International Journal for Modern Trends in Science and Technology, 9(05): 560-564, 2023

ISSN: 2455-3778 online
DOI: https://doi.org/10.46501/IJMTST0905095
Available online at: http://www.ijmtst.com/vol9issue05.html

Estimation of Unconfined Compressive Strength of Expansive Soils with Different Compactive Efforts

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To Cite this Article
J. Surya Narayana, M.Vamsi Reddy, A .Vennela and E.Aneesh. Estimation of Unconfined Compressive Strength of Expansive Soils with Different Compactive Efforts. International Journal for Modern Trends in Science and Technology 2023, 9(05), pp. 560-564. https://doi.org/10.46501/IJMTST0905095

Article Info
Received: 16 April 2023; Accepted: 10 May 2023; Published: 19 May 2023.

ABSTRACT

Field compaction of fine grained soils usually involves different equipments with the compaction energy varying significantly. Hence the compaction characteristics (maximum dry unit weight and optimum moisture content) need to be obtained at different compaction energies. Thus knowledge of compaction behavior and its characteristics of fine grained soils at different compaction energies assume great importance from the viewpoint of practical significance.

In past some of works have been done on determination of compaction properties namely the maximum dry density and optimum moisture content is both time consuming and costly. Therefore, it is useful if simple correlation equations can be developed to estimate the compaction properties using relatively easier index properties test. The relationship between maximum dry density and optimum moisture content and their correlation function with index properties. Based on the results of nine soil samples using standard proctor compaction test, the maximum dry density and the optimum moisture content was well correlated.

In this present work determination of unconfined compressive strength of expansive soils namely High Compressible Clayey Soil (CH) and Intermediate Compressible Clayey Soil (CI) of soils which are collected from below ground surface. Determine Optimum Moisture Content (OMC) and Maximum Dry Density (MDD) of two soil samples at different compactive efforts. The Compactive efforts are fixed by changing number of layers and number of blows. At the OMC obtained from different compactive efforts, Estimate Unconfined compressive strength of all the soil samples at different compactive efforts. We develop the relationships for how unconfined compressive strength varying with optimum moisture content and at different compactive efforts and determine optimum moisture content and suitable compactive efforts at which will get maximum unconfined compressive strength of soil.

KEYWORDS: Field compaction , Compaction Energy, High Compressible Clayey Soil (CH), Intermediate Compressible Clayey Soil (CI), Optimum Moisture Content (OMC), Maximum Dry Density (MDD), Unconfined compressive strength.

1. INTRODUCTION

Soil is the indispensable element of this nature. It is attached to everyone in one or another way. All the basic amenities of life, whether it is concerned with food, clothes and house, have been fulfilled by the soil .Without the soil it is just next to impossible to think about life on this earth. The word “soil” is derived from the Latin word solium which according to Webster’s dictionary means the upper layer of the earth that may be dug or ploughed; specifically, the loose surface material of earth in which plant grows. The top soil contains a large organic quantity matter and is not suitable as a construction material or as a foundation for structures.

The term soil in soil engineering is defined as an unconsolidated material, composed of solid particles produced by disintegration of rocks. The voids space between particles may contain air, water or both. The solid particles may contain organic matter. The soil particles may be separated by such mechanical means as agitation and water. Soil deposits in nature exist in an extremely erratic manner producing thereby an infinite variety of possible combination which will affect the strength of the soil and the procedures to make it purposeful. So is the particular case of black cotton soil with a wide range of challenges associated with the construction at sites with black cotton soil. The engineering behaviour of a soil mass is expected to be greatly influenced by the mineral composition of the soil grains forming the soilmass. This, however, is only partly true. In case of coarse grained soil, the mineralogical composition of the grain hardly affects the engineering properties of the soils perhaps the grain to grain friction is influenced to a degree. Is such soils, inter particle forces other than those due to gravity are of no consequence, but the finer particles, the more significant becomes the forces associated with the surface.

