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Soil Enhancement by using Marble Powder

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Abstract: As we have seen many types of soils in our surroundings, of all these Black cotton soils i.e., one type of expansive soil can cause major problems to the civil engineers.

These black cotton soils can have Montmorillonite mineral which is the main reason for Shrinkage and Swelling nature to the soil.

So that, soil stabilization is required to strengthening the soils with addition of admixtures like waste products of industries. In this study we have used waste marble powder which is the byproduct of marble industry during cutting process. In all over the world 5 to 7 million tons of wastage produced every year which leads to serious environmental problems to the world. So that we decided to improve the index and engineering properties of the soil.

We had replaced soil with marble powder as 0%, 5%, 10%, 15% and 20%. The laboratory test results showed a significant change in consistency limits of samples containing marble powder. The liquid limit decreases from 60.91% to 46.5% and plastic limit changes from 33.67% to 25.83%.

The compaction values increased from 1.582 gm/cc to 1.72 gm/cc. The CBR values increased from 4.335% to 8.474%. The UCS values increases from 310.028KN/M2 to 777.11KN/M2. We can conclude that addition of marble powder to black cotton soil can be effective up to 15% can give satisfactory results.

Keywords: Black cotton soil, marble powder, soil stabilization, CBR, UCS

I. INTRODUCTION

The black cotton soils constitute an important soil group covering nearly about 20-23% of land in India i.e., 6.7 lack sq.km. Expansive soils are found in major parts of Madhya Pradesh, Andhra Pradesh, Gujarat, Telangana, Karnataka and Tamilnadu. Montmorillonite is mineral content present in the black cotton soil to show high swelling and shrinkage properties to the soil which causes foundation and embankment problems to the civil engineering structures. These problems may rise when soil in contact with water then they causes swelling and when water content decreases they can shows shrinkage problems.

Soil stabilization is the one type of technique that is used in ground improvement of soil. Ground improvement techniques are used for a variety of engineering works like foundations in high raised buildings, construction of roads and air field pavements. The main objective of this project is to increase the strength or stability of soil to resist external loads acting on it. And to reduce the cost of construction by using locally available lowcost material. For the stabilization of soil, industry generated waste materials can cause huge environmental problems to the world. Marble powder is the one such waste product. The marble powder is generated from the marble industry during cutting and polishing of marble stones. The marble slurry i.e., 25 - 30% is produced as waste product in industry which in turns 6 – 7 million tons per every year.

Many researchers had proved that marble stone having more than 50% of lime content in it which is responsible for soil stabilization. The influence of marble dust, fly-ash and Beas sand on subgrade characteristics of expansive soil was studied by Gupta and Sharma (2014). The marble powder was mixed with rice husk ash on expansive soil by Sabat and Nanda (2011). They concluded that CBR and UCS values has improved due to addition of these materials. The usage of marble slurry to increases the properties of soil was studied by Vishwakarma and Rajput (2013). By these references we had been used marble powder as soil stabilizer. And there was an increment in compaction and CBR values.

II. MATERIALS AND METHODOLOGY

A. Soil

Black cotton soil has been taken from “Amaravai, Koldinne road near Gadwal Dist” located in Telangana. The expansive soil (BC) is classified as Highly Compressible (CH) soil. The experimental result shows that Medium swelling in nature. The physical property of soil has been shown in Table.2.1.

Table 2.1 Physical properties of Black cotton soil

S. No	BC SOIL PROPERTY	VALUE
1.	Free swell index	26.315%
2.	Atterberg's limits	
	1. liquid limit	61.1%
	2. Plastic limit	33.67%
3.	Specific gravity	1.988
4.	Grain size analysis	
	1.uniformity co-efficient (C_u)	6.125
	2.co-efficient of curvature (C_c)	1.23
5.	Optimum moisture content	21%
6.	Max Dry Density	1.58gm/cc
7.	CBR	4.13%
8.	UCS	310.028KN/m ²

B. Marble Powder

The marble powder was collected from Betamcherla near Kurnool, AP. A marble can be defined as a metamorphic rock that consists of Calcite/Dolomite OR Lime stone which has been fully re-crystallizes and hardened under hydrothermal conditions.



