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A Review Paper on Prediction of Relative Density of Sand

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Abstract: *Sand being an integral aggregate in the construction industry and at the same time, its proportion in soil affecting the properties to a large extend, it is imperative to study its properties and how these are affected. One of the important phenomenon's regarding sand is compaction. So, it is imperative to study about compaction of sand. Various equipment are employed in field for the compaction of sand. Different equipment imparts different compaction energies. For the calculation of amount of compaction in soil we have a parameter called relative density, which is a better indicator of compaction of granular soils. In soil mechanics, relative density is defined in terms of void ratios. But these void ratios themselves depend upon the grain size. But we don't have a direct relationship between grain size and relative density. Various researchers have tried to relate relative density with mean grain size, and the results have been encouraging.*

Key words: ***compaction, compaction energy, relative density, effective size, void ratio.***

1. INTRODUCTION:

Compaction is a mechanical operation of improving the properties of soil, it is generally done with the help of a mechanical instrument and is one of the most common method of soil stabilization and is also economical method of compaction. By compaction we alter the various properties of a soil which is meant for a specific application, viz soil used in pavements, foundations, or abutment of a bridge etc. To check the effectiveness/usefulness of the mechanically controlled process of compaction various density measurements are done, in which the aim is to improve the behaviour of soil which then have a vast range of applications in the field of geo technical engineering. These density measurements can be done in-situ as well as in the lab. Compaction test is the starting point of any geo technical project. Compaction test is the one of the tests that should be mostly carried out before the geo technical project work is about to be started. The various parameters of soil like type of soil, density of soil, moisture content of soil is determined using the compaction tests. These parameters influence the strength of the soil. compaction and its effectiveness depend on various factors like compaction energy/effort, moisture content, type of soil etc out of which compaction effort (equipment type, equipment's weight, number of blows, vibration during compaction etc) is one of the most important factor that influence the compaction sweepingly. Field compaction of coarse soils i.e. sand, usually engage different machinery/equipment with the compaction energy showing substantial variation. Different compaction tests like, the modified Proctor tests and standard Proctor tests are done with varying energy levels and then there results had been used to show the comparisons. Various action, operations and activities have been detected which will be used to the objectives of project, i.e., literature survey/review, then conducting several tests related to the proposed research work in the laboratory, determining various parameters of the sand like density, grain size distribution, MDD, various void ratio's coefficient of uniformity, coefficient of curvature, mean size of sand, effective size of sand and then analysing these results obtained from various laboratory tests to reach a conclusion or to support the proposed research work. When the compaction effort or compaction energy is increased The Maximum Dry. Density of soils also increases but the Optimum Moisture Content or OMC shows the opposite trend its value reduce with higher values of compaction effort or compaction energy. In case of cohesionless soils having small quantity of fines or zero percent fines the water content has significant influence on the density or we can say compacted density. For the low water content & generally under a lesser compaction effort or compaction energy the density of the soil may reduce. If we compare it to that soil on which same compaction effort was applied but it was an air dried or oven dried soil. The main reason for this decrease is capillary tension, and this capillary tension is not fully compensated by the compaction effort or compaction energy, this capillary tension holds the soil particles in loose state. During fully saturated condition the cohesionless soil has maximum density. Again, this maximum density may not be very much larger than dried condition if we compare it to the air or oven dried condition. This maximum density at full saturation condition is not because of lubricating action of water but is because of reduction in effective pressure between soil particles by pressure which is hydrostatic in nature. Sand being an integral aggregate in the construction industry and at the same time, its proportion in soil affecting the properties to a large extend, it is imperative to study its properties and how these are affected.

2. LITERATURE REVIEW:

Various researchers have studies about the relative density of sand and tried to relate it with some index property. Some of the works done regarding this topic are as under:

Masih (2000) [1] was the first researcher to develop a mathematical model for the determination of density of soil. His model included analytical parameters and fine biasness coefficient for the determination of density. He the compared his predicted values with lab values and they were iv total agreement and margin of error was very low.

Barton et al. (2001) [2] worked on combined grading, and its effect on maximum dry density of sand. He collected samples from various sources so that a uniformly graded sample of sand is produced. The resulting sample of sand was totally different from the original sand samples. The sample showed increase in dry density as the sample moved toward ideal grading combination.