2. LITERATURE REVIEW

M.S.Yesim Gurtu and A. Sridhar (2004), ''Compaction behaviour and prediction of its Characteristics of Fine Grained Soils with Particular reference to Compaction Energy'' Field Compaction of fine grained soils usually involves different equipment's with the compaction energy varying significantly. Hence the compaction characteristics (Maximum Dry Unit Weight and Optimum Moisture Content) need to be obtained at different compaction energies. Thus knowledge of compaction behaviour and its characteristics of fine grained soils at different compaction energies assumes great importance from the view point of practical significance. In this paper the effect of compaction energy on the behaviour and compaction characteristics of fine grained soils has been brought out. It has been seen that the optimum moisture content bears a good relation with plastic limit and the maximum dry unit weight correlating well with the dry unit weight of soil at plastic limit for all compaction energies studied. Apart from the experimental data obtained by the authors, extensive results from literature have also been used in the analysis. In view of large quantities of soils from different borrow pits to be tested for their potential use, the above correlation with Plastic Limit enables not only saving of time but also cost of investigation for preliminary design.

Kokshienng, Osman M.H., Mohamad GhazaliS.K (2015), ''Estimating maximum dry density and optimum moisture content of compacted'', This study aims to investigate the relationship between maximum dry density and optimum moisture content and their correlation function with index properties. Based on the results of nine soil samples using standard proctor compaction test, the maximum dry density and the optimum moisture content was well correlated. These two compaction properties have much better correlation with the plasticity index than they have with other index properties. Three best predictive models were proposed to estimate the compaction properties based on multi linear regression (MLR) analyses. Additional variables are included in the MLR analyses such as grain size distribution and specific gravity other than the index properties. The recommended model requires only the plasticity index and specific gravity.

"NG K.S.*, CHEW Y.M., OSMAN M.H., MOHAMAD GHAZALI S.K " Laboratory determination of compaction properties namely the maximum dry density and optimum moisture content is both time consuming and costly. Therefore, it is useful if simple correlation equations can be developed to estimate the compaction properties using relatively easier index properties test. This study aims to investigate the relationship between maximum dry density and optimum moisture content and their correlation function with index properties. Based on the results of nine soil samples using standard proctor compaction test, the maximum dry density and the optimum moisture content was well correlated. These two compaction properties have much better correlation with the plasticity index than they have with other index properties. Three best predictive models were proposed to estimate the compaction properties based on multi linear regression (MLR) analyses. Additional variables are included in the MLR analyses such as grain size distribution and specific gravity other than the index properties. The recommended model requires only the plasticity index and specific gravity.

"**Armand Augustin FONDJO*1, Elizabeth THERON2 and Richard P RAY3**" Soil compaction is one of the basic engineering technique, carry out to guarantee the stability of soils dependent on specified strength. Nonetheless, in large scale construction projects, the estimation of compaction features required tremendous effort and time that can be saved utilizing empirical relationships at the initial phases. It becomes critical to develop models to predict the compaction features, namely the maximum dry unit weight ($\gamma dmax$) and optimum water content (WOP). This article attempts to develop models to predict the γ_{dmax} and WOP of fine-grained clay soils. Geotechnical tests such as grain size distribution, Atterberg limits, specific gravity, and proctor compaction tests are performed to assess the physical and hyro-mechanical characteristics of soil samples. Multivariate analysis is conducted using MINITAB 18 software to develop the predictive models. The validation process of developed models includes the determination coefficient, probability value (P-value), comparing predicted values with experimental values, comparing the models proposed in this study with other existing models found in the recent literature, and employing a different soil data set. The predicted values obtained from the models proposed in this research project are more accurate than other models developed recently. The proposed models estimate the compaction features of fine-grained clay soils with acceptable precision.

3. MATERIALS AND METHODS

MATERIALS

Soils :

1. High compressible clay soil
2. Intermediate compressible clay soil

METHODS

Methodology of compactive energy

S.No	Number of Layers	Number of Blows	Height of Fall (Cm)	Weight Of Hammer (kg)	Compaction Energy(Joule)	Compaction Energies Designated
1	2	25	31	26	403.0	E1
2		40	31	26	644.8	E2
3		56	31	26	902.72	E3
4	3	25	31	26	604.5	E4
5		40	31	26	967.2	E5
6		56	31	26	1354.08	E6
7	4	25	31	26	806.0	E7
8		40	31	26	1289.6	E8
9		56	31	26	1805.44	E9
10	5	25	31	26	1007.5	E10
11		40	31	26	1612.0	E11
12		56	31	26	2256.8	E12

