RESEARCH ARTICLE

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A Comparative Study of the California Bearing Ratio Value of Subgrade Made by Stone Dust and Natural Sand with Coarse Aggregate

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Abstract

Resources of engineering materials (sand) used for construction activities are limited, so some other materials should be introduced by changing the sand. Stone dust produced from Stone Crushing Zone appears as a problem for effective disposal. Stone dust can be replaced by sand which is used as a fine aggregate in construction work. In this study, the main concern is to find an alternative to sand. Replacement of normal sand by stone dust will work both solid waste minimization and sand recovery. Stone dust is one of the alternatives to sand which can meet the demand of fine aggregate. In the engineering practice, the properties of existing sub-grades are required for the construction of the earth, thereby improving density and strength of the subgrade. A series of California Bearing Ratio (CBR) tests have been conducted for determination of soaked and un-soaked CBR by using the stone dust as a fine aggregate blended with 10 mm and 20 mm size Coarse Aggregates (CA). A detailed comparison is made for the findings of the CBR tests conducted on samples prepared using natural sand (as a fine aggregate) blended with 10 mm and 20 mm size coarse aggregates.

Keywords: CBR Value, Coarse Aggregate, Natural Sand, Stone Dust, Subgrade.

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Introduction

All types of earth structures i.e. the highways, pavement etc. rest directly on the soil below them. The protection of these structures depends on the strength/ bearing capacity of the soil on which they are resting. Therefore, an appropriate evaluation of the engineering properties of soil and its strength parameters becomes necessary to ensure that these structures remain stable and safe against any possible failure and excessive/differential settlements. In order to determine the suitability of any soil type for use as a sub grade, sub-base or base material, one of the commonly used parameters is the California Bearing Ratio (CBR).

The outcome obtained from the CBR test is an essential design parameter for the pavements as well as a primary evaluation of the modulus of sub grade and shear strength. Generally, CBR value is used to design the thickness of the pavement on the sub grade by the pavement engineers.

Stability of any structure requires good foundation material to bear the load without any undesirable failure. Civil engineering structures such as buildings, roads, embankments etc. should be required for the needs of the people to meet many needs of the population. Structures built on poor plains are subjected to failure, which increases the cost of maintenance due to differential settlements and plastic deformations.

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To reduce the plastic deformation due to the presence of fines in natural soil, as the foundation material to increase the bearing capacity of foundation material and fill material. Stone dust is an important waste product used as the fill material. The availability of these effluents in large quantities encourages geotechnical engineers to use as a replacement material for the natural sand used in various construction activities. In the present study, efforts are made to study the performance of stone dust in the form of geo- technical material in construction activities. Stone dust has extensive applications in the field of multiple construction activities, Stone dust has extensive applications in the field of multiple

construction activities, such as a maintenance material without furring fill the material in the highway construction, etc. It is a challenge to dispose the waste material efficiently without having any adverse effect on the environment due to its large production every day. The enormous budget for the safe disposal of the waste and related management issues are a great challenge for the developing countries like, India. To overcome the problems associated with strength of clayey soil, several techniques have been suggested to enhance its properties. It is also a challenge to reduce the thickness of the layer, so that the cost of construction gets reduced with modified soil properties and its subgrade strength. Thus the objectives riveted in the process of soil stabilization is to investigate the properties of stone dust to be used as subgrade material as a substitution of normal sand. The problem of waste disposal can be reduced which is obtained from Stone crushers (Jhansi city).

It is noted from the available literature that a few studies have been carried out to investigate the potential use of stone dust for the engineering properties of stabilised soil using stone dust.[1-5] However, many studies are reported on the use of stone dust with/ without lime and/ or fly ash.[6-8]

Hence, a study is needed to estimate the strength of subgrade in those places where coarse aggregates are easily available. In such areas, adding coarse aggregates will be a suitable option, along with the replacement of normal sand with stone dust. Hence, the present study serves both solid waste minimization and fine aggregate recovery.

MATERIALS USED

Coarse Aggregate

Coarse aggregates are carried out from the local market. It is the major constituent of sub-base and base courses of flexible pavement layer. Aggregate predominantly bear the load stress happening on the pavement and also wear abrasion action of traffic movement. Therefore, toughness, hardness, resistance from getting polished or smooth, good shape factors, and resistance to weathering are the desirable properties of aggregates. The mixer of stone dust and coarse aggregate is selected for the study. All standard requirements for the aggregate used with stone dust are specified in the ministry of road transport and highways. For this study, 10 and 20 mm size aggregate is used (Figure 1).

Stone Dust (Fine Aggregate)

Stone dust is a coarser version of sand. Crushing machines produce stone dust after screening through a fine sieve. Availability of stone dust was through Stone Crushing Industries Bijauli, Jhansi city (Figure 2). Stone dust is being mixed through varying percentages of a coarse aggregate of size 10 or 20 mm.

Methodology/ Experimental Procedure

CBR tests have been conducted for determination of soaked and un-soaked CBR[9] by using the stone dust as a fine aggregate.