C. Methodology

The soil has been conducted with different types of tests. The black cotton soil is replaced with marble powder with various proportions of marble powder i.e., 0%,5%,10%,15% and 20% by weight of dry soil sample. The following are the some tests conducted on black cotton soil and marble powder as per IS code provisions.

- 1) Grain size distribution (IS 2720 PART- 4 1985)
- 2) Liquid limit and Plastic limit (IS 2720 PART -5 1985)
- 3) Differential free swell (IS 2720 PART -40 1977)
- 4) Standard proctor test (IS 2720 PART -7 1980)
- 5) California bearing ratio test (IS 2720 PART -16 1987)
- 6) Unconfined compression strength test (IS 2720 PART -10 1991)
- 7) Permeability test (IS 2720 PART -17 1986)

III. TEST RESULTS

The various experiments are conducted on partial replacement of black cotton soil with marble powder in different proportions as for IS code provisions. The test results getting from various percentages are summarized in Table 3.1

Table 3.1 Comparison of results for all mix proportions of marble powder

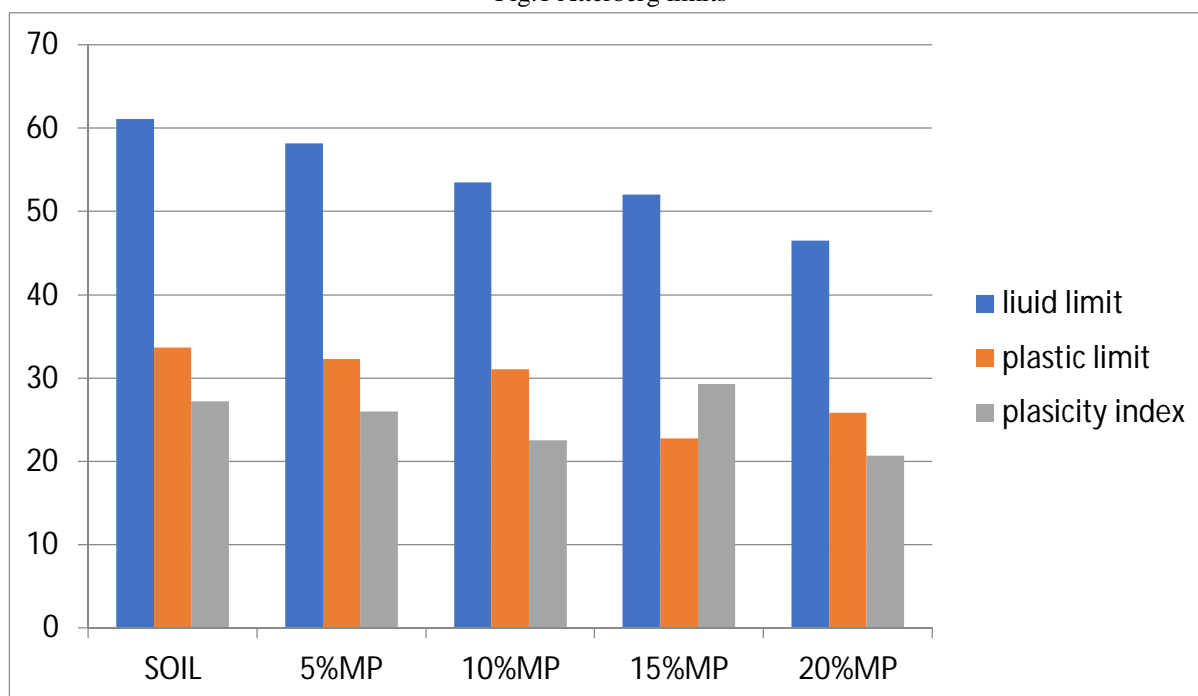
S.no	Particulars of test	Soil	95%soil+5%MP	90%soil+10%MP	85%soil+15%MP	80%soil+20%MP
1	Liquid limit(%)	60.91	58.2	53.5	52	46.5
2	Plastic limit(%)	33.67	32.24	31.05	22.74	25.83
3	Plasticity index(%)	27.24	25.956	22.499	29.262	20.67
4	MDD (gm/cc)	1.582	1.645	1.63	1.72	1.675
5	OMC(%)	21	19.5	19	17.8	17
6	CBR(%)	4.335	5.02	7.883	8.474	7.09
7	UCS(KN/m2)	310.028	709.86	718.121	777.11
8	Permeability	0.0186	0.0083	0.00415	0.43	0.564

