Effect of Addition of Granular Soils on Physical Properties of Clayey Soil

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Abstract

The experimental work is performed to improve the geotechnical properties of available clayey soil by adding admixtures or granular soil i.e. Sand up to some suitable proportion. The suitable proportion to form the optimum mix in which the granular soil can be added in the clay soil was decided after performing the proctor compaction test. These optimum mixes obtained by the experimental investigation were carried further and checked for index properties of clayey soil. Materials has been used to improve the geotechnical properties of soil, in this regard experimental work was performed and it is studied that the change in properties of clayey soil by adding granular soil sand up to suitable selected proportion. After this we were able to checked the change in geotechnical properties of clayey soil. To understand the effect of granular soil on clayey soil different samples were made. To compared properties of these samples different tests were performed on these soil samples. To Check and understand the effect of the addition of granular soil on the engineering properties of a clayey soil, almost forty groups of different soil specimens were prepared and tested at different percentages of granular Soil i.e. 0%, 5%, 10%, 15%, 20%, 25% by weight of the parent soil. In this experimental work the compaction properties of clayey soil with the addition of different percentage of granular soil i.e sand from standard proctor test of sample S_A, it is determined that the value of maximum dry density is increased from 18.30 KN/m^3 to 19.55KN/m^3 (6.45% increased) and sample S_B, it is determined that the value of maximum dry density is increased from 18.00 KN/m^3 to 19.30KN/m^3.From Modified proctor test the two soil sample S_A & S_B, it is observed that the value of maximum dry density is increased from 19.40 KN/m^3 to 20.30KN/m^3 and 19.05 KN/m^3 to 19.90KN/m^3 (4.44% and 4.27% increased).

Keywords: SPT: Standard Procter Test, S_A: Sample A, S_B: Sample B, CS: clayey soil.

1 INTRODUCTION:

In our country Pakistan clayey soil covers a big part of the land. Due to lack of land resources in big cities we started to improve the soil properties by adding some other materials as admixtures to change its properties according to our geotechnical requirements. Many of the civil engineering structures are constructed on weak or soft soil which leads us to develop some soil improvement techniques such as soil stabilization technique. (Coduto, D. P.*et al*. 2014)

For in improvement and increased in shear strength of clayey soil we used granular soils sand for to check the shear strength of clayey soil. After this we are able to checked the change in properties of soil. We compared properties of these samples by performed the different geo technical standard tests to find different values and by plotting graphs to find the required information. (Das, B. M.*et al*. 2013)

It is highly risky that the construction of buildings and others structures on weak or soft soil because such soil is mostly chances of highly settlements due to its poor shear strength and high compressibility. So that the changes in certain desired geotechnical properties of soil specially the most important for buildings and others structures bulk density, load carrying capacity, shear strength and permeability properties of soil can be improved by the use of available different soil improvement techniques such as the use of soil stabilization techniques. (Bowles, J. E.*et al.* 2012)

2 EXPERIMENTAL PROCEDURES:

2.1 Test Standards

In this section we discussed those materials which are being used in the research and their properties related to scope. These tests are carried out according to ASTM code. In methodology section we use approach which was adopted for the goal. Soil as a material that occurs naturally in wide range over the earth and its physical properties of different from one site to other are different from one part of site to the other. So, for civil engineering point of view soil is an un-consolidated agglomerate material without organic matter found at or near the surface of earth crust, with witch and upon which civil engineers build their structures.

2.2 Materials

The materials used in this research were Clayey soil and granular soil which was collected from Ravi river near Lahore Pakistan.

3 METHODOLOGY

4 RESULTS AND DISCUSSIONS:

After taking the sample from the international Airport Lahore and city Kasur the first test we performed was determination of moisture content. Two sample of different site were taken to determine the moisture content. The test was performed after 24 hours of extracting the sample. The moisture content was determined as 13.87% and 6.61% for sample S_A and S_B respectively.

