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EXPERIMENTAL STUDY ON EXPANSIVE SOIL WITH MARBLE POWDER, STONE DUST AND FLY ASH

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Abstract: Soil stabilization is required when the soil available for construction is not suitable for the particular use. In all the soils, expansive soils causing major problems to the civil Engineering structures. Such soils are having high volumetric changes in dry and wet conditions. Soil stabilization using chemical admixtures is the oldest and most widespread method of ground improvement. The conventional soil stabilization techniques are generally expensive, involving large quantities of costly materials. Due to shortage of energy, materials and also the high cost of construction operation, there is a need to go for alternate low cost materials. In this study, waste marble dust which is the by-product of marble industry, waste stone dust which is the byproduct of stone queries and fly ash which is the waste product generated from the thermal power plant are used for the soil stabilization. Disposal of this waste creates serious problems to the humans surrounding them as well as acts as a pollutant so affect the ecological system of the environment. So, in this paper decided to use the marble powder, stone dust and fly ash to improve the engineering property of expansive soil, thus making it more stable and also to stabilize the soil with a very low cost material. The marble has very high lime (CaO) content and is reported by many researchers, stone dust have strength and fly ash have very good adhesive property. We have added the marble, stone dust and fly ash powder to the expansive soil as different proportions and studied the compaction characteristics and strength characteristics.

Keywords: Atterberg limit (LL and PL), Compaction (OMC and MDD)

I. INTRODUCTION

In India, Expansive soil is found in major parts of Maharashtra, Madhya Pradesh and Andhra Pradesh. And it covers 0.7X106 km² approximately 20-25 % land area. When the expansive soil comes in the contact with water then they causes swelling and when water content decreases shrinkage occurs in the soil. In geotechnical engineering, soil stabilization or other methods are required when a given site does not have suitable engineering properties to support structures, roads and foundations. One technique is to adopt the foundation based on geotechnical conditions at the site location. Another technique is to improve the engineering properties of the soils at the site location. Depending on the circumstances, this second technique may be the most economical for improving the soil and also this is achieved by mixing the soils with additives. Such materials include fly ash, stone dust, etc. Many researchers have reported that marble has very high lime (CaO) content up to 55 % by weight and fly ash has adhesive properties. Thus, stabilization by waste marble dust is done due to their high lime (CaO) content. On the other hand, in the world, marble production amount was 21.7 million tons in the year of 1986; However in 1998, this was increased to 51 million tons (DPT, 2001). The proportion of marble discharged as waste during block production at the quarries is equal to 40-60% of the overall production volume. Out of which only small portion of the waste marble and queries products is utilized economically, most of them are stored on lands. Increasing of usage fields of waste marble, quarry dust products will eliminate the potentially harmful effects of them on environment and minimize the cost due to storage. Many research works have been done in the direction of utilizing of marble dust waste into the soil stabilization technique in worldwide. The influence of marble dust, fly-ash and Beas sand on sub grade characteristics of expansive soil was studied by researchers. The marble powder was mixed with rice husk ash on expansive soil by researchers also. They reported that UCS and CBR value increases due to addition of these materials and also modify the engineering properties. The main aim is to improve the characteristics of black-cotton soil by using additive. There was an improvement in compaction and CBR characteristics. Several had reported that marble dust powder and stone dust and fly ash separately is effective waste material in the stabilization of expansive soil which improve the index and engineering properties of soil.

II. MATERIALS

A. Soil:

Soil was collected from Lihigaon near Kamptee in Nagpur district. It is very near to Veena river bed. The degree of expansiveness of the soil was very high. The soil properties were listed in Table-1.There is need for improvement of this type of soil due to development of infrastructural facility in these areas.

