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A REVIEW

Improvement of engineering characteristics of locally available soil mass by use of marble dust

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ABSTRACT

Marble powder is an excellent material for mechanical stabilization of cohesive soil. A need is existed for thorough understanding of outcomes of various engineering tests when the marble slurry is mixed with soil samples. Very few researchers have been attracted by enhancing the soil properties by marble slurry. Use of marble slurry with soil can be a sustainable solution for its disposal.

KEY WORDS : Marble Dust, Soil, Stabilization, CBR value, Permeability

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INTRODUCTION

Marble industry is producing huge quantities of powdered marble waste. The waste produced during cutting and grinding of marble is very fine but non-plastic and almost well graded. The particle size of the powdered waste depends on the strength of marble, the type of the cutter or grinder and the pressure applied during cutting and grinding. Hard marble and low cutting pressure produces finer particles and *vice-versa*. The marble powder although non plastic contains an appreciable colloidal fraction that forms a gel which significantly reduces the permeability and allows deformation without cracking which is desirable for any non permeable structure.

Marble is the second largest quarried stone in Rajasthan. There are around 4000 marble mines and 1100 marble processing units spread over 16 district of Rajasthan. All these generate a huge quantity of marble dust (5-6 MT) in the form of slurry during cutting and processing of marble stone. On an average, cutting of 25 mm marble block results in 5 mm thick waste (~20 %) known as marble slurry. Marble slurry is a semi liquid substance containing high percentage of very fine particles and water used as coolant during sawing and polishing. The major environmental concern is the disposal of this by product. The marble cutting industries are dumping the marble dust in any nearby pit or vacant spaces near their unit, although notified areas have been marked for dumping. This leads to serious environmental problems like dust pollution and occupation of vast areas of land, especially after the slurry dries up. This also contaminates the underground water reservoirs (Singh and Khanna, 1999). Swami, 2002; Baser, 2009 and Palaniappan and Stalin, 2009 had studied the stabilizing effect of marble dust on engineering properties of expansive soil and has found varied success. The objective of this paper is to review the effect of Marble dust on Compaction, UCS, Soaked CBR, Swelling pressure and durability characteristics of an expansive soil stabilized.

The marble powder although being non-plastic contains an appreciable amount of colloidal fraction that forms a gel which significantly reduces permeability and increases strength. Various researches made to investigate the effect on various engineering properties after addition of marble dust to soil are reviewed below:

Eskioglou P.C. carried out a study on the influence of soil types on stabilization with marble dust for forest road construction. Author is reported that plastic soils can be successfully improved after stabilization with marble dust. The soil with the highest clay content showed the best improvement. Significant PI reductions occurred with MD treatment, particularly for high PI

soils. Experimental results showed that the geotechnical parameters of forest soils are improved substantially by the addition of marble dust. Plasticity was reduced by 15 to 30 per cent and strength increased by 25 to 50 per cent. The highest strength were achieved at 8 per cent marble dust. For MD- treated soils, the most significant strength gains occurred after 28 days. The deflection has been reduced at 11 per cent, CBR and the strength layer co-efficient are increased 50 and 30 per cent, respectively. The stabilization of forest roads with marble dust represents an environmentally friendly process, as using materials of nature, which are abundant and they provide the basis for improved road constructions, from the biological, technical and economical points of view.

According to Khan (2005), marble powder is an excellent material for mechanical stabilization of cohesive soils. With an addition of only 10 per cent of marble waste, almost 100 per cent increase in the CBR value and 23 per cent increase in unconfined compressive strength was achieved for un-soaked condition. The plasticity index reduced by 4.08 per cent.

Khan (2005) SA conducted a study on physical characteristics of find soil stabilized with marble industry waste. Khan reported that marble powder is an excellent material for mechanical stabilization of plastic/cohesive soils. The soil stabilized with marble powder will give more stable and economical dam cores. The limit of the marble powder for maximum improvement in properties range from 10-15 percent. However the type of soil and the marble powder will affect the upper limit. Depending on the requirement of stabilization, the mix may require to be designed for each project. The results are representative of the white marble and may not be applied to all types of the marble wastes.

