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Evaluation of geotechnical properties of marble dust treated clayey soil

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Abstract- **It has always been a topic of interest for engineers around the world to economically utilize the wastes produced from different industries. Especially in developing countries, the waste production is enormous and the disposal of it poses a huge threat to the society. The waste marble dust produced from marble producing industries, through the manufacture of marble has been utilized as an additive in concrete in recent years. The current study is to observe the variation in geotechnical properties of soil treated with 0% to 20% marble dust. The change in properties like liquid limit, plastic limit, optimum moisture content, maximum dry density and unconfined compressive strength has been recorded. From the results obtained, it was observed that on addition of marble dust the optimum moisture content of soil reduced while the dry density increased and UCC strength also increased to a maximum value. Favorable results were also obtained for liquid limit and plastic limit, making it an effective stabilizer of soil.**

Keywords- Marble dust;Thonakkal clay; Compaction; UCC

IINTRODUCTION

The population of the world has been rapidly increasing and with increased population the demand for more constructions occurs. The availability of suitable foundation soil may not be possible in many regions of the world. So an inevitable demand rises to use low strength soils for different purposes like construction and fill. To improve the quality of soil over those regions, it is more practical to utilize different additives which will improve the quality and geotechnical property of soil thereby making it an effective foundation soil. This method also helps in utilizing the waste products effectively,which when dumped without any regard will cause ill effects and hazards.

Production of waste from any industry is a part of the industry's functioning. It is of utmost importance to ensure that the waste produced does not affect the society or living organisms. The best suitable way to manage the wastethus produced is to recycle it or make it useful as some additive in soil, concrete or as fill.Upon addition of some preferable waste products in soil, the properties of soil improve and also help in managing the wastes.

In the current study, the stabilization of a locally available soil by improving its geotechnical properties using waste marble dust is done. The soil used here is naturally occurring soil collected from Thonakkal region, Thiruvananthapuram.

Marble dust is produced from marble producing industries through the cutting, polishing and smoothening of marble tiles. These processes are done by spraying water over it.So the waste marble is discarded as slurry, which on drying gets transported by wind and cause

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problems to humans and society. These wastes are also produced from buildings under construction where tiles are laid and polished. Thus the effective utilization of this waste is of high importance, and has been used as cement replacement additive in concrete blocks. Studies relating to utilization of marble dust to improve soil properties have also been evolving in the recent years.

II MATERIALS AND METHODS

A.Materials used

1) *Soil:* The soil used in this study is naturally occurring soil, collected from English India Clay Ltd., Thonakkal which is mineralogically kaolinite clay. The properties of soil are studied using standard procedures and the results are tabulated in Table1. From the test results, it was identified that the soil can be classified as clay of high plasticity according to Unified Soil Classification system.

2) *Marble dust:* The marble dust used in the study is collected from marble producing industries, Bangalore. The sample was air dried before testing. They were added to soil in percentages of 5%, 10%, 15% and 20% of soil.

B. Methods

1) Index properties: The tests to determine index properties of soil were done using IS 2720.1985 (Part V). They were done in soil treated with 0%, 5%, 10%, 15% and 20% marble dust to understand the variation in properties of untreated as well as treated soil.

2) Compaction tests: The tests to determine the optimum moisture content and maximum dry density were done using standard proctor effort according to IS 2720.1980 (Part VII). The same is repeated for soil treated with 5%, 10%, 15% and 20% marble dust.

3) Unconfined compressive strength test: The variation in unconfined compressive strength of soil at 0%, 5%, 10%, 15% and 20% marble dust treated soil compacted at OMC were obtained based on IS 2720.1991(Part X).

III RESULTS AND DISCUSSION

A. Index properties

The particle size distribution of soil is presented in figure1 and the index properties of soil [3] is summarised below in Table1.

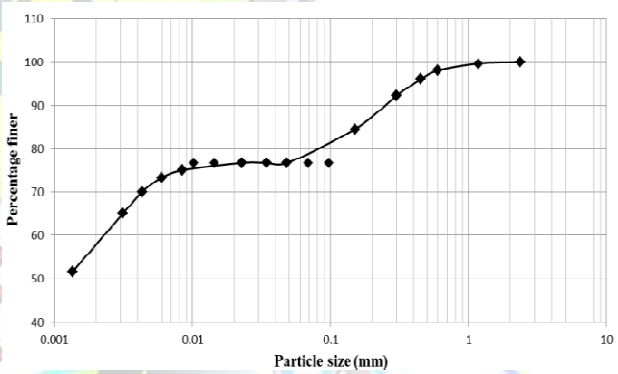

Fig1: Particle size distribution of natural soil

TABLE1: Properties of soil used

Properties	Value obtained
Natural water content (%)	22.5
Liquid limit (%)	56.5
Plastic limit (%)	28.9
Shrinkage limit (%)	27.8
Plasticity index (%)	27.6
Specific gravity	2.5

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Optimum moisture content (%)	31.1
Maximum dry density (g/cc)	1.384
Unconfined compressive strength (kN/m^2)	144.3
Percentage sand (%)	21.5
Percentage silt (%)	20.5
Percentage clay (%)	58
Unified Soil Classification	CH

The hydrometer analysis and specific gravity tests were done for marble dust and the results are obtained as in Table2. The properties are in accordance with values obtained in [4].

