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Determination of Shear Strength of Organic Soil in Kashmir

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ABSTRACT- As a conference and tourist resort hub, Kashmir is one of India's most rapidly expanding states. There is a lot of building work going on right now. It's also projected that there will be a lot more building in the future. However, there has been relatively little research on the engineering qualities of Kashmir valley's soils. Shear strength, or the capacity to resist sliding along internal surfaces inside a soil mass, is one of the most essential engineering qualities of soil. All stability assessments in geotechnical engineering, whether they be for foundations, slopes of cuttings, or earth dams, require a fundamental understanding of this soil engineering feature. The shear strength parameters of Kashmir's alluvial soil are going to be investigated in this study. The shear strength parameters (c and Φ) are investigated using disturbed soil samples that have been remoulded with various densities and water contents to imitate field conditions. Infrastructural developments have now progressed in Jammu and Kashmir and strength evaluation of peat remains complex and uncertain. Considering failures of infrastructures resulting from inappropriate measurement of peat shear strength, this research paper present on the shear strength of peat and the modification of existing testing methods to assess its strength in the laboratory and on the field. The initial part of this research is the laboratory testing of peat specimens. Scanning electron microscopy (SEM), triaxial tests are conducted to characterise the morphology, compressibility and shear strength properties of peat. The results of the microstructural and compressibility analysis are presented together with the triaxial stress-strain analysis. The analysed results show the effect of decomposition on peat and shear strength characteristics.

KEYWORDS- Shear Strength, Peat, Organic Soil, Jammu and Kashmir, SEM

I. INTRODUCTION

Shear strength of soils is the main designing property. This is on the grounds that all security examination in the field of geotechnical designing, whether they connect with establishment, strength of slants cuts or earth dams, include an essential information on this designing property of the dirt. Shear strength might be characterized as the protection from shearing stresses and a resulting inclination for shear twisting. Shear strength of soil is the most challenging to understand considering the huge number of elements known to influence it [1]. A great deal of development and expertise might be expected with respect to the designer in deciphering the consequences of the research center tests for application to the circumstances in the field. Essentially, a dirt gets its shear strength from the accompanying: (1) Resistance because of the interlocking of particles.
(2) Frictional opposition between the singular soil grains, which might be sliding contact, moving grating, or both. (3) Cohesion between soil particles. Granular soils of sands might get their shear strength from the initial two sources, while firm soils or muds might get their shear strength from the second and third sources. Profoundly plastic muds in undrained condition anyway may display the third source alone for their shearing strength. Most normal soil stores are part of the way firm and somewhat granular and thusly, may fall into the two or every one of the three classes recently referenced, according to the perspective of shear strength [2].
Organic soils are deposits of decaying vegetation in a waterlogged environment, and it can be found in many parts of the world from the temperate to tropical regions. These geotechnical materials contain high organic matters that are going through a process of decomposition [3]. The rate of organic soil formation and degree of decomposition largely depends on the climate, types of vegetation and the available microbes [4]. Organic soil ranges from low decomposed to highly decomposed ones. It is often associated with poor strength characteristics, high compressibility, and high magnitude and rates of creep [5-9]. It is viewed as one of the most complex geotechnical material. It is a common practice to remove or avoid organic soil areas whenever construction on organic soil is unavoidable because of its challenging engineering properties.
In some part of the world, urbanisation necessitates expansion to organic soillands due to insufficient good land space. Large stretches of existing road, bridges, embankments and buildings constructed on organic soil are facing one or more engineering problems. The engineering problems commonly associated with organic soil ranges from unexpected failures to excessive settlement and landslide in some highland areas [10]. Currently, lots of funds are being expended on routine maintenance of existing infrastructure constructed on organic soil and critical concerns are being raised on the proposed developments to be situated in organic soil lands. In cases where construction of infrastructure on organic soil is unavoidable, careful

measurement of the undrained strength of organic soil is required for proper geotechnical stability analyses and economical design of infrastructures founded on organic soil. Over the years, the apparatus and testing methods developed for strength characterisation of inorganic soils are the ones employed for organic soil, with no consideration for the morphological differences and anisotropy properties of organic soil. The interparticle arrangement of organic soil mostly consists of linked cellular and entangled fibres, and not in frictional contacts like that of inorganic soils [11-14]

