

Experimental Study on Expansive Soil with Marble Powder

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Abstract— Soil stabilization is required when the soil available for construction is not suitable for the particular use. Of all the soils, Expansive soils causing major problems to the civil Engineering structures. Such soils are having high volume changes upon adding the water. 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, is 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 (Gupta et.al 2014). So that, we decided to use the marble powder is used 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 powder has very high lime (CaO) content and is reported Many researchers. We have added the marble powder to the expansive soil as 5%, 10% 15%, 20%, 25% and studied the compaction characteristics and strength characteristics.

Keywords— Soil, Marble powder, Plasticity Index, Unconfined compressive strength

I. INTRODUCTION

In India, Expansive soil is found in major parts of Madhya Pradesh and Andhra Pradesh. In It covers 0.7×10^6 km² approximately 20-25 % land area. When the expansive soil comes in the contact of water then they causes swelling and when water content decreases shrinkage occurs in the soil(Gupta et.al 2014). 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 (cokca, 1999; Indraratna et al. 1991, 1995), rice husk(Muntohar, 1999); (Muntohar and Hantoro 2000), (Preethi et.al 2014), (Ashkan GHolipoor Norozi et.al 2015).Many researchers (Shyam singh. 2014; Gupta, 2014; Osman, 2014; Amit, 2013; Celik and Sabah, 2007;) have reported that marble has very high lime (CaO) content up to 55 % by weight. Thus, stabilization characteristics waste marble dust is mainly 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 (Celik 1996). Out of which only small portion of the waste marble products is utilized economically, most of them are stored on lands. Increasing of usage fields of waste marble 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 Gupta and Sharma (2014).The marble powder was mixed with rice husk ash on expansive soil by Sabat and Nanda (2011). They reported that UCS and CBR value increases due to addition of these materials and also modify the engineering properties. The utilization of waste marble

slurry to enhance the soil properties was studied by Vishwakarma and Rajput (2013). The main aim is to improve the characteristics of black-cotton soil by using marble slurry. There was an improvement in compaction and CBR characteristics. Palaniappan (2009) and Agrawal *et al.* (2011) had reported that marble dust powder is effective waste material in the stabilization of expansive soil. Which improve the index and engineering properties of soil.

II. MATERIALS

2.1 Soil:

Soil was collected from Authoor, near Tiruchendur. It is very near to Thamirabharani 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.

2.2 Marble powder:

The marble powder was collected from marble cutting industry at Tirunelveli. 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).

Table 01 Properties of Soil

S.No	Properties	value
1	Colour	Black
2	Specific Gravity of soil	2.44
3	Specific Gravity of Marble powder	2.78
4	Degree of Expansiveness	Very High
5	Atterberg limits	
i	Liquid limit	70%
ii	Plastic limit	33.61%
iii	Shrinkage limit	12.88%
3	Free swell index	60%
5	Compaction characteristics	
i	Optimum Moisture Content	18%
ii	Maximum dry density	1.48 g/cc
6	Unconfined compressive strength	93 kN/m ²
7	Grain size distribution	
i	Gravel	1%

ii	Sand	9%
iii	Clay and silt	90%
8	IS soil classification system	Clay of High plasticity (CH)

III. EXPERIMENTAL PROGRAM.

3.1 Objectives

- To stabilize and study the behaviour of the soil using marble powder (Marble industry waste).
- To add the marble powder with the clay 0-25% at an interval of 5%.
- To treat the soil with a low cost material or industrial waste material.

3.2 Experiment details

The following Soil Properties were studied by using various percentages of marble Powder.

Atterberg Limits

Proctor Compaction Test

Unconfined Compressive strength

IV RESULTS AND DISCUSSIONS

4.1 Atterberg Limits

Liquid limit

Figure 1 explained about liquid limit of soil with the different percentage of Marble powder. It was noticed that the percentage of marble powder increases, the Liquid limit value decreases constantly. The value was varied from 70% to 55%. The value was decreased to 27% at 25% addition of marble powder.

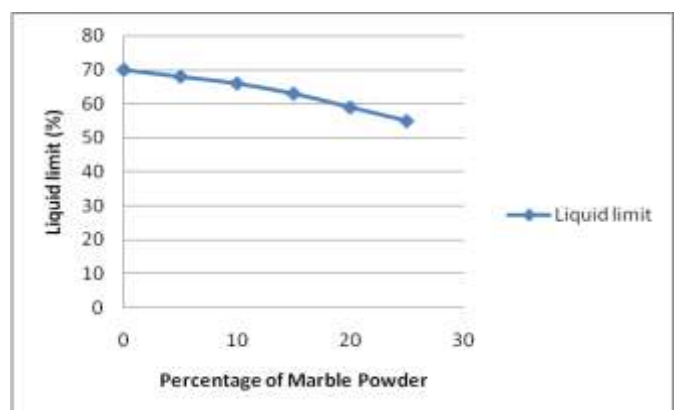


Figure 1 liquid limit of soil with the different percentage of Marble powder

Plastic limit

The figure 2 showed about plastic limit of soil with the different percentage of Marble powder.

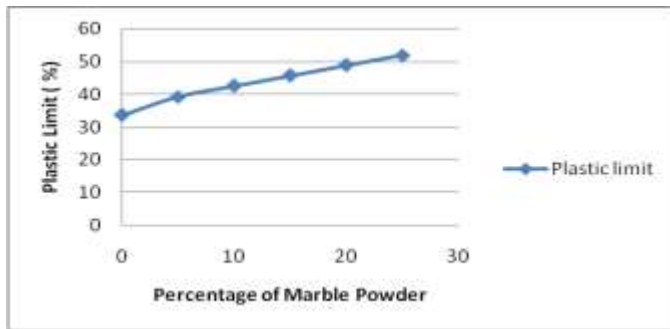


Figure 2 Plastic limit of soil with the different percentage of Marble powder

The plastic limit value was increased gradually when the marble powder from 5% to 25% at an interval of 5% to the soil. Increase in the marble powder to the soil sample caused a change in the liquid limits and plastic limits, which affects the plasticity index of the soil. The plastic limit was increased approximately 50% at 25% addition of marble powder.