TABLE2. Properties of marble dust collected

Properties	Value obtained
Percentage silt (%)	60
Percentage clay (%)	40
Specific gravity	2.63

1) *Effect of marble dust addition in liquid limit:* Marble dust added to soil in 0%, 5%, 10%, 15% and 20% were subjected to liquid limit test using Casagrande apparatus and the variation is given in Figure2. The liquid limit decreased with increased addition of marble dust[4], which may have resulted by the non-plastic behavior of marble dust [1]. The value reduced from 56.5% for 0% marble dust to 43.1% for 5% marble dust addition. After which the reduction was gradual with minimum value obtained at 40.75% for 20% marble dust addition.

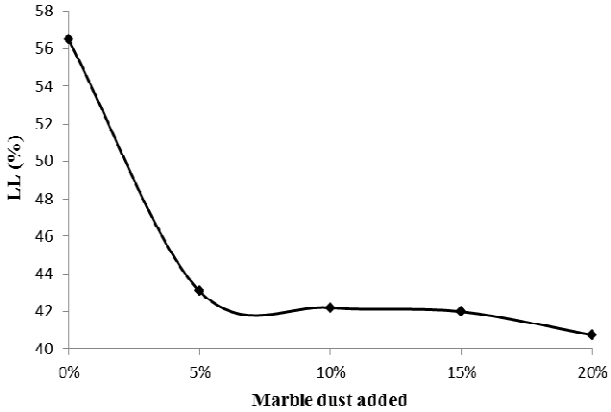

Fig2: Variation of liquid limit with marble dust addition

2) *Effect of marble dust addition in plastic limit:* The addition of marble dust in soil increased the plastic limit of soil from its natural plastic limit. The increase was higher till 5% marble dust addition, with which the plastic limit increased from 28.9% (for untreated soil) to 34.15%. After which, the increase was gradual and a maximum value of 36.73% was obtained for 20% marble addition[1]. The variation is shown in Figure3.

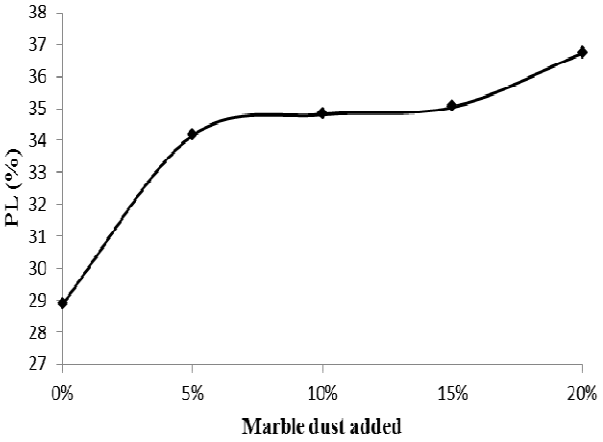

Fig3: Variation of plastic limit with marble dust addition

3) *Effectof marble dust addition in plasticity index:* As the liquid limit decreases and

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plastic limit increases with marbled dust addition, a decrease of plasticity index was observed in the treated soil [4]. The variation is reported in Figure 4. Also from the plasticity chart, the soil has become silt of low plasticity upon addition of marble dust.

