EFFECT OF ORGANIC MATTER (VERMI-COMPOST) ON COMPACTION CHARACTERISTICS OF KAREWA SOILS: AN EXPERIMENTAL STUDY

Nadeem Qayoom Dar[1], Er. Abhishek[2],

[1] *M.Tech Scholar, Department of Civil Engineering, Galaxy Global Group of Institutions, Ambala, Haryana, India,*

[2] *Assistant Professor & Head, Department of Civil Engineering, Galaxy Global Group of Institutions, Ambala, Haryana, India.*

***Abstract*:** Soil rich in organic matter is apt for the growth of plants as it provides them with nutrients essential for their growth and nourishment. Apart from that, it also affects the soil structure and mineralogy and ultimately the soil properties. Based on same purpose, this study was carried out to investigate the effect of organic matter (Vermi-compost) on the compaction characteristics of Karewa soils. In thus study, three soil samples were taken from three sites and characterised as **"CL"** (clayey soil with low plasticity). Proctor tests of different compaction energies (viz., Standard Proctor, Modified Proctor and Reduced Standard Proctor) were conducted on the samples with and without Vermi-compost. The percentages of Vermi-compost by dry weight of soil was taken as 3%, 6%, 9% and 12% and mixed with soil thoroughly before each Proctor test. The maximum dry density and optimum moisture content of the Karewa soil corresponding to each Vermi-compost percentage was determined in Geo-Technical Laboratory of NIT Srinagar. Proctor results indicate that on introduction of Vermi-compost to the Karewa soils, maximum dry density decreases and Optimum moisture content increases with the increase in Vermi-compost percentage upto 12**%** and beyond that the mixture became unworkable. An empirical model relating maximum dry density and optimum moisture content with organic matter content was also established on the basis of the acquired Proctor test results.

Index Terms - **Maximum dry density, Optimum moisture content, proctor compaction, Vermi-compost, Karewa soils.**

I.INTRODUCTION

Geo-Technical Engineering is all about how does soil behave in loaded and unloaded conditions. What phenomenon does occur when its natural conditions/characteristics are disturbed and how it modifies its behaviour to counter that disturbance is what mainly Geo-Technical engineering is all about. Different techniques to impart strength to soil also depend upon the type of soil in consideration. Some soils readily adapt to the technique used gaining significant strength while some take time or did not respond to it at all.

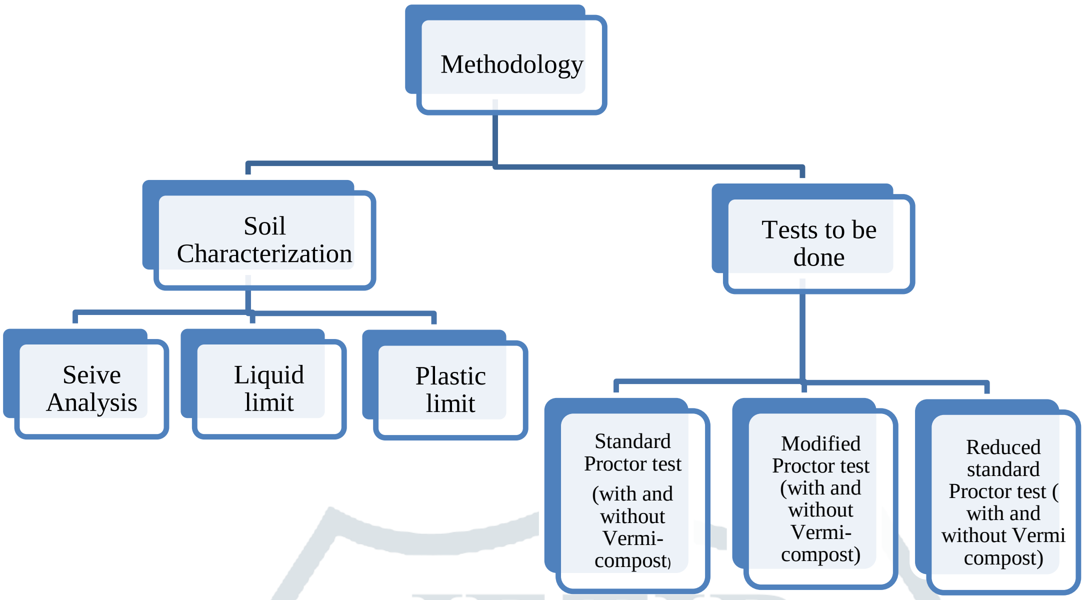
Many techniques previously developed when used on a commercial scale pose environmental concern. Today, research in this field also focuses on its environmental impact. More and more thrust is being developed to have an environment friendly material to be used in soil so as to improve its compaction characteristics and thus its strength. Natural materials like Jute fibres, rice husk, reed etc act as a promising agent and have been observed to have a significant effect on the strength characteristics of the soil. On the same lines, an organic matter containing material called *Vermi-compost*, often used as manure for agricultural purposes was selected for the present study in order to analyse the effect of it on various compaction characteristics of the soil. The material was selected because it is entirely organic so does not have any adverse effect on environment. Furthermore, there is no code available to which the limiting organic matter content in the soil can be referred to in order to make the soil suitable for construction purposes. So, an analysis of the response of soil with organic matter will be done to find out the extent of the effect of organic matter content on compaction characteristics of soil.