Laboratory shear strength testing of organic soil specimens is often ignored due to the operational challenges experienced in the laboratory and the complexity in result interpretations. The mode of failure mechanism of a particular geotechnical system on organic soillands is difficult to simulate with most of the laboratory tests available, due to high compressibility and fibre content. Therefore, the reliability of laboratory strength measurement for design and construction on organic soil is poor. There is a need to understand the stress-strain response of organic soil and improve laboratory measurements of organic soil shear strength. In-situ tests such as T-bar and ball penetrometers are viewed to be alternative tools for organic soil characterisation. These penetrometers which were developed to improve upon CPTu penetrometer and vane shear test have been shown to give consistent results in soft soil and organic soil testing [15]. The test procedure and interpretation methods for these tests are well standardised, especially for clay and sand. The standard penetration rate of 20 mm/s is expected to bring about fully drained test in sand and fully undrained test in clay. However, the accuracy of the standard rate of penetration testing in transitional soils such as organic soil, silts, sandy and clayey silts is doubtful. The compressibility and permeability characteristics of transitional soils vary between those of clays and sands, therefore utilising standard penetration rate in such soils can result in a partially drained response. Partially drained condition has been observed in organic soil. The degree of partial drainage is dependent on the soil compressibility, permeability and penetration rate in a standard penetrometer test [13-17].

The effects of variable penetration rate has been studied in some inorganic soils and appropriate rate for undrained resistance has been identified. However, rate effects is yet to be studied in organic soil, and the rate at which undrained strength test can be performed is unknown. In light of the increase in construction and development in areas of organic soil land, it is timely to study the rate effect in organic soil and identify appropriate penetration rate for organic soil testing.

The-primary goal of this-project is to investigate the shear strength characteristics of Kashmir’s alluvial soils. Its purpose is to look into the impact of consistency/density and water content on shear strength parameters in Kashmir’s alluvial soils. Different density and water content are obtained from the compaction curve to derive the shear strength values.

II. MATERIAL AND METHODS

The research method in this study is primarily experimental. Routine soil tests on a large number of soil samples are required to fully comprehend the soil's shear strength. Target soil sampling techniques are used at the site where soil sampling is carried out in order to reduce labour and cost while maximizing the information value of the research. The sample locations are supposed to be representative of the entire research region in this method.

For the experimental research, NIT Srinagar and IOT Srinagar labs have been used after getting the permission from the dean for the purpose of this study.

This review is a trial research that accentuated on lab test. This section portrays the materials utilized and the test strategies continued in carrying out a few trial examinations. The idea to complete the analysis and research facility testing are additionally introduced and talked about in this section. Moreover, the exploratory program can be ordered into two fundamental stages which are research center examination and furthermore the pilot of Central University of Kashmir, Ganderbal, Srinagar.

A. Collection of Data

This research will collect data from different organizations.

- The organic soil soil sample was collected from Anchar, Soura by the permission of UT government.
- Geotechnical data has been collected from R&B department.

B. Determination of Index Properties of Organic soil

Index tests carried out on the organic soil specimens includes Colour identification, von-Post, loss of ignition, fibre content, specific gravity, moisture content and liquid limit tests. All the index tests were carried out on disturbed specimens. Table 1 shows the summary of the standard/methods used for the index property tests.

Table 1: Summary of the standard/methods used for the index property tests

Index properties	Technique and device
Von Post	Hand squeezing
Organic Content (%)	High-temperature oxidation method (ASTM D2974).
Fibre Content (%)	Oven drying (ASTM D1997-91)
Moisture Content (%)	Oven drying (ASTM D2216)
Specific Gravity	Pycnometer using the kerosene (ASTM D854-10)
Liquid Limit (%)	Fall cone (BS 1377-2)
Colour	Visual Examination

III. RESULT AND DISCUSSION

A. Analysis of Results of the Index Properties of Organic Soil

Visual examination of the sample indicates a dark brown coloured organic material with a smooth texture. The von-Post squeeze test on the organic soil specimen does not show any recognisable plant structure on the hand after squeezing out the organic soil paste in between fingers. Almost all organic soil escaped through the fingers except for few undecomposed fibres. The nearly complete decomposed organic soil is classified to be H8-H10 (Sapric) according to the MSCS and Von-Post index. The estimated loss of ignition ranges from 92% to 96%. After the specimens were washed through a No. 100 sieve and oven-dried at 110 ± 5 °C, the measured fibre content was within 3.5 to 6.2 %. The measured specific gravity ranges from 1.69-1.71. The water content ranges from 378% to 620% and the liquid limit ranges from 540% - 602%. Based on the index tests results in Table 2, the organic soil can be considered as highly decomposed with less fibre. Note that humus materials are the product of secondary synthesis of organic soil and are chemically active due to their small sizes and high electrical surface charge [12]. These humus materials are also referred to colloids of organic soils similar to fine clay in mineral soils because of their comparable chemical characteristics [9].

