EFFECT OF ORGANIC MATTER ON COMPACTION CHARACTERISTICS OF SOILS: A REVIEW

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

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Abstract: *An organic matter has in fact natural origin but its interaction with soil poses a different situation altering the properties both physical as well as chemical of the latter. Its main use is regarding agriculture where it is used to improve fertility of the soil by increasing the macro-nutrient content in the same. Though many studies have been conducted on the effect of organic matter on geo-technical properties of soil but still the conclusion differs much and there is need to further the study in order to have clear understanding of the effect of different organic matters on the soil. This paper introduces a review of the effect of organic matter on compaction characteristics of the soils.*

Index Terms: organic matter, macro-nutrient, geo-technical properties, compaction characteristics

I. INTRODUCTION

Everything that has a natural origin is considered an organic matter. It can either be living or decomposed part. Though organic matter may contain macro-nutrients and complex compounds, its composition can affect the physical as well as chemical properties of the substance with which it interacts. Organic matter in its raw or decomposed form has great use in agricultural practices, it being cent percent natural without any synthetics involved. Different forms of organic matter like Vermi-compost improves the soil fertility and also nourishes it with nutrients and minerals. Further, it also improves water holding capacity of soil to some extent. Numerous studies have been conducted on the effects of vermi-compost on soil regarding agricultural practices and have concluded that generally the soil fertility, soil aggregate stability improves and tendency of soil erosion reduces on application of vermi-compost to soil.

Effect of organic matter on compaction characteristics has not been studied much. There is dearth of literature regarding the same. In fact, various researches in geo-technical engineering have only investigated the its effect on Atterburg limits only and only a few have attempted to study its effect on compaction and consolidation characteristics as far as the current research literature is concerned.

Organic matter being cost-effective, easily available, environment-friendly could prove a potent material to alter the geo-technical properties of soil for efficient use as and when required.

II. AIMS AND OBJECTIVES

1. A very limited research studies have been done on the influence of organic matter on the compaction characteristics of soils.

2. Apart from improving fertility of the soil, organic matter also has potency to affect the geo-technical properties of soil

3. Effects of different types of organic matter have been investigated in the studies. A review of the same follows in this paper.

III. DISCUSSION

Fawzi Hamouche and Rachid Zentar (2018) conducted their research on the dredged sediments for road construction. Even in small amounts, the presence of organic matter (OM) in sediments affects their engineering properties. Upon conducting various tests on the material, they found that effect of organic matter content on the optimum water content is important. The results were independent of the energy used. It was also concluded that "the effect of the compaction energy on the Proctor test characteristics seems to be reduced when a high amount of organic matter content was used" [5].

X. Morvan and et.al. (2018) in their study assessed the "influence of a recent conversion to organic farming on the physical properties. They conducted experiments on two agriculture fields separated by 400m with similar slopes and soil types (silty) in the **Brie** area of France. The study concluded that no significant differences were detected among the bulk density, soil water retention or saturated hydraulic conductivity. The aggregate stability, measured both under simulated rainfall and in a laboratory, was significantly higher in the organic management field (OF) than in the conventional management field (CM), indicating that CM soils are more prone to soil crusting that OF soils" [10]. Moreover, they also concluded that parameters like aggregate stability and soil erosion improved in silty soils when organic farming was employed [10].

Gholam Hussain Shahgoli and Javad Jnatkhah (2018) investigated soil compaction in agricultural fields due to machine traffic. The authors studied the effects of sheep manure and vermi-compost with 0, 2, 4, 6 and 8% levels on compaction of loam and clay loam soils using standard Proctor test at moisture content under the critical moisture. The SPSS.17 software was employed for statistical study in the study. They concluded that all application levels of both organic matters had significant effects on decrease in soil compaction [Fig 2]. They found that application of 8% organic matter decreased soil compaction by 9.25%. A linear relationship existed between organic matter applications in the soil and decreased critical moisture. Organic matter application was more effective on clay loam soil than loam soil, especially at higher levels of 6% and 8% [Fig 3]. In the study, it was found that at lower application levels of 2 and 4%, vermi-compost was more effective on soil compaction than manure; however at higher level of 6% and 8%, manure was more effective in decreasing soil compaction. The lowest bulk density of1.48gr/cm^3 was obtained with adding 8% of organic matter [Fig 4] which decreased soil compaction by 10% in compaction with the treatment without organic matter.