II.EXPERIMENTAL PROCEDURE

Karewas are famous for cash crop cultivation in Kashmir valley. *Saffron* is exclusively cultivated on *Pampore Karewas*. Fruit cultivation like Apple and Pear is also done on *Budgam Karewas* in the *Chrar-e-Sharif* and *Pakherpora Vudr* stretch. Karewa soils are clayey in nature and highly fertile. For the study, samples were taken from three different sites each at:

- ***Awantipora Karewas* in Distt. Pulwama (**hereafter referred to as **Sample "A"**) **with co-ordinates** 33°52'55.1"N 74°59'26.3"E
- ***Pampore Karewas*** in Distt. Pulwama (hereafter referred to as **Sample "B"**) with co-ordinates**33°58'16.8"N 74°55'29.5"E** and from
- ***Noubug Karewas*** in Distt. Budgam (hereafter referred to as **Sample "C"**) with co-ordinates **33°56'54.8"N 74°50'58.2"E**

The following methodology was followed in the study:



Flow chart of the research methodology employed

The consistency limits (liquid limit, plastic limit) tests were conducted as per

IS: 2720 (Part5) – 1985 and compaction tests as per:

IS: 2720 (Part VII) –1974 "Determination of Moisture Content-Dry Density Relation Using Light Compaction", and

IS: 2720 (Part VIII) –1965 "Determination of Moisture Content- Dry Density Relation Using Heavy Compaction"

III.TABLES AND FIGURES

Table 1: Atterberg's limits and characterization of three soil samples

Sample	Liquid Limit	Plastic Limit	Plasticity Index	Soil type	A-Line	%age passing 75μ	G
A	34.48%	18.38%	16.10%	"CL"	10.57%	< 2	2.606
B	34.56%	17.29%	17.27%	"CL"	10.63%	< 1	2.614
C	35.21%	20.92%	14.29%	"CL"	11.10%	< 3	2.608

Table 2: Natural MDD and OMC of the soil samples

Property	Standard Proctor test		
	Sample A	Sample B	Sample C
MDD (gm/cc)	1.733	1.751	1.692
OMC (%)	17.51	17.79	18.12
	Modified Proctor test		
MDD (gm/cc)	2.174	2.201	2.111
OMC (%)	14.01	14.48	14.77
	Reduced Proctor test		
MDD (gm/cc)	1.687	1.732	1.676
OMC (%)	18.11	18.27	18.38

