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Research Paper

USE OF STONE DUST FROM CONSTRUCTION SITE AS A STABILIZING AGENT IN FLEXIBLE PAVEMENT CONSTRUCTION: A CASE STUDY

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The stone dust from the crusher units of construction sites is an environmental hazard. The disposal of stone dust is a major problem. In this paper an attempt is made to study the effective use of stone dust as a stabilizing agent. An experimental investigation is carried out to study the effect of stone dust on engineering properties of soil. The engineering properties considered are Optimum Moisture Content, Maximum Dry Density and California Bearing Ratio. The changes in these properties of the natural soil with the addition of soil dust in different proportions were evaluated. It is observed that the above properties have optimally improved by adding stone dust. This study shows that stone dust can be satisfactorily used as a cheap stabilizing agent for sub-grade layers and sub-base layers of a flexible pavement. The study area considered is Ranchi, in Jharkhand, India.

Keywords: Stone Dust, OMC, MDD, CBR, Stabilizing Agent

INTRODUCTION

Jharkhand in India is a newly formed state, with Ranchi as its capital. A lot of development has taken place in Ranchi since its formation, especially in the construction field. Multi-storied residential flats and Multiplexes have emerged and hence lots of construction wastes are formed. One such waste is stone dust which is a by-product of stone crushing operations. It not only pollutes water, air or land but its disposal is also a great problem. It has a detrimental effect on people and environment including flora and fauna.

Attempts have been made by many researchers to study the suitability of stone dust as an admixture with soil for different types of construction. Experiments were carried out by adding fines obtained from demolished concrete slabs as admixture to clayey. (Ranisnchung *et al.*, 2013). Results shows that admixing of FDCS enhances the soaked CBR value, unconfined compressive strength and

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split-tensile strength. In another work (Ali and Korrane, 2011) studied the index properties and unconfined strength of expansive soil when treated with fly ash and stone dust. The results showed that when soil was treated with an optimum percentage of 20% -30% of admixture, the swelling of expansive clay could be controlled and also there is marked improvement in other properties of soil. Sabat A K studied the effect of lime on some geotechnical properties of an expansive soil stabilized with optimum percentage of quarry dust. It is concluded that addition of quarry dust decreases liquid limit, plastic limit and plasticity index but increases shrinkage limit of expansive soil. It also decreases the OMC but increases the MDD of the expansive soil. The addition of quarry dust to expansive soil decreases the cohesion and increases the angle of internal friction. Onyelowe Ken *et al.* (2012) conducted studies on those qualities and applications that make quarry dust a good replacement or admixture during soil improvement. When quarry dust is added with expansive soil, it is expected that it will make it more porous, less durable, reduce cohesion, etc., and also quarry dust has rough, sharpened angular particles and as such causes a gain in strength due to better interlocking. Sabat and Bose (2013) studied the combined effect of fly ash and quarry dust on compaction characteristics, unconfined compressive strength, california bearing ratio (CBR), shear strength parameters and swelling pressure of an expansive soil. It is seen that maximum dry density, california bearing ratio and angle of internal friction increases and cohesion and optimum moisture content decreases with addition of increased percentage of fly ash – quarry dust mix. The maximum value of unconfined compressive strength is achieved when the fly ash – quarry dust mix is 45%. Crusher dust is mixed with high plastic gravels to reduce the excess deformation of the gravel soils and increase the life period of pavement. Addition of crusher dust reduced the plastic characteristics and improved the CBR value (Satyanarayana *et al.*, 2013). In another study conducted by Pandian *et al.* (2011), it is seen that CBR value of black cotton soil – fly ash mixture increase up to an optimum fly ash content beyond which CBR value decreases. The study conducted by Sreedharan *et al.* (2005) to know the effect of quarry dust in highway construction shows that CBR and angle of shearing resistance values steadily increases with increase in percentage of quarry dust.

A study is conducted by Mahzuz *et al.* (2011) to know whether normal sand can be substituted by stone powder from stone crushing units in concrete and mortar. It is revealed from laboratory experiments that concrete made of stone powder and stone chip gained about 15% higher strength than that of the concrete made of normal sand and brick chip. It also shows that better mortar can be prepared by the stone powder. Stone crusher dust has been used as a substitute for other construction activities. It is used as fine aggregate in concrete for paving blocks (Radhikesh *et al.*, 2010). In brick masonry, sand in cement mortar is substituted by crusher dust and investigation indicates that the crusher dust can replace natural sand completely in masonry construction with higher strength and cheaper cost (Appukutty *et al.*, 2009).

EXPERIMENTAL INVESTIGATIONS

In this project the stone dust is collected from crusher units at different construction sites in and around Ranchi. The soil used is locally available and its properties are tested in the laboratory. The results are given in Table 1.

Table 1: Properties of Soil

Grain Size Distribution	
Gravel (%)	0
Sand (%)	34
Silt (%)	41
Clay (%)	24
Engineering Properties	
Specific Gravity	2.51
Optimum moisture content, (%)	15
Maximum dry density, (gm/cc)	1.76
Liquid Limit (%)	32%
Plastic Limit (%)	21.45
Plasticity index (%)	10.55
Free swelling index (%)	**10%**
California Bearing Ratio (CBR)	1.97

As per IS soil classification it is seen that the local soil is clayey silt.

Table 2: Properties of Stone Dust

Properties	
Maximum dry density (gm/cc)	3
Optimum Moisture Content (%)	11.92
CBR at 2.5mm penetration (%)	8.03
CBR at 5 mm penetration (%)	10.94

The properties of stone dust are given in Table 2.