Sabat and Nanda (2011) carried out at study on effect of marble dust on strength and durability of Rice husk ash stabilised expansive soil. They reported that The optimum percentage of RHA in stabilization of expansive soil is found out be 10 per cent. The MDD goes on decreasing and OMC goes on increasing irrespective of the percentage of addition of Marble dust to RHA stabilized expansive soil. The UCS of the RHA stabilized expansive soil increased up to 20 per cent addition of Marble dust. Further addition of Marble dust decreased the UCS of the expansive soil. There is 228 per cent increase in UCS of the virgin soil. The soaked CBR of the RHA stabilized expansive soil increased up to 20 per cent addition of Marble dust. Further addition of Marble dust decreased the soaked CBR of the expansive soil. There is 293 per cent increase in Soaked CBR of the virgin soil. The swelling pressure of the expansive soil goes on decreasing irrespective of the percentage of addition of Marble dust to RHA stabilized expansive soil. The swelling pressure was 112kN/m^2 when the percentage of Marble dust was 0 per cent and Zero when Marble dust was 25 per cent. The swelling pressure of the soil decreased to 19 kN/m^2 when 20 per cent Marble dust was added to expansive soil stabilized with 10 per cent Rice husk ash, the swelling pressure which will not create any problem with the structures to be founded on it. The RHA stabilized expansive soil could not survived the durability test. Addition of Marble dust makes the RHA stabilized expansive soil a durable one, the RHA stabilized soil is least affected by wetdry cycle when 20 per cent Marble dust was added. For best stabilization effect, the optimum proportion of Soil: Rice husk ash : Marble dust was found to be 70: 10: 20.

Joulani (2008) investigated the effect of stone powder compaction properties of fine grained soil. The variables of research were two additives and three percentages (10 %, 20 % and 30 %).

Moisture-density relationship of soil-marble powder mixtures were studied by performing standard proctor compaction test and the results were plotted on graph shown below.

Misra (2001 and 2010) carried out work to study for utilization of marble slurry dust (MSD) in soil stabilization during road construction. To demonstrate the technology developed at CRRI for the construction of sub-grade layer and embankment using marble dust, a road stretch was constructed at Rajsamand district, Rajasthan and was under evaluation for three monsoon seasons. Site provided for construction of demonstration road stretch had no low line area, an embankment in cutting/confined condition was constructed with 100 per cent MSD to study settlement behaviour of MSD under prevailing load and environment conditions. From this study it was concluded that effect of mixing MSD (up to 40 %) with soil resulted in minor changes in plasticity of soil but load bearing capacity (CBR test) of soil was improved. Dust made the soil slightly cohesive and resulted in better compaction. Unconfined compressive strength of soil with MSD was also improved. It was also stated that low cohesion and high value of internal friction of MSD have great potential in stable embankment preparation.

Shear strength characteristics of soil with marble dust :

The direct shear conducted by Joulani (2008) on soil by adding a specific percentage (10 %, 20 % and 30 %) of marble powder by weight of soil and mixed it with optimum moisture content obtained from compaction test without soaking or curing the specimen. The result revealed that the addition of 30 per cent of marble powder has increased the angle of friction (Φ) by about 50 per cent and reduced cohesion by about 64 per cent.

Sarkar (2012) carried out a study on characteristics of pond ashes mixed with marble dust and various properties were investigated. The chemical and physical characteristics of marble dust were determined in laboratory. Under Consolidate