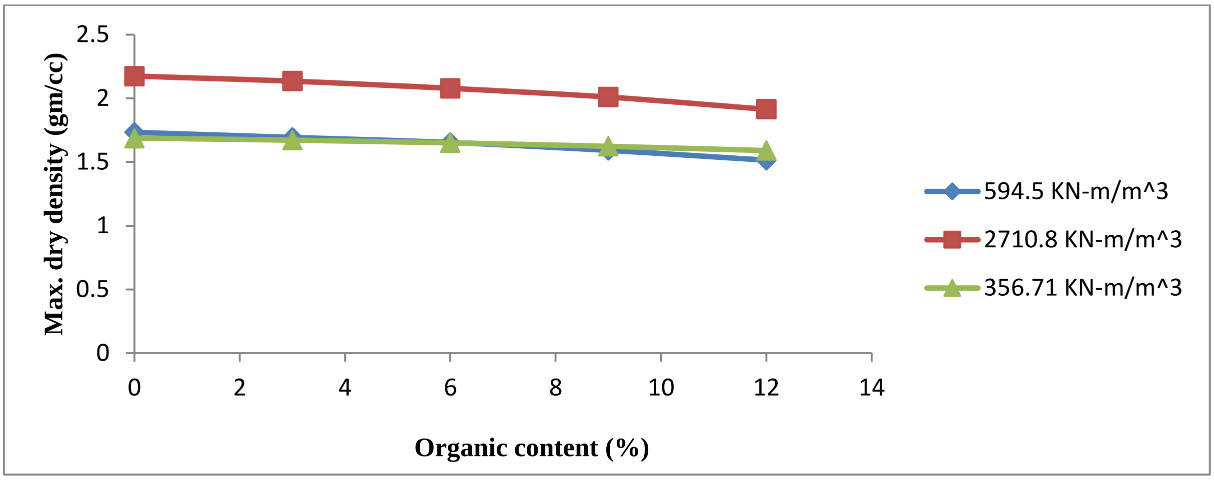


Fig 1: Comparison graph showing variation of MDD of sample A with organic content at different compaction energies

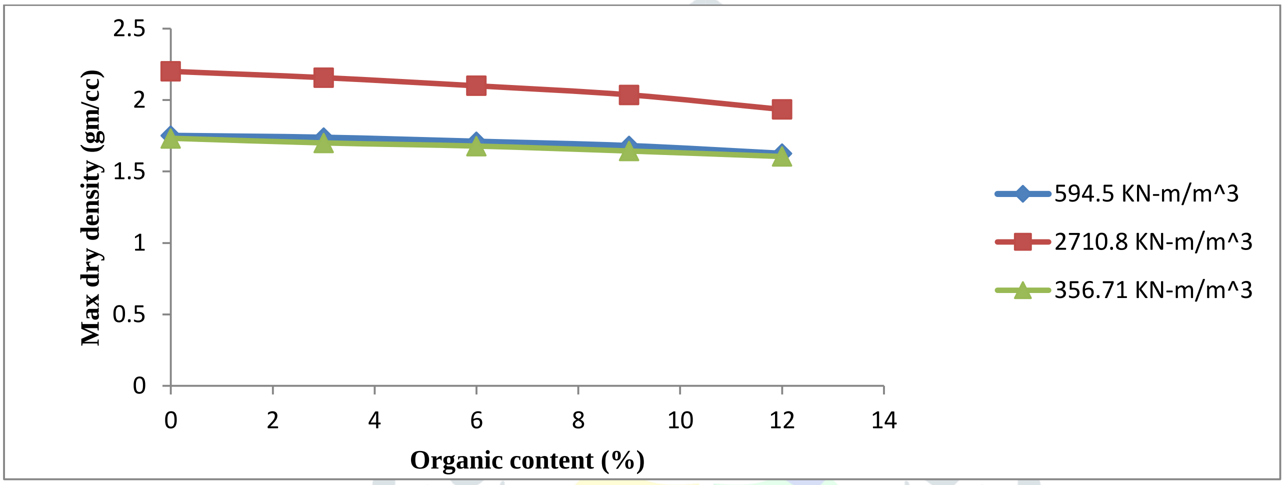


Fig 2: Comparison graph showing variation of MDD of sample B with organic content at different compaction energies

