

Stabilization of Waste Sand Obtained from Stone Industries as Foregoing Alternatives for Modern Bricks

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ABSTRACT:The waste material generated directly in the environment can cause the environmental problem. Hence the reuse of this waste material is necessary in the construction industry. Presently large amounts of stone dust are generated in natural stone processing plants with an important impact on the environment and humans. Stone wastes are generated as a waste during the process of cutting and polishing of Marble/Granite/Kotastone/Jodhpurstone. Stone industry produces large amounts of stone waste which causes environmental problems. The work is regarding, how to make stone waste sand obtained from stone industries after cutting the stone which has low compressive strength and thus has nil cohesion and high permeability, useful for construction of embankments for all engineering works and improves the engineering characteristics of soil and also useful for manufacturing of bricks. This paper analysis discusses the potential of stone waste sand stabilization with white cement as admixture. Present work has been taken up by addition of white cement admixture. The varying percentage 6%, 8%, 10%, 12% and 14% of white cement were mixed with stone waste sand of different densities and moisture content. All the Compressive Strength Tests were conducted at different mix compositions of normal cement and waste sand of different dry densities as arrived from Standard Proctor Test. On the basis of the experiments performed, it is determined that the stabilization of stone waste sand with white cement as admixture improves the strength characteristics of the waste sand so that it becomes usable as construction of embankment and manufacturing of bricks. And also we manufacture a brick that is of mixture of stone sand waste and white cement and the strength of this brick is as similar as II class brick.

KEYWORDS: Compressive Strength Tests, C.B.R. Test, Standard Proctor Test, Stone Waste Sand, White Cement.

I. INTRODUCTION

Stone, one of the most common building material of ancient times, is a ubiquitous material. A sustainable growth in the consumption of stone is observed all over the world in the recent years. Various types of stone such as granite, marble, limestone, slate etc. are used in construction purposes. There is continuous increment in the demand of various types of stone which leads to enormous increase in the business of stone sector industry. Today, different operations on stones, like quarrying, sawing, cutting etc. are being processed by modern technologies which are improving the rate of production of stones as well as stone waste continuously.

The stone waste is now-a-days a serious environment problem which is threat to modern civilization. As it is a non-biodegradable material, therefore poses numerous hazards. If this stone waste is dumped on land then, it can reduce the rate of rain water percolating and deteriorate the soil fertility. Stone waste dumped in rivers, streams and seas contaminates the water and marine. Although land-filling can be an alternative to reuse stone waste but apart from this, it can also be used to make various cement composites, as one of the best solution for disposing of stone waste, due to its economical and ecological advantages.

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An immense work has already been done on the use of stone waste in the production of Self-compacting concrete (SCC), Mortar, Tiles, Cement concrete as aggregate and filler. In this paper we prepare a bricks that is made of the mixture of stone waste sand and white cement as admixture.

II. RELATED WORK

Many studies have been carried out in regard to stabilizing the soil, so as to enhance its properties. Some of the notable works are mentioned here. Sridharan and soosan et.al (2005) identified that quarry dust manifest high shear strength and is beneficial for its use as a geotechnical material. Sabat et.al (2012) conducted compaction, tri-axial and durability tests on lime stabilized expansive soil-quarry dust mixes. Satyanarayana, et al (2013) has studied that the strength characteristics of compacted crusher dust and Crushed Stone mixes through a series of CBR tests by varying the crusher dust. Ramadas and Kumar et.al (2010) reported that the combination of fly ash and stone dust found to be suitable to reduce swelling and increase the strength of expansive soil. Onyelowe Ken et.al (2012) exposes the qualities and applications of quarry dust as admixture during soil improvement and for a more economic approach. Agrawal and gupta et.al (2011) reported that the potential use of marble dust as stabilizing additive to expansive soil, which involves the determination of the swelling potential of expansive soil in its natural state as well as when mixed with varying proportion of marble dust.