RESULTS AND DISCUSSION

On comparing the CBR value of sandy subgrade blended with coarse aggregate and the CBR value of subgrade made by stone dust blended with 10 and 20 mm sized aggregate, the CBR value of stone dust blended with 10 and 20 mm sized aggregate is reported much greater than that of sandy subgrade.[10]

Comparison of CBR Value for Sandy Soil and Stone Dust Mixed with 10 mm Aggregate in Unsoaked Condition

The CBR values is compared with varying percentage of coarse aggregate i.e. 0%, 5%, 10%, 15%, 20%, 25%, and 30%. In the experimental program, huge variation in the CBR value is observed (Table 1) in between 10% to 30% for 10 mm coarse aggregate in unsoaked conditions. Maximum variation is obtained at 22.18 at a 15% mix of coarse aggregate with sand or stone dust (Figure 3).

Figure 1: 10 and 20 mm aggregates from stone crusher (Jhansi city)

Figure 2: Stone dust from stone crusher (Jhansi city)

Table 1: Difference in CBR values of stone dust and sandy soil, blended with 10 mm aggregate in unsoaked condition

Coarse aggregate (%)	Difference in CBR values of stone dust and sandy soil (%)
0	1.89
5	6.86
10	17.46
15	22.18
20	18.78
25	16.34
30	21.39

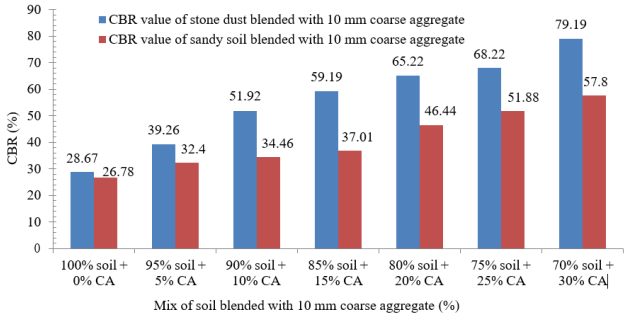

Figure 3: Comparison between CBR value of sandy soil and stone dust subgrade blended with 10 mm aggregate in unsoaked condition

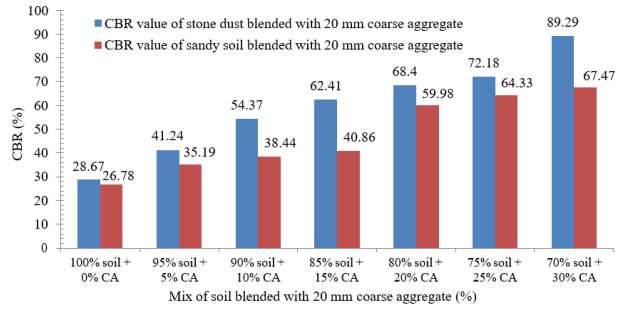

Figure 4: Comparison between CBR value of sandy soil and stone dust subgrade blended with 20 mm aggregate in unsoaked condition

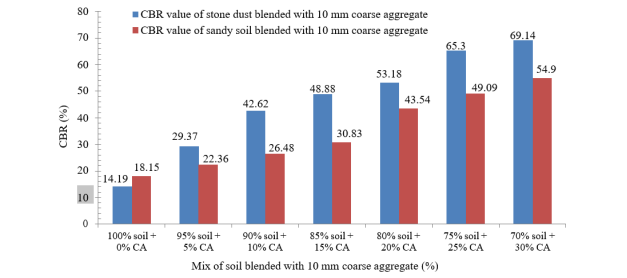

Figure 5: Comparison between CBR value of sandy soil and stone dust subgrade blended with 10 mm aggregate in soaked condition

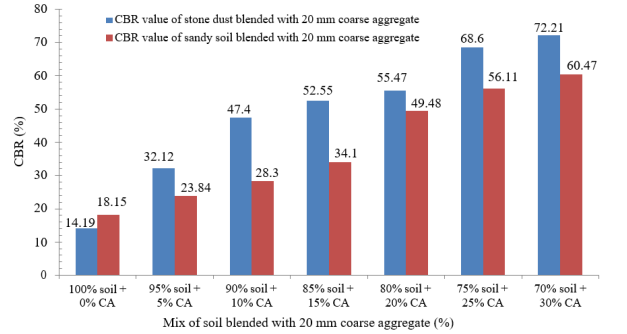

Figure 6: Comparison between CBR value of sandy soil and stone dust subgrade blended with 20 mm aggregate in soaked condition

Table 2: Difference in CBR values of stone dust and sandy soil, blended with 20 mm aggregate inunsoaked condition

Coarse Aggregate (%)	*Difference in cbr values of stone Dust and sandy soil (%)*
0	1.89
5	6.05
10	15.93
15	21.55
20	8.42
25	7.85
30	21.82

Table 3: Difference in CBR values of stone dust and sandy soil, blended with 10 mm aggregate in soaked condition

Coarse aggregate (%)	*Difference in CBR values of stone dust and sandy soil (%)*
0	- 3.96
5	7.01
10	16.14
15	18.05
20	9.64
25	16.21
30	14.24

Table 4: Difference in CBR values of stone dust and sandy soil, blended with 20 mm aggregate in soaked condition

Coarse aggregate (%)	Difference in CBR values of stone dust and sandy soil (%)
0	- 3.96
5	8.28
10	19.1
15	18.45
20	5.99
25	12.49
30	11.74

Comparison of CBR Value for Sandy Soil and Stone Dust Mixed with 20 mm Aggregate in Unsoaked Condition

The CBR values are compared with varying percentage of coarse aggregate i.e. 0%, 5%, 10%, 15%, 20%, 25%, and 30% and significant variation in CBR values between 20% to 30%, for 10 mm coarse aggregate in unsoaked condition is observed (Table 2). Maximum variation is obtained at 21.82 at 30% coarse aggregate (Figure 4).