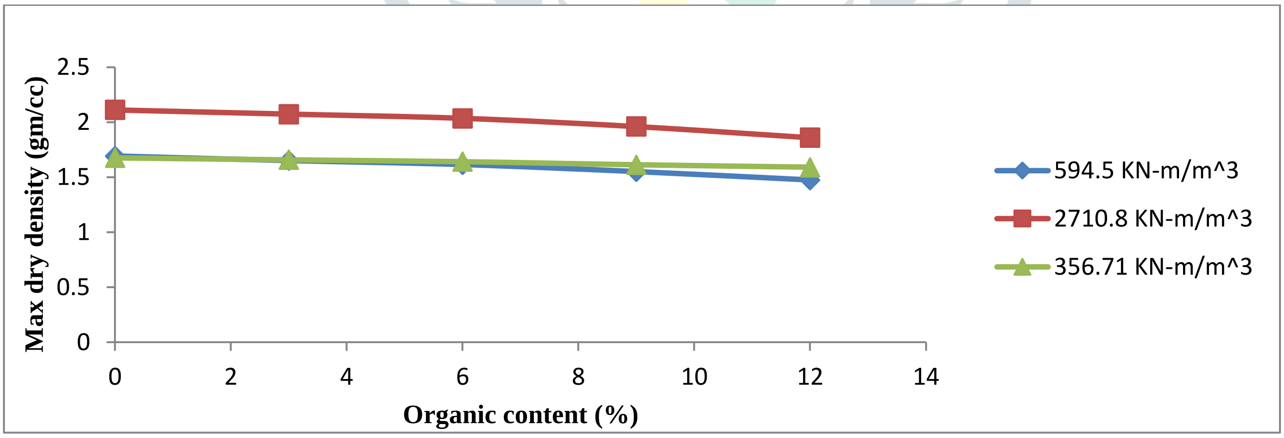


Fig 3: Comparison graph showing variation of MDD of sample C with organic content at different compaction energies

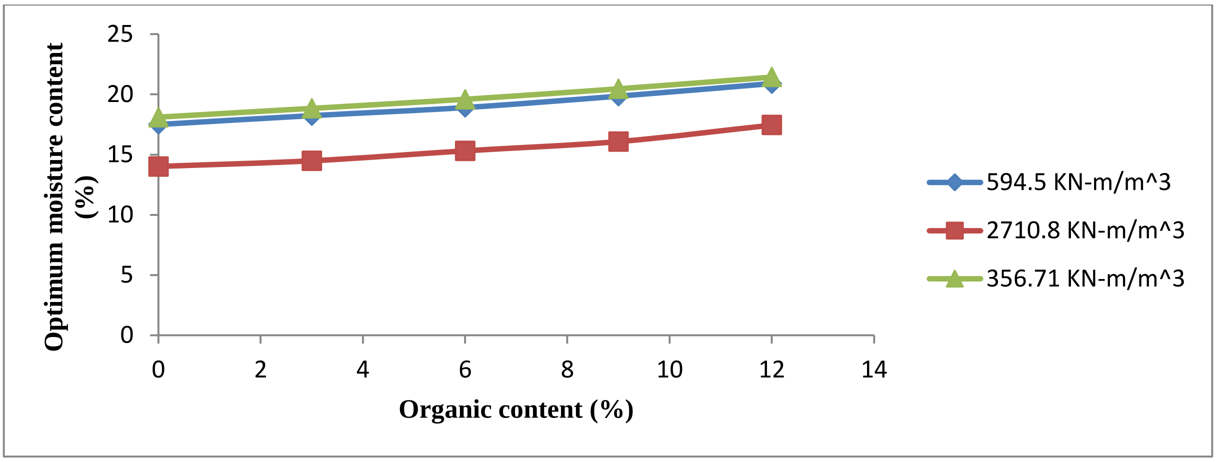


Fig 4: Comparison graph showing variation of OMC of sample A with organic content at different compaction energies

