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STUDY OF STRENGTH VARIATION IN COHESIVE SOIL WITH MOISTURE CONTENT AND TIME

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Abstract - *The subgrade of roads used below both flexible and rigid pavements are made by placing suitable soil in specific thickness and compaction, laid in layers after mixing specified water so that moisture content of mixed becomes equal to Optimum Moisture Content (OMC) and compacted to reach specified maximum dry density as achieved in laboratory by standard compaction test. In India strength of such soils are generally measured by California Bearing Ratio (CBR) value. For laid sub-grade in worst condition of submergence CBR value are determined in laboratory. In view of above a detail investigation is initiated to study the strength and corresponding initial tangent modulus of the locally available silty clayey soil. Proctor compaction test has been conducted to determine the maximum dry density (MDD) and optimum moisture content (OMC) of the chosen cohesive soil. From the compaction curve, five moisture contents have been selected, i.e. one at OMC (10.6%), two moisture contents (8.6 and 9.6%) on dry side of OMC and two moisture contents 12.6 and 14.6%) on wet side of OMC. With these six moisture contents, several numbers of unconfined compressive strength (UCS) tests have been conducted at different time interval of 0 day, 1 day, 7days, 14 days, 25 days, and 30 days. From each test, stress-strain plots have been made to find UCS value and*

Keywords: *Sub-grade, Optimum Moisture Content (OMC) and Unconfined compressive strength.*

1. INTRODUCTION

Soil is defined as "sediments or other unconsolidated accumulation of solid particles produced by the physical and chemical disintegration of rocks which may or may not contain organic matter. The soil may also contain air, water, organic matter, consisting of more or less decomposed remains of plants and animal organism and other substance which remain dispersed throughout the mineral particles of the soil. Thus, soil is non-homogeneous, porous and extremely variable in its composition as well as in properties. Soil not only forms the foundation of road pavements but also is the principal material used for their construction. Since there is a wide variation in soil types, an adequate knowledge of the properties of different types of soil is, therefore, essential for proper design and construction of road pavements.

The loss of strength of the subgrade may be due to variation of time and moisture content of the subgrade under adverse seasonal effect. Besides this there is also decrease in deformation modulus of the soil with moisture content and time. A detail investigation is initiated to study the strength and corresponding initial tangent modulus of clayey soil. Several numbers of unconfined compressive strength (UCS) tests have been conducted at different time interval with different moisture contents. From the results of each test, the effect of time and moisture content on the strength and the initial tangent modulus of the soil have been studied.

2. LITERATURE REVIEW

Georgiannou, V.N., made an investigation on the behavior of clayey sands under monotonic and cyclic loading. He concluded that the fines content has a remarkable influence on the stress-strain response of the soil mass. As the fines content increases, the dilatant behavior of the soils is suppressed, and the response gradually becomes controlled by the fine matrix at about % 40 fines content.

Wasti and Alyanak have worked on sand-clay mixtures and stated that when clay content is just enough to fill the voids of the granular portion at its maximum porosity, the structure of the mixture changes and the linear relationship between the Atterberg limits (plastic and liquid limits) and the clay content is no more valid and soil changed its behavior from sand to clay. For mixture including kaolin clay at its liquid limit, they showed out that this threshold value exists about 25 % kaolin content.

3. OBJECTIVES

1. A quick test to obtain the shear strength parameters of cohesive (fine grained) soils either in undisturbed or remolded state

2. The test is not applicable to cohesion less or coarse grained soils.

3. The test is strain controlled and when the soil sample is loaded rapidly, the pore pressures (water within the soil) undergo changes that do not have enough time to dissipate

4. Hence the test is representative of soils in construction sites where the rate of construction is very fast and the pore waters do not have enough time to dissipate

4. MATERIALS AND METODOLOGY

4.1 MATERIALS

For this experimental study, a blackish gray clayey soil is chosen and has been collected from the area near KADAPA.. The soil is classified as "CL", as per IS soil classification. The physical properties of clay as determined according to IS codal provision are given in Table 1.

Table -1: PHYSICAL PROPERTIES OF SOIL

SL.NO	PROPERTIES OF SOIL	VALUE
1	Classification (IS)	CL
2	Liquid Limit (%)	46
3	Plastic Limit (%)	25.5
4	Plasticity Index (%)	20.5
5	Maximum dry density (gm/cc)	1.94
6	Optimum moisture content (%)	10.6
7	UCS (N/cm^2) at OMC	12.5

4.2 METODOLOGY

In this study, five numbers of moisture contents have been chosen 8.6%, 9.6%, 10.6%, 12.6% and 14.6% respectively. At these chosen moisture content, soil samples have been compacted in Proctor's mould and seven number of identical compacted soil samples were extracted and marked with dates. For obtaining cylindrical soil samples three tubes were inserted inside the Proctor mould and machine extractor was used for extracting the samples from the tubes.

Then all samples were put into plastic bags with labeling and were kept in several numbers of desiccators for preserving them for UCS test.