4.1 Moisture Content

After taking the sample from the international Airport Lahore and city Kasur the first test we performed was determination of moisture content. Two sample of different site were taken to determine the moisture content. The test was performed after 24 hours of extracting the sample.
Average Moisture Content of sample 'S_A' located near to Airport Lahore=13.87%

Average Moisture Content of sample **'S_B'** located near to Kasur =6.61%

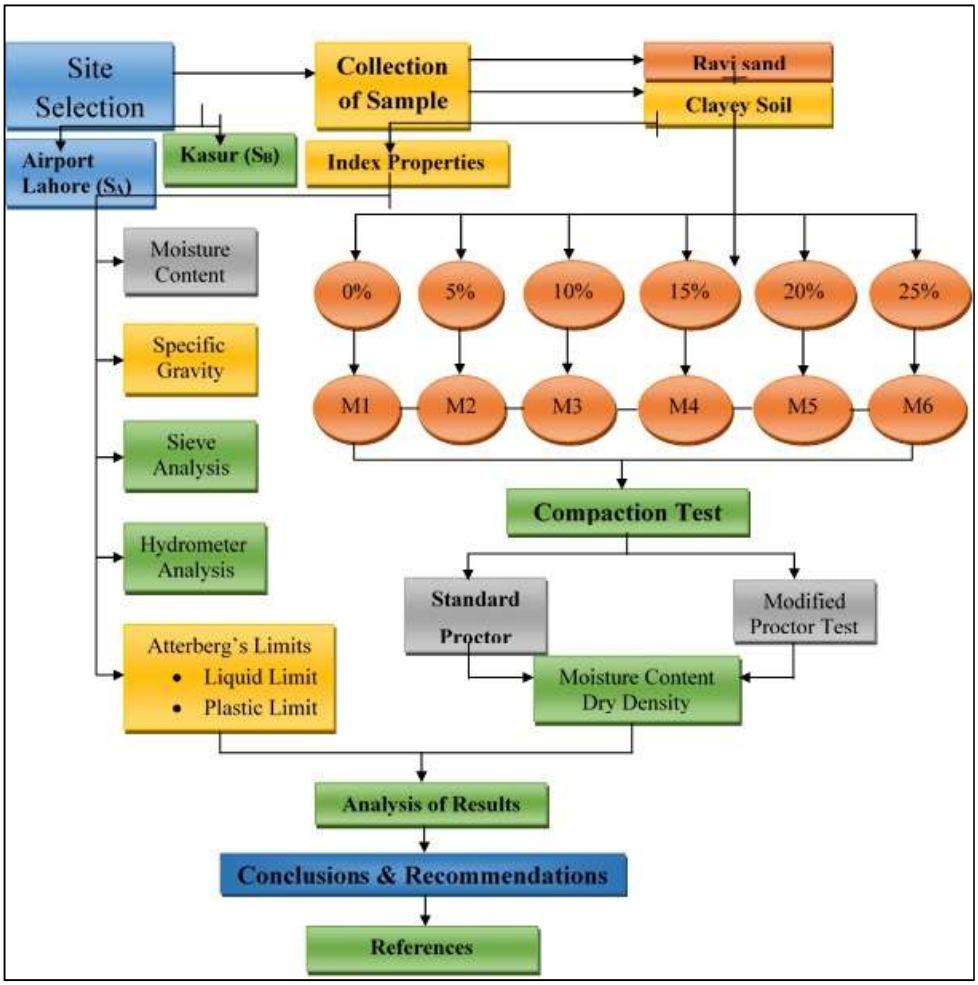

Fig. 1: Flow Chart of Research Methodology

4.2 Sieve Analysis

Sieve analysis test was performed on two sample to determine the coefficient of permeability C_c and coefficient of uniformity C_u. As the sample is clay so the value of D_{10}, D_{30} and D_{60} and grain size value were shown on graph. So further classification of soil was performed on hydrometer test.

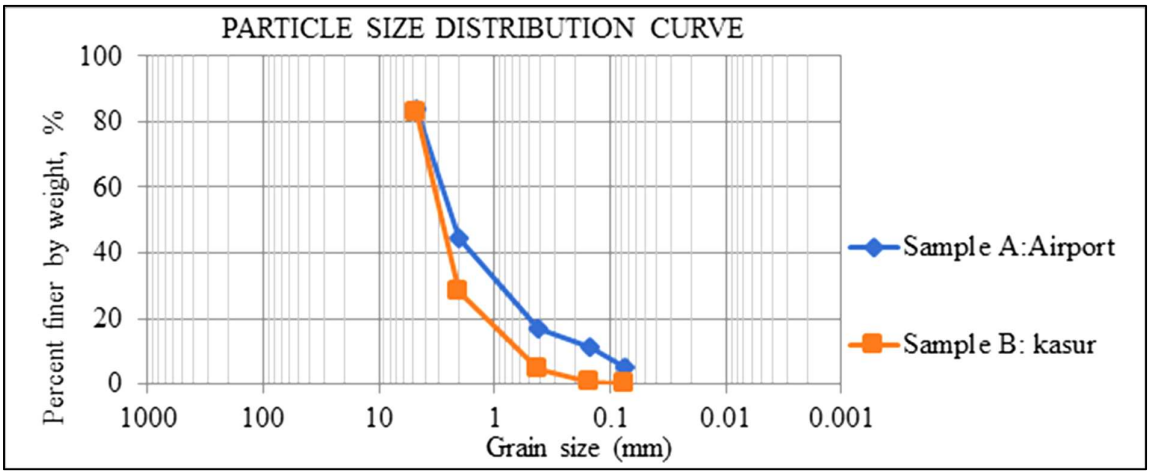

Fig. 2: Gradation curve of samples 'S_A, S_B'

Following graph shows the particle size distribution curve of sample 'S_A, S_B'.