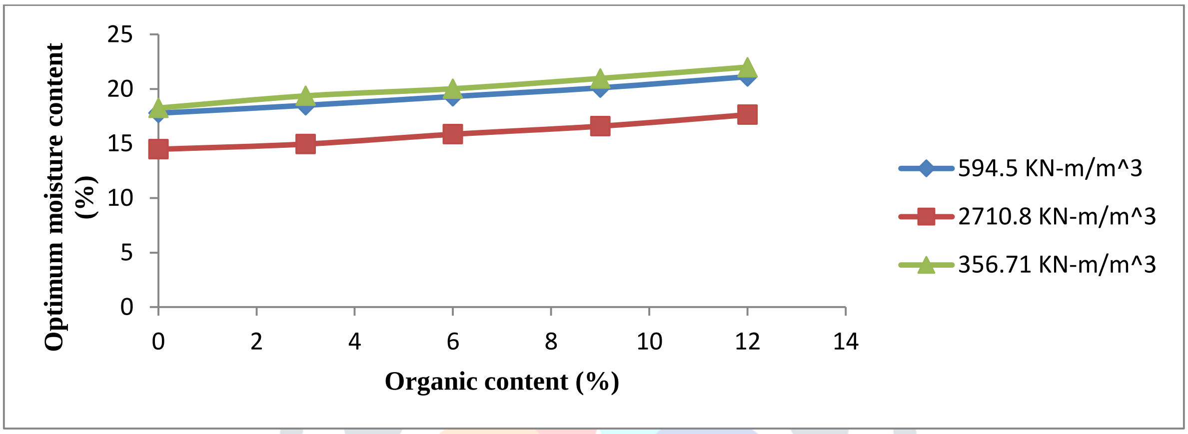


Fig 5: Comparison graph showing variation of OMC of sample B with organic content at different compaction energies

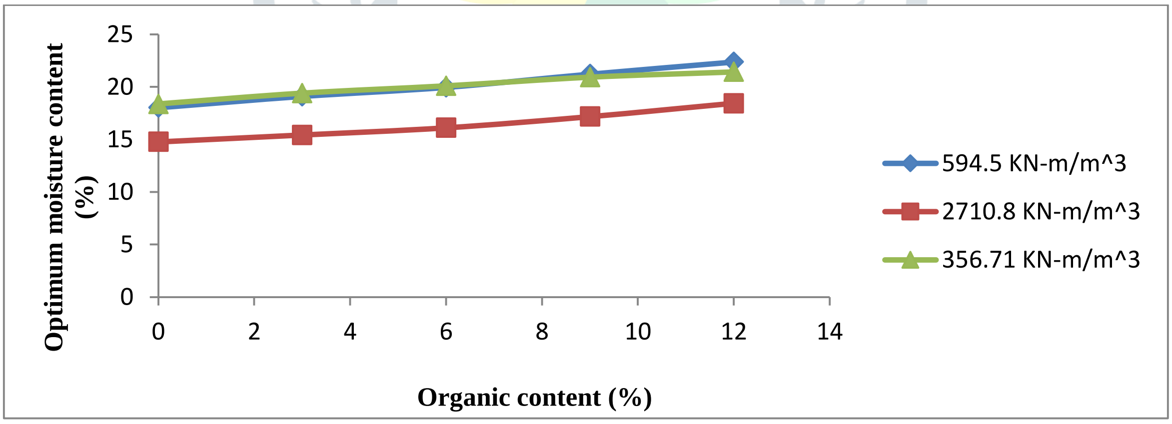


Fig 6: Comparison graph showing variation of OMC of sample C with organic content at different compaction energies