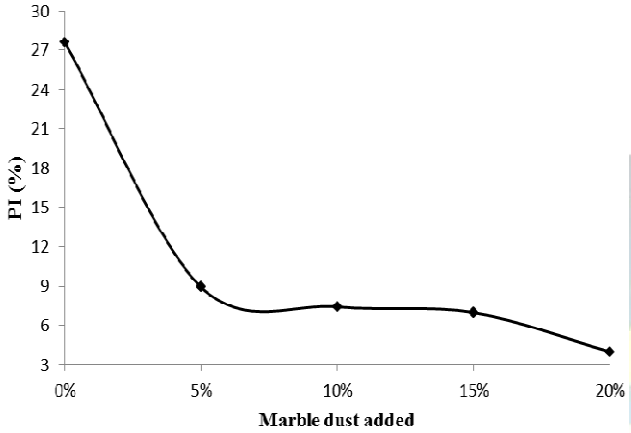

Fig4: Variation of plasticity index with marble dust addition

B. Compaction characteristics

The maximum dry density and optimum moisture content of untreated and marble dust-treated soil is obtained through standard proctor method. The variation in OMC and maximum dry density upon marble dust addition is presented in Figure5. As the percentage of marble dust addition increases from 0% to 20%, it was observed that the maximum dry density increased from 1.384g/cc for 0% marble dust to 1.552g/cc for 20% marble dust and the optimum moisture content decreased from 31.1% for 0% marble dust to 24% for 20% marble dust addition. The decrease of optimum moisture content maybe accounted to the fact that the replacement of soil with marble dust reduces the attraction to water particles. The increase in maximum dry density maybe related to the increased specific gravity of marble dust (2.63) replacing soil with lower specific gravity (2.5)

The variation of optimum moisture content and maximum dry density with different marble dust additions are presented in Figure 6 and Figure 7. The results are consistent with [2] and [4]

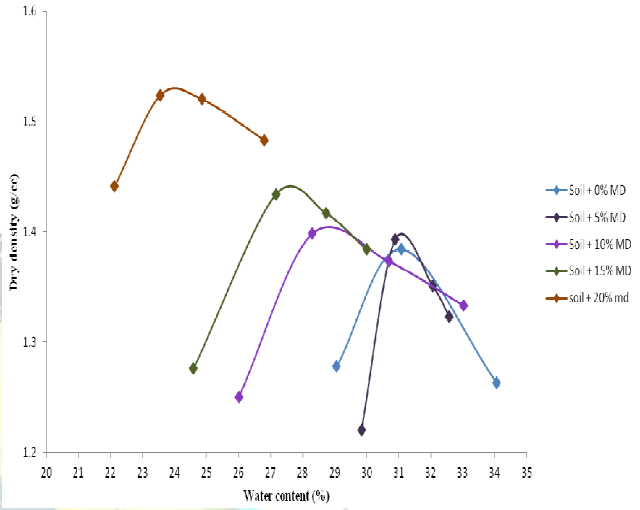

Fig 5: Comparison of compaction curves on different percentage of marble dust addition

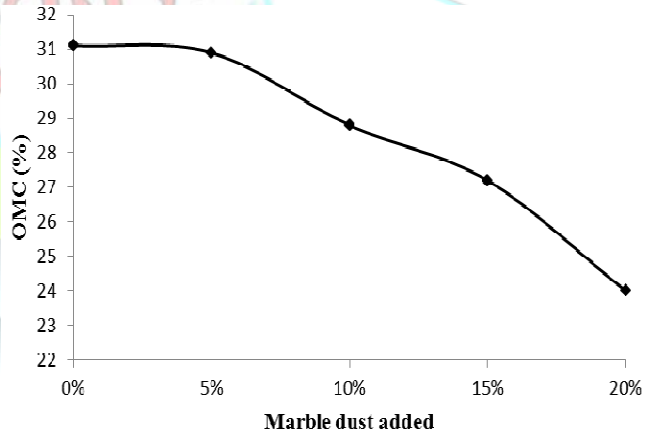

Fig 6: Variation of OMC with marble dust addition

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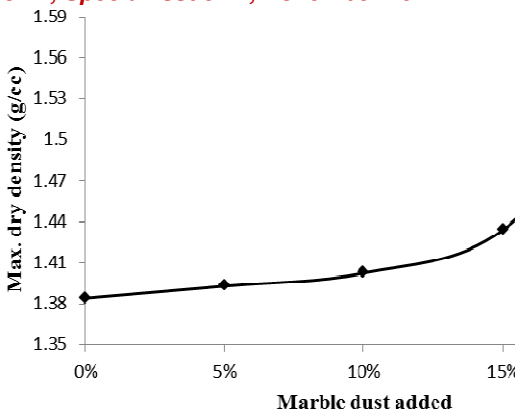

