International Journal of Trend in Scientific Research and Development (IJTSRD)
Volume 4 Issue 4, June 2020 Available Online: www.ijtsrd.com e-ISSN: 2456 – 6470

Effect of Compaction Moisture Content on Strength Parameters of Unsaturated Clay using Triaxial Test

Vedwala Khushbu M[1], Priyank H. Patel[2], Vishal N. Patel[1]

[1]Assistant Professor, [2]Lecturer,

[1,2]Civil Engineering Department, SNPIT & RC, Umrakh, Bardoli, Surat, Gujarat, India

ABSTRACT

Soil compaction is a process of mechanical densification of soil by pressing the soil particles close to each other and removing the air between them. It is of utmost importance in the broad science of Geotechnical engineering playing a significant role in all types of Geotechnical investigations. The principle soil properties affected by compaction include the shearing resistance. The constitutive equations for volume change, shear strength and flow for unsaturated soil have been generally accepted in Geotechnical engineering (Fredlund and Rahardjo, 1993a). The shear strength of an unsaturated clayey soil and soil-water characteristic curve depend on the soil structure or the aggregation which in turn depends on the initial water content and the method of compaction. The aim of this research work is to determine the cohesion, angle of internal friction of the clay soil based on the moisture content. For this clay soils classified as CH, CI are used. Soil samples are chosen on the basis of soil type and clay content (more than 25%). Maximum dry density and Optimum moisture content is are determined after 24-hour soaking, using light compaction. The hydrometer test are carried out for the grain size distribution. For the present work six different type of clayey soils are consider. The sample are taken from Dahej (02), Surat (02) and Bhavnagar (01). All the sample were tested at OMC & MDD as obtain from standard proctor test. The compaction was done at 0.95,1.00 and 1.05 times of OMC. Each sample were tested for triaxial test as well as direct shear at the strain rate of 0.625 mm/min and 1.25 mm/min. direct shear test and triaxial test are conducted for unconsolidated undrained (UU) condition.

***How to cite this paper**:* Vedwala Khushbu M | Priyank H. Patel | Vishal N. Patel "Effect of Compaction Moisture Content on Strength Parameters of Unsaturated Clay using Triaxial Test" Published in International Journal of Trend in Scientific Research and Development (ijtsrd), ISSN: 2456-6470, Volume-4 | Issue-4, June 2020, pp.888-891, URL: www.ijtsrd.com/papers/ijtsrd31250.pdf

IJTSRD31250

KEYWORDS: *Compaction, Triaxial Test, Shear Strength, unconsolidated undrained*

INTRODUCTION

The shearing behavior of a saturated soil is related to one stress-state variable; namely, the effective stress, σ', defined as $(\sigma - u_w)$. The term, σ, is the total stress, and u_w is the pore water pressure. The pore water pressure in saturated soil are typically positive or zero. Shear strength test for the saturated and unsaturated soils can be performed in most geotechnical and agricultural laboratories. Detailed test procedures related to the determination of shear strength of saturated or unsaturated soils are not discussed in this section. Standard testing procedures as per American society for testing and materials (ASTM) and Indian standard (IS-Code) methods for various shear strength tests for the different types of soils. More information related to procedures is available in Lambe (1951), Holtz and Kovacs (1981), and other books also. In this study, shear strength parameters of an unsaturated compacted clay sample were measured. The triaxial test and direct shear testing methods was used to measure shear strength parameters. The relationships between moisture content, suction and shear strength parameters were found. Triaxial test for the unconsolidated undrained condition was performed where the compacted samples at optimum moisture content were soaked and consolidated prior to shearing. Soil compaction is a process of mechanical densification of soil by pressing the soil particles close to each other and removing the air between them.

The principle soil properties affected by compaction include settlement, shearing resistance, water movement and volume change. The shear strength of an unsaturated clay soil and soil-water characteristic curve depend on the soil structure or the aggregation which in turn depends on the initial water content and the method of compaction. As moisture content increases cohesion decreases because of greater separation of clay particles. The bearing capacity of all types of soils and clayey soils in particular, by and large, depend on their shear strength. The drained and undrained shear strengths of clayey soil are different due to varying soil structures.The engineering behavior will vary from one specimen to other due to differences in soil structure or aggregation which are related to the initial moulding water content. The constitutive equations for volume change, shear strength and flow for unsaturated soil have been generally accepted in Geotechnical engineering (Freedlund and Rahardjo, 1993a). Hence, undrainedshear strength analysis of compacted soils is of relevance in dealing with these structures.Soil are often separated into coarse – grained soils. Coarse – grained soils include boulders, cobbles, gravels and sand; fine – grained soils consist of silts and clays.