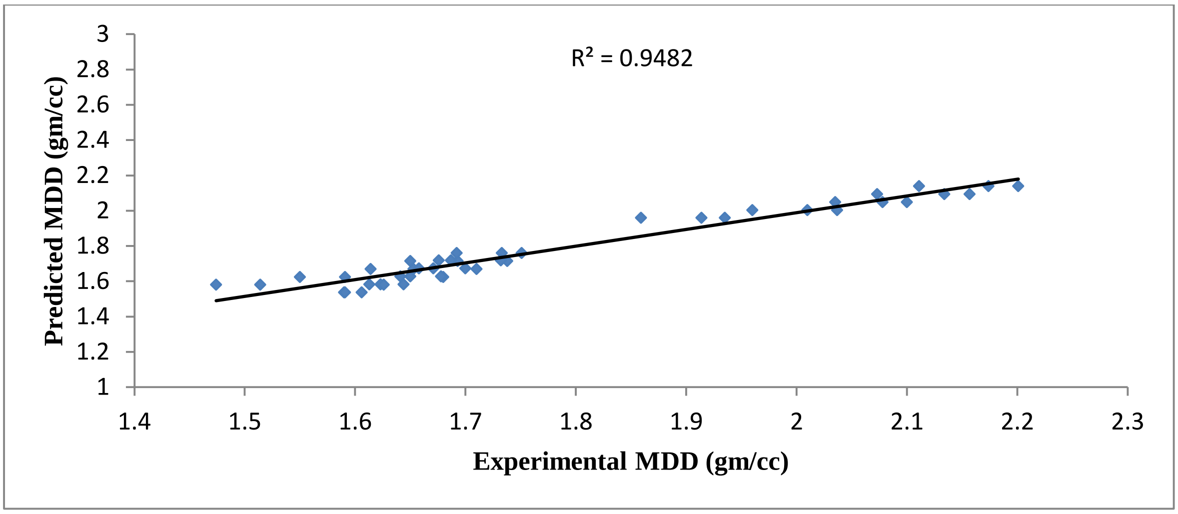


Fig 7: Correlation graph of Predicted MDD v/s Experimental MDD

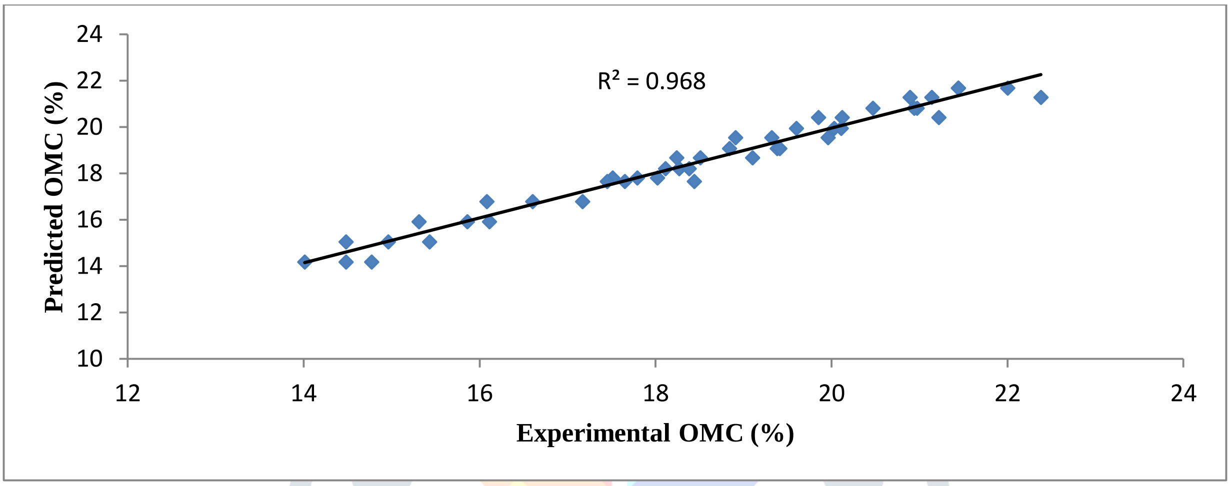


Fig 8: Correlation graph of Predicted OMC v/s Experimental OMC

IV.EMPIRICAL MODEL

As the analysis suggest, there is a linear relationship between organic matter content and dry density as well as OMC of the sample soil on all compaction energies. On these basis, a multiple regression analysis of 45 data points (only MDD data points selected to predict MDD of the soil) was done generating an empirical model of three parameters viz. dry density, organic content and compaction energy. The empirical model is as follows:

$$y_d' = -0.0150444*O.C + 0.0001791*E + 1.654007383 \qquad \text{(i)}$$

where; y_d' = predicted value of dry density in gm/cc

O.C = organic content in %

E = compaction energy in KN-m/ m^3

A similar empirical model was also developed for pre-determined prediction of OMC. The empirical is as follows:

$$M' = 0.289074074*O.C - 0.00171203*E + 18.82537899 \qquad \text{(ii)}$$

where; M' = predicted value of optimum moisture content in %

O.C = organic content in %

E = compaction energy in KN-m/ m^3

For **Eq. (i)**, the value of correlation coefficient (R^2) is **0.948** and standard error is **0.048**. P-value calculated from **ANOVA** output is **9.71* E^{-28} << 0.05**, which is valid for modelling purposes.

