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Enhancing the Properties of Dune Sand Using Marble Dust

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Abstract. Dune sand is generally cohesionless soil and non-plastic in nature with the major hinder that it is having high hydraulic conductivity and weak in shear strength making it problematic to use from civil engineering point of view. Rajasthan is jewel of mines and minerals also the chief source of marble mining. The marble industry and marble cutting units produces hazardous waste material in form of small chips and marble dust in huge amount which causes problem to the human nearby them and also adversely affects the delicate ecological system of environment. It has been observed that there is lot of respiratory problems found in the places nearby the installed marble cutting units. Equally the unplanned and illegitimate disposal of these waste materials into streams or rivers disturbs the aquatic life, creates pollution and reduces the penetration capacity and fertility of existing soil.
The research is to study the possibility of utilizing waste marble dust generated from the marble cutting industries in stabilizing dune sand which is generally weak in shear strength, so that it can improve the geotechnical properties of the soil and waste disposal problem can also be resolved. In this research work the soil sample was selected from the Arjunsar (Bikaner district, Rajasthan) and tested experimentally like Proctor, CBR, Atterberg's etc. for the stabilization at a progressive mix of 5% to 30% with white marble waste so as the properties of dune sand can be enhanced.

Keywords: Dune Sand, Marble Dust, Soil Stabilization, California Bearing Ratio (CBR).

1 Introduction

In project works, frequent times we found poor soil exist, so the stabilization and enhancement of properties of non-suitable soil is necessary. If the soil fails, the structure founded on it can collapse. The main intend of stabilization is to surge the strength of the soil as the safety of any geotechnical structure is dependent on strength of the soil. The stabilization process may comprise mechanical, chemical, electrical or thermal process. The execution of these stabilization methods is entirely depending upon type of soil, onsite condition, closing date of project and the cost of stabilization compared to the taken as a whole cost of the project and to the cost of full replacement of the soil at the site. It all takes one main point which is economy the civil engineer has to make work economical so he or she may consider only one method or several methods together. Baghdadi and Rahman (1990) [1] concluded that the sand stabilized with CKD could be exploited for base materials in highway construction as the value of CBR got improved. Homauoni and Yasrobi (2011) [2] observed that on stabilizing dune sand with the two polymers poly (methyl methacrylate) and polyvinyl acetate increased the strength as well as the CBR value of dune sand in dry state. Bushra et al. (2012) [3] investigated that the stabilization of collapsible soil with CKD increased the ultimate bearing capacity to 250% at 8% CKD and could be economical in work. Awad and Sherif (2012) [4] examined the stabilization of dune sand with Portland cement as the stabilizing agent and came up with the result that Portland cement influenced the engineering properties of soil, strength features of the stabilized soil enhanced which made it fit to be utilized as a base material for road construction and in foundation for superstructures. Panwar and Ameta (2013) [5] came up with the aid of lime and bentonite to stabilize the dune sand, at 15% bentonite and 3% lime mixed with dune sand showed the significant increase in unconfined compressive strength. Ameta et al. (2013) [6] observed a linear increment in CBR value on stabilizing dune sand with ceramic tile waste. Ghrieb et al. (2014) [7] presented the use of granular corrector and hydraulic binder for stabilization of dune sand of the region of Djelfa. Value of MDD increased significantly. Kumar et al. (2016) [8] studied the stabilization of dune sand combined with plastic (LDPE) waste strips. Study revealed that the CBR value increased as the LDPE value is increased which helped in reducing the thickness of flexible pavement in construction of roads. Fattah et al. (2016) [9] investigated the utilization of Lime-Silica Fume mix as a stabilizing agent in order to stabilize the dune sand. Treatment of dune sand with L-SF showed a significant increment in the value of dry density and CBR than the untreated dune sand. Tiwari et al. (2016) [10] obtained the features of dune sand and issues associated with it like stabilization for highways, minimization of foundation settlements under load and reduction of permeability. Introduction of lime and cement increased the UCS of dune sand.

2 Materials Used

2.1 Dune sand

Dune Sand was collected from Arjunsar, district Bikaner in Rajasthan state. Soil engineering properties listed in Table 1.

2.2 White marble dust

The white marble dust was collected from Bikaner Marble Factory in Rani Bazar district Bikaner in Rajasthan state.

Table 1. Test result values of dune sand and WMD

Sr. No.	Descriptions	Dune Sand	White Marble Dust
1	Unified Soil Classification System	SP	-
2	Liquid Limit (%)	19.70	31
3	Plastic Limit (%)	NP	NP
4	Maximum Dry Density (g/cm^3)	1.79	1.58
5	Optimum Moisture Content (%)	11.0	17.0
6	California Bearing Ratio (%)	13.18	7.57

3 Experimental Program

3.1 Objective

To study the engineering properties of the Dune Sand (DS) and stabilize the DS using White Marble Dust (WMD) as a stabilizer by mixing WMD with the interval of 5% from 0-30%, as after 30% the value doesn't show any improvement and tends to decrease.

