DISCOVERING SHEARING PERFORMANCE OF PEAT SOIL WITH GEOTEXTILES

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Abstract

Soil construction is defined as geometrical preparation of soil elements with admiration to each other. But peat soil is collected of normalliving materials. Plant soil is mainly made up of fresh plant and animal remains that break down in a very short time. The properties of this soil arechanged from other soils. Performance of peat soil is site detailed and it has been regarded as problematic soil that poses significant threat to roads and building foundations stability due to its unique characteristic of low shear strength and consolidation payments. It needs to be reinforced. The purpose of this paper is to study the effect of geotextile as a reinforcement factor on peat soil`s strength parameters in Salmas.

The result showed that the amount of organic matter in peat soils has a significant role on its cohesion and angle of internal friction.

Keywords:Salmas peat soil, Geotextile, Reinforcement,Shear strength, Angle of internal friction, Cohesion

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Introduction

Historically, major advances in construction industry are made possible through considerable developments in construction materials. Construction of bigger and more complex structures is possible when reinforced and pre-stressed reinforced concrete are used instead of wood and stone. Development of steel industry enabled establishment of buildings and bridges with wider spans. Since main masonries used in geotechnical engineering were soil and stone, imagination of similar developments in geotechnical constructions seemed difficult before. Maybe the best example of advance in geotechnical constructions is reinforcing soil. Like reinforcing concrete by steel, polymeric materials lead to improvement of tensile strength of soils having low shear strength.

Peat soil is recognized as one of the problematic soils by geotechnical engineers and construction over this soil demands taking specific measures such as reinforcement. Plant origin and fibrous structure led to its unique geotechnical characteristics compared to other soils. For this reason, this paper intends to investigate the role of geotextiles in improving resisting characteristics of the soil.

Preparation of peat soil samples

Soil used in this research is taken from lands of Salmas industrial city near Salmas – Tasouj road in km 9 from the 2.2m depth. In some parts, buildings and streets are constructed in industrial city and leaks are available in some main roads. After geotechnical studies in 2012 and 2014 and after taking soil samples and performing soil mechanics and geotechnical experiences, it was discovered that a thick layer of peat soil covers this region.

For preparing samples, cubic metal boxes with sharp edges and 20×30cm dimensions and metal thin-walled tubes with 20cm diameter and 30cm height were used. Cubic samplers enable preparation of three samples from each layer of soil for shear tests. Central parts of samples which are less touched during inserting and drawing samplers are used for performing shear tests and remaining adjacent soils are used for determination of initial physical characteristics of peat soil.

Moreover, to prevent contact with air and reducing humidity of samples after extraction, samplers were covered by paraffin and were kept in cool and humid place after carrying into laboratory.

Data analysis

In this stage, tests of direct shear were performed on peat soil and geotextile peat according to test procedure and results will be explained below. Further, factors contributing to shearing behavior of the peat soil will be described.

Initial and physical characteristics of soil

According to classification methods of von Post and Granland, samples obtained from excavations were classified into H4 and H6 groups. H4 peat soil was pale brown in color and its plant texture was not easily discriminated and after squeezing in water, muddy water with dark brown color comes out of it which is a little pasty while H6 peat soil is brown and its plant texture and strongly pasty. Since in peat, percent of organic materials decreases with increasing corrosion and average value of organic materials in H4 and H6 groups are 79 and 33%, respectively, such implied differences and different level of corrosion leads to various behaviors in two groups during tests.

Since in H4 peat soil, corrosion level was low, more plant fibers are available in its texture and void spaces within fibers can absorb more water and its humidity is higher compared to H6. As such, more organic materials of H4 result in less specific gravity and density with respect to H6.

Direct shear test

Test procedure

First, cubic samples with 50mm height and 10×10mm section are prepared after cutting the sampler with high accuracy and intact. It must be noted that for performing peat tests with geotextile, 20mm thickness is considered for layer. Before inserting sample in cutting box, porous stones are placed in lower part of the box. Then, by placing weights, their weights were applied with factor 5 in normal direction and the process of strengthening with applying normal force was initiated. All samples were fixed in 24 hours under the applied force. After 24 hours of strengthening and saturation, screws of cutting box are opened and cutting test started with state of strain control. Values of shear force in horizontal strains are read with 0.5mm increments and recorded.

Since shear of samples are performed after initial strengthening and according to drainage conditions and permeability of peat soil, it can be said that obtained parameters are resistance ones.

Table 1.1: result of direct shear tests for H4 and H6 peats

Effective internal friction angle φ'(deg)	Cohesion C'(kPa)	Ultimate shear stress τ(kPa)	Normal stress σ'(kPa)	Cutting speed(mm/min)	Corrosion level
38/2	12/76	16/9	5	0/1	H4
		20/7	10	0/1	
		25	15	0/1	
23/42	14/8	16/6	5	0/1	H6
		19/8	10	0/1	
		21/5	15	0/1	
39/2	11/66	15/8	5	0/9	H4
		18/5	10	0/9	
		23/5	15	0/9	
24/06	13	15	5	0/9	H6
		18	10	0/9	
		19/5	15	0/9	

According to table below and taking into account the type of peat soil and normal stress, it can be inferred that shear stress increases with horizontal deformation. This is in agreement with reports of triaxial compressive tests based on fracture of peat even in large strains.