Also for **Eq. (ii)**, the value of correlation coefficient (R^2) is **0.968** and standard error is **0.411**. The P-value calculated from **ANOVA** output is **3.97866*E^{-32} << 0.05**, which being valid for modelling purposes.

The Equations (i) and (ii) can be used to predict the dry density and OMC respectively in terms of compaction energy and organic content.

V.CONCLUSION

Required compaction tests were conducted on the soil and results analyzed. The introduction of organic matter was restricted to 12%, reason being the soil became **unworkable** on increasing the organic content further. Based on the result analysis, an empirical model has been developed for calculating dry density and optimum moisture content of Karewa soils in terms of organic matter content and compaction energy which can be of great use on field to predict the dry density on application of organic matter and suitable compaction method. On the basis of factors, tests and discussions made above, the following conclusions were drawn:

- The vermi-compost when blended with soil increases void ratio. With varying compaction energy from **356.71 to 2710.8 KN-m/m^3**, maximum dry density (MDD) increases while as optimum moisture content (OMC) decreases.

- Noting the trend in the study, as the organic matter content (Vermi-compost) **increases (3% to 12%)**, maximum dry density (MDD) **decreases** while as optimum moisture content (OMC) **increases**.

- The negative variation of MDD of Karewas (collected from three different sites) on introduction of organic matter (four levels up to 12%) as per standard Proctor compaction energy is **1.738 - 1.474gm/cc (i.e., 15.19% decrease)** while as per modified Proctor and reduced Standard Proctor compaction energy, it is **2.157 – 1.859gm/cc (13.81% decrease)** and **1.700 – 1.590 gm/cc (6.47% decrease)** respectively.

- The positive variation of OMC of Karewas (collected from three different sites) on introduction of organic matter (four levels up to 12%) as per standard Proctor compaction energy is **18.24% - 22.38% (18.49% increase)** while as per modified Proctor and reduced Standard Proctor compaction energy, it is**14.48% - 18.44% (21.47% increase)** and **18.84% - 22.00% (14.36% increase)** respectively.

- Multiple regression analysis of the results from 45 data points lead to the development of an empirical model for predicted calculation of dry density and optimum moisture content of Karewa soils in terms of organic matter content (Vermi-compost) and compaction energy. The model can be employed on field to predict the maximum dry density and optimum moisture content of Karewa soil.

- This empirical model is based on compaction energy range from 356.71 to 2710.8 KN-m/ m^3 and vermi-compost content upto 12%. Beyond this range, further experiments are needed to be done to verify and generalize the model.

VI. ACKNOWLEDGEMENTS

First and foremost, I would like to thank Almighty Allah for his blessings. I am also thankful to my guide Er. Abhishek who always assisted me at every stage of this project. It would be an act of ingratitude if faculty and staff of Geo-Technical Division, Civil Engineering Deptt. (NIT, Srinagar) especially Head, Geo-Tech Engg Division NIT, Srinagar, Professor B.A Mir whose timely interest in allowing me to perform required soil tests at the Institute is not credited here paving a smooth path for completion of this study.

