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EFFECT OF STONE DUST AND FLY ASH ON SOME GEOTECHNICAL PROPERTIES OF SOIL

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Abstract-*Stone dust is a kind of solid waste material that is generated from stone crushing industry which is abundantly available. It is estimated that each crusher unit produce 15%-20% stone dust. Disposal of such wastes creates lots of geo-environmental problems such as landfill disposal problems, health and environmental hazards. One of the best way to eliminate these problems is to make use such waste. Fly ash is a waste by product from thermal power plants, and consuming thousands hectares of precious land for its disposal and also causing severe health and environmental hazards. This paper presents the results of an experimental program undertaken to investigate the effect of stone dust & fly ash combined in equal percentages on physical properties soil and to study effect of this admixture on the geotechnical properties such as index properties including Liquid Limit, Plastic Limit, Compaction characteristics and CBR value.*

Keywords- *Stone Dust, Fly Ash, Optimum Moisture Content (OMC), Maximum Dry Density (MDD), California Bearing Ratio (CBR).*

I. INTRODUCTION

1.1. General

Disposal of waste is a challenge for all developing countries mainly due to the increasing generation of waste, the high costs associated to its management and the lack of understanding over a diversity of factors that affect the different stages of waste management. Stone dust is also a solid waste material that is produced from stone crushing industry which is plentifully available in India. It has been identified that crusher dust exhibits high shear strength and is beneficial as a geotechnical material. Stone dust is a kind of material that has pozzolanic properties and coarser contents in it while other materials like fly ash contains only pozzolanic property and no coarser soil particles. Significant enhancement in the properties of soils is described by different researchers by blending it with stone dust.

Fly ash is a waste by product from thermal power plants, which uses coal as fuel. It is estimated that about 120 million tons of fly ash is being produced from various thermal power plants in India consuming several thousand hectares of precious land for its disposal causing severe health and environmental hazards. In order to utilize fly ash in bulk quantities, ways and means are being explored all over the world to use it for the construction of embankments and roads. In spite of continuous efforts made and incentives offered by the government, hardly 10% of the product ash is being used for construction purposes such as brick making, cement manufacturing, soil stabilization and also as a fill material. . In this study stone dust and fly ash in equal proportions by dry weight of soil were taken as 10%, 20% and 30% and mixed with the soil so as to examine the effect of mixing on OMC, MDD and CBR properties of soil.

1.2. Objective of the Study

- To determine MDD, OMC, Consistency limits and CBR of virgin soil by conducting laboratory tests.
- To study and determine index properties of soil by mixing equal proportions of fly ash and stone dust.
- To study and determine compaction characteristics of soil by mixing equal proportions of fly ash and stone dust.
- To study and determine CBR value of soil by mixing equal proportions of fly ash and stone dust.
- To compare results obtained and derive conclusion.

II. EXPERIMENTAL INVESTIGATION

2.1 Grain size distribution

Sieve Analysis of soil was carried out as per IS 2720 (Part 4): 1985. Soil taken was passed through 4.75 mm sieve. The soil is soaked with water and washed thoroughly, stirred and left for soaking .Now, the soil soaked is passed through IS sieve 75 micron until the wash water if fairly clean. The weight of the soil retained on sieve is taken for dry sieve analysis. Soil is passed through series of sieves from 4.75 mm, 2mm, 1.18 mm, 600 µ, 425 µ, 300 µ, 150 µ and 75 µ through a mechanical shaker .The weight of soil retained on each sieve is measured and recorded separately.

2.2 Liquid limit test

The boundary water contents at which soil undergoes a change from one state to another are called "consistency limits". Liquid limit is the water content at which soil is practically in a liquid state but has infinitesimal resistance against flow. Liquid limit of soil was tested as per IS 2720 (Part 5):1985. Four tests are conducted by altering the moisture content and no of blows required are calculated in each case. A semi log plot between log N and water content is plotted and moisture content corresponding to 25 blows is noted. This water content is liquid limit of the soil sample.

2.3 Plastic limit test

The plastic limit is the water content at which soil just begin to crumble when rolled into a thread of approximately 3 mm diameter. Three samples are tested and average of three values is taken as plastic limit of soil. Plastic limit of soil was tested as per IS2720 (Part 5):1985.