IV. DISCUSSION OF RESULTS

A. Atterberg Limits

The liquid limit for black cotton soil (i.e., CH soil) is considerably decreased from 60.91% to 46.5% with the replacement of marble powder in different proportions of 0%,5%,10%,15% and 20% and similar decrement appeared in Plastic limit as 33.67% to 25.83%.Based on these results the Plasticity index also reduced from 27.24% to 20.67%. These results have been shown in Fig.1.

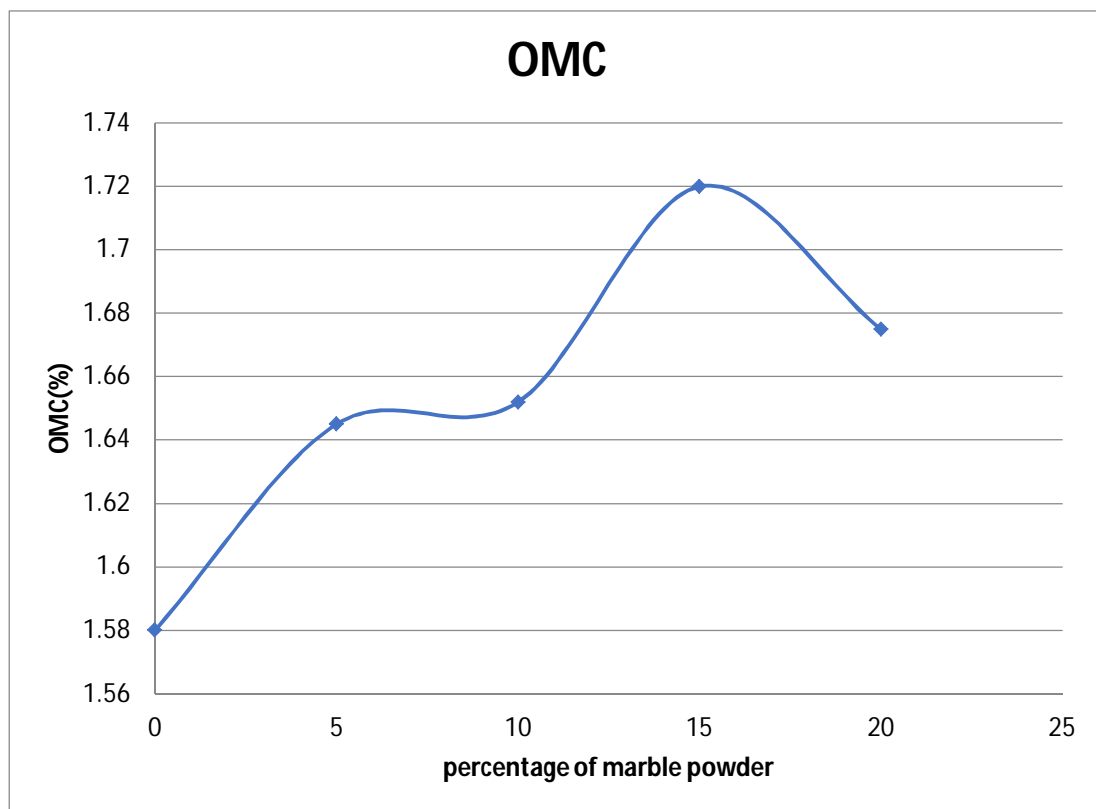
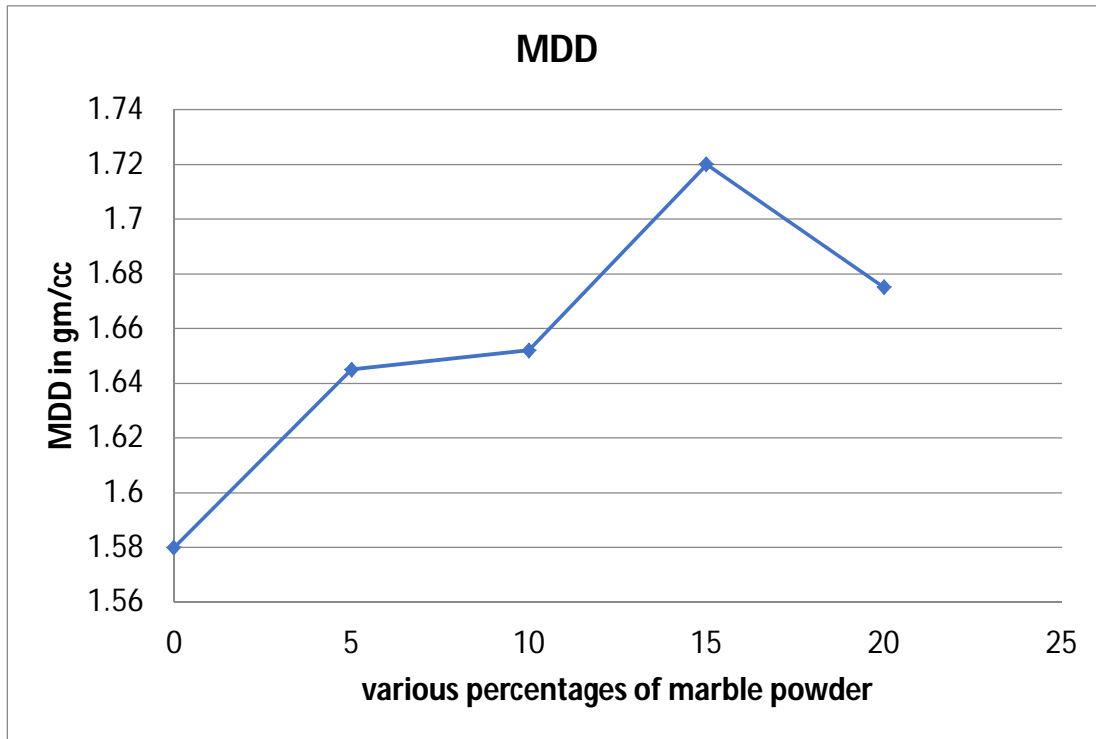
Fig.1 Atterberg limits



