Global Journal of Researches in Engineering
Civil And Structural Engineering
Volume 13 Issue 2 Version 1.0 Year 2013
Type: Double Blind Peer Reviewed International Research Journal
Publisher: Global Journals Inc. (USA)
Online ISSN: 2249-4596 & Print ISSN: 0975-5861

Civil Engineering Significant of Peat

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Abstract - Peat deposits are the partly decomposed and fragmented remain of plants that have accumulated under water (excessively moistened) and fossilized, and consist of more than 50% organic substances. This type of subsoil foundation has high compressibility and low shear strength when subjected to imposed loads from civil engineering projects. It is essential to distinguish this problematic soil from better quality soils. Visual inspections including colour (dark brown to black) and odour (organic odor) tests can help to recognize peat. Field strength evaluation tests such as FVST and PLT can give good estimates of peat shear strength. Also laboratory tests such as moisture content, organic content and UCS and CBR may be used to evaluate peat physical and mechanical properties as well.

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GJRE Classification : FOR Code : 090599

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I. Introduction

Hawkes and Webb (1962), define soil as "any loose surface material overlying solid rock". Thus the concept of soil includes not only the detritus of weathered rocks and accumulation of inorganic sediments, rather includes peat as well. According to the Oxford dictionary, the word "peat" is a soft black or brown substance formed from decaying plants (Oxford University Press 1995). In general, peat deposits are the partly decomposed and fragmented remain of plants that have accumulated under water (excessively moistened) and fossilized, and consist of more than 50% organic substances.

These features determine their polyfunctional nature. Botanists and geobotanists study the specific features of bog vegetation on peat soils and the climatic characteristics of the period of the peat accumulation based on the stratigraphy of peat deposits, and they define peat as bogs. Geologists explore peat reserves for industrial purposes and consider peat bogs as peat fields (economic deposits). Hydrologists study the hydrological regime of bogs and determine them as water bodies. Foresters study bogs from the position of improving the quality class of forest stands and call them forest bogs. Soil scientists study peat as agricultural highly fertile soils (Soper and Osbon 1922; Radforth 1969; Babel 1975; Stanek and Worley 1983; Van der Heidjden *et al.* 199; and Inisheva 2006).

To civil engineers peat is an example of extreme type of soft soil, and is called a problematic type of soils, and they characterize peat deposits with the following behaviours (Huat 2004, Kalantari 2010).

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a) High organic content
b) High natural water content
c) High compressibility
d) Low shear strength

Also organic soils and peat in general show: high liquid limit, low density, relatively low plasticity, and different particle size distribution compared with inorganic soils. It is therefore understandable that any kind of civil engineering construction is usually avoided when facing peat lands. However, peat is found in many countries around the globe. In US, peat is found in 42 states, with a total acreage of 30 million hectares (each hectare is 10,000 m^2). Canada and Russia are the two countries with the largest area of peat, 170 and 150 million hectares respectively. Also, tropical peat cover a total of 30 million hectares of the world land, where two third is located in Southeast Asia (Duraisamy *et al.* 2007).

Due to population increase, and demand for social improvements, and therefore land scarce, there is a strong feeling among civil engineers in general and geotechnical engineers in particular to find ways to strengthen organic soils and peat while keeping the project cost as low as possible. In-order to strengthen peat against imposed loads, it is essential to know its civil engineering characteristics. In the following sections behaviour of this type of foundation subsoils that are more important to civil engineering projects are discussed with more details.

II. Organic Soils and Peat

Any material that contains carbon is called "organic". However, engineers and geologists use more narrow definition when applying the term to soils. An organic soil is one that contains a significant amount of organic material recently derived from plant remains. This implies to be fresh and still in the process of decomposition, and thus retain a distinctive texture, a dark brown to black color, spongy consistency, and an organic odor (Kalantari 2010, Coduto *et al.* 2011). Plant fibres are sometimes visible but in the advanced stages of decomposition, they may not be evident. Organic soils with more than 50% organic content may be considered peat. Peat is usually found as an extremely loose, wet, unconsolidated surface deposit which forms as an integral part of a wetland system, and their civil engineering properties are much worse than those of inorganic soils (Huat 2004, Coduto *et al.* 2010).