2.4 Compaction test

Standard Proctor test was performed to determine OMC and MDD of the soil sample mixed with varying proportion of the admixture. It is performed strictly as per Five soil samples are tested and graph is plotted between dry density and water content. From this graph MDD and OMC is determined.Test was performed as per IS 2720(Part 7):1980

2.5 California Bearing Ratio (CBR) Test

California Bearing Ratio test was developed by the California Division of Highway as a method of classifying and evaluating soil subgrade and base course materials for flexible pavements. It is an empirical test that has been used to determine the material properties for pavement design. It was performed as per IS 2720 (Part 16):1987.

III. MATERIALS AND METHODS

3.1. Soil

The soil taken for the study was procured from the campus of DTU. The soil has following properties:

Table 3.1. Geotechnical properties of soil

Property	Value
Sand content(4.75-0.075mm),%	19.68
Fine soil fraction (<75µ),%	80.32
Specific Gravity	02.64
Liquid Limit (%)	35.07
Plastic Limit (%)	22.41
Maximum Dry Density (MDD) kN/m^3	17.40
Optimum moisture content (OMC),%	14.31

3.2. Stone Dust

The stone dust used in the study was taken from a dealer in New Delhi. The stone dust has following properties:

Table 3.2. Geotechnical properties of stone dust

Property	Value
Sand content(4.75-0.075mm),%	93.24
Fine soil fraction (<75µ),%	06.76
Specific Gravity	02.59
Liquid Limit (%)	NP
Plastic Limit (%)	NP
Maximum Dry Density (MDD) kN/m^3	18.24
Optimum moisture content (OMC),%	10.85

Table3.3. Geotechnical properties of fly ash

Property	Value
Sand content(4.75-0.075mm),%	35.62
Fine soil fraction (<75μ),%	64.38
Specific Gravity	2.21
Liquid Limit (%)	NP
Plastic Limit (%)	NP
Maximum Dry Density (MDD) kN/m^3	14.28
Optimum moisture content (OMC),%	17.08