Table 2: Index tests results

Index properties	Value Range
Von Post	H8-H9
Organic Content (%)	92 - 96
Fibre Content (%)	3.5 - 6.2
Moisture Content (%)	378 - 620
Specific Gravity	1.69-1.71
Liquid Limit (%)	540 - 602
Colour	Dark Brown

B. Results and Discussion of the Geotechnical Characterization Tests

Micrographs of organic soil

The micrographs of 15 specimens were taken to study the morphology of the organic soil used in this paper. Figure 1 and Figure 2 present representative images from SEM micrographs of the organic soil specimens that were taken at different magnifications. Majorly, the observed microstructure shows homogeneous non-crystalline micro-particles that are colloidal in structure and jelly-like in texture. Figure 1 (A) to Figure 1 (C) is a different magnification of the same specimen while Figure 1 (D) to Figure 1 (f) is also a different magnification of another specimen. Looking at the higher magnifications (Figure 1 (C) and Figure 1 (F)), it is clear that the colloidal structure has no intra-assemblage pore space, but pore water bounds their surfaces. Organic soil with colloidal microstructure is referred to as sapric granular material and are in the range of H8 to H10 in the Von-Post classification [9-12][18].

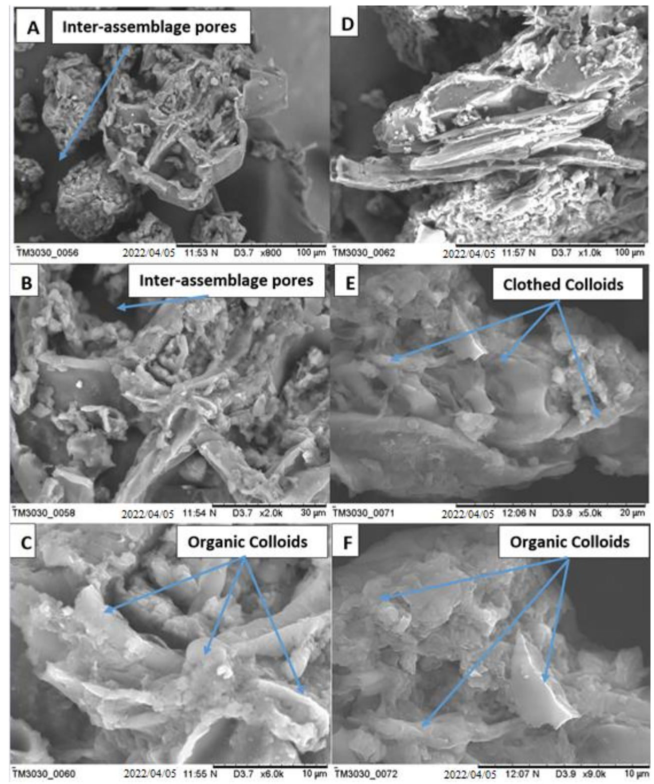

Figure 1: Scanning electron micrograph of organic soil specimens showing colloidal structures[18]

The second type of microstructure particles observed is sheet-like microstructure, existing in some of the specimens investigated (Figure 2). The microstructure appears in the form of honeycomb intra-assemblage with a solid intraparticle arrangement without any discernable water-holding cells or voids (Figure 2 (B) and Figure 2 (D)). The sheet-like particles have no direct contact with one another. It is also not possible to observe any distinct leaf structures, which means they are highly decomposed. Organic soil with sheet-like microstructure are mostly stemmed sheaths (integuments) and are classified as H7 organic materials [8,11][18].