Fig 7: Variation of maximum dry density with marble dust addition

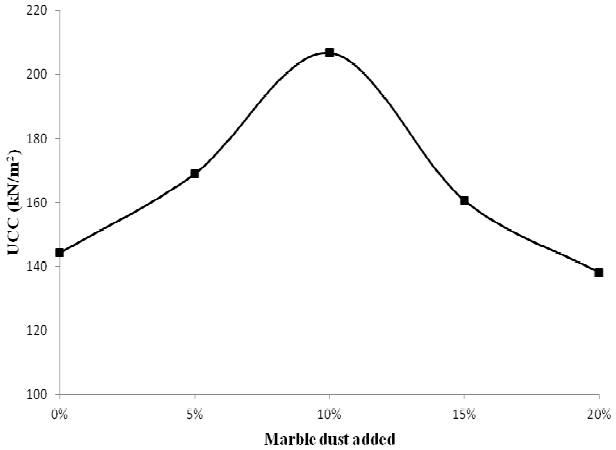

Fig8: Variation of unconfined compressive strength with marble dust addition

C. *Unconfined compressive strength*

The variation of UCC strength with different percentage addition of marble dust is given in Figure 8. The value was observed to increase from 144.3kN/m^2 for 0% marble dust to 169kN/m^2 for 5% marble dust and 206.7kN/m^2 for 10% marble dust addition. After this, the value reduced to 160.7kN/m^2 for 15% marble dust and further decrease to 138.2kN/m^2 for 20% marble dust. This suggests that the optimum amount of marble dust addition lies between 10% and 15% addition. The increase in UCC strength maybe attributed to the bonding of calcium ions of marble dust with silicates or aluminates present in the soil. After 10%, the reduction observed can be related to the availability of excess pozzolanic material which remainsunbonded with soil [10].

IV CONCLUSIONS

From the study conducted, marble dust can be used as an effective soil stabilizer. The strength characteristics improved 1.4 times that of untreated soil with optimum content ranging between 10% and 15% marble addition. Also the consistency limits were improved with addition of marble dust, making it a silt of low plasticity. The compaction characteristics also indicated an increased maximum dry density and reduced optimum moisture content. All the results indicate that marble dust can be effectively utilized as a stabilizer to improve properties of soil.

REFERENCES

[1] Osman Sivrikaya, Koray R. Kıyıldı and ZekiKaraca,'Recycling waste from natural stone processing plants to stabilize clayey soil', Environmental Earth Science journal, pp. 4397–4407, (2014).

[2] Parte Shyam Singh1, Yadav R.K., 'Effect of Marble Dust on Engineering Characteristics of Black Cotton Soil', International Journal of Emerging Trends in Engineering and Development, Issue 4, Vol.5, pp 104-111, (2014).

[3] EmyPoulose, Prof. Ajitha A R, Dr. Sheela Evangeline Y, 'Design of Amended Soil

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ISSN 2394-3785 (Online)
Available online at www.ijartet.com
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Liner', International Journal of Scientific & Engineering Research, Volume 4, pp. 45-46, (2013).

[4] Jagmohan Mishra, R K Yadav and A K Singhai, 'Effect of granite dust on index Properties of lime stabilized black cotton soil', International journal of Engineering Science and Research & Technology, Vol. 3, No. 1, pp. 19-23, (2014).

[5] Aneel Kumar, GhousBuxKhaskheli and Atta Muhammad Phul, 'Effect of Marble Powder on Various Geotechnical Properties of Jamshoro Soil', Third International Conference on Construction in Developing Countries (ICCIDC–III), (2012).

[6] R.P. Arora, Dr. N.K. Ameta, Kapil K. Samar and K.L. Samdani, 'Improvement of Engineering Characteristics of Locally available Soil Mass by use of Marble Dust: A Review', International Inventive Multidisciplinary Journal, Volume II, Issue IV, pp. 8-15, (2014).

[7] Ramadas, T.L. Kumar, N. Darga and Aparna, G, 'Swelling and Strength Characteristics of Expansive Soil Treatedwith Stone Dust and Fly Ash', IGS Mumbai Chapter & IIT Bombay, pp. 557-560, (2010).

[8] Ismail Zorluer and LemiTufanTaspolat, 'Reuse of Waste Marble Dust in the Landfill Layer', International Symposium on Sustainable Development, pp. 57-60, (2009).

[9] Khushbu S. Gandhia, 'Stabilization of Expansive Soil of Surat Region using Rice Husk Ash & Marble Dust', International Journal of Current Engineering and Technology, Vol.3, No.4, pp. 1516-1521, (2013).

[10] Akshaya Kumar Sabat, 'Stabilization of Expansive Soil Using Waste Ceramic Dust', Electronic Journal of Geotechnical Engineering, pp. 3915-3926, (2012).

[11] VinayAgrawal and Mohit Gupta, 'Expansive Soil Stabilization Using Marble Dust', International Journal of Earth Sciences and Engineering, Volume 04, pp 59-62, (2011).

[12] Ismail Zorluer, Ismail Muratoglu, 'Effect of Marble Dust on Consolidation Characteristics of Clay Soils', International Symposium on Sustainable Development, pp. 514-517, (2010).