop, number of layers of soil and the volume of mold are specified.

Cohesionless soils is efficiently compacted by vibration, also known as *static* compaction. In static compaction test the soil is subjected to a static stress of a given magnitude. Hands – operated vibrating plates and motorized vibratory rollers of various sizes are very efficient for compacting sand and gravel soils in the field. Rubber-tired equipment can also be used efficiently to compact sands. Even large free falling weight has been used to dynamically compact loose granular fills.

Fine grained and cohesive soils may be compacted in the laboratory by falling weight and hammers, by special "*kneading*" compactors and even statically in common loading machine or press. In the field, common equipment includes hand –operated tampers, sheepsfoot rollers rubber-tired rollers and other types of heavy compaction equipment. Considerable compaction can also be obtained by proper routing of the hauling equipment over the embankment during construction.

2.3 Theory of compaction

With the application of compactive effort in a soil, its density is found to increase with the increase of water content and then decreased. This compaction phenomenon is graphically explained using the dry density, the attainable value that is related to the water content. A typical of this plot is shown in Figure 2.1. Several investigators have attempted to explain this phenomenon. All these explanations must be considered tentative since they are based almost entirely on what appeared to be logical for the state of knowledge at the time rather than on reproducible measurement (Fang, 1991)

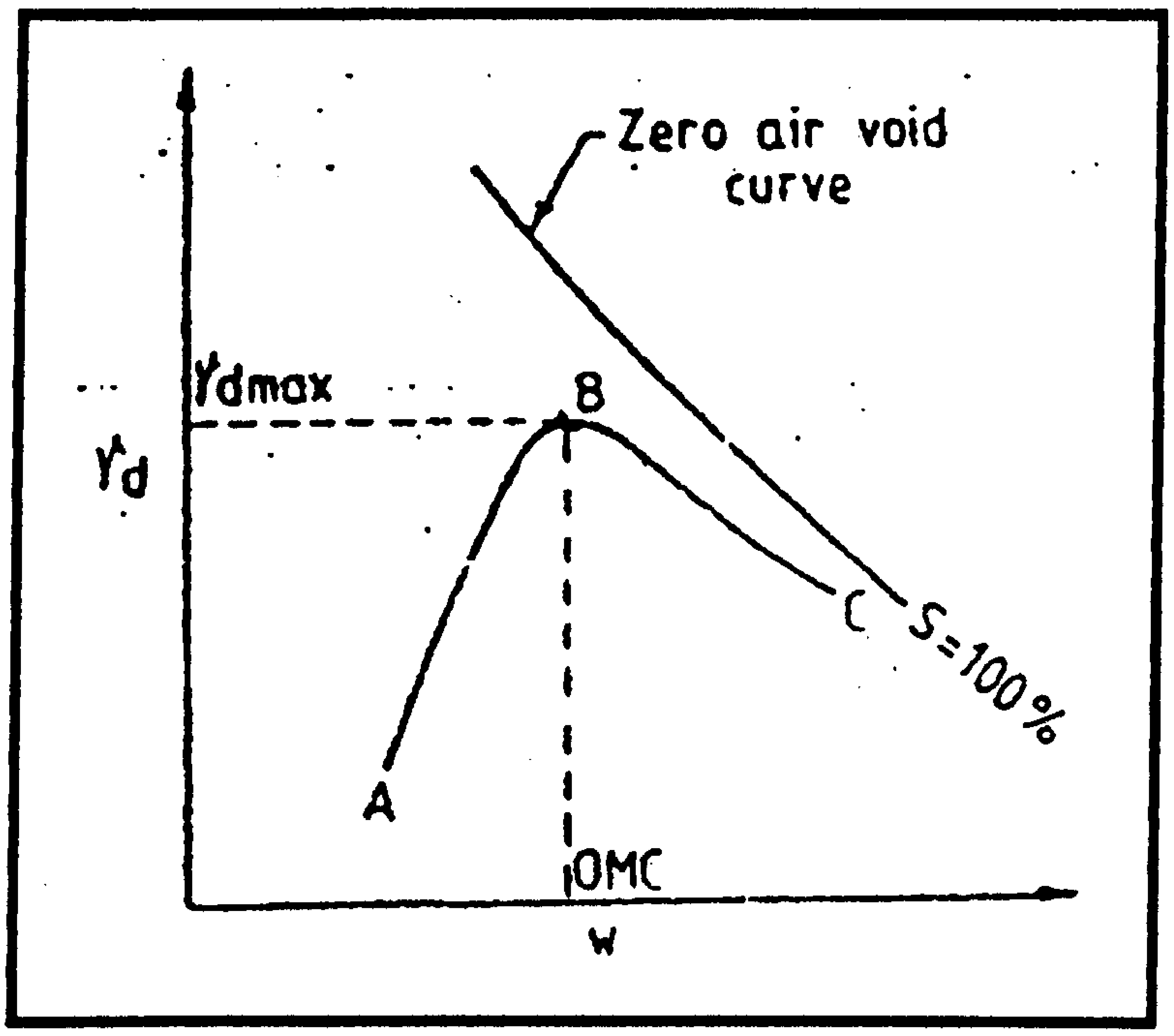

Figure 2.1: Moisture Density Relationship for Compacted Soil

The pioneering theory of compaction of soil is due to Proctor (1993). According to Proctor the moisture in a relatively dry soil creates capillary effects that held particles together, resulting in high frictional resistance that opposes the compaction forces. Thus at a very low moisture content of soil, compaction result in a hard and firm due to capillary moisture. Compacting the soil at higher moisture content causes a greater rearrangement of variously sized soil particles owing to the additional lubrication furnished by the additional water. The result is a soil of greater density but one that is less firm.

By compacting the soil with increasing amount of water, this effect continues until the point at which the moisture content with a small amount of contained air that the compaction process cannot remove becomes just sufficient to fill the voids when the compaction process is completed. The soil at this stage has the greatest density and least void that this method of compaction can obtain.

A still higher moisture content limits the compaction to a point at which the voids equals the volume of contained air and water, resulting in a compacted soil with more voids, less density, and increased plasticity (softness). This effect continues with the addition of more water until the soil becomes too soft too sustain compaction equipment.