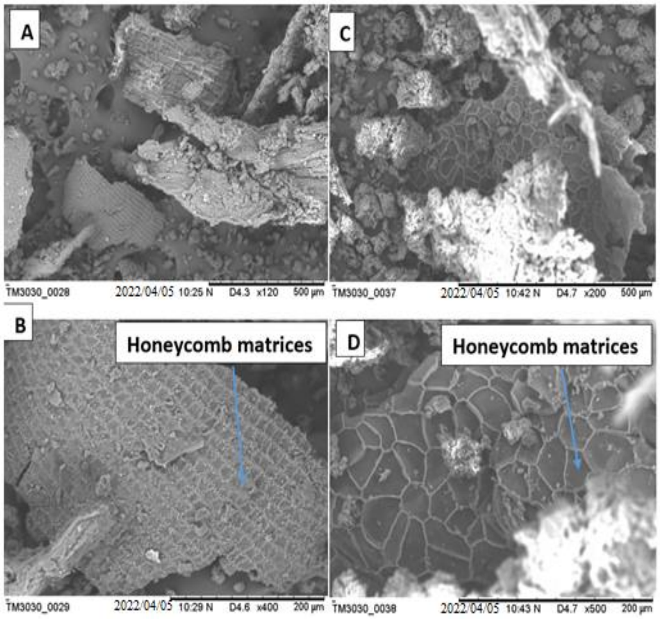

Figure 2: Scanning electron micrograph of organic soil specimens showing sheet-like structures[18]

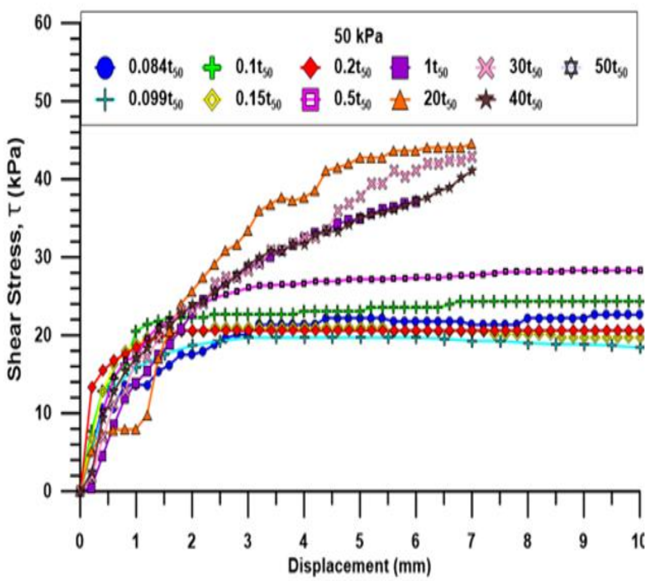

Figure 2: Shear stress Vs. horizontal displacement

The shear stress-horizontal displacement curves of the mortar-sand interface produced with different water contents (saturation) are shown in Figure 3. All curves show similar trends and shapes. The shear stress at the interface gradually increases with shear displacement until the maximum shear strength is reached, after which it decreases slightly or remains nearly constant [19]. The SEM results supplement the information of the list properties and the SEM micrograph shows that the empty punctured cell design of sinewy natural soil has been lost. Subsequently the natural soil could turn out to be more coagulated and minimal, generally high unambiguous gravity.

IV. CONCLUSION

The correct estimation of organic soil shear strength is one of the significant challenges faced by geotechnical engineering professionals. Lack of accurate shear strength data has contributed to unexpected structural failures and large settlement of infrastructures in the past. The determination of operational strength of organic soil has now become a critical concern in India due to the need for developments on organic soil lands. This paper has presented an investigation into the rate dependency of laboratory shear box test and full-flow penetration on organic soil by performing physical modelling experiments and supporting laboratory soil element tests. The natural soil used for this exploration has been recognized as sapric natural soil in view of the list properties and SEM micrographs. The natural soil is exceptionally decayed, with extremely high natural substance. The humification cycle has prompted the overall expansion in unambiguous gravity and decrease in water content. The micrographs uncovered homogeneous non-translucent miniature particles that are colloidal in structure, with no actual proof of empty cell associations or fiber trap. The deliberate compressibility and strength properties mirror the impact of decay and are fairly not the same as that of sinewy natural soil. The examples had the option to accomplish an overall pinnacle disappointment at higher strains in the CIUC tests. The point of contact (35°) assessed from this study is somewhat low when contrasted with stringy natural soil in the writing. Strangely, the strain solidifying trademark which convolutes the understanding of solidarity results is less critical, and the pressure cutoff line isn't reached. This review exhibited that the intricacies in the research facility trial of natural soil, particularly triaxial testing are less huge in sapric natural soil.

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