IV. RESULTS AND DISCUSSION

4.1. Effect on Liquid Limit and Plastic Limit

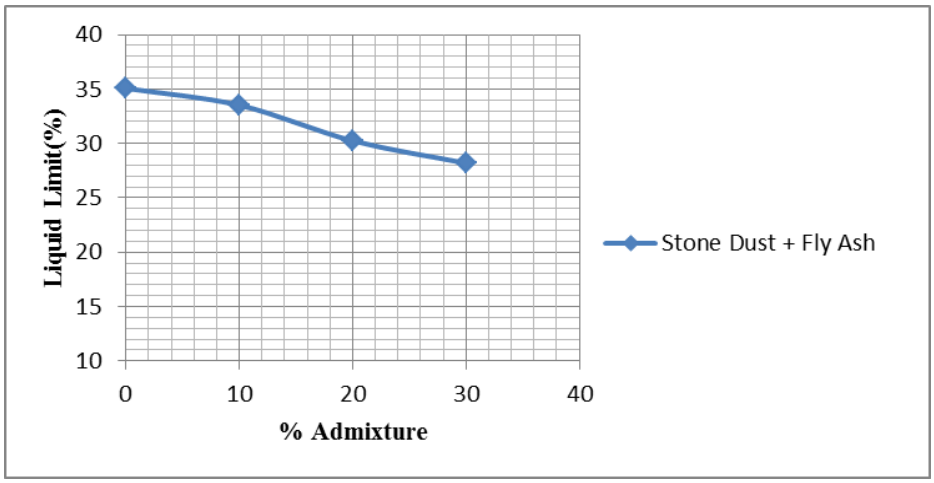

Fig.4.1. Liquid Limit Variation

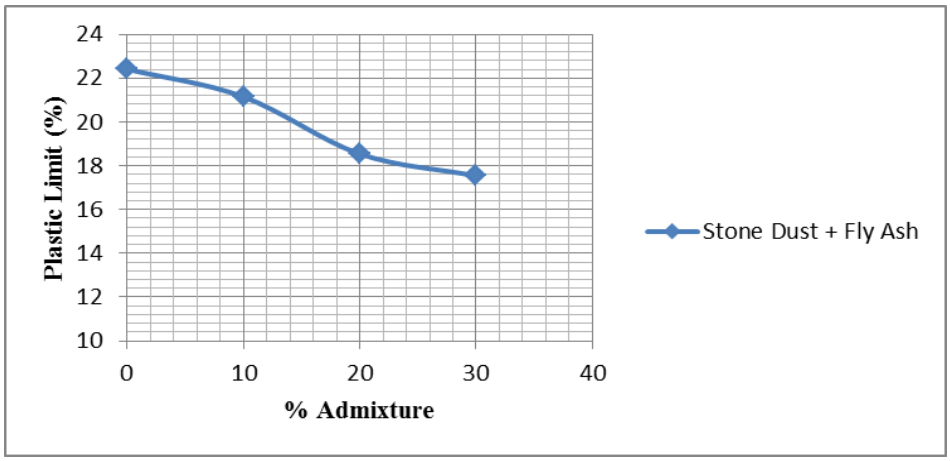

Fig.4.2.Plastic Limit Variation

Table 4.1.Variation of Liquid Limit when soil is mixed with various % of admixture

Sample Mix	Liquid Limit	Plastic Limit
Virgin soil	35.07	22.41
90% Soil + 5% SD + 5% FA	33.52	21.15
80% Soil + 10% SD + 10% FA	30.25	18.54
70% Soil + 15% SD + 15% FA	28.19	17.54