Proctor's explanation provided him with an excellent method of controlling the construction of cohesive fills, considering the limited knowledge then existing of pore pressure and shear strength. (Fang, 1991).

Hogentogler (1963) considered that the shape of compaction curve reflects four stages of wetting soil; hydration, lubrication, swelling and saturation. Hilf (1956) used to theory of pore water pressure to explain the compaction phenomenon. Of the other significant contributors in the field are Gilbert (1959), Bishop (1959), Lambe (1960) and Olson (1963). Details of their explanation of compaction phenomenon can be found in Fang (1991). It now appears that the process that results in the familiar peaked compaction curve is quite complex, involving capillary pressure, hysteresis, pore air pressure, pore water pressure, permeability, surface phenomenon, osmotic pressure and concept of effective stress, shear strength and compressibility (Fang, 1991). However, the simple explanation provided by Proctor coupled with concept of pore water pressure explains the phenomenon reasonably well. It is now understood that the compaction of soil, which is usually expressed in terms of dry density, depends on the following factors:

- soil type
- water content
- compactive effort

Compactive effort is measure of the mechanical energy applied to a soil mass. The amount of compactive effort delivered to a point in a soil during compaction depends upon the mass of the compacting units and the number of times that is runs over the point (i.e. the number of passes). The greater the number of passes the greater the compactive effort.

2.4 Moisture Content Dry Density Relationship

Compaction is quantified in terms of soil 's dry unit weight, γ_d , which can be computed in terms of wet unit weight, γ and moisture content, w, by: -

$$\gamma_d = \frac{\gamma}{1+w}$$

(Equation 2.1)

When water is added to the soil during compaction, it acts as a softening agent on the soil particles. The soil particles slip over each other and move into a densely packed position. The dry unit weight after compaction first increase as the moisture content increase (Figure 2.2). When the moisture content is gradually increased and the same compactive effort is used for compaction, the weight of the soil solids in a unit volume gradually increase. Beyond certain moisture content, any increase in the moisture content tends to reduce the dry unit weight. This is because the water takes up the spaces that would have been occupied by the solid particles. The moisture content at which the maximum dry unit weight is attained is generally referred to as the optimum moisture content.

In Figure 2.2, the right side of the moisture content versus dry unit weight curve roughly parallels the dashed line labeled "zero air void." This line represents the dry unit weight when saturation is 100 %. This line actually represents in theory the upper limits on unit weight at any moisture content versus dry unit weight curves. It can be determined from the equation.

$$\gamma_d = \frac{SGs\ \gamma_w}{S + wGs}$$

(equation 2.2)