TABLE I. PROPERTIES OF SOIL

Sr. No	PROPERTIES	IS CODE	VALUE
1.	Colour		Black
2.	Specific Gravity of soil	IS 2720 Part III	2.396
3.	Specific Gravity of Marble powder		2.78
4.	Degree of Expansiveness		Very High
5.	Atterberg limits	IS 2720 Part V	

	i Liquid limit		74.5%
	ii Plastic limit		41.25%
	iii. Plasticity Index		33.25%
	iv Shrinkage limit		13.2%
6.	Free swell index	IS 2720 Part XI	80%
7.	Compaction characteristics	IS 2720 Part VIII	
	i Optimum Moisture Content		22.94%
	ii Maximum dry density		1.44 g/cc
8.	California Bearing Ratio	IS 2720 Part XVI	2.72
9.	Unconfined Compressive Strength	IS 2720 Part X	2.66 kg/cm2
10.	Grain size distribution	IS 2720 Part IV	
	i Gravel		1%
	ii Sand		9%
	iii Clay and silt		90%

B. Marble powder:
The marble powder was collected from marble cutting industry at Nagpur. Marble or real marble is a metamorphic rock that consists predominantly of calcite and/or dolomite. Marble may be considered as metamorphosed limestone (i.e. limestone which has been fully re-crystallized and hardened under hydrothermal conditions).

C. Stone dust:
The stone dust was collected from the quarry located on the Umrer road in Nagpur. Properties of stone dust basically rely upon the properties of the parent rock, such as chemical and mineralogical arrangement, physical and substance steadiness, petro graphic qualities, specific gravity, hardness, strength, pore structures and color.

2.4 Fly Ash:
The fly ash was collected from the Koradi power plant, Nagpur.

TABLE II. PROPERTIES OF FLY ASH

CHEMICAL PROPERTIES	VALUE
Silicon dioxide Sio2	1.30
Aluminium oxide Al2O3	25.70
Ferric oxide Fe2O3	5.30
Calcium oxide CaO	5.60
Potassium oxide K2O	0.60
Sodium oxide Na2O	0.40
Magnesium oxide MgO	2.10
PHYSICAL PROPERTIES	VALUE
Specific gravity	2.16
Loss of ignition	0.90
Moisture	0.30
Magnesium oxide MgO	2.10
PHYSICAL PROPERTIES	VALUE
Specific gravity	2.16

III. EXPERIMENTAL PROGRAM.

A. Objectives
To stabilize and study the behavior of the soil using marble powder (Marble industry waste), stone dust (Quarry wastes) and fly ash (Power plant waste). To treat the soil with a low cost material or industrial waste material. The following iterations were taken

TABLE III. % QUANTITY OF MATERIAL

Sr. No.	Fly ash	Stone dust	Marble dust
I	10%	10%	5%
II	10%	5%	10%
III	5%	10%	10%

B. Experiment details
The following Soil Properties were studied by using various percentages of materials.
a. Atterberg Limits
b. Proctor Compaction Test (OMC and MDD)

IV. RESULTS AND DISCUSSIONS

The summary of the comparative analysis of the influence of Soil + Fly ash (10%) + Stone dust (10%) + Marble dust (5%), Soil + Fly ash (10%) + Stone dust (5%) + Marble dust (10%), Soil + Fly ash (5%) + Stone dust (10%) + Marble dust (10%) on the Index Properties of soil is given in table below.

TABLE IV: INDEX PROPERTIES COMPARISON

Sr	Properties	IS Code	Soil	Soil+10% Fly Ash+10% Stone Dust+5% Marble Dust	Soil+10% Fly Ash+5% Stone Dust+10% Marble Dust	Soil+5% Fly Ash+10% Stone Dust+10% Marble Dust
1	Sp.Gravity	IS 2720 Part III	2.396	-	-	-
2	Liquid Limit	IS 2720 Part V	74.55%	59%	56%	58%
3	Plastic Limit	IS 2720 Part V	41.25%	36.50%	37.21%	37.89%
4	Plasticity Index	IS 2720 Part V	33.50%	22.50%	18.79%	20.11%
5	FSI	IS 2720 Part XI	80%	60%	80%	65%
6	OMC	IS 2720 Part VIII	26.94%	25%	28.52%	27.63%
7	MDD gm/cc	IS 2720 Part VIII	1.44	1.48	1.4	1.45
8	Sieve Analysis	IS 2720 Part IV				
	1.Gravel		1%	-	-	-
	2.Sand		9%	-	-	-
	3.Clay And Silt		90%	-	-	-

A. Atterberg Limits
a. Liquid Limit & Plastic Limit:
Liquid limit and plastic limit decreased for soil on addition of all the ingredient admixtures. This indicates increment in strength.