REFERENCES

Journal Papers:

[1] Adejumo TE. (2012); “Effect of organic content on compaction and consolidation characteristics of lagos organic clay”, Electron J Geotechnol Eng (EJGE), Vol.17, pp: 2201-2211

[2] Al- Kifae A, Hamad M.A (2017); “Inspecting the effects of organic content on compaction and consolidation characteristics of organic soil models”, Am Sci J Eng Technol Sci (ASRJETS), 321, pp: 289-297

[3] Chitra. R, Dixit. R, Sen. P, Sarin. M (2016); “Stabilization of Organic Soil using Additives”, International Journal for Research and Technology in Development, Vol. 5, Issue 2

[4] Dixit. M, Chitra. R, Sen. P, Sarin M (2017); “Tolerable Limits of Organic Matter for Use of Soil as Construction Material and Stabilisation of Organic Soils”, Indian Geotechnical Conference, Geotechnics for Natural and Engineered Sustainable Technologies, IIT Guwahati, 2017

[5] Hamouche, Fawzi & Zentar, Rachid. (2018); “Effects of Organic Matter on Mechanical Properties of Dredged Sediments for Beneficial Use in Road Construction”, Environmental Technology, Vol. 41, pp: 1-38.

[6] Hong, W.P, Song Y. S., Tun, J. M., and Kim, T. H (2003); "Investigation of Solid Waste Soil as Road Construction Material", Environmental Geology, 44, pp: 203-209

[7] IS: 2720 (Part I) –1972 "Preparation of Dry Soil Samples for Various Tests"

[8] IS: 2720 (Part II) –1973 "Determination of Water Content"

[9] IS: 2720 (Part III) --1974 "Determination of Specific Gravity"

[10] IS: 2720 (Part IV) – 1975 "Grain Size Analysis"

[11] IS: 2720 (Part V) –1970 "Determination of Liquid and Plastic Limits"

[12] IS: 2720 (Part VII) –1974 "Determination of Moisture Content-Dry Density Relation Using Light Compaction"

[13] IS: 2720 (Part VIII) –1965 "Determination of Moisture Content- Dry Density Relation Using Heavy Compaction"

[14] Kumar. D, Bansal, M. &Phogat, V.K. (2009); "Compactability in relation to texture and organic matter content of alluvial soils", Indian Journal of Agricultural Research Vol. 43 (3), pp: 180-186

[15] Mamman, E. &Ohu, John &Crowther, Thomas.(2007); "Effect of soil compaction and organic matter on the early growth of maize (Zea mays L) in a vertisol", International Agrophysics, 21.

[16] Minasny.B & Mcbratney. A. (2017); "Limited effect of organic matter on soil available water capacity: Limited effect of organic matter on soil water retention", European Journal of Soil Science. 69.

[17] Morvan. X, Verbeke L, Laratte S, Schneider A.R, (2018); "Impact of recent conversion to organic farming on physical properties and their consequences on runoff, erosion and crusting in a silty soil", CATENA, Vol. 165, pp: 398-407

[18] Ohu, John & Mamman, E. (2014); "The influence of an organic material on stabilizing a vertisol in Borno State, Nigeria for agricultural and structural uses", American Society of Agricultural and Biological Engineers Annual International Meeting 2014, 1 pp: 217-225.

[19] Ohu, John &Mustapha, Abubakar & Mamman, E. (2013); "Critical moisture content of compacted agricultural soils with varying organic matter content", American Society of Agricultural and Biological Engineers Annual International Meeting 2013, Vol. 5, pp: 3652-3664

[20] Rivenshield. A and Bassuk Nina L (2007); "Using organic Amendments to Decrease Bulk Density and Increase Macroporosity in Compacted Soils", Scientific Journal of the International Society of Arboriculture, Vol. 33(2), pp: 140-146

[21] Shahgoli. Gholamhossein & Jannatkhah. J. (2018); "Investigation of The Effects of Organic Matter Application on Soil Compaction", YYU J AGR SCI, Vol. 28(2),pp:175-185.

[22] Tahia. R and Islam M. Rafizul (2012); "Strength and Compressibility Characteristics of Reconstituted Organic Soil at Khulna Region of Bangladesh", International Journal of Engineering and Technology Vol. 2

[23] Thiyyakkandi S. and Annex S. (2011); "Effect of Organic content on Geotechnical Properties of Kuttanad Clay", Electronic Journal of Geotechnical Engineering (EJGJ), Vol. 16, Bund U, pp: 1653-1663

Books:

[24] Arora K.R., soil mechanics and foundation engineering second edition, standard publication: New Delhi (2002)