5. RESULTS AND DISCUSSIONS

5.1 Standarad proctor's compaction

Table 2: Details of various moisture contents and time intervals

Soil type	Moisture content (%)	Time interval (day)
Cohesive soil	8.6, 9.6, 10.6, 12.6 and 14.6	0, 1, 7, 14, 25 and 30.

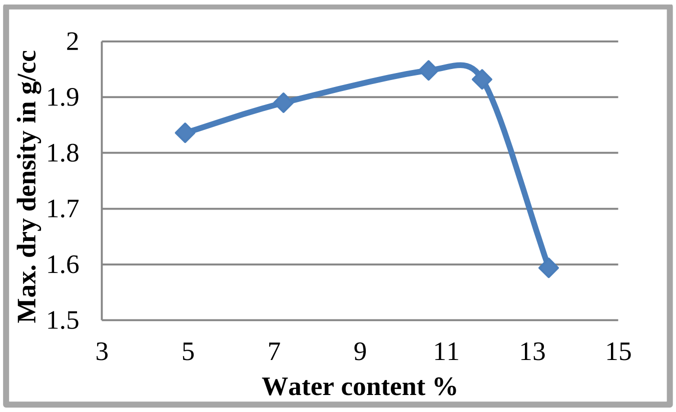

Fig 1: Max.dry density Vs Optimum moisture content

5.2 UNCONFINED COMPRESSION TEST:

Table: 3 Values of UCS (qu) of clayey soil at different water content (%) for different no. of days

No of Days	Unconfined compressive strength N/cm^2				
	w/c 8.60	w/c 9.60	w/c 10.60	w/c 12.60	w/c 14.60
0	21.2	17.6	10.5	9.3	6.23
1	21.9	17.89	10.75	9.52	6.35
3	22.12	18.2	10.9	9.68	6.52
7	23.02	18.35	11.2	9.82	6.73
14	23.1	18.29	11.42	10.2	7.1
25	23.18	17.8	11.8	10.35	7.32
30	23.5	17.58	12	10.42	7.82

From results of Unconfined Compressive Strength tests conducted on clayey soil for different moisture contents and time intervals, stress vs strain curves have been drawn. The values of UCS and also the initial tangent modulus have been obtained directly from these curves for placement water content changing from 10.6% to 14.6% at different time intervals of 0 day, 1 day, 7 days, 14 days, 25 days, and 30 days, after preparation of the samples.

The values of UCS and initial tangent modulus of compacted soils at different moisture content with different time intervals in days after compaction are given in table 3 and 4 respectively.

(a) Variation of UCS value with water content:

The variations in the value of unconfined compressive strength (qu) of the chosen soil samples with water content are plotted for different time intervals of 0 day, 1 day, 7 days, 14 days, 25 days, and 30 days, after preparation of the samples, is shown in figure 2. The result shows that the UCS values of the clayey soil decrease with water content for all cases of different time interval. The rate of decrease is higher at initial stage and gradually lower with increase of time interval.

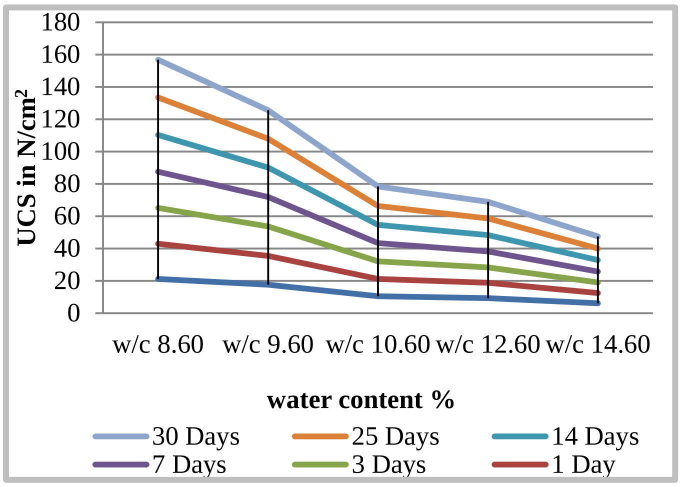

Fig 2: Variation of Unconfined compressive strength (UCS) with water content

(b) Variation of UCS value with time period:

The variations in the value of unconfined compressive strength (qu) of the chosen soil samples with time period, plotted for different moisture contents of 8.6%, 9.6%, 10.6%, 12.6% and 14.6%, is shown in figure 3.

The result shows that the values of the UCS value of clayey soil increases with time period for all cases of different water contents.