3.2 Experimental details

Following properties of the dune sand were studied by using varying percentage of WMD: -

1. Grain Size Analysis IS: 2720 (Part IV) [11].
2. Atterberg's Limit IS: 2720 (Part V) [12].
3. Standard Proctor Compaction Test IS: 2720 (Part VII) [13].
4. California Bearing Ratio Test IS: 2720 (Part XVI) [14].

Particle size distribution test

The particle size distribution is found out by conducting sieve analysis test. Percentage passing through each sieve was determined and lay against particle size. The cumulative percentage passing of the sample is obtained by deducting the percent retained from 100%. The soil was listed as poorly graded sand as shown in Fig 1.

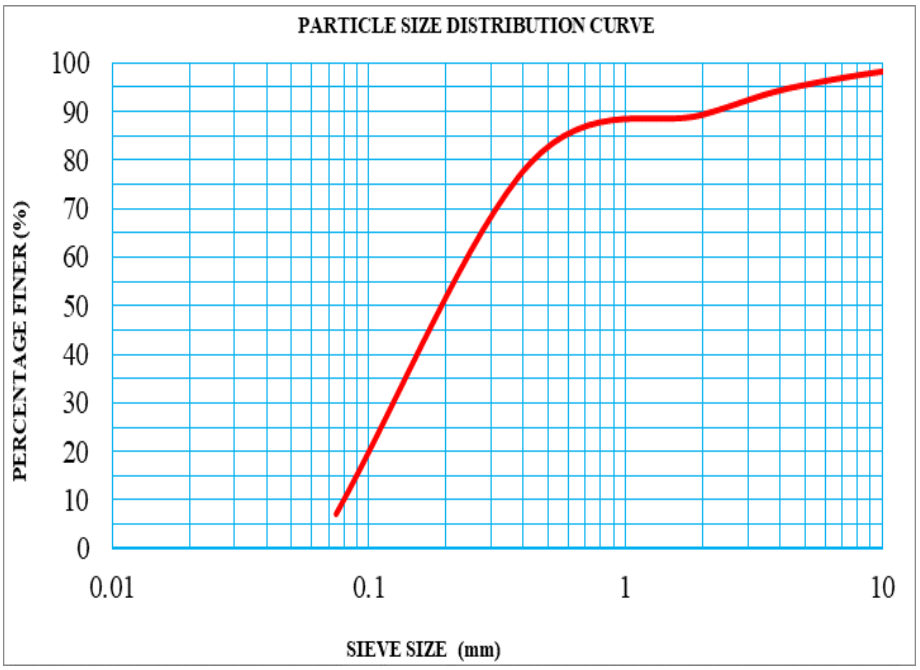

Fig. 1. Particle Size Distribution Curve of Dune Sand

Liquid limit

The object of the test is to determine the liquid limit that shows the lowest water content at which the sample is in liquid state. An increment in liquid limit was observed as additional fine contents to the samples which need supplement water in inclusion to WMD that needed extra water for the reaction to begin. As the soil is cohesionless hence the soil is non-plastic in nature.

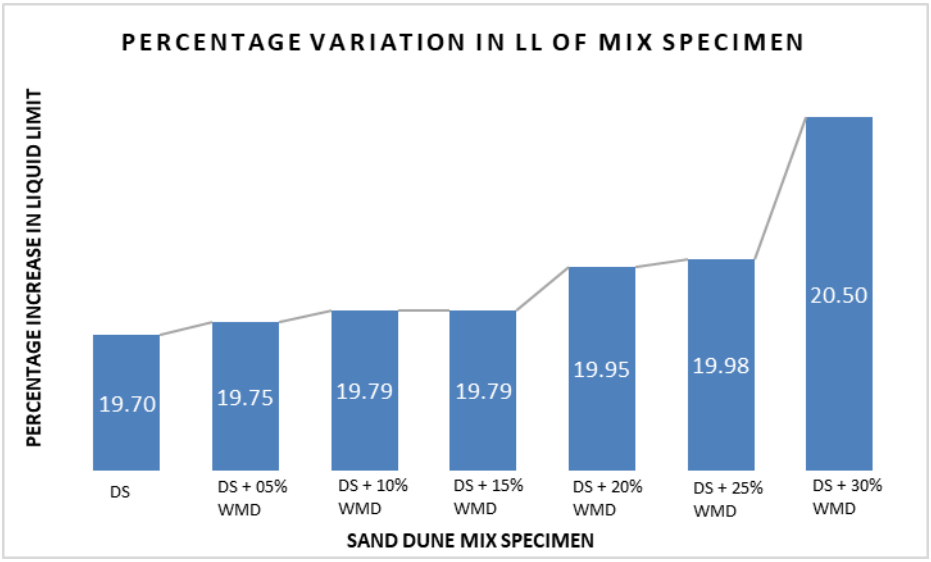

Fig. 2. Percentage variation in Liquid Limit (LL)

Fig. 2 shows the percentage variation in liquid limit of the dune sand mixed specimen. Liquid limit of the dune sand was 19.70% and it was increased up to 20.50%. WMD was added at the interval of 5% from 5% to 30%. Increase in liquid limit shows increase in volume. This behavior indicates that the soil is permeable in nature. Liquid limit test was performed by the Casagrande's apparatus. Also, as it is dune sand hence it is non-plastic in nature.