Clay is an aggregate of microscopic and sub microscopic particles derived from the chemical decomposition and disintegration of rock constituents. It is plastic within a moderate to wide range of water content.

Soil Type	Particle Size
Boulder	> 300 mm
Cobbles	150 to 300 mm
Gravel	4.76 to 150 mm
Sand	0.076 to 4.76 mm
Silt	0.002 to 0.076 mm
Clays	< 0.002 mm

Unsaturated soils are characterized by the presence of an air phase, a water phase and an air-water interface in the voids. Because of this, it has been difficult to describe an appropriate stress state variable for unsaturated stress agricultural soils. For a saturated soil both the strength and volume change behaviour are governed by the effective stress.

EASE OF USE

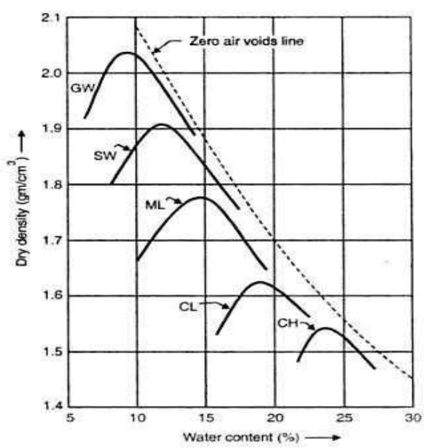
Compaction

The densification of a soil by means of mechanical manipulation.

Compaction Curve

The compaction curve showing the relationship between the dry unit weight (density) and the water content of a soil for a given compactive effort. Compaction curve is also called as moisture-density curve.

For compaction of any particular soil in the field, the engineer can vary water content, amount of compaction, and type of compaction. In 1933, Proctor showed that there existed a definiterelationship between the soil water content and degree of dry density to which a soil might be compacted, and that for a specific amount of compaction energy applied on the soil there was a water content termed as 'optimum moisture content' at which a particular soil attained maximum density,

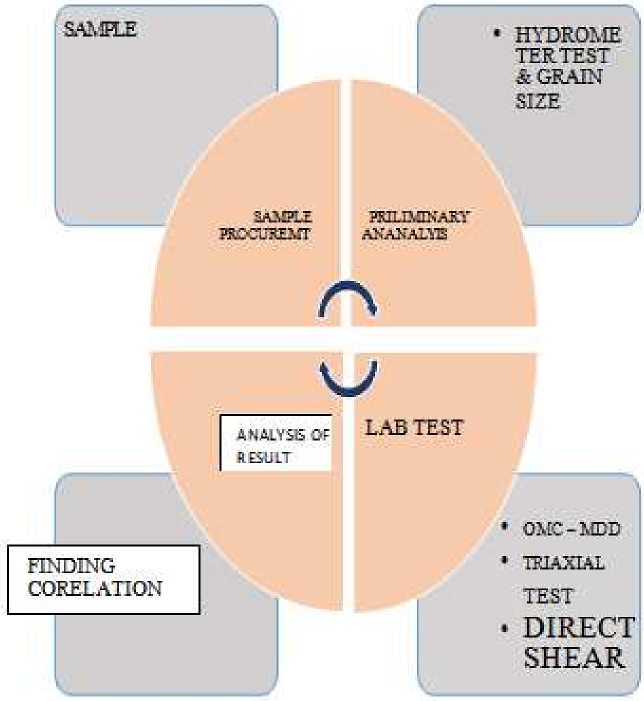


Shear Strength

The shear strength of soil is the resistance to deformation by continuous shear displacement of soil particles or on masses upon the action of a shear stress. The failure conditions for a soil may be expressed in terms of limiting shear stress, called shear strength, or as a function of the principal stresses.
The shearing resistance of soil is constituted basically of the following components:

1. The structural resistance to displacement of the soil because of the interlocking of the particles,
2. The frictional resistance to translocation between the individual soil particles at their contact points, and
3. Cohesion between the surfaces of the soil particles.

