Soil Stabilization of Clayey Soil using Ceramic Dust and Cement

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Abstract— *The expansive soils alternatively swells and shrinks depending upon the presence of moisture in it. This behavior causes the volume change of the soil and it results the cracking and failure of structures built on that soil in this study of ceramic dust is mixed with parent soil in various percentages 5%, 10%, 15%, 20%, 25% and 30% of ceramic dust and cement is mixed with parent soil on various percentages 0%, 5% and 10% cement. The main objective of this study is to evaluate shear strength characteristics, unconfined compressive behavior of untreated and stabilized soil with ceramic dust and cement the result obtain from standard proctor compaction test. The ideal MDD and OMC values used for further unconfined compression test. The waste material like ceramic dust and cement used as a binding material which was mixed with soil to study improvement of weak sub grade in terms of compaction and strength characteristics.*

Keywords— OMC, MDD, UCS, Ceramic Dust and Cement

I. Introduction

Soil stabilization is a general term for any physical, chemical, biological and combined method of changing a parent (natural) soil to use an engineering purpose like roads, railway tracks including pavement design, side walk, Improvement of sub grade soil etc. And improvements include increasing the weight bearing capacity and performance of sub-soil, sands, and other waste materials in order to strengthen road surfaces.

II. Objective of the Study

Basically the study is centered on

1) Improvement of locally available soil using waste materials.
2) Gain of strength characteristics of soil using different percentages of ceramic dust.
3) Determination of strength of soil by using standard proctor test and unconfined compressive strength test and how soil's plastic limit and liquid limit results are obtained.
4) Reducing the plasticity of the soil to achieve more stable soil.

III. Material Collection

A. Collection of Clayey Soil

Soil used in the experiments has been collected from Kaithal (Haryana). Soil sample is collected from 0.3-0.5 m below the ground surface and remove impurties in soil lab.

S. No.	Parameters	Results
1.	I.S. Classification	CI
2.	Liquid Limit	44.48
3.	Plastic Limit	23.56
4.	Plastic Index	20.92
5.	Specific Gravity	2.65

Table 1: physical properties of soil

B. Ceramic Dust

Around 10 kg of ceramic tiles taken from local supplier from Kaithal and crushed them in college and passed from 300 micron sieve. The ceramic dust was mixed with parent soil in percentage of 5%, 10%, 15%, 20%, 25% and 30%.

Materials	Ceramic powder (%)
SiO_2	63.29
Al_2O_3	18.29
Fe_2O_3	4.32
CaO	4.46
MgO	0.72

Table 2: Chemical properties of ceramic dust

C. Cement

Commercially available Ordinary Portland Cement of 43 grades manufactured by the JP Cement Company confirming to IS 8112:1989 was used in the field (Specification, Bureau of Indian Standards, New Delhi).

Property	IS Code - IS: 8112-1989
Specific Gravity	3.05
Consistency	26.75
Initial setting time	30 minimum
Final setting time	600 minimum

Table 3: Physical properties of cement

IV. Methodology

A. Compaction Test

In this standard proctor test detailed investigation of the compaction of the parent soil with different samples on different percentages of ceramic dust and cement to find out or to obtain optimum moisture content and maximum dry density.

B. Unconfined compressive strength (UCS)

After the standard proctor test the compressive strength of soil is measured with the help of unconfined compressive strength test. Cylindrical specimen is compacted by static compaction in 3.8 cm diameter and 7.6 cm high mould. The inner surface of the mould is lubricated with mobile oil so as to extrude the sample from mould with minimum disturbance. The sample is placed inside the specimen mould in seven layers using spoon, levelled and gently compacted. Pressure pad will be inserted into the mould and the whole assembly will be statically compacted in loading frame to the desired density. The sample is to be kept under static load for not less than 10 minutes in order to account for any subsequent increase in height of sample due to swelling. The sample will then be removed from the mould with the help of sample extruder.

V. Test Result and Discussion

A. Effect of Ceramic Dust and Cement on MDD and OMC

From the proctor test the OMC & MDD of the parent soil are 22.727%& 1.676gm/cc respectively but further addition

of ceramic dust it has been observed that the maximum dry density (MDD) increase by the addition of ceramic dust in parent soil upto 20% after that it gradually decreases and the optimum moisture content decreases at various percentage of ceramic dust mixed with soil. It still increases when compared to parent soil. It is also been observed that the optimum moisture content decreases with addition of ceramic.