4.2. Effect on Compaction Characteristics

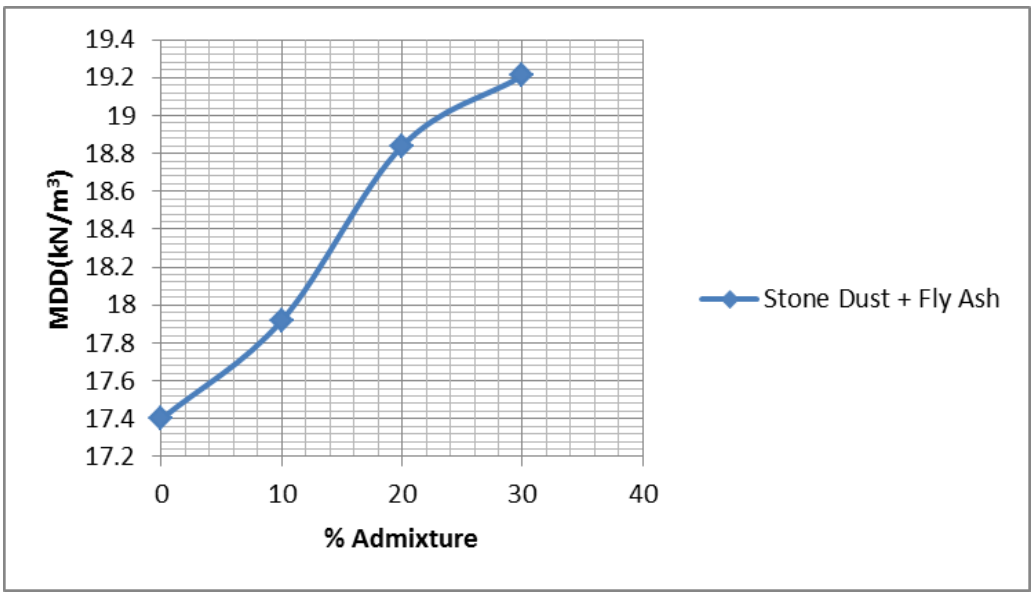

Fig.4.3. Variation of MDD v/s % Admixture

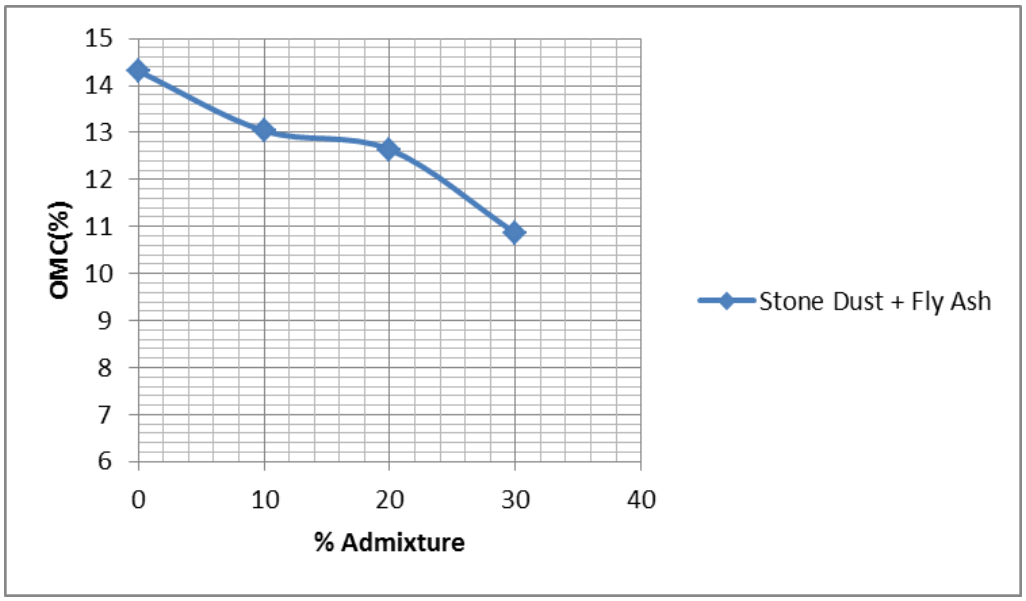

Fig.4.4. Variation of OMC v/s %Admixture

Table.4.2. MDD and OMC variation for various admixtures

Sample Mix	MDD (kN/m^3)	OMC (%)
Virgin soil	17.40	14.31
90% Soil + 5% SD + 5% FA	17.92	13.40
80% Soil + 10% SD + 10% FA	18.84	12.64
70% Soil + 15% SD + 15% FA	19.21	10.86

4.3. Effect on CBR

Effect of admixture on the unsoaked CBR value of soil is shown in the figure below:

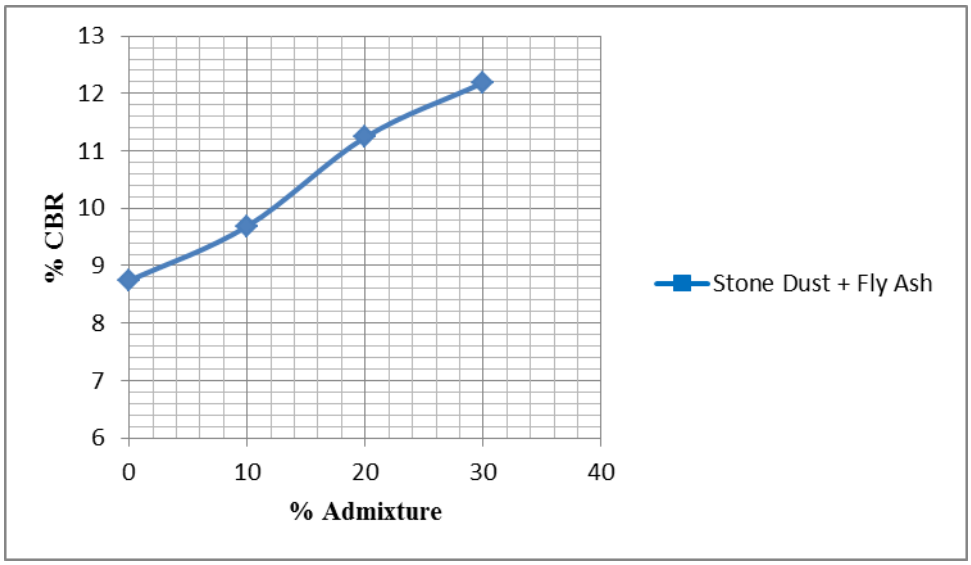

Fig.4.5. Variation of CBR for various % of Admixture

Table.4.3. Variation of CBR for different soil mix

Sample Mix	%CBR (Unsoaked)
Virgin Soil	08.74
90% Soil + 5% SD + 5% FA	09.69
80% Soil + 10% SD +10% FA	11.24
70% Soil +15% SD + 15% FA	12.19

V. CONCLUSIONS

The following conclusions can be drawn on the basis of above study and discussion:

a) After addition of fly ash and stone dust admixture, Atterberg limits (liquid limit and plastic limit) are reduced considerably with maximum decrement at 30% admixture.

b) Addition of stone dust and fly ash in equal proportions resulted in increase of maximum dry density and decrease in optimum moisture content of the soil sample.

c) CBR value of the soil is increased after adding equal proportions of fly ash and stone dust, having maximum value at 30 % admixture.

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