Comparison of CBR Value for Sandy Soil and Stone Dust Mixed with 10 mm Aggregate in Soaked Condition

The CBR values is compared with varying percentage of coarse aggregate i.e. 0%, 5%, 10%, 15%, 20%, 25%, and 30%, the huge variation in CBR values between 10% and 25%

for 10 mm coarse aggregate in unsoaked conditions (Table 3). Maximum variation is obtained at 18.05 at 15% coarse aggregate (Figure 5).

Comparison of CBR Value for Sandy Soil or Stone Dust Mixed with 20 mm Aggregate in Soaked Condition

Comparing the CBR value with varying percentage of coarse aggregate i.e. 0%, 5%, 10%, 15%, 20%, 25%, and 30%, there is a vast deviation is obtained in CBR values at 10% and 15%, and after that at 25% and 30% for 10 mm coarse aggregate in unsoaked conditions (Table 4). Maximum variation is obtained at 19.1 for 10% coarse aggregate (Figure 6). Without mixing coarse aggregate it is observed that the CBR value of sand is more. On the basis of the above comparative study, it can be noticed that the use of stone dust by replacing natural sand, reduces the cost and reduce the problem of disposal of solid waste.

CONCLUSION

CBR values of subgrade made by stone dust and natural sand, blended with 10 mm and 20 mm sized coarse aggregate, are compared for the unsoaked and soaked conditions in the present study. On the basis of experimental studies, the following conclusions are drawn.

- CBR value of soil increases with an increase in the 10 mm and 20 mm aggregate percentage.
- CBR value of soil, when mixed with 20 mm sized aggregates, is more than that with 10 mm sized aggregates.
- Use of 10 mm and 20 mm coarse aggregate in the stone dust is beneficial for improvement subgrade construction of roads as it increases the subgrade strength and also reduces the required thickness and cost of construction of the pavement layer.
- The mix having 70% stone dust and 30% coarse aggregate contents has the highest CBR value.

REFERENCES

[1] Amu O.O., Adewumi IK, Ayodele AL, Mustapha RA, and Ola O.O., Analysis of California Bearing Ratio Values of Lime and Wood Ash Stabilized Lateritic Soil. Journal of Applied Sciences, Asian Network for Scientific Information, 2005, 1479-1483.

[2] Ali M.S., and Koranne S.S., Performance Analysis of Expansive Soil Treated with Stone Dust and Fly Ash. Electronic Journal of Geotechnical Engineering, Vol. 16, 2011, pp.973-982.

[3] Sabat A.K., A Study on Some Geotechnical Properties of Lime Stabilized Expansive Soil- Quarry Dust Mixes. International Journal of Emerging Trends in Engineering and Development, Vol. 1, Issue 2, 2012, 42-49.

[4] Satyanarayana PVV, Raghu P., Kumar R.A., and Pradeep N., Performance of Crusher Dust in High Plastic Gravel Soils as Road Construction Material. IOSR Journal of Mechanical and Civil Engineering, 10, 3, 2013, 01-05.

[5] Bshara A.S., Bind YK, and Sinha P.K., Effect of Stone Dust on Geotechnical Properties of Poor Soil. International Journal of Civil Engineering and Technology, Vol. 5, Issue 4, 2014, pp.37-47.

[6] Pandian N.S., Krishna K.C., and Sridharan A., California Bearing Ratio Behavior of Soil/ Fly Ash Mixtures. Journal of Testing and Evaluation, JTEVA, ASTM, 29, 2, 2001, 220-226.

[7] Modak R., Nangare P.B., Nagrale S.D., Nalwade R.D., and Chavhan V.S., Stablization of Black Cotton Soil Using Admixture. International Journal of Engineering and Innovative Technology, 1, 5, 2012, 11-13.

[8] Roobhakhshan A., and Kalantari B., Stabilization of Clayey Soil with Lime and Waste Stone Powder. International Journal of Scientific Research in Knowledge, 1, 12, 2013, 547-556.

[9] IS:2720 (Part XVI)-1987, Reaffirmed 2002, Methods of test for soils: Laboratory determination of California Bearing Ratio. Bureau of Indian Standards.

[10] Mudgal, A., Sarkar, R., & Sahu, A. K. (2014). Effect of lime and stone dust in the geotechnical properties of black cotton soil. GEOMATE Journal, 7(14), 1033-1039.