Abdul Aziz Al-Kaifae and Muhannad Abdullah Hamad (**2017**) made a "model of organic soil samples by the use of Eucalyptus leaves as an organic matter and then mixed with inorganic silty clay soil taken from a specific district of Baghdad city at three levels (0% as mineral soil, 20% as organic soil and 40% as highly organic soil or peat by dry weight). After determining various physical and engineering properties, the result showed that the Atterburg limits increase with the increase in the organic content (O.C), while the plasticity index (P.I) is decreases at (20% O.C), then increases slightly at (40% O.C)" [2]. They also noticed that the maximum dry density (M.D.D) decreased while as optimum water content (O.W.C) increased with the increase of the organic content affecting the compaction characteristics [Fig 1].

Budiman Minasay and Alex Mcbratney (2017) analysed large databases and "carried out a meta-analysis of numerous published studies and attempted to find a relation between organic carbon (OC) and water content at saturation and other critical moisture points" [9]. It was found that on an average, 1% mass increase in organic content in soil increases water content at saturation. The increase was greater in sandy soils and least in clays.

Mahabir Dixit and et.al (2017) conducted tests on inorganic soil blended with organic manure and concluded that no significant change in LL and PL was observed till blending of 10% of organic manure which is equivalent to 2% of effective organic matter in the blended mixture. Further addition of organic matter results in undesirable changes in Atterberg limits i.e., increase in compressibility and thus making soil unsuitable for construction. It was also observed in the study that maximum MDD of the blending material is obtained around 10% of organic manure or 2% of effective organic content. Further increase in organic content causes sharp reduction in MDD values.

Sudheesh Thiyyakkandi and Shima Annex (2017) studied "the effect of organic content on Geotechnical properties of Kuttanad clay and found that though the Atterberg limit of the Kuttanad clay increased linearly with the increase in organic content. The study also confirmed that no much variation in maximum dry density was observed with increase in organic content whereas optimum moisture content (OMC) increased at a rate of 0.68% per unit (i.e., 1%) increase in organic content" [16]. Further, the coefficient of consolidation and shear strength decreased significantly with the increase in organic content.

Purabi Sen and et.al., (2016) in their study on the "properties of fine grained soil blended with organic matter found that liquid limit increases, plastic limit decreases with increase in blending material beyond 6%" [3]. The plasticity index increases with the increase in blending material beyond 2% [3]. Further, they concluded from their study that MDD values are significantly reduced and OMC values increased with increase in blending material beyond 10% [3].

Ohu and Mamman (2014) investigated vertisol in North-eastern Nigeria, where it is generally used for agricultural as well as structural purposes. The sensitivity of the vertisol has been a major hurdle in its extensive use. In the study, easily available organic matter- cow dung was used as a stabilizer in the vertisol. The results indicated that the increase in organic matter decreased bulk density, penetration resistance, shear strength and cracking patterns of the soil.

John Ohu and et.al (2013) conducted compaction test on three samples of Agricultural soil in Borno state incorporating three types of organic matter viz, cow dung, chicken dung and groundnut haulms in the soil sample at different concentrations (2% and 4% by weight). The three soil-organic matter moistures were compacted at three levels (5, 15 and 25 blows) at different moisture contents [12]. It was observed in the study that organic matter doesn't affect the critical moisture content (CMC) but surely has its effect on maximum dry bulk densities. Results also implied that increase in compaction energy also increase dry bulk density, however it decreases after maximum dry density is reached. In all the three organic materials used, cow dung was observed to have affected the most followed by groundnut haulms and chicken dung.

Tahia Rabbee and Islam M. Rafizul (2012) investigated "the effect of organic content on the shear strength and compressibility parameters of blended soil. They selected disturbed samples from two locations of Khulna region and concluded upon performing various test on it that undrained shear strength decreased while as initial void ratio increased with the increase in organic matter content" [15]. This follows the bulk density also decreased with the increase in organic content.