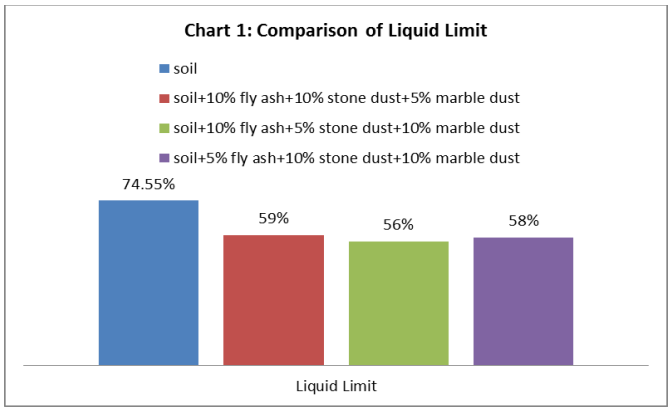

Chart 1: comparison of liquid limit

B. Plasticity Index:

Decrease in plasticity index shows that the volume change during wetting and drying is less. Here there is comparatively decrease in plasticity index is higher.

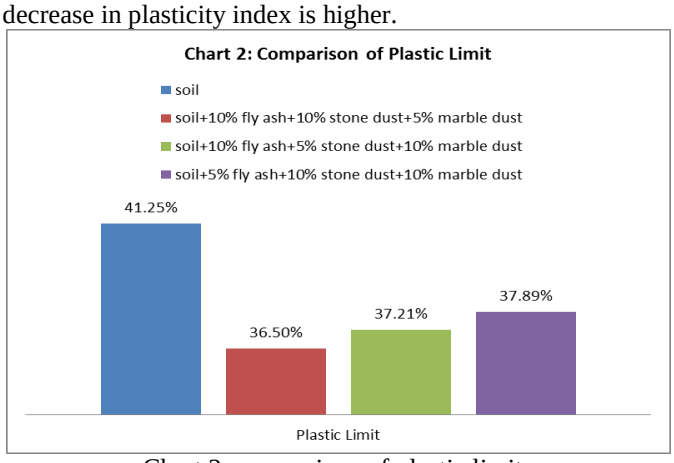

Chart 2: comparison of plastic limit

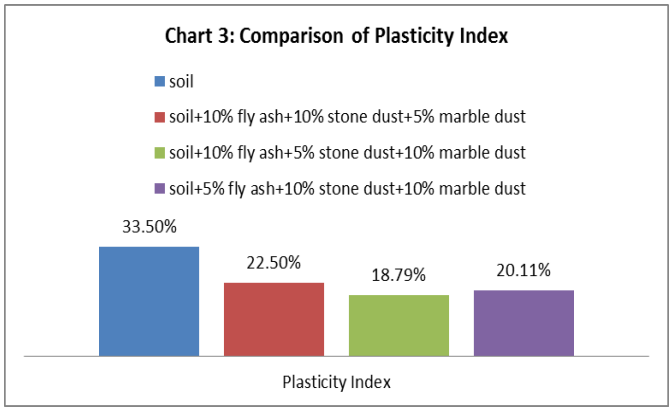

Chart 3: comparison of plasticity index

C. Free Swell Index:

Free swell index decreases with the addition of three proportions i.e. Soil+5% Fly Ash+10% Stone Dust+10% Marble Dust and Soil+10% Fly Ash+10% Stone Dust+5% Marble Dust whereas Free swell index Remain constant with the addition of Soil+10% Fly Ash+5% Stone Dust+10% Marble Dust.