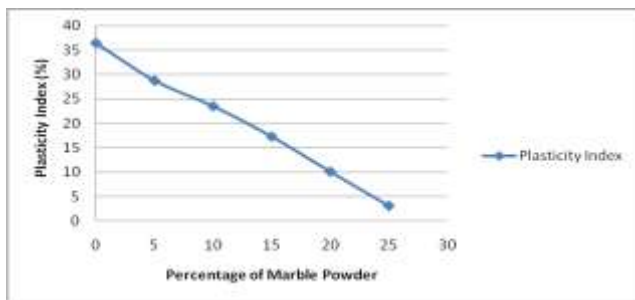


Figure 3 Plasticity Index of soil with the different percentage of Marble powder

The plasticity index of the soil was reduced from 36.39% to 3.04%. The reduction of plasticity index was an indication of improvement of soil property. These results are consistent with previous researchers (Shyam singh et.al 2014; Ali et.al 2014; Amit et.al 2013 ;) and in agreement marble powder can be utilised as additives in soil stabilisation. The soil samples were changed from having high plasticity to silty behaviour, which is in terms of favorable workability.

4.3 Proctor Compaction characteristics

With different percentage of marble powder to the soil, the maximum dry density and optimum moisture content was found by Proctor compaction test as per IS 2720. The figure 4 explained about variation of OMC with the different proportion of marble powder.

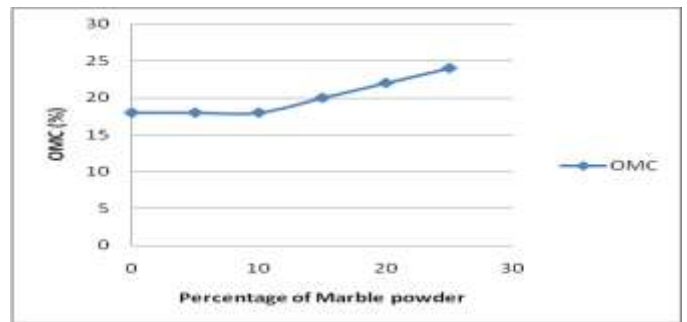


Figure 4 Variation of OMC (Optimum Moisture Content) with different percentage of Marble powder

From the figure 4, it was noticed that the Optimum moisture Content of clay goes on increasing with the addition of Marble powder. The value changes from 18% to 24%. Figure 5 represented the variations in maximum dry density with the increase marble powder content. it was noticed that the Maximum dry Unit Weight of clay is increased up to 10% addition of marble powder after that it goes on decreasing with the further addition of Marble powder.

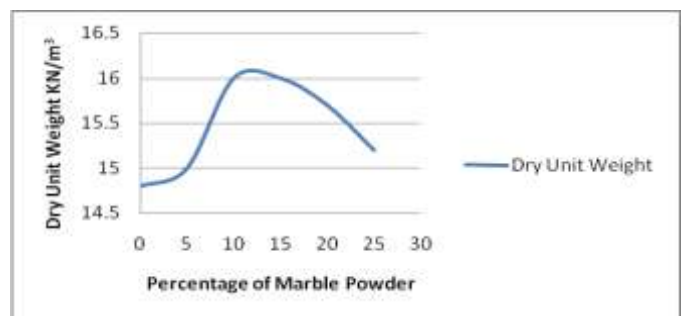


Figure 5 Variation of Maximum Dry Unit weight with different percentage of marble powder

4.4 Unconfined compressive strength

Following table 5 represented the unconfined compressive strength of soil for different percentages of marble powder. The marble powder was taken from 0 % to 25% as 5% interval

Table 02 – UCS test result for Clay + % of Marble powder

% of Marble Powder	Unconfined Compressive Strength (kN/m ²)
0%	93.00
5%	121.00

10%	186.00
15%	215.00
20%	205.00
25%	155.00

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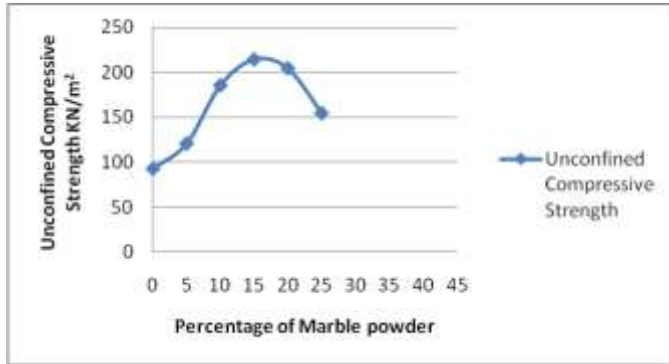


Figure 6 Variation of UCS (Unconfined Compressive strength) with variation of marble powder

The initial increase in the UCS value was expected because of the gradual formation of cementitious compounds (calcium silicate hydrate) due to the reaction between the calcium carbonate present in the marble powder, soil and water. The decrease in the UCS values after the addition of 15%. The increase in UCS value at 15% addition of marble powder was 131%.

V CONCLUSION

From this experimental work the following results were made

- Utilization of waste marble powder may reduce the disposal problem and preserve the ecological system.
- The maximum unconfined compressive strength of the clay is 215kN/m² at 15% of marble powder. The Marble Powder is added about 15%.to the soil as strength point of view.
- The expansive soil was modified in to low plasticity and silty behaviour.