EXPLORING AND STUDYING SHEARING BEHAVIOR OF PEAT SOIL WITH REINFORCING MATERIALS IN SALMAS CITY

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Abstract

Soil structure is defined as geometrical arrangement of soil particles with respect to each other. But peat soil is composed of natural organic materials. Organic soil is primarily made up of fresh plant and animal residues that break down in a very short time. The properties of this soil is different from other soils. Behavior of peat soil is site specific 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 settlements. 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 second section of this paper deals with direct shear testing of peat soil in the range of 33 to 79% organic matter and two types of geotextile with different tensile strength and the same strain rate.

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

High percentage of organic material in peat soil leads to more frictional behavior and lower cohesion. Usage of geotextile technique increases tensile strength.

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

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Introduction

From engineering point of view, soil is comprised of non-cemented aggregates from minerals and corroded organic materials together with water and gases available in void spaces within solid particles. In various civil engineering projects, soil is used as masonry in combination with other materials and it provides support for structural foundations. Therefore, civil engineers must study and analyze soil characteristics such as origin of grading, water drainage capacity, compressibility, shear strength and load bearing capacity. Soil mechanics is a branch which studies physical properties of the soil and behavior of soil bulks under various forces. Soil engineering is the application of soil mechanics principles in scientific problems. Geotechnical engineering is a branch of civil engineering which deals with near ground masonries. This field includes fundamentals of soil and rock mechanics in design of foundations, retaining structures and soil structures.

Geo-synthetics are plain products which are produced by polymeric materials. There are limited products like geo-synthetics which have such a significant development and contribution to various aspects of civil engineering. In 1970, there were only 5-6 geo-synthetic products while today; more than 600 products of this king are supplied all around the world. In less than 30 years, geo-synthetics made a revolution in various fields of civil engineering and in some cases; they are alternatives for traditional construction materials. Sometimes, their usage leads to improvement of safety factor, performance and reduction of construction costs compared to traditional options of construction.

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.

Direct shear test on peat – geotextile

Testing procedure

To perform the direct test between peat and geotextile, two textiles produced in Iran with trade names R650 and R200 are used. Geotextiles are made from polyester and are unwoven with 6 and 2.6mm thickness and 10.5 and 38 kN/m tensile strengths. During test, in middle section of the cutting box, where cutting is performed, geotextiles are put in contact with peat soil. These tests were performed with H4 and H6. For simplicity, R650 and R200 are considered as Geotextile (1) and (2), respectively. Moreover, in tables 1.5 and 1.6, values of ultimate shear strengths, cohesion and internal friction factor obtained from direct shearing tests are provided.

Table 1.1: characteristics of geotextiles R650 and R200

Characteristics	Test method	Unit	R650	R200
Material	-	-	Polyester	Polyester
Tensile strength	-		38	10/5
Thickness			6	2/6
Weight per unit volume			650	200

Table 1.2: results of direct shear test for peat-geotextile, 0.9mm/min speed

Internal effective friction factor φ'(deg)	Cohesion C'(kPa)	Ultimate shear strength τ(kPa)	Normal stress σ'(kPa)	Geotextile	Corrosion
51/78	11/8	18/3	5	1	H4
		24/2	10		
		31	15		
45/5	12	16/9	5	2	H4
		22/64	10		
		27/11	15		
28/8	14	16	5	1	H6
		21	10		
		21/5	15		
26/5	14/7	17	5	2	H6
		20	10		
		22	15		

Table 1.3: results of direct shear test for peat-geotextile, 0.1mm/min speed

Internal effective	Cohesion	Ultimate shear	Normal stress	Geotextile	Corrosion

friction factor φ'(deg)	C'(kPa)	strength τ(kPa)	σ'(kPa)		
51/1	13/3	19/4	5	1	H4
		26/1	10		
		31/8	15		
48	12/2	18/2	5	2	H4
		24	10		
		30	15		
28/7	15/3	18/2	5	1	H6
		20/6	10		
		23/7	15		
28/3	16/4	18/7	5	2	H6
		23	10		
		24/2	15		

Data analysis

As can be seen in values obtained from tests, it is evident that friction angle between peat soil and geotextile in all experiments regardless of the type of soil, cutting speed and type of used geotextile is larger than internal friction angle of peat itself.