Table 1: Coefficient of uniformity and Coefficient of curvature.

Sample	D_{60}	D_{30}	D_{10}	C_u	C_c
A	2.25	0.90	0.15	19.33	1.86
B	3.00	2.00	0.60	3.75	2.96

4.3 Hydrometer Test

ASTM D4221, gives the standard procedure for hydrometer analysis for performing this test on soil sample passing sieve No. 200 for all the soil samples, in order to have an idea about the finer percentage of the soil, like silts and clays. Silt is type of soil particle having plasticity (size ranges from 0.002mm to 0.05mm). Clay is the type of soil having plasticity (size ranges from less than 0.002mm).

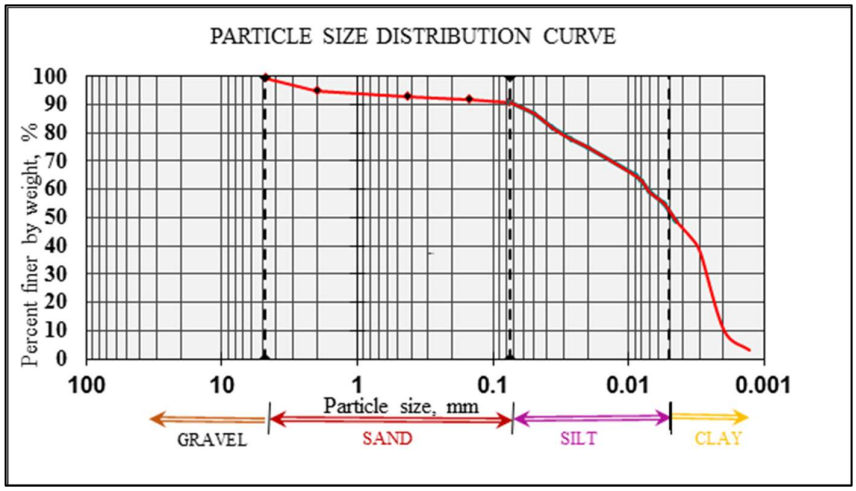

Fig. 3: Particle size distribution by sieve analysis

Graph shows the further particle size distribution curve of soil like clay, silt and sand percentages.

Table 2: Sieve and Hydrometer analysis.

Sieve and Hydrometer analysis						
Sample	Coarse Gravel	Fine Gravel	Coarse Sand	Fine Sand	Silt	Clay
A-B	0%	0%	0%	9 %	44 %	47 %

4.4 Atterberg's limits

After the sieve analysis the value of Cc and Cu shows that the soil is greater than 0.75mm so performed Atterberg's limit test for further classification of our soil sample, two tests were performed for the determination of Atterberg's limit.

- Liquid limit
- Plastic limit

4.5 Liquid limit

Liquid limit test was performed for further classification of our sample. This test was performed on two samples, in table 4.5.It is shown that the average liquid limit of these two sample is (S_A=23.5%and S_B=22%).this liquid limit is used for classification of soil.

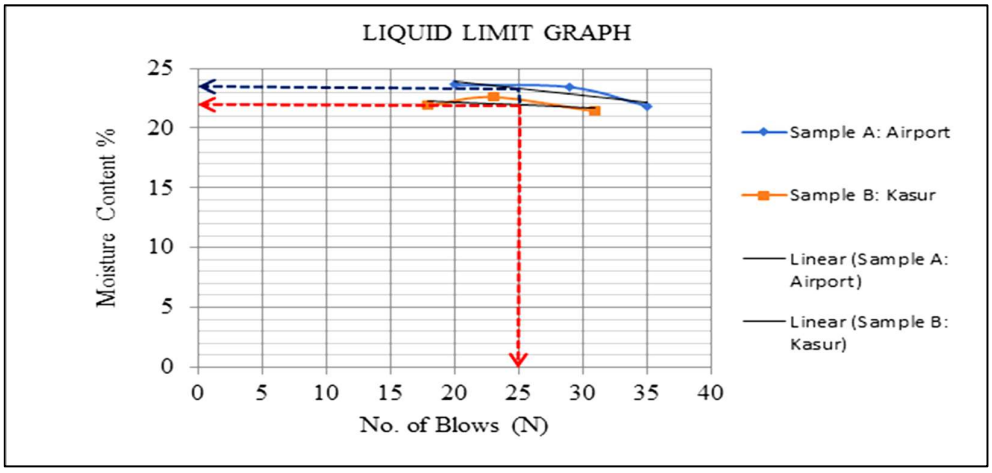

Fig. 4: Liquid Limit

Graph shows the liquid limit curve of sample 'S_A, S_B' at the no. of blows 25.