III. Distributions of Peat in World

Peat deposits accumulate wherever the conditions are suitable, that is, in areas with excess rainfall, and the ground is poorly drained, irrespective of latitude. Nonetheless, peat deposits tend to be most common in those regions with a comparatively cool, wet climate. Usually water logged poorly drained conditions not only favour the growth of a particular type of vegetation but also help preserve the plant remains (Huat 2004).

Peat is found in many countries around the globe. Canada and Russia are the two countries with a large area of peat, 170 and 150 million hectares respectively (Duraisamy 2008; Alwi 2007; and Huat 2004). Figure 1 shows distribution of peat deposits covering fifteen countries.

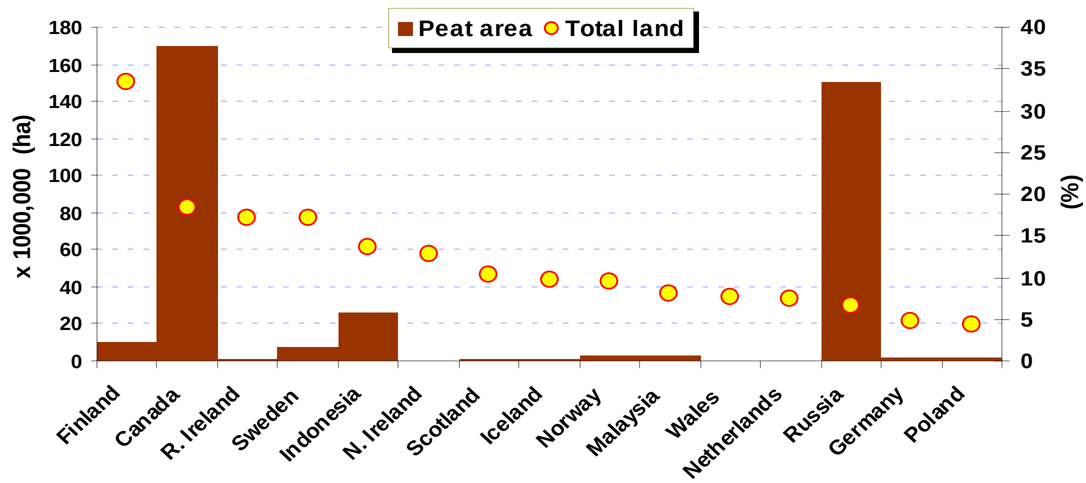

Figure 1 : Percentage of area covered by peat in different countries in rank order (Mesri and Ajlouni 2007; Kalantari 2010; Huat *et al.* 2011)

IV. Description of Peat

For civil engineering purposes, it is essential to describe organic soils or peat. Therefore some essential index properties of these types of subsoil foundations are needed in-order to classify them and find best ways to counter their negative effects on the designed imposed loads. Hobbs (1986) and Edil (1977) suggested the following characteristics to be included for a full description of peat.

a) Colour, and odour
b) Water content
c) Degree of humification
d) Fibre content
e) Liquid limit and plastic limit
f) Principal plant component, namely coarse fibre, fine fibre, amorphous granular material and woody material

V. Classification of Peat

Based on unified soil classification system (USCS), organic soils are recognized as a separate soil entity and have a major division called highly organic soils (pt), which refers to peat, muck and highly organic type of soils. Jarret (1995) gives a classification for organic soils, which can be integrated with the USCS to bridge the gap between peat, and purely inorganic soils that is shown in Table 1.