Standard proctor compaction test

Compaction characteristics of the dune sand and specimen have been determined by using Standard Proctor's test according to the procedure laid down in IS 2720 (VII): 1980 [13].

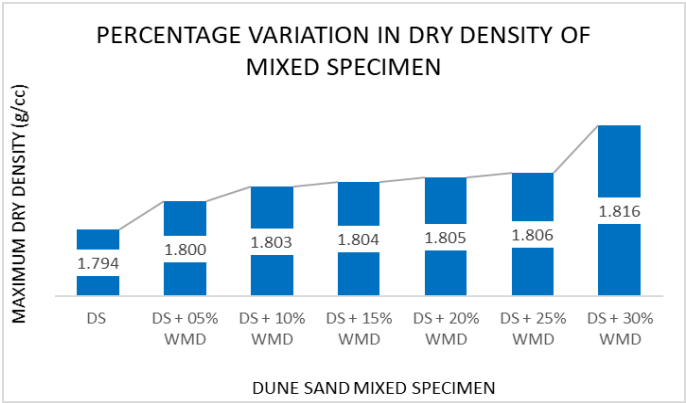

Fig. 3. Percentage variation in dry density

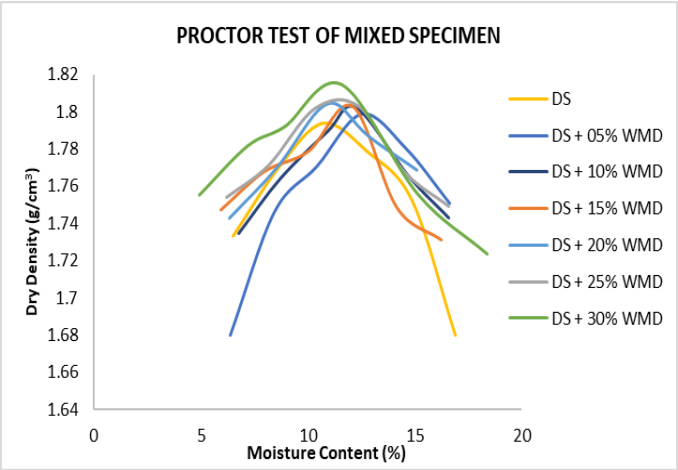

Fig. 4. Variation of dry density with moisture content

Fig. 4 represents a relationship between dry density vs moisture content. The maximum dry density of the dune sand was found to be 1.79g/cm^3 corresponding to moisture content 11%. The maximum dry density obtained was 1.81g/cm^3 of the mix having 30% white marble dust corresponding to moisture content 11.20%. Percentage increasing in maximum dry founded was 1.21%. There was a slight variation was observed at percentage mix of 20% and 25% of WMD. Percentage increasing in maximum dry density indicates improvement in the characteristics of the dune sand.

California bearing ratio (CBR)

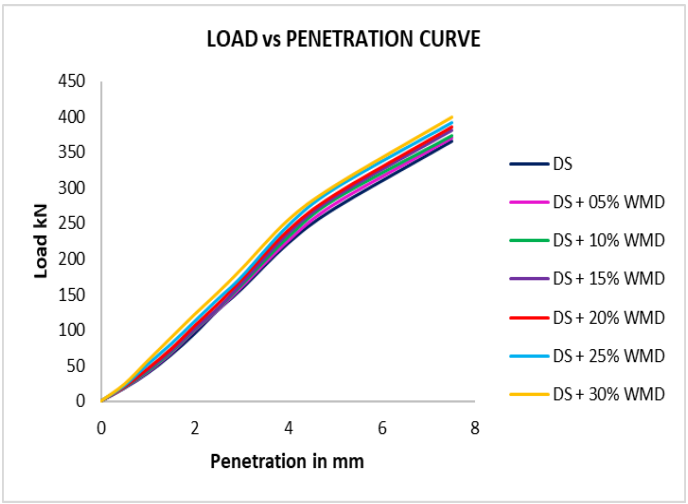

Fig. 5. Variation of CBR of DS with varying percentage of WMD

Fig. 5 shows a variation of CBR of dune sand with varying percentage of white marble dust. The CBR value of the dune sand was found to be 13.18%. The maximum value of CBR obtained was 14.76% of the mix having 30% white marble dust. Percentage increasing in the CBR value founded was 10.70%. Percentage increasing in CBR value indicates improvement in the characteristics of the dune sand as well as its strength. Improvization in the strength of soil due to increase in its CBR value indicates that it may be used in the embankment for roadways construction purpose at low cost.