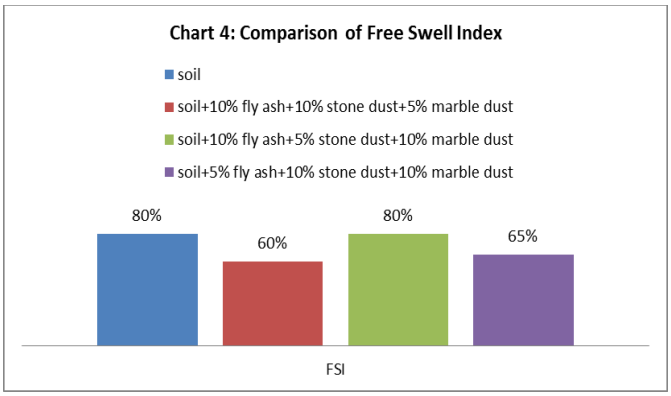

Chart 4: comparison of free swell index

D. OMC & MDD:

OMC decreases and MDD increases with addition of 10% Fly Ash+10% Stone Dust+5% Marble Dust which shows increase in strength. OMC increases and MDD Decreases when 10% Fly Ash+5% Stone Dust+10% Marble Dust is added, shows a decrease in strength. OMC increases and MDD increases minutely with addition of Soil+5% Fly Ash+10% Stone Dust+10% Marble Dust which means mere effect of proportion on soil.

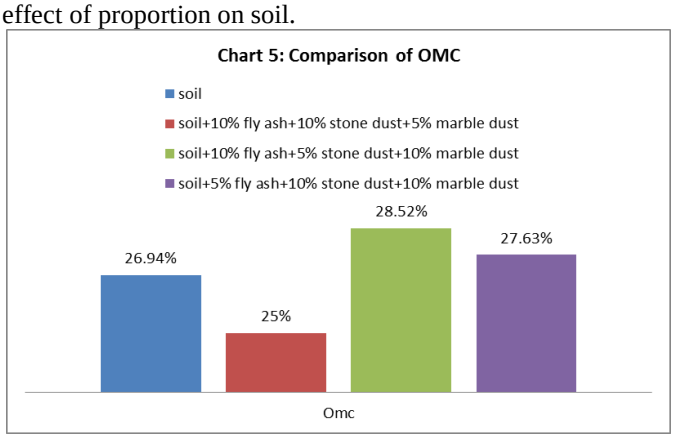

Chart 5: comparison of OMC

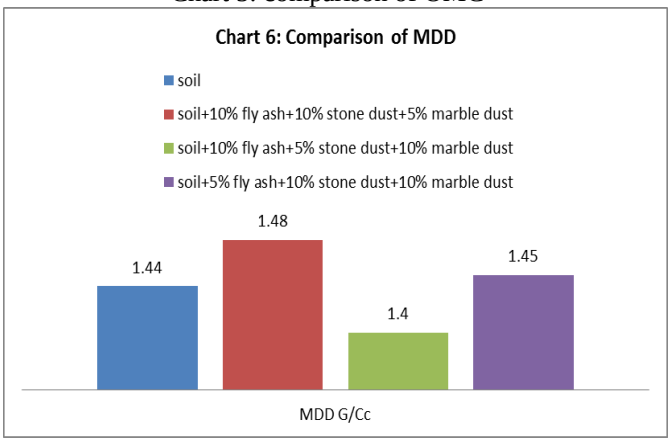

Chart 6: comparison of MDD

V. CONCLUSION

This work was intended to evaluate the index properties of local soil with addition of fly ash, stone dust and marble dust. The results of addition of fly ash, stone dust and marble dust was studied by comparing various parameters of soil in terms of Liquid Limit, Plastic Limit, Plasticity Index, Free

Swell Index, OMC, MDD, values.
The conclusions drawn from the study are:-

- From the study it has concluded that, by the addition of fly ash, stone dust and marble dust Liquid Limit, Plastic Limit and Plasticity Index decreases.
- Free swell index decreases with the addition of fly ash, stone dust and marble dust in two proportions whereas Free swell index remains constant on the addition of proportion containing less % of stone dust.
- OMC increases and MDD Decreases when 10% Fly Ash + 5% Stone Dust + 10% Marble Dust is added whereas OMC decreases and MDD increases with the addition of 10% Fly Ash + 10% Stone Dust + 5% Marble Dust.
- From the laboratory investigations conducted, fly ash and stone dust showed more influence on the soil rather than marble dust; but all the three of these locally available waste materials can be used to stabilize the local soil.
- But the most effective proportions for the stabilization of the expansive soil which can be used is Fly ash (10%) + Stone dust (10%) + Marble dust (5%). This proportion gives the best results .

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