Table 3: liquid limit of sample S_A&S_B.

Sample	**Liquid Limit (%)**
S_A– Near Airport Lahore	23.5
S_B –Near City Kasur	22

4.6 Fineness Modulus of Sand

Fineness modulus of Ravi sand was determined to study the effect of fineness modulus on density. Fineness modulus of Ravi sand was determined according to ASTM C33 and found 0.9.

4.7 Standard proctor test

The test was performed to measure the maximum dry density and optimum moisture content (OMC) by addition of sand in soil sample.

Table 4: Results of Standard proctor test sample 'S_A' with Ravi Sand.

Sample	Sand added (%)	Density KN/m^3	OMC (%)
1	0	18.30	14.20
2	5	18.50	10.50
3	10	18.70	11.40
4	15	19.10	9.70
5	20	19.25	10.10
6	25	19.55	10.50

Table shows the results of standard proctor test for sample S_A with Ravi sand of different percentages (0% 5%, 10%, 15%, 20% 25%).

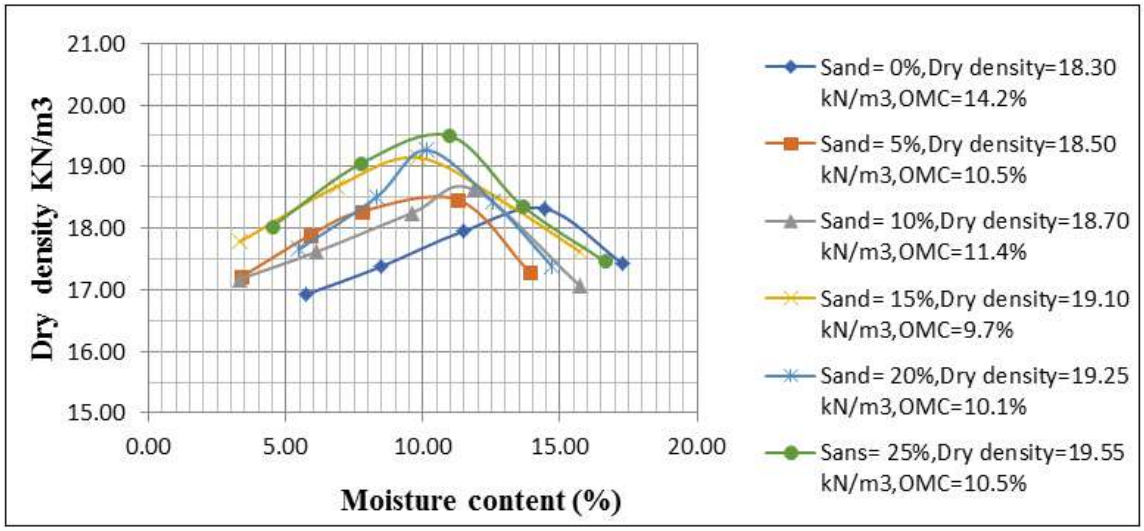

Fig. 5: Standard Proctor test of sample 'SA ' near to Airport Lahore

The test was performed to determine the maximum dry density is 19.55 kN/m^3 and optimum moisture content (OMC) is 14.20 % by addition of sand in soil sample.

4.8 Modified proctor test

The test was performed to determine the maximum dry density and optimum moisture content (OMC) by adding sand in soil sample.
Weight of soil sample =3000gm
Weight of sand added = 0% 5%, 10%, 15%, 20% 25%

Table 5: Results of Modified proctor test sample 'S_A' Airport with Ravi Sand.

Sample	Sand added (%)	Density KN/m^3	OMC (%)
1	0	19.40	11.40

2	5	19.60	9.70
3	10	19.75	9.40
4	15	20.10	9.60
5	20	20.20	10.10
6	25	20.30	9.60

Table shows the results of Modified proctor test for sample S_A with Ravi sand of different percentages (0% 5%, 10%, 15%, 20% 25%).