4 Conclusions

Geotechnical engineering pickle associated with the dune sand are myriad. An experimental study was carried out to analyze the engineering properties of dune sand and technique to improve its engineering properties using white marble dust. Following conclusions are extracted from this study:

1. The liquid limit of dune sand increases with increase in the percentage of white marble dust, as additional fine contents to the samples which needs supplement water in inclusion to the WMD that needed extra water for the reaction to begin.
2. With the inclusion of white marble waste, the MDD of dune sand tends to increase while OMC of dune sand also increases due to additional fines content requiring more water to start up the reaction. The MDD of virgin soil was 1.794g/cm^3 at 11% OMC. At inclusion of 30% white marble waste with dune sand, MDD was increased up to 1.816g/cm^3 at 11.20% OMC.
3. A rectilinear surge was observed in CBR value.
4. Study carried out shows that the improvement in the values of MDD, OMC and in CBR value is quite marginal.
5. From the study carried out it was observed that loose dune sand after stabilization with white marble dust got bind up to form a firm mass, which indicates the improvement in the strength of the DS.
6. Study revealed that white marble dust can be used in regions where normally used materials for subgrade are lacking, or costly.
7. As white marble dust can enhance the dune sand and duo of them are profusely existing in Rajasthan hence, white marble dust can be exploited as substitute of chemical methods in enhancing dune sand in direction to make the work economical.

References

1. Baghdadi, Z. A., and M. A. Rahman. "The potential of cement kiln dust for the stabilization of dune sand in highway construction." *Building and Environment* 25, no. 4 (1990): 285-289.

2. Homauoni, Ziba J., and Seyed Shahaboddin Yasrobi. "Stabilization of dune sand with poly (methyl methacrylate) and polyvinyl acetate using dry and wet processing." *Geotechnical and Geological Engineering* 29, no. 4 (2011): 571-579.
3. Albusoda, Bushra S., L. A. Salem, and K. Salem. "Stabilization of dune sand by using cement kiln dust (CKD)." *Journal of Earth Sciences and Geotechnical Engineering* 2, no. 1 (2012): 131-143.
4. AlKarni, Awad, and Sherif M. ElKholy. "Improving geotechnical properties of dune sands through cement stabilization." *Journal of Engineering and Computer Sciences* 5, no. 1 (2012): 1-19.
5. Panwar, P., and N. K. Ameta. "Stabilization of dune sand with bentonite and lime." *Electr J Geotech Environ* 18, no. M (2013): 2667-2674.
6. Ameta, N. K., A. S. Wayal, and Puneet Hiranandani. "Stabilization of dune sand with ceramictile waste as admixture." *American Journal of Engineering Research* 2, no. 9 (2013): 133-139.
7. Ghrieb, Abderrahmane, Ratiba Mitiche-Kettab, and Abderrahim Bali. "Stabilization and utilization of dune sand in road engineering." *Arabian Journal for Science and Engineering* 39, no. 3 (2014): 1517-1529.
8. Kumar, Pankaj, Vinit Das, Akash Gupta, and N. K. Ameta. "Stabilization of dune sand mixed with plastic (LDPE) waste strips for design of flexible pavement in construction of roads." *Am. J. Eng. Res. (AJER)* 5, no. 11 (2016): 315-320.
9. Fattah, Mohammed Y., Hasan H. Joni, and Ahmed S. A Al-Dulaimy. "Compaction and collapse characteristics of dune sand stabilized with lime-silica fume mix. "*Earth Sciences Research Journal* 20, no. 2 (2016): 1-8.
10. Tiwari, S. K., J. P. Sharma, and J. S. Yadav. "Behaviour of dune sand and its stabilization techniques." *Journal of Advanced Research in Applied Mechanics* 19, no. 1 (2016): 1-15.
11. Standard, Indian. "IS: 2720 (Part IV)-1975: Methods of test for soils: Part 4 Grain size analysis." *India: Bureau of Indian Standards* (2006).
12. Code, Indian Standard. "IS 2720 (Part 5)–1985." *Determination of liquid limit and plastic limit (second revision)*.
13. BIS, IS. "2720 Methods of Test for Soils: Part 7 Determination of Water Content-Dry Density Relation Using Light Compaction." *Bureau of Indian Standards, New Delhi, India* (1980): 1-9.
14. Standard, Indian. "Laboratory determination of CBR." *IS 2720 (Part XVI)* (1987).