Method Adopted in Research work



Details of Laboratory Test

EXPERIMENT	IS REFERENCE
HYDROMETER TEST	IS : 2720 - (1985) part 4
STANDARD PROCTOR TEST	IS : 10074 – 1982
TRIAXIAL TEST	IS : 2720 - (1971) part 11
DIRECT SHEAR TEST	IS : 2720 - (1986) part 13

RESULTS AND DISCUSSION

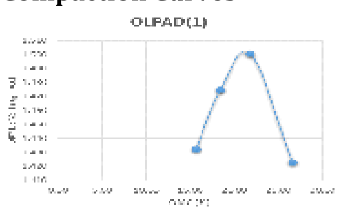
Six sample were selected as per criteria from the region of Dahej (01), Bhavnagar (01), Surat (03).

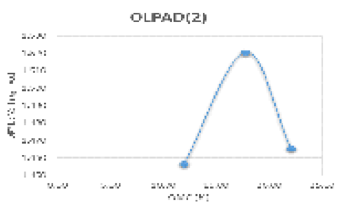
After the completion of the testing such as liquid limit, plastic limit, shrinkage limit, specific gravity, hydrometer, free swell, proctor test, Direct shear test, Triaxial test, following results were recorded and analysis was done which are described below.

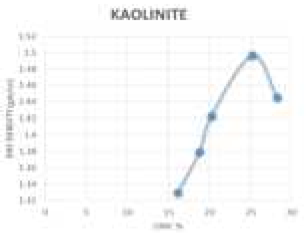
After investigation it was classified that samples were CH types and CI types.

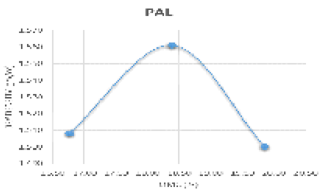
Direct shear test and Triaxial test were performed at 0.625 mm/min and 1.25 mm/min. test were performed at MDD. And 95% of OMC, 100% of OMC, 105% of OMC. Direct shear test and triaxial test were performed for unconsolidated undrained condition.

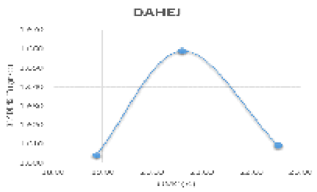
Compaction Curves











Direct Shear Test Results

SAMPLE NAME	STRAIN RATE	OMC	DST	
			COHESSION kg/cm²	Φ
OLPAD(1)	1.25	95	0.17	19.27
		100	0.21	15.21
		105	0.12	18.91
	0.625	95	0.12	20.3
		100	0.09	19.71
		105	0.09	20.5
OLPAD(2)	1.25	95	0.15	19.24
		100	0.16	19.42
		105	0.15	19.6
	0.625	95	0.13	17.64
		100	0.15	19.78
		105	0.08	20.5
PAL	1.25	95	0.17	19.7
		100	0.14	21.2
		105	0.16	21.2
	0.625	95	0.14	21.2
		100	0.1	22.07
		105	0.12	22.25
DAHEJ	1.25	95	0.27	15.97
		100	0.16	18.37
		105	0.17	18.55
	0.625	95	0.2	21.2
		100	0.1	20.67
		105	0.07	21.73
BHAVNAGAR	1.25	95	0.26	15.21
		100	0.19	16.53
		105	0.14	17.23
	0.625	95	0.08	17.33
		100	0.06	18.12
		105	0.04	16.73
KAOLINITE	1.25	95	0.34	18.36
		100	0.4	17.81
		105	0.39	21.92
	0.625	95	0.41	20.37
		100	0.47	22.77
		105	0.52	23.11