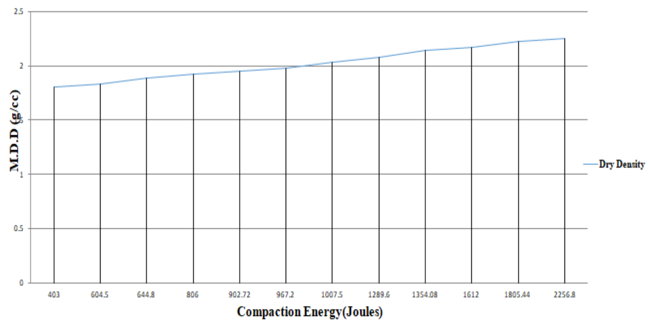
4. EXPERIMENT WORK

Figures and Tables

CH Soil Laboratory Results :

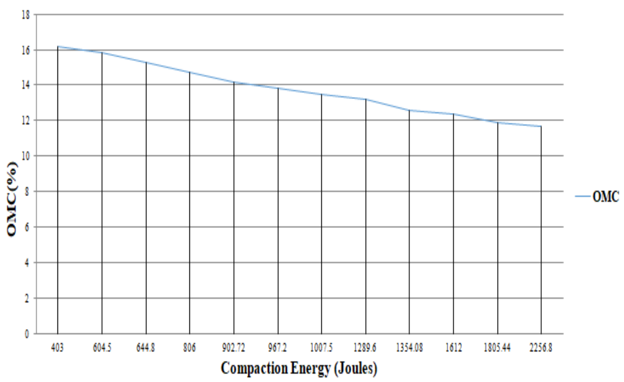
S.NO	Compaction Energy (Joules)	Compaction Energy denoted with (E)	OMC (%)	MDD (g/cc)	UCS(KPa)
1	403.0	E1	16.2	1.81	114.5
2	604.5	E2	15.8	1.83	140.5
3	644.8	E3	15.3	1.89	199.5
4	806.0	E4	14.7	1.92	216.5
5	902.72	E5	14.2	1.95	234.0
6	967.2	E6	13.8	1.98	278.5
7	1007.5	E7	13.5	2.03	303.5
8	1289.6	E8	13.2	2.08	360.0
9	1354.08	E9	12.6	2.14	406.5
10	1612.0	E10	12.4	2.17	408.5
11	1805.44	E11	11.9	2.23	410.0
12	2256.8	E12	11.7	2.25	411.5

Variation of dry density w.r.t compaction energy



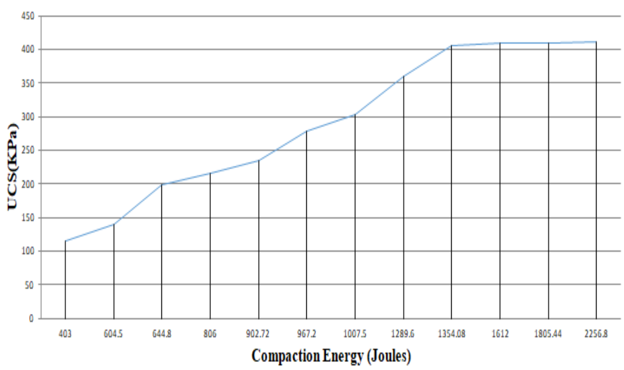
The above graph shows the variation of compaction energy w.r.t MDD.... As compaction energy increases MDD increases upto compaction energy E9 from their no significant improvement.

Variation of OMC w.r.t compaction energy



The above graph shows the variation of compaction energy w.r.t OMC.... As compaction energy increases OMC increases upto compaction energy E11 from their no significant improvement.

Variation of UCS w.r.t compaction energy

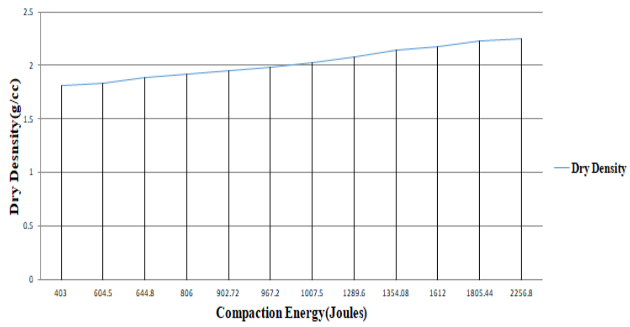


The above graph shows the variation of compaction energy w.r.t UCS.... As compaction energy increases UCS increases upto compaction energy E9 from their no significant improvement.