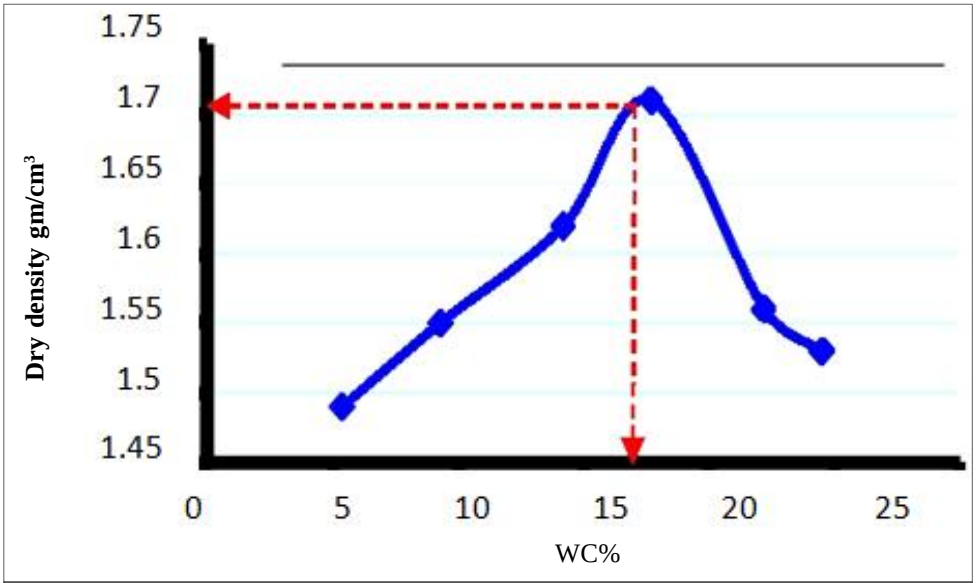

Fig. 1 : Density- moisture content relationship of soil (Joulani, 2008)

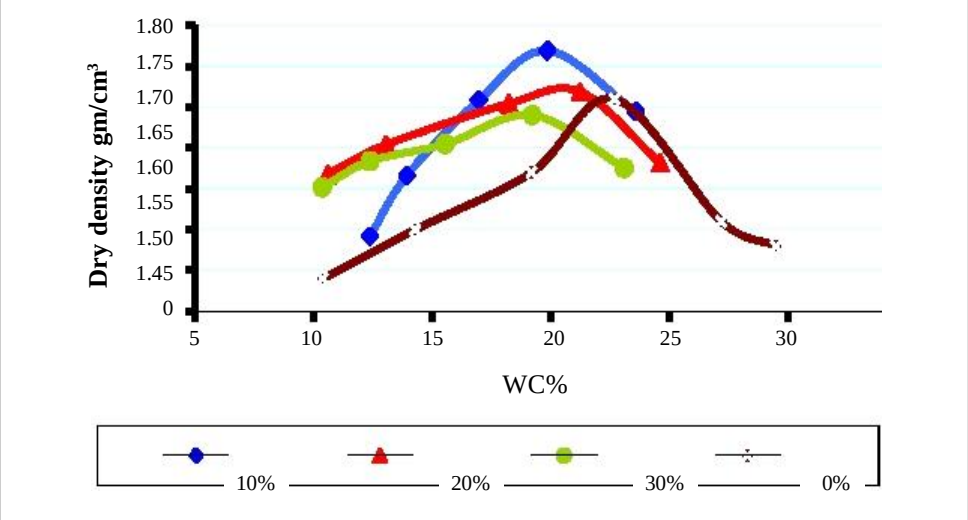

Fig. 2 : Effect of stone powder on dry density and moisture content (Joulani, 2008)

Undrained Triaxial Shear test, it was observed that on addition of marble dust Φ' value increases but there was no change in original zero value of c'. It was also observed that Φ' value increases linearly by addition of lime up to 8 per cent but increases quite significantly at 10 per cent.

CBR characteristics of soil with marble dust :

Misra *et al.* (2000 and 2007) determined that CBR per cent increased up to addition of 20 per cent MSD in soil and then it reduced on further increase of MSD per cent. From this study it was concluded that effect of mixing MSD (up to 40 %) with soil resulted in minor changes in plasticity of soil but load bearing capacity (CBR test) of soil was improved. Dust made the soil slightly cohesive and resulted in better compaction (Fig. 5).

Permeability characteristics of soil with marble dust :

Khan SA conducted a study on the effect of marble powder on permeability. Different soil-marble powder mixtures were