Taiye Elisha Adejumo (2012) carried out investigations on "the effect of organic content on the compaction and consolidation parameters of organic clay soils in **Ikoyi** area of Lagos and concluded that plasticity, optimum moisture content, initial void ratio (e_0), compression index increases with the increase in organic content [Fig 5] while as the shear strength of clay and coefficient of primary consolidation decreases with increase in organic content" [1].

Dinesh Kumar and et.al., (2009) in their study published in **Indian Journal of Agricultural Research** concluded that soil organic matter reduces the risk of soil compaction at given moisture content. The clay loam soil being more sensitive to compaction was found to reduce its susceptibility to compaction to a larger extent [7] on introduction of organic matter as compared to other soils.

Angela Rivenshield and Nima L. Bassul (2007) investigated the effect of organic matter on bulk density and macro porosity of soil. They were actually studying the retarded growth of tress in compacted urban soils. The investigation showed that "the addition of organic amendment (atleast 33% for sandy loam and 50% for clay loam) to a compacted soil reduced bulk density to below root restricting thresholds and increased macro porosity significantly- more than 100% in some cases. **Sphagnum peat** was marginally more effective at lowering bulk density and increasing macro porosity than food waste compost, probably because of the deleterious "particle nesting" effects of the added sand in the food waste compost" [13].

E.Mamman and et.al, (2007) in their study analysed the effect of organic matter in determining 'the emergence and early growth of maize (zea mays) seeds in a dark clay soil known as vertisol. The incorporated three quantities of groundnut haulms into the vertisol as organic matter and then compacted at three moisture content levels using four different compactive efforts. The three organic matter and moisture content levels were 2, 4 and 6% (db) and 20, 35 and 50% (w/w), respectively. The four compactive efforts used in the investigation were 0, 5, 10 and 15 proctor hammer blows. They concluded that incorporation of organic matter into vertisol could reduce the effect of compaction. In their study, they also found that for all moisture content levels, the highest mean values of the crop parameters were recorded at 4% organic matter level and 5 hammer blows. This implies that although the organic matter has some influence on the crop parameters, there is a limit to the amount that could be added to improve yields' [8].

W. P Hong and et.al., (2003) in their study on solid waste soil as Road construction material concluded that magnitude of organic matter affects the "geotechnical properties of soil. The maximum dry unit weight, shear strength and bearing capacity of ground decreases, while the void ratio and compressibility increases with increase in the organic matter content. They also found that if the organic matter content is more than about 8% in solid waste oils, it is not suitable for use as a sub-base material in road construction due to the significant reduction in shear strength and bearing capacity" [6].