Further if we add ceramic dust with different material such as cement the MDD and OMC of the clayey soil shows tremendous increases as compared to ceramic dust. From the proctor test, it has been observed that the maximum dry density (MDD) increases by the addition of ceramic dust in parent soil upto 25 percentage, after it gradually decreases and optimum moisture content varies at each percentage. The comparison of MDD and OMC for ceramic dust and ceramic dust with cement are given in fig. 1 and fig. 2.

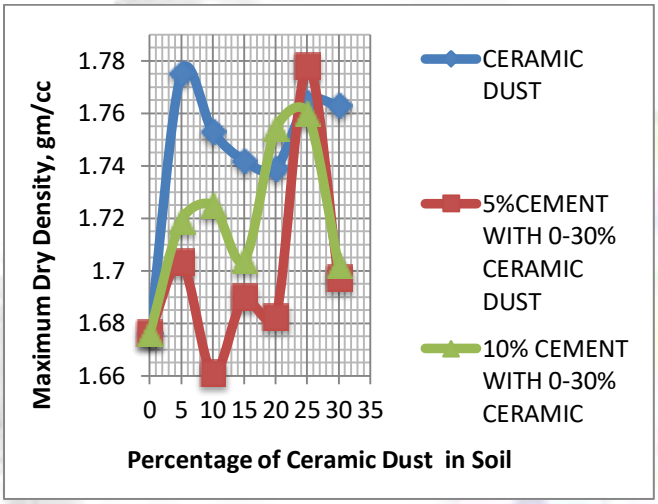

Fig. 1: Effect of ceramic dust and ceramic dust with cement on MDD at different percentage

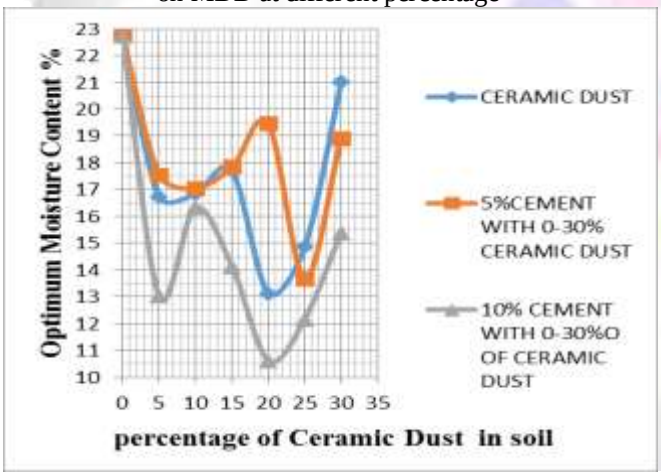

Fig. 2: Effect of ceramic dust and ceramic dust with cement on OMC at different percentage

B. Effect of Ceramic Dust and Cement on UCS

From UCS test conducted for the same sample as described in proctor test, the strength of samples shows increasing tendency for some samples with the increment of ceramic dust and cement percentage in the soil i.e. for parent soil strength obtained 0.8539 kg/cm^2.for the ceramic dust –soil mixture and cement –soil mixture shows incremental results in the compressive strength as compared to the parent soil. The comparison for ceramic dust and cement are given in fig.3.

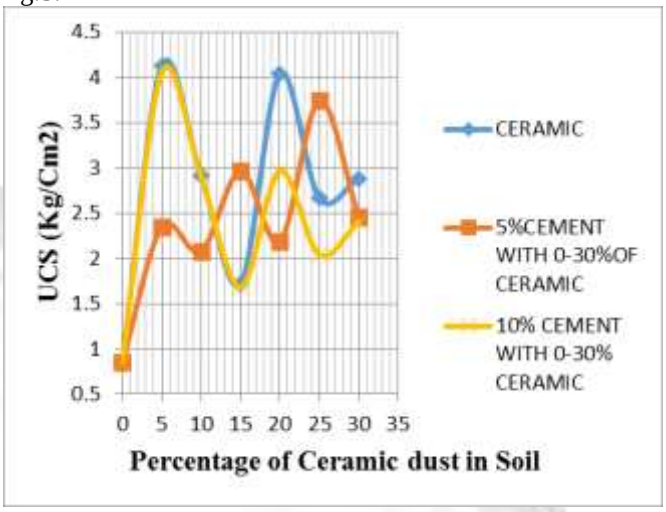

Fig. 3: Effect of ceramic dust and ceramic dust with cement on UCS at different percentage