Similarly, shear strength increases with displacement during tests. In addition, slope of curves increases with normal stress and it seems that this increase in slope is due to fibrous effect of peat soil.

Moreover, results reveal that with low corrosion in peat, even in low strain rates, has more shear strength compared to peat with high corrosion level. However, due to having more internal friction angle, its shear strength increased significantly with σ'_v. It must be noted that effective normal stress in surface layers of the peat is very low owing to low specific gravity (nearly equal to that of water) and its saturation and soil is relatively in suspended state.

By comparison of values of internal friction angles and cohesion of both groups, it can be claimed that resistive behavior of peat depends upon corrosion level and percent of organic materials so that H4 soil with low corrosion, shows frictional behavior while H6 soil with higher corrosion has high corrosion. As stated earlier, portion of inorganic materials in peat increases with corrosion level. Moreover, shape and size of organic materials of the peat are dependent on humus process. Therefore, different shear behaviors of peats result from differences in their structures.

In what follows, results of H4 and H6 tests are compared.

It can be concluded that H4 peat soil having shear strength is close to H6 even in low strain rates. However, as normal stress increases, shear strength of the H4 soil increases significantly and in normal stress as much as 15kPa, its shear strength exceeds that of H6 soil. More increase in strength of H4 compared to H6 under normal stresses is because of the presence of more organic materials in H4 peat texture compared to H6 and when normal stress increases over it, its plant fibers act as reinforcement in soil structure.

If internal effective friction factor of peat soil is assumed to be $\mu = \tan\varphi'$ and its cohesion as C', role of corrosion on resistive parameters in shear speed as much as 0.9mm/min can be summarized in table 1-2:

Table 1-2: comparison of resistive parameters of H4 and H6 peat soils with high speed

$C'_{(H4)}/C'_{(H6)}$	$\mu_{(H4)}/\mu_{(H6)}$	$C'(kPa)$	$\mu = \tan\varphi'$	Corrosion level
0/89	1/84	11/66	0/81	H4
		13	0/44	H6

In direct shear test with 0.9mm/min speed, friction factor of H4 peat is 0.84 more than H6; while this value in high speed test is 0.11 more than cohesion of H4 and in low speed, this value is 0.14. Therefore, performing tests with high speed leads to increase in difference between values of resistive parameters of peats.

Comparison of resistive parameters of H4 and H6 in various velocities

To investigate the effect of shearing test speed on resistive parameters of peats, results are compared to each other and summarized in tables 1.3 and 1.4

Table 1.3: comparison of the effect of shearing speed on resistive parameters of H4

$C'_{(H4,HS)}/C'_{(H4,LS)}$	$\mu_{(H4,HS)}/\mu_{(H4,LS)}$	$C'(kPa)$	$\mu = \tan\varphi'$	Shearing speed (mm/min)	Corrosion level
0/9	1/04	11/66	0/81	0/9	H4
		12/76	0/78	0/1	H4

Table 1.4: comparison of the effect of shearing speed on resistive parameters of H4

$C'_{(H4,HS)}/C'_{(H4,LS)}$	$\mu_{(H4,HS)}/\mu_{(H4,LS)}$	$C'(kPa)$	$\mu = \tan\varphi'$	Shearing speed (mm/min)	Corrosion level
0/87	1/023	13	0/44	0/9	H6
		14/8	0/43	0/1	H6

Performing various tests on H4 and H6 with high speed led to obtaining different results for effective friction factor. In H4 peat soil, obtained friction factor for 0.9mm/min is 0.4 higher than that of 0.4mm/min. this difference for H6 is 2%.

Conclusion

1. Since peat soil is comprised of fibrous organic materials which are the product of incomplete decomposition of trees and other plants, therefore, presence of fiber with specific size and orientation leads to complexity of mechanical behavior of it.
2. It was observed that preparation of intact samples from peat is so difficult and factors of physical interference of sampler and removal of local stresses can lead to change in soil though its level can be lowered with certain methods. However, regarding peat, additional factors such as compression during inserting sampler in earth, tensile strength of fibers near to edges of sampler upon its pulling out, drainage and redistribution of humidity in sample increase the probability of change in sample.
3. Percent of organic materials available in peat depends upon the level of its corrosion. In general, this characteristic is the main reason for difference of peat characteristics compared to inorganic soils and determination of the percent of organic materials available in peat

play an important role in prediction of its physical characteristics. For instance, specific gravity of peat depends upon composition and value of organic materials available in it and less corrosion and percent of organic materials; specific gravity will be less as well. Hence, for prepared samples which are in H4 with low corrosion and average of organic materials as much as 79% and H6 with high corrosion and 33% organic materials, H4 peats have lower specific gravity and natural weight compared to H6.

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