Table 1 : Classification of organic soils based on their organic content (Jarret 1995)

Basic soil type	Description	Organic content (%)
Clay or silt or sand	Slightly organic	3-20
Organic soil	Organic	20-75
peat	Highly organic	> 75

Another useful tool to classify organic soils or peat is based on their fibre content as well as their humification (decomposition) of the fibres. von Post (1920) proposed a classification system, which is based on a number of critical factors such as degree of humification, botanical composition, water content, content of fine and coarse fibres and woody remnants. There are 10 degrees of humification (H_1 to H_{10}, with H_1 being the least and H_{10} being the most decomposed) in the von Post classification system that are determined based on the appearance of peat water that is extruded when the soil is squeezed in the hand. A more summarized version of von Post classification guideline that is also in part proposed by Malaysian soil classification systems for engineering purposes is shown on Table 2.

Table 2 : Classification of peat on the basis of degree of decomposition (Karlson and Hansbo 1981; Jarret 1995)

Designation	Group	Description
Fibrous peat	H_1-H_4	Low degree of decomposition. Fibrous structure. Easily recognized plant.
Pseudo-fibrous peat	H_5-H_7	Intermediate degree of decomposition. Recognizable plant structure.
Amorphous peat	H_8-H_{10}	High degree of decomposition. No visible plant structure. Mushy consistency.

The U.S department of agriculture (USDA) classifies peat in three-point scale with respect to fibre content that is determined by ASTM D 1997 test and is the result of decomposition process of peat materials. This type of classification is shown in Table 3.

Table 3 : USDA classification of peat (Huat 2004)

Type of peat	Fiber content	von Post Scale
Fibric peat	Over 66%	H_4 or less
Hemic peat	33-66%	H_5 or H_6
Sapric Peat	Less than 33%	H_7 **or more**

Also American association of state and highway transportation officials (AASHTO), as well as federal aviation administration (FAA) among soils from A-1 to A-8 classify peat as A-8.

VI. Engineering Properties of Peat

In order to identify major components of any type of soils and determining soil engineering properties, it is essential to conduct various types of tests. These tests may be divided to physical and mechanical tests. Physical tests begin with visual inspection of the soil, as far as soil's appearance, colour, possible odour, and plasticity are concerned. These methods, however, represent only the first step in adequate description of soil material. They must be supplemented by other procedures leading to quantitative results that may be related to the physical properties with which the engineer is directly concerned (Peck *et al.* 1974). After visual inspection of soil, tests that usually follow are index property tests and mechanical property tests. Organic soils and peat are not exceptions and the same types of tests are to be carried out on them as well.

Some of the most useful index property tests for civil engineers for organic soils and peat include:

a) Water content
b) Loss on ignition and organic content
c) Fibre content
d) Grain size distribution
e) Density and Specific Gravity
f) Atterberg Limits

Also the most useful mechanical tests (laboratory and field) for organic soils and peat are:

a) California bearing ratio (CBR)
b) Unconfined compressive strength (UCS)
c) Triaxial
d) Permeability (falling head)
e) Consolidation
f) Compaction (unusual but possible)
g) Field strength evaluation tests
   i. Vane shear test
   ii. Plate load test

Other tests such as pH (for degree of acidity), scanning electron microscopy or SEM (for microstructure analysis) and energy dispersing x-ray analysis or EDXA (for chemical characterization analysis) may also be used to complete the testing procedure for peat as well.

VII. Conclusions

Peat is one of the most problematic subsoil foundations that engineers are faced when civil engineering projects are concerned. This type of soil has low shear strength, and high compressibility when subjected to imposed loads. It is essential to distinguish this problematic soil from better quality soils. Visual inspections including colour (dark brown to black) and odour (organic odor) tests can help to recognize peat at field. Peat usually has unusual high moisture content (more than 100%) compared with inorganic soils. This type of soil may be changed (more decomposed) in shape through time. Peat may be classified as three types namely; fibric, hemic and sapric with sapric being the most decomposed compared with fibric that is the most fibrous and less decomposed. Field tests such as vane shear test (VST) and plate load test (PLT) can be carried out to check shear strength of peat. Also a few laboratory tests may provide some important parameters which can help the civil engineers to analyze best possible methods to combat this difficult soil. These tests include; water content, organic content, unconfined compressive strength (UCS), and California bearing ratio (CBR). Also, depth of existing peat, type of project, and cost-benefit ratio are considerable factors to be considered when dealing with peat deposit as well.