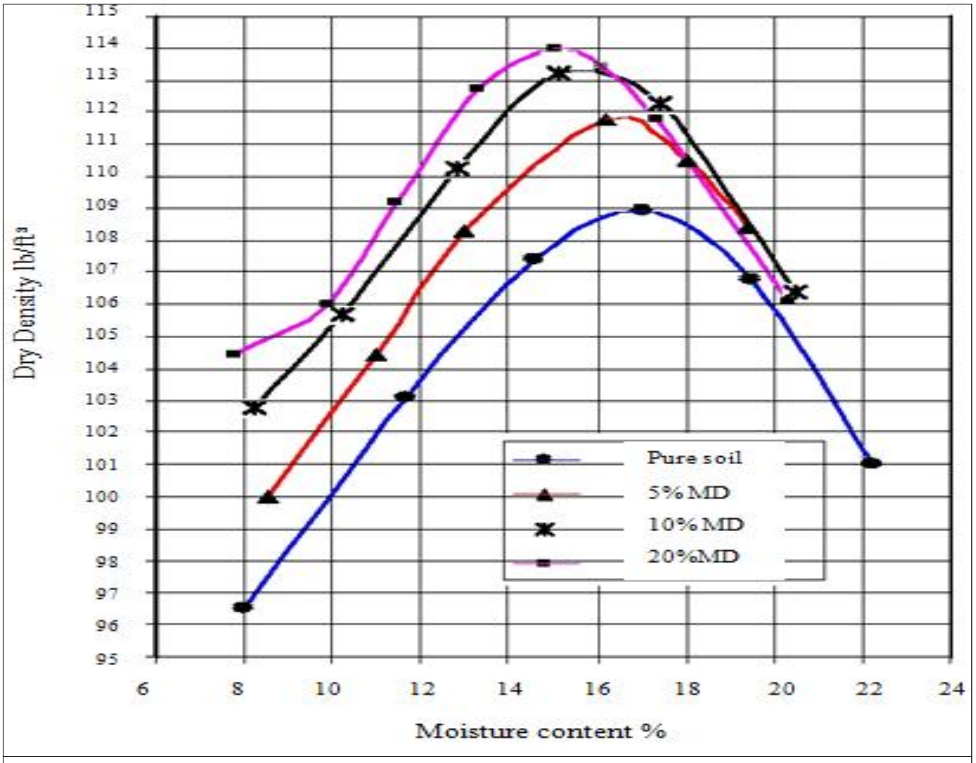

Fig. 3 : Moisture density curve of soil mixed with varying percentage of marble power