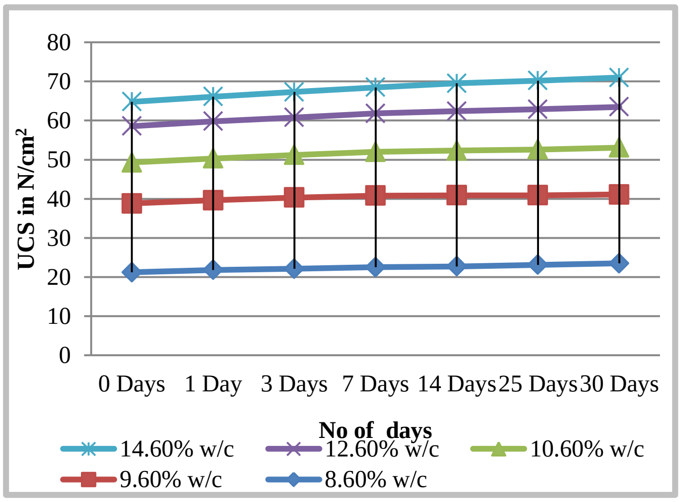

Fig 3: Variation of Unconfined compressive strength (UCS) with number of days of curing

(c) Variation of tangent modulus (Ei) with water content:

The variations in the value of initial tangent modulus (Ei) of the chosen soil samples with water content are plotted for different time intervals of 0 day, 1 day, 7 days, 14 days, 25 days, and 30 days after preparation of the samples, is shown in figure 4.

The result shows that the values of the initial tangent modulus of clayey soil are decreases with water content for all cases of different time interval. The rate of decrease is higher at initial stage and gradually lower with increase of time interval.

Table: 4 Values of Tangent Modulus (Ei) of clayey soil at different water content (%) for different no. of days

No of Days	Tangent modulus Ei in N/cm²				
	w/c 8.60	w/c 9.60	w/c 10.60	w/c 12.60	w/c 14.60
0	640.8	340.50	281.8	275.30	126.90
1	660.6	360.40	300.00	286.20	136.50
3	680.3	380.60	360.20	330.40	144.30
7	720.4	410.70	370.30	360.10	156.80
14	760.8	430.30	410.00	385.60	167.70
25	790.6	470	448.60	420.40	180.20
30	810.10	510.20	450.90	430.20	210.30

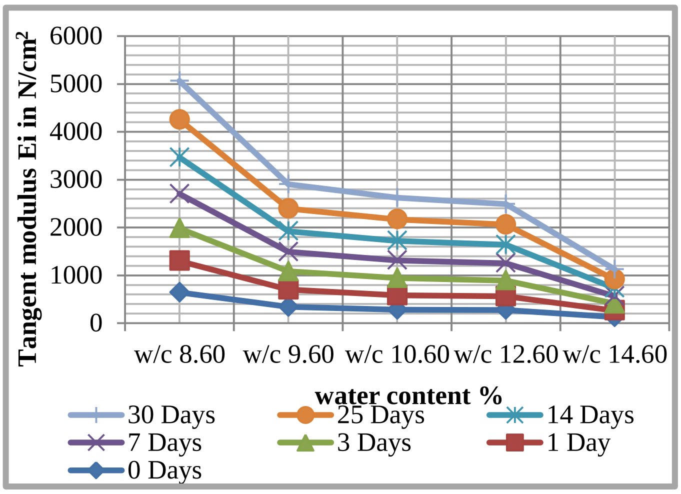

Fig 4: Variation of initial tangent Modulus (Ei) with No. of days @ Water Curing

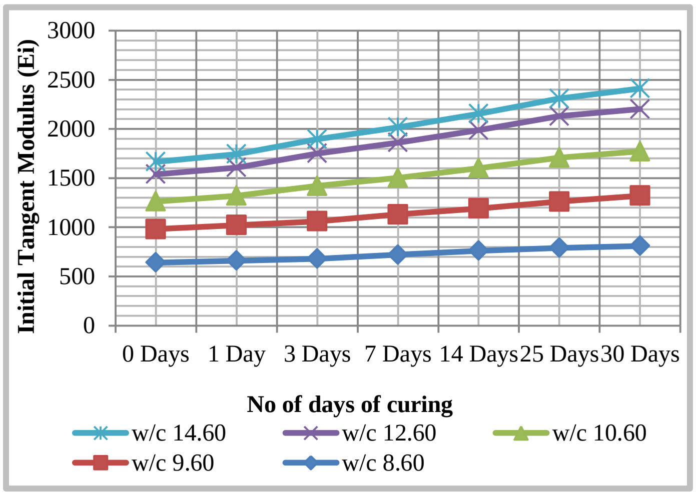

Fig 5: Variation of initial tangent Modulus (Ei) with No. of days @ Number of days of curing

(d) Variation of tangent modulus (Ei) with time period:

The variations in the value of initial tangent modulus (Ei), of the chosen soil samples with time period are plotted for different moisture contents of 8.6%, 9.6%, 10.6%, 12.6% and 14.6% is shown in figure 5. The result shows that the values of the initial tangent modulus of clayey soil increases with time period for all cases of different water contents.

6. CONCLUSIONS

1. Unconfined compression strength (UCS) of the clayey soil decreases with water content for all cases of different time interval. The rate of decrease is higher at initial stage and gradually lower with increase of time interval.

2. The UCS value of clayey soil increases with time period for all cases of water contents ranging from 8.6% to 14.6%.

3. The initial tangent modulus of clayey soil also decreases with increasing water content for all cases of different time interval. The rate of decrease is higher at initial stage and gradually lower with increase of time interval.

4. The value of the initial tangent modulus of clayey soil increases with time period for all cases of different water contents.

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