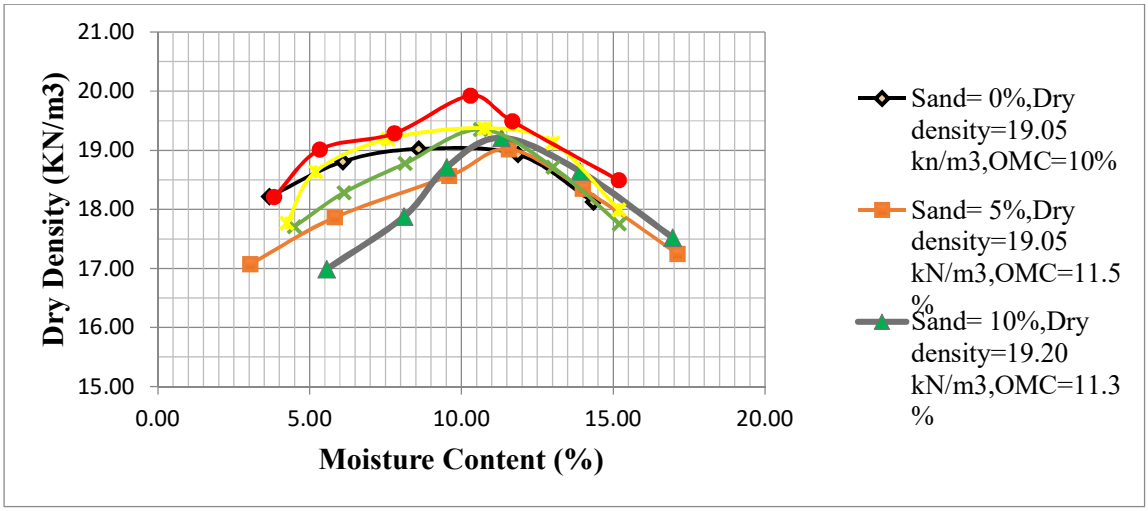

Fig. 6: Modified Proctor test sample ' S_A ' located near to Airport Lahore

5 ACKNOWLEDGEMENTS:

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6 Conclusions

This research was carried out to find the effect of sand on compaction characteristics of Airport and City Kasur soil sample to correlate different properties of soil such as, maximum dry density and optimum moisture content. This research resulted into following conclusions.

- This soil samples are a fine soil of low plasticity and have 51% clay and 40% silt in it;
- According to USCS soil classification system the soil is CL, ML (clay with low plasticity index);
- For the determinations of compaction characteristics, sand is added 25% with the increment of 5% in each test for standard and modified compaction test;
- From standard proctor test of Airport sample, it is observed that the value of maximum dry density is increased from 18.30 KN/m^3 to 19.55KN/m^3 the sand ranges 0% to 25% (6.45% increased);
- From standard proctor test of City Kasur sample, it is observed that the value of maximum dry density is increased from 18.00 KN/m^3 to 19.30KN/m^3;
- From Modified proctor test the two soil sample, it is observed that the value of maximum dry density is increased from 19.40 KN/m^3 to 20.30KN/m^3 and 19.05 KN/m^3 to 19.90 KN/m^3 (4.44% and 4.27% increased);

- From the result of standard and modified proctor test it is concluded that 25% of sand added in soil is the increase value of the maximum Dry density;
- For the determinations of compaction characteristics, we chose one of the best clayey soils at two different site samples according to maximum Dry density at the optimum moisture content;
- The value of γ of 0% soil was 19.4 KN/m^3 by performing modify proctor test. But after the addition of 25% sand, the density increase to 20.30 KN/m^3.this shows that soil improves its density hence bearing capacity and shear strength of this soil is increased. This shows that this soil can withstand against the settlement; and
- This result helps us to the civil engineer to use the adding material more economical in clayey soil for construction of civil engineering projects.

7 Recommendations

- The addition of sand and other than material i.e. flies ash, lime, cement and tile waste should be used to study the compaction characteristics of Airport Lahore and city kasur soil;
- More soil sample collected from different area of the site should be tested in same way to verify these results;
- This project covers only a few properties of soil, including particle size distribution, Atterberg's limits, and compaction characteristics of soil by adding sand. Other tests including strength characteristics, plastic index. Liquid limit, compressibility and swell pressure may also be carried out to determine the characteristics of soil by adding sand in it;
- Estimate of Ravi sand should also be considered w.r.t Cost, durability and accessibility for a project; and
- Combination of sand and soil should be studied to determine compaction characteristics of Airport and Kasur soil.

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