Triaxial Test Results

SAMPLE NAME	STRAIN RATE (mm/min)	OMC (%)	TRIAXIAL TEST	
			COHESSION kg/cm²	Φ
OLPAD(1)	1.25	95	0.4	23.35
		100	0.24	26.03
		105	0.18	25.24
	0.625	95	0.19	24.97
		100	0.17	25.21
		105	0.14	26.2
OLPAD(2)	1.25	95	0.51	7.45
		100	0.44	9.68
		105	0.49	12.2
	0.625	95	0.35	8.47
		100	0.34	8.6
		105	0.34	11.95
PAL	1.25	95	0.55	10.78
		100	0.5	11.49
		105	0.21	18.92
	0.625	95	0.68	8.32
		100	0.47	12.23
		105	0.47	13.37
DAHEJ	1.25	95	0.41	14.24
		100	0.35	18.78
		105	0.31	17.09
	0.625	95	0.28	16.48
		100	0.2	19.5
		105	0.35	13.94
BHAVNAGAR	1.25	95	0.31	15.18
		100	0.26	17.98
		105	0.2	19
	0.625	95	0.34	15.12
		100	0.25	18.55
		105	0.43	13.89
KAOLINITE	1.25	95	0.42	13.78
		100	0.4	13.16
		105	0.34	14.39
	0.625	95	0.5	11.13
		100	0.48	13.79
		105	0.47	13.78

CONCLUSION

- On increase of moisture content the Cohesion of soil decreases.
- For unsaturated clay the angle of internal friction is higher at 0.625 mm/min strain rate as compared to angle of internal friction at 1.25 mm/min.
- The angle of internal friction and cohesion are on higher side in case of triaxial tests compare to direct shear test for unconsolidated undrained (UU) condition.
- Among the six regions Dahej, Bhavnagar, Surat (03 samples), kaolinite clay the maximum angle of internal friction in triaxial test is achieved from Bhavnagar region clay.
- Among the six regions' Dahej, Bhavnagar, Surat (03 samples), kaolinite clay the maximum angle of internal friction in direct shear test is achieved from Kaolinite clay.
- For particular soil if clay content increases cohesion increases.

REFERENCES:

[1] A.A.BELLO (2011), Analysis of Shear Strength of Compacted Lateritic Soils – The Pacific Journal of Science and Technology – volume 12.

[2] A Sridharan and K. Prakash – classification procedure for expansive soil

[3] Azam S.I to M., Chowdhry R – Environmental system engineering, university of SK,CANADA

[4] ASTM Designation D - 2850-95 (reapprove 1999). - Standard test method of Unconsolidated – Undrained Triaxial compressive test on cohesive soil.

[5] B.M.DAS, Principles of geotechnical engineering – fifth edition

[6] B.M.DAS Advance soil mechanics – fifth edition

[7] B.M.DAS, Principles of foundation engineering – fifth edition

[8] D.G.FREDLUND and H.RAHARDJO (1993): An Overview of Unsaturated Soil Behavior – Geotechnical Engineering Division/ASCE

[9] Dante Fratta, Jennifer Aguettant, Lynne Roussel Smith - Introduction to soil Mechanics Laboratory testing

[10] E.COKCA, O.EROL and FARMANGIL (2003): Effects of compaction moisture content on the shear strength of an unsaturated clay – Geotechnical and Geological Engineering volume (22).

[11] IS: 1498-1970: Classification and identification of soils for general engineering purposes.

[12] J agric Engng Res (1998) 69, D VO ralai wulfsohn; Bankole A. – Triaxial testing for unsaturated agricultural soils. (received 1996)

[13] J.K.M. Gan & D.G Fredlund (September 1994). - Direct shear & Triaxial shear testing of Hong Kong soil under saturated and unsaturated condition

[14] John T Germaine and Amy V. Germaine. - Geotechnical laboratory measurements for engineers

[15] Joseph E. Bowel - Physical and geological properties of soils (second edition)

[16] K.NOKKAEW, Dr.SUPAKIJ NONTANANANDH, Dr. APINITI JOTISANKASA Relationship between the Soil-Water Characteristic Curve and the Unsaturated Shear Strength of a Sandy High Plasticity Clay – RSID 6 – GEO

[17] L..BJERRUM (1954), Theoretical and Experimental Investigations on the Shear Strength of Soils – The Swiss Federal Institute of Technology (Thesis work).

[18] ROHIT GHOSH (2013): Effect of soil moisture in the analysis of un-drained shear strength of compacted clayey soil – Journal of Civil Engineering and Construction Technology volume 4(1).

[19] R.E.GRIM, clay mineralogy