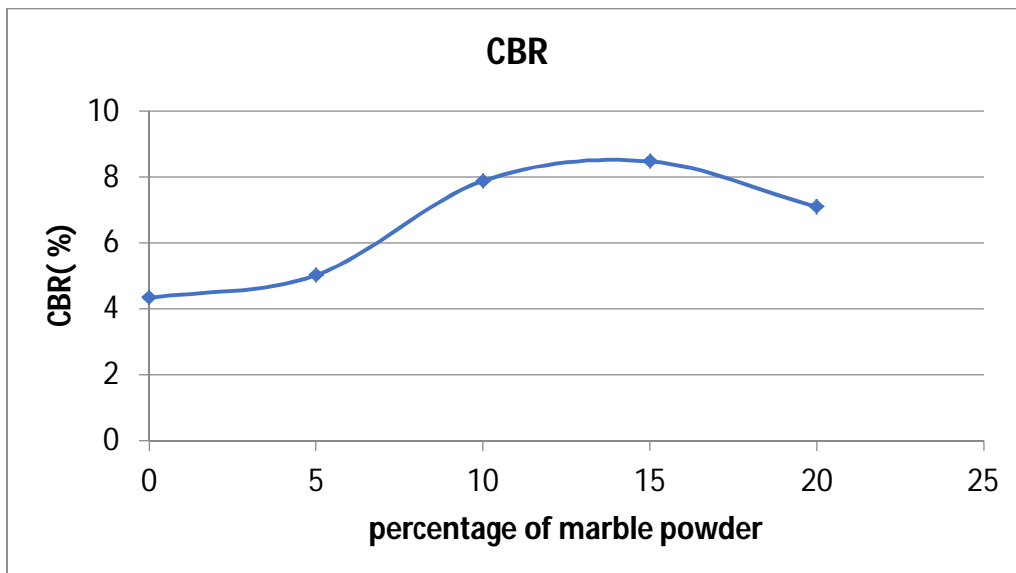
Graph:Comparison of Atterberg limits for different percentages of marble powder