CI Soil Laboratory Results :

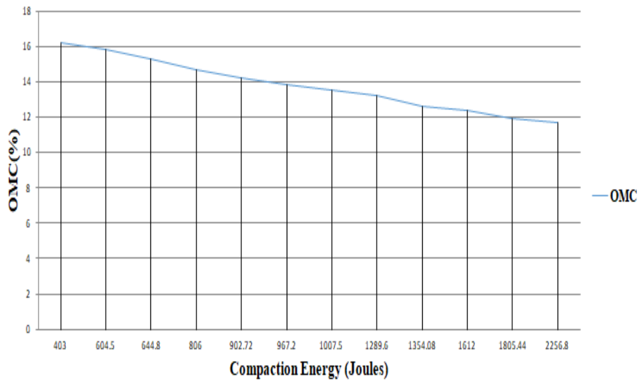
S.NO	Compaction Energy (Joules)	Compaction Energy denoted with (E)	OMC (%)	MDD (g/cc)	UCS(KPa)
1	403.0	E1	14.0	1.72	188.0
2	604.5	E2	13.6	1.78	194.0
3	644.8	E3	13.4	1.79	222.0
4	806.0	E4	13.0	1.84	234.5
5	902.72	E5	12.9	1.86	248.0
6	967.2	E6	12.5	1.88	315.5
7	1007.5	E7	12.3	1.89	322.5
8	1289.6	E8	12.1	1.91	361.0
9	1354.08	E9	12.0	1.95	364.5
10	1612.0	E10	11.8	1.98	367.0
11	1805.44	E11	11.5	2.01	369.5
12	2256.8	E12	11.2	2.03	370.5

Variation of dry density w.r.t compaction energy



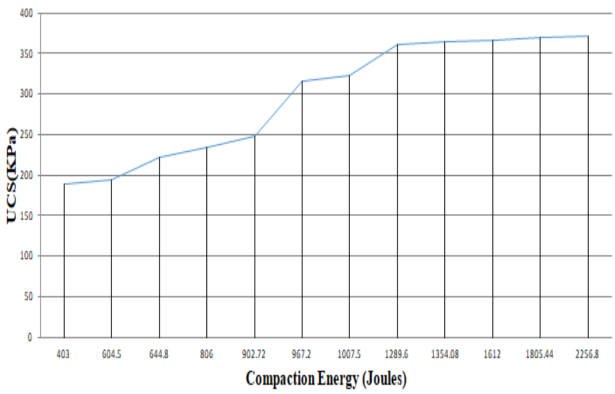
The above graph shows the variation of compaction energy w.r.t MDD.... As compaction energy increases MDD increases upto compaction energy E10 from their no significant improvement.

Variation of OMC w.r.t compaction energy



The above graph shows the variation of compaction energy w.r.t OMC.... As compaction energy increases OMC increases upto compaction energy E10 from their no significant improvement.

Variation of UCS w.r.t compaction energy



The above graph shows the variation of compaction energy w.r.t UCS.... As compaction energy increases UCS increases upto compaction energy E8 from their no significant improvement.

5. CONCLUSION

- As compactive energy increases the unconfined compressive strength of soil will increase up to some extent. Further increase in compactive effort will not show significant increase in strength.
- If compactive energy increases the optimum moisture content (OMC) decreases upto E9,further then is not significant for CH soil.
- If compactive energy increases the maximum dry density (MDD) increases upto E9,further then is not significant for CH soil.
- If compactive energy increases the optimum moisture content (OMC) decreases upto E8,further then is not significant for CI soil.
- If compactive energy increases the maximum dry density (MDD) increases upto E8,further then is not significant for CI soil.
- With reference to present work we can reduce compaction work and money at the field.

Conflict of interest statement

Authors declare that they do not have any conflict of interest.

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