Abdel-Rahman (2008) [3] used an Artificial neural network abbreviated as ANN. He developed this model to predict optimum moisture content and maximum dry density. The research was conducted according to ASTM D 1557. From the results obtained from ANN model empirical relationships were developed. Furthermore, the predicted and experimental results were compared.

Gunaydın (2008) [4] used statistical analyses and artificial neural networks. This research work was done on dams of Nigde (Turkey). Soil compaction analysis was done, then data was used to arrive at a correlation. Regression analysis and artificial neural network estimation intimated strong correlations (r 2 = 0.70–0.95).

N. Vijayakumar Raju and et. al (2014) [5] in the paper titled **"Functional correlations between compaction characteristics, un-drained shear strength and Atterberg limits."** tried to correlate density with specific gravity and grain size distribution, and concluded that, "due to the variation of grain size distribution and specific gravity, the density varied considerable."

Abdul Hakam (2016) [6] in a study titled **"Laboratory Liquefaction Test of Sand Based on Grain Size and Relative Density"** concluded that there is a limit for density when we analyse the mean grain size of the sand particles corresponding with the liquefaction resistance for a certain acceleration.

Khayreddine DOUMI and et. Al (2017) [7] in the paper titled **"Influence of gradation parameters on compaction of sand-silt mixtures: a laboratory assessment"** stated that the process of compaction is a classical technique used for the purpose of ground improvement in geotechnical structures. It is of vital importance in numerous geotechnical engineering projects such as highways, airports, earth dams and other structures. They regarded gradation of sand as one of the important parameters that may influence soils very much during the process of compaction. For the aforementioned purpose, the compaction of silty sands are evaluated by laboratory tests that were carried out on various samples with low plastic fines whose content ranging from 0% to 30%. The obtained data and the analysis done on it indicates that the compaction response in terms of maximum dry density could be correlated to the different grading properties of the tested soil materials. Moreover, there results showed that the maximum dry density increases with the decrease of effective size (D10) and mean grain size (D50) of silty sand soils. However, the maximum dry density increases with the increase of fines content (Fc), effective size ratio (ESR) and mean grain size ratio (MGSR) of different sand-silt mixture samples under consideration.

Abdulrahman M Hamid et. al (2019) [8] in the paper titled "**Assessing the effect of density and water level on the degree of compaction of sand using Dynamic Cone Penetration Test"** concluded that "there is a significant correlation between angle of internal friction, dry density and void ratio." They tested various soil samples and developed an analytical relationship between dry density, angle of friction and void ratio.

3. AIM AND OBJECTIVE:

Field compaction is very significant in civil engineering. Almost every civil engineering project requires field compaction. Field compaction is very important for the stability of structures. Compaction also helps soil against adverse environmental effects. To check the effectiveness/usefulness of the mechanically controlled process of compaction various density measurements are done, in which the aim is to improve the behaviour of soil which then have a vast range of applications in the field of geo technical engineering. These density measurements can be done in-situ as well as in the lab. Compaction test is the starting point of any geo technical project. Compaction test is the one of the tests that should be mostly carried out before the geo technical project work is about to be started. The various parameters of soil like type of soil, density of soil, moisture content of soil is determined using the compaction tests. These parameters influence the strength of the soil. compaction and its effectiveness depend on various factors like compaction energy/effort, moisture content, type of soil etc out of which compaction effort (equipment type, equipment's weight, number of blows, vibration during compaction etc) is one of the most important factor that influence the

compaction sweepingly. The primary objective of the study is to identify the consequences of different compaction energy on the various soil compaction parameters

4. CONCLUSIONS:

The main conclusions from the study are:

1) One of the important phenomenon's regarding sand is compaction. So, it is imperative to study about compaction of sand.
2) Various equipment are employed in field for the compaction of sand. Different equipment imparts different compaction energies.
3) For the calculation of amount of compaction in soil we have a parameter called relative density, which is a better indicator of compaction of granular soils.
4) In soil mechanics, relative density is defined in terms of void ratios. But these void ratios themselves depend upon the grain size. But we don't have a direct relationship between grain size and relative density.
5) Various researchers have tried to relate relative density with mean grain size, and the results have been encouraging. But no work has been done to relate relative density with effective grain size (D_{10}).
6) Now I will try to relate relative density with effective grain size (D_{10})

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