The soil is stabilized by adding 4%, 8%, 12%, 16% and 18% of stone dust by weight of the soil. The Optimum moisture content, maximum dry density and CBR values for the soil – stone dust mixture is determined in the laboratory for each percentage by Standard Procter and CBR testing Machine. The results are shown in Tables 3 and 4.

Table 3: Values of OMC and MDD for Different Soil–Stone Dust Mixtures

Percentages of Stone Dust mixed withsoil (%)	**Compaction Properties**	
	OMC(%)	**MDD(kN/m^3)**
0	15	1.740
4	13.5	1.762
8	12.5	1.761
12	12	1.772
16	11.5	1.820
18	11	1.840

Table 4: Values of CBR for Different Soil–Stone Dust Mixtures

Percentages of Stone Dust mixed withsoil (%)	**Soaked CBR Value at**	
	2.5 mm Penetration	**5 mm Penetration**
0	1.97	2.67
4	2.26	3.26
8	2.99	3.60
12	4.01	5.11
16	5.91	7.20
18	7.81	9.73

RESULTS AND DISCUSSION

Graphs are plotted to show the variation of OMC, MDD and CBR for different percentages of stone dust in Figure 1 to 3. It is seen that there is slight decrease in OMC values and increase in MDD values as percentage of stone dust is increased. The CBR value also shows an increase if percentage of stone dust is increased. The soil considered for study is having a CBR of 1.97 which can be increased to the required value satisfying traffic characteristics by adding stone dust.

As per IRC SP72-2007, if silty clays and sandy clays to be used as subgrade soil, the typical soaked CBR value should be 4-5. It is seen from the results that the locally available soil which is having a very low CBR value can be used as subgrade by adding 12% of stone dust by weight of soil.

Figure 1: Variation of OMC with Different % of Stone Dust

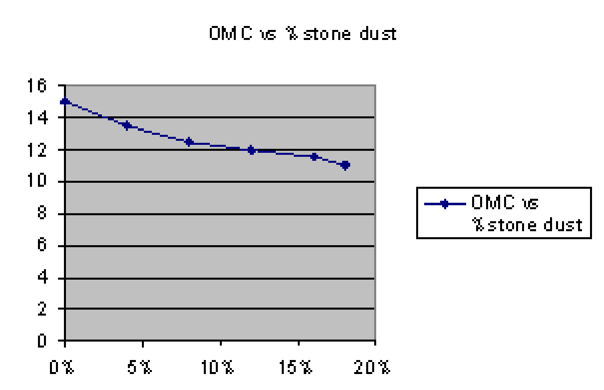


Figure 2: Variation of MDD with Different % of Stone Dust

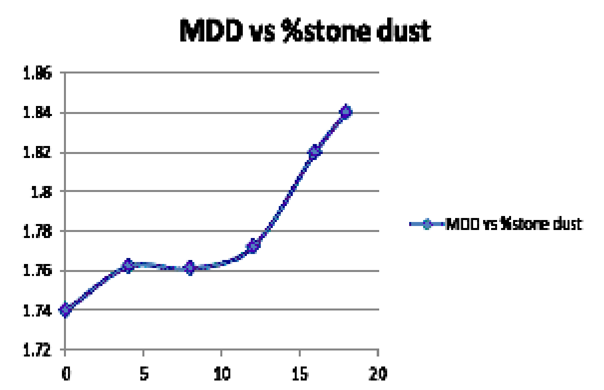
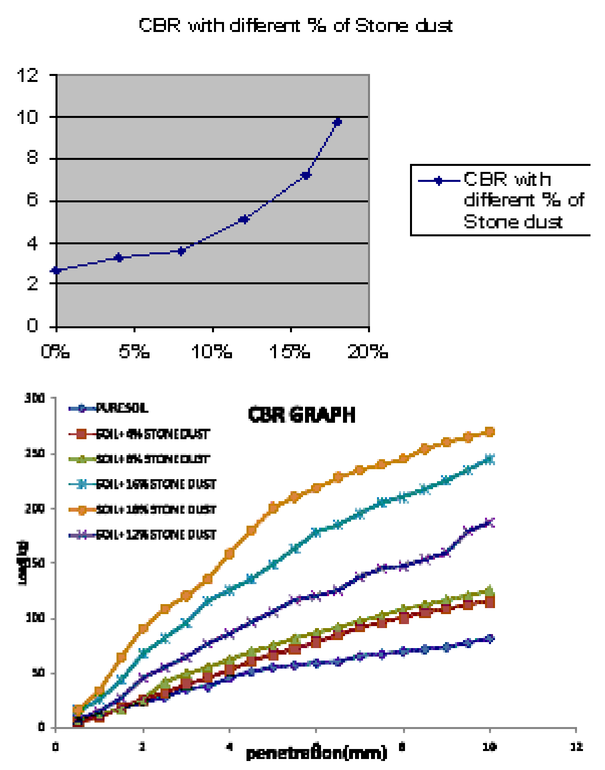


Figure 3: Variation of CBR with Different % of Stone Dust



CONCLUSION

The construction cost can be reduced to a large extent if locally available materials are used. In the flexible pavement construction the main constituent is soil, which comprises the base layer and sub-base layer. If the locally available soil is having a very low CBR value, it can be treated with locally available materials to improve its quality. Stone dust from construction site is not only an environmental hazard but its disposal is also a problem. In this study it has seen that stone dust when mixed with the locally available soil improved the engineering properties of soil, especially MDD and CBR.

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