B. Engineering Properties

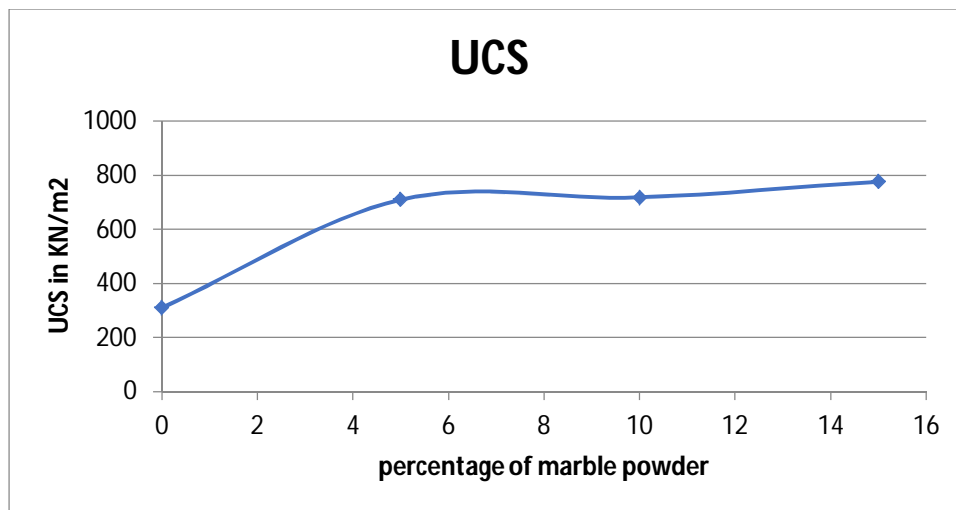
1) **Standard Proctor Test:** We have conducted heavy compaction for the soil with various percentages of 0% to 15% having incremental MDD values of 1.582 gm/cc to 1.72 gm/cc and for 20% of MP there is a small decrement of MDD value as 1.675 gm/cc. The OMC values has been decreased from 21% to 17%.



- 2) *California Bearing Ratio Test:* As the Table.2 shows that initial CBR value as 4.335% and when we replaced the soil with marble powder of different proportions up to 15% the CBR values has increased to 8.474% and for 20% of MP the value has decreased to 7.09%.



- 3) *Unconfined Compression Strength Test:* The bearing capacity of soil has increased to very much more when compared to conventional soil. The bearing capacity of soil initially i.e., 0% noted as 310.02KN/m² and replaced with MP of proportions like 5% to 15% the value has increased to 777.11KN/m²



- 4) *Permeability Test:* The permeability values have increased to 0.0186 to 0.0043 with the replacement of marble powder up to 15% and for 20% of MP the value decreased to 0.00564.

V. CONCLUSION

- A. By the usage of Marble powder we will conclude that it has the character to modify the soil properties.
- B. Utilization of marble powder can reduce the environmental pollution.
- C. The Maximum dry density obtained at 15% marble powder i.e., 1.72 gm/cc.
- D. The maximum CBR value also obtained at 15% of marble powder as 8.474%.
- E. The maximum unconfined compression strength of the soil was obtained at 15% as 777.11KN/m².

The following results obtained above can conclude that up to 15% of marble powder can be replaced with soil sample to get better results.



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