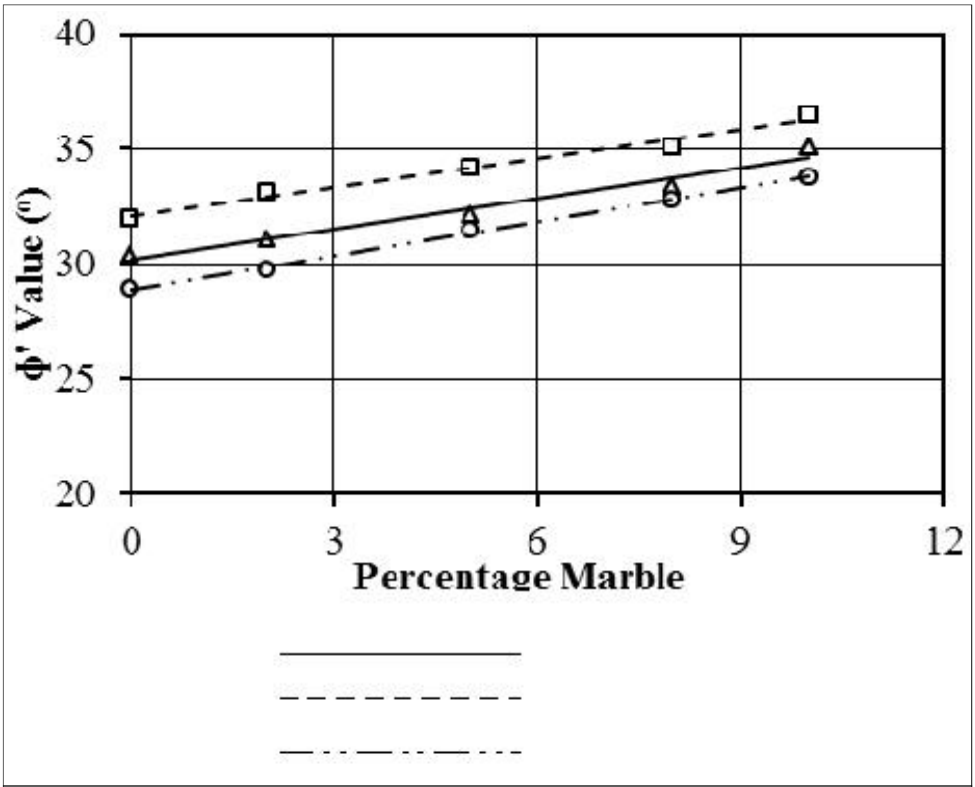

Fig. 4 : Variation of C value with percentage marble dust

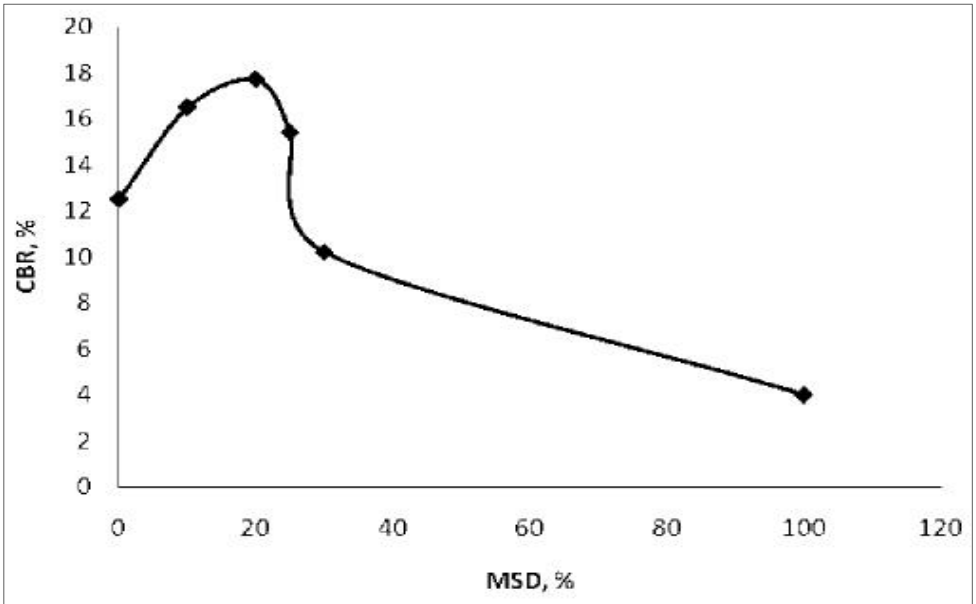

Fig. 5 : Effect of MSD on SBR of soil (Mishra *et al.*)

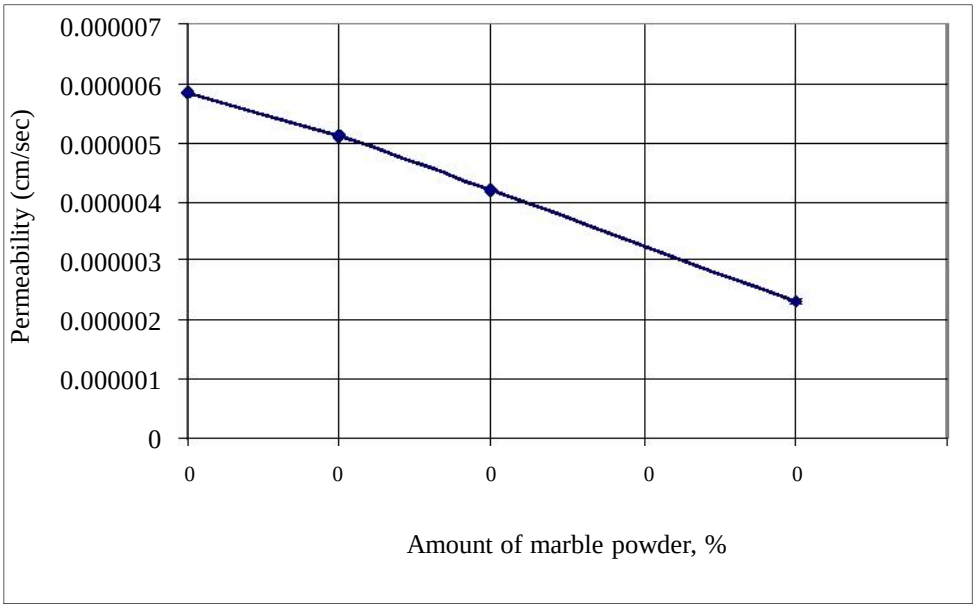

Fig. 6 : Variation of c value with percentage marble dust

compacted in mould at OMC achieving MDD. The curve of permeability values versus marble powder is shown in Fig. 6.

Similar work related to the topic was also done Amu *et al*., 2005; Havanagi, 1999l Mclaren and Digioia, 1987 and Gupta, 2000.

Conclusion :

Results obtained can be summarized as addition of marble powder to soil improved the gradation of soil, reduces swelling characteristics, increased the maximum dry density, reduced the optimum moisture content increases shear resistance and reduced the permeability as well. The marble powder enhances the properties of soil up to 10-15 per cent, upper limit varying with type of soil and marble powder.

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