References Références Referencias

1. Alwi, A., 2007. *Ground improvement on Malaysian peat soils using stabilized peat-column techniques*. Thesis (PhD). University of Malaya, Kuala Lumpu.r
2. Coduto, P. D., Yeung, M.C.R., Kitch, W.A. 2010*. Geotechnical engineering, principles and practices. PHI learning private limited. New Delhi, India. 69, 15-158.*
3. Duraisamy, Y., 2008. *Compressibility behaviour of tropical peat reinforced with cement column*. Thesis (MS). University Putra Malaysia, Serdang.
4. Duraisamy, Y., Huat, B.B.K. and Aziz, A.A. 2007. Method of Utilizing Tropical Peat Land for Housing Scheme. *Amer. J. Environmental Sci*., 3 (4), 259–264.
5. Hawkes, H.E. and Webb, J.S. 1962. *Geochemistry in Mineral Exploration*. New York: Harper and Row.
6. Hobbs, N.B., 1986. Morphology and the properties and behavior of some British and forign peats. *Quaterly J. Eng. Geology*, 19, 7–80.
7. Huat, B., Kazemian, S., Prasad, A and Barghchi, M. 2011*. State of an art review of peat: General perspective.* International Journal of the Physical Sciences Vol. 6(8), pp. 1988-1996.
8. Huat, B.B.K., 2004. Organic and peat soils engineering. University Putra, Malaysia, 4–7, 14, 55, 58, 119 -120.
9. Inisheva, L.I., 2006. Peat Soils: genesis and Classification. *Eurasian Soil Sci*., 39 (7), 699–704.
10. Jarret, P.M., 1995. *Geoguide 6. Site investigation for organic soils and peat*. JKR document 20709-95, Inst. Kerja Malaysia.
11. Kalantari, B. 2010. *Stabilization of fibrous peat using ordinary Portland cement and additives*. Thesis (PhD). University of Putra Malaysia.
12. Karlsson, R. and Hansbo, S. in collaboration with Laboratory Committee of the Swedish Geotechnical Society, 1981. *Soil Classification and Identification*. Swedish Council for Building Research, D8:81, Stockholm.
13. Mesri, G. and Ajlouni, A. M. 2007. Engineering Properties of fibrous Peats. *J. Geotechn. and Geoenvironmental Eng*.. ASCE, 133 (7), 850–864.
14. *Oxford University Press,* 1995. Oxford Advanced Learners Dictionary New York: 853.
15. Peck, B.P., Hanson, E.W., and Thornburn, H.T. 1974. *Foundation Engineering*. 2nd. Edition. New York: John Willy & Sons. 7–8 & 83–84.
16. Radforth, N.W., 1969. Muskage as an engineering problem. *In:* I.C. MacFarlane, ed. *Muskeg Engineering Handbook,* Univ. of Toronto Press, Toronto. 3–30.
17. Soper, E.K. and Osbon, C.C. 1922. The occurence and uses of peat in the United States. *U.S.G.S. Bulletin No. 728,* 1–207.
18. Stanek, W., and Worley, I.A. 1983. A terminology of virgin peatlands. In: Proc. int. symp. peat utilization, Bemidji State University, Bemidji, Minn. 75–104.
19. Van der Heijden, E., Bouman, F. and Boon, J. J. 1994. Anatomy of recent and peatified Calluna vulgaris stems: Implications for coal maceral formation. *Proc. Int. J. Coal Geology,* 25 (1), 1–25.
20. Von Post, L. and Granlund, E. 1926. *Södra Sveiges torvtillgangångar I. Peat resources in southern Sweden*. Sveriges geoliska undersökning.

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