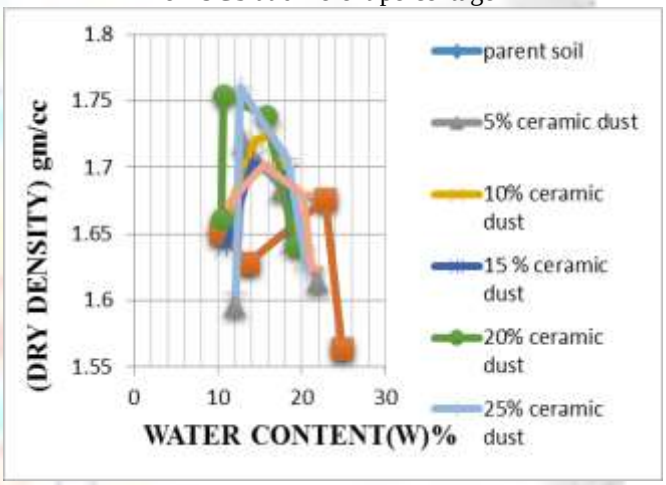

Fig. 4: Graph showing Moisture Density Relationship of parent soil mixed with various % of ceramic dust

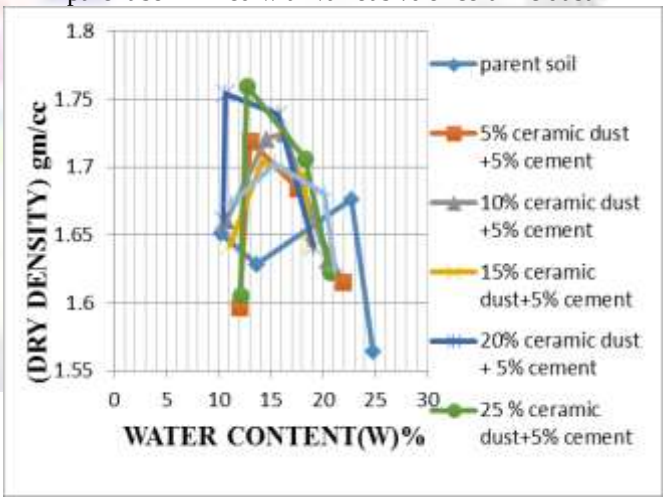

Fig. 5: Graph showing Moisture Density Relationship of parent soil mixed with various % of ceramic dust+5% cement

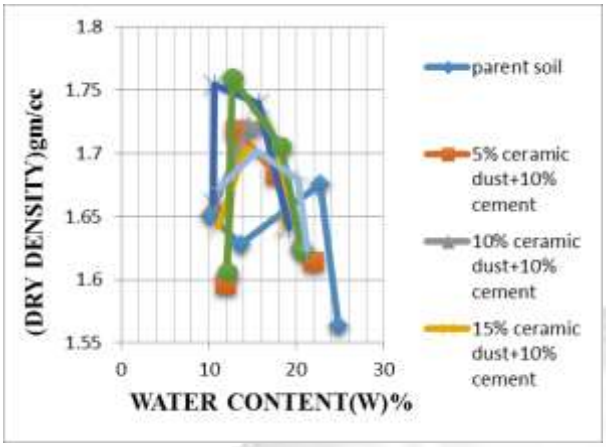

Fig. 6: Graph showing Moisture Density Relationship of parent soil mixed with various % of ceramic dust+10% cement

VI. CONCLUSION

In this thesis, the comparative study has been done of Soil-ceramic-cement mixture to find out the compaction characteristics, strength parameter and unconfined compressive strength of this soil mixed with different material at different percentage. Based on this the following conclusion can be made on the basis of test performed in laboratory:

1) From the proctor test the OMC & MDD of the parent soil are 22.727%& 1.676gm/cc. it has been observed that the maximum dry density (MDD) increase by the addition of ceramic dust in parent soil at various percentage.
2) In Procter test, with increase in ceramic dust with cement and soil the Optimum Moisture Content value has been decreasing trend than the parent soil.
3) In UCS, with increase in ceramic dust with cement and soil the UCS value has been increasing trend than the parent soil.

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