IV. FIGURES

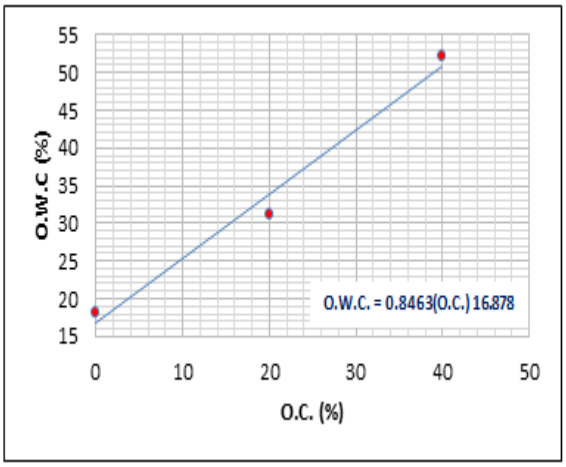

Fig 1: Optimum water content versus organic content

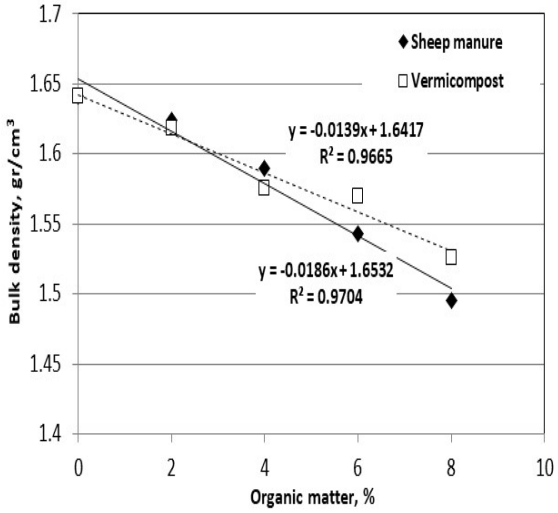

Fig 2: Effect of OM type and its added rate on soil compaction.

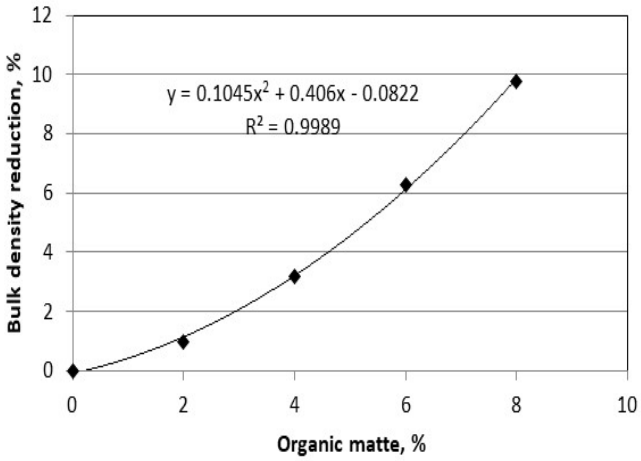

Fig 3: Relationship between added OM percentages on reduction of soil bulk density.

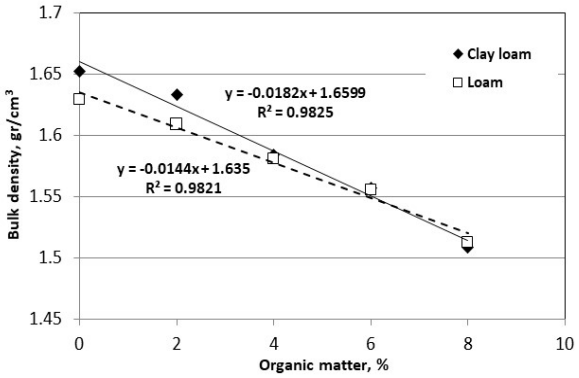

Fig 4: The effect of added OM on bulk density in both soil types of loam and cay loam.

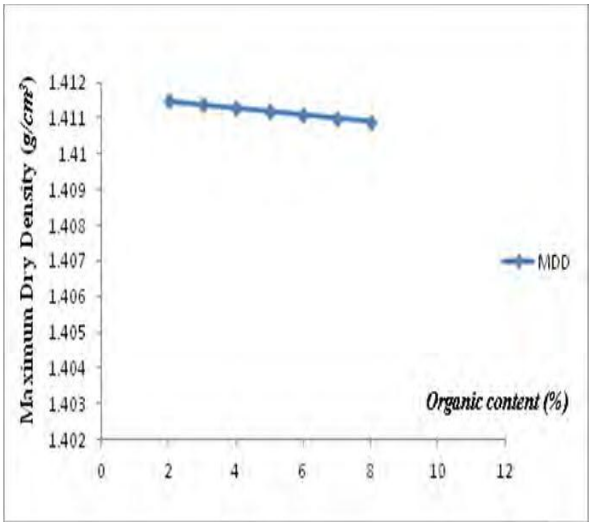

Fig 5: Variation of Maximum Dry Density with Organic content

V. CONCLUSION

Because of its innate properties, vermi-compost finds its extensive use in agricultural practices. Literature review implies that it improves the fertility of soil, aggregate stability and water holding capacity of soil. Very few studies also indicate that MDD decreases and OMC increases on introduction of organic matter in the soil. More studies need to be done in this regard which will not only clear the ambiguity in the matter but also assist in selecting the best organic matter to improve the geo-technical properties of the soil.

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