Moreover, from results, it can be found out that geotextile 1 makes larger angle compared to geotextile 2 with peat soil and this difference can be attributed to difference in structure and texture of each of them and high tensile strength of geotextile 1 compared to geotextile 2. In analysis of results, friction angle between peat and geotextile is represented as δ. Now, if we consider the friction angle between peat and geotextile as $\mu_{pg} = \tan\delta$ and that of peat itself as $\mu_{pp} = \tan\varphi'$, ratio of friction angles shows the effect of geotextiles.

Table 1.4: comparison of friction factors

Ratio of friction angles	Effect
	+
	No effect

	-

Geotextiles 1 and 2 lead to increase in ultimate shear strength of peat soil and this in turn increases the normal stress.

In direct shear test with 0.9mm/min between peat and geotextile 1, effective internal friction between H4 and geotextile 1 is more than effective friction angle of H4. Regarding cohesion, cohesion of H4 and geotextile 1 is nearly equal to peat H4. As normal stress increases, value of ultimate strength of H4 with geotextile 1 will be more than in the case of H4 with 20% strain so that in test with 0.9mm/min, ultimate stress of H4-geotextile 1 in normal stresses 5, 10 and 15kPa, are 22, 41 and 35%, respectively and more than ultimate strength of peat H4 under same normal stresses.

In direct shear test with 0.9mm/min, effective friction angle between H4 and geotextile 2 is 24% more than that of H4. Owing to reduction from 56% to 24% in geotextiles 1 and 2 with peat H4, it can be concluded that tensile strength of geotextiles play a pivotal role in reinforcing peat soil. Moreover, cohesion between H4 and geotextile 2 is approximately equal to cohesion of H4.

In shear test with 0.9mm/min, effective friction factor between H6 and geotextile 1 is 11% more than that of H6. Moreover, cohesion of H6 and geotextile 1 is 13% more than H6. Corrosion level plays a pivotal role in increasing friction angle between peat and geotextile so that more portion of organic materials in peat soil leads to larger friction angle between peat soil and geotextile.

In direct shear test with 0.9mm/min between peat and geotextile 1, effective internal friction between H6 and geotextile 2 is 7% more than effective friction angle of H6. Regarding cohesion, cohesion of H6 and geotextile 2 is nearly equal to peat H6. Difference in tensile strengths of geotextiles 1 and 2 leads to difference in the increase in friction factors between H6 and geotextiles compared to effective friction angle.

In tests of direct shear with 0.9mm/min, highest value of increase in effective friction angle between peat and geotextile compared to peat corresponds to H4 and geotextile 1 with 56% increase and lowest value corresponds to H6 and geotextile 1 with 13% increase.

In tests of direct shear with 0.1mm/min speed between peat and geotextile 1, value of effective friction factor between H4 and geotextile 1 is 57% more than that of H4. With regard to cohesion, that of H4 and geotextile 1 is nearly the same as H4. By increasing normal stress, value of ultimate stress of H4 and geotextile 1 is more thanH4 in 20% strain rate so that in test with 0.1mm/min, ultimate stress of H4 and geotextile in normal stresses 5, 10 and 15 kPa will be 14, 26 and 27% more than ultimate stress of H4 in the same normal stresses.

In tests of direct shear with 0.1mm/min, highest value of increase in effective friction angle between peat and geotextile compared to peat corresponds to H4 and geotextile 1 with 57% increase and lowest value corresponds to H6 and geotextile 1 with 23% increase.

Conclusion

1. By performing direct shear tests on peat, it was revealed that due to fibrous structure of the soil with increase in horizontal displacement, shear stress increases and peat wont fracture in large strains since fibers available in it act as a reinforcement in the soil and it was discovered in experiments that these two types of sample have different frictional and cohesion behaviors and in comparison of test results with high and low speeds, effective friction angle of H4 is 81% and 84% more than H6 and cohesion of H4 is 14 and 11% lower than H6.
2. Different speeds of performing shear test in same samples as a result of corrosion led to conclusion that effective friction angle of H4 in high speed experiments is about 4% higher than in case of low speed tests and this value is about 3% in H6 soil.
3. Performing direct test on samples reinforced with geotextile led to results such as increase in effective friction factor of the soil and had no contribution to cohesion so that friction angle factor of H4 and geotextile 1 in direct shear test is 56% higher than H4 without geotextile and this value is 24% for geotextile 2 and in peat H6, due to low friction produced between peat and geotextile, effective friction factor between peat and geotextile in direct shear test with high speed is 25% and 11% more than that of without geotextiles. This shows that by reducing tensile strength of geotextile, a significant reduction in effective friction factor between peat and geotextile will occur.

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