III. MATERIALS USED FOR PRESENT STUDY

3.1 Stone Waste Sand

The principle waste coming into the stone industry is the stone itself, specifically in the forms of overburden, screening residual, stone fragments. Stone wastes are generated as a waste during the process of cutting and polishing. It is estimated that 175 million tons of quarrying waste are produced each year, and although a portion of this waste may be utilized on-site, such as for excavation pit refill or berm construction, The disposals of these waste materials acquire large land areas and remain scattered all around, spoiling the aesthetic of the entire region. It is very difficult to find a use for all scrap stone and fines produced. This soil remains after cutting of sandstone is collected from the Stone Park, 9 Mile, Nagour Road, NH-65 Jodhpur, Rajasthan. The Sandstone Block is transported to the stone factories from stone mines which is located at Soorsager, Keru, Balsamand, Balesar region. The geology of the zone is obscured by the high temperature 40°-50°C. Table 1 show the properties of stone waste and figure 1 show the source of sand stone and figure 2 show Waste Sand Obtained from Stone Industries as below.

Table 1: properties of stone waste

Sr. No.	Constituent	Value (%)
1	SiO ₂	36.96
2	Al ₂ O ₃	0.49
3	Fe ₂ O ₃	3.40
4	CaO	28.60
5	MgO	6.08
6	SO ₃	0.15
7	LOI	22.16

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Fig.1. Source of Sand stone



Fig.2. Waste Sand Obtained From Stone Industries

3.2 White Cement

In this experimental work the admixture is used as Portland White Cement with their Universal properties. White cement is used as admixture because of its good bonding property and for colour of bricks is come whitish or pink. Below figure 3 show the newly manufactured bricks show the light pink colour because of white cement.



Fig.3. Brick of waste soil remains from stone industries

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IV. TEST PROGRAM AND PROCEDURE

The laboratory investigation on stone waste sand stabilization with Portland white cement admixture was performed. This work is done for beneficial utilization of stone waste sand and a mix proportion that can be mixed with white cement as a best stabilizer with limited detrimental effects.

The objective of the present study is to evaluate the use of stone waste sand as a construction material after stabilizing it with white cement as admixture and manufacturing value added products like bricks. The present study has been undertaken with the following objectives:

1. To study the effect of moisture content on dry density of stone waste sand.
2. To study the changes in compressive strength of stone waste sand of different percentage mixed with white cement in different proportions.

4.1 Test Program

The test program included the preliminary tests for stone waste sand and mix compositions of stone waste sand with white cement. Following tests were carried out:

1. Determination of particle size distribution of fine sand.
2. Standard Proctor Test (Proctor Compaction Test) for determining different dry densities for fine sand.
3. CBR Test to determine CBR value for stone waste sand and mix compositions with white cement.
4. Unconfined Compressive Strength Test to determine compressive strength of Stone waste sand and mix compositions with white cement.

Table 2 shows the variables which are investigated in present study.

Table 2: Variables Investigated

S. No.	Effect of	Variables	Range Investigated
1	Moisture content in sand	Dry density	Various Ranges
2	Stone Waste Sand	Amount in Kg	As per Test Required
3	Mix White Cement	Proportion percentage	6%, 8%, 10%, 12% and 14%

4.1.1 Particle Size Distribution or Gradation Test of Fine sand

The particle size distribution test or gradation test was carried out with Indian Standard Sieve size 4.75 mm, 2.36 mm, 1.18 mm, 600 μ, 425 μ, 300 μ, 150 μ, 75 μ, pan and weigh balance in the laboratory.

A typical sieve analysis involves a nested column of sieve with wire mesh cloth (screen). A representative sample of 1000 gm is poured into the top sieve which has the largest screen opening of 4.75 mm. Each lower sieve in the column has smaller opening than the one above. The base is a round pan, called the receiver. The sample was shaken vigorously for 10 minutes on sieve shaker. After the shaking, the weight of material retained on each sieve was weighed. Percentage passing through each sieve was calculated and plotted against particle size. Since percentage passing 75 μ is within 1% only, hydrometer analysis was not done.

$$\text{Percentage (\%) Retained} = \frac{W_{sieve}}{W_{total}} \times 100\%$$

Where W_{sieve} is the weight of aggregate in the sieve in gm

W_{total} is the total weight of the aggregate in gm

The cumulative percentage passing of the aggregate is found by subtracting the percent retained from 100%.

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Percentage (%) Cumulative Passing = 100% - Percentage (%) Cumulative Retained
The results of particle size distribution have been shown in table 3, table 4 and figure 4.

Table 3: Particle Size Distribution of Fine Sand

S.No.	Sieve Size	Weight Retained (gm)	% Weight Retained	Cumulative % Weight Retained	Cumulative % Weight Passing	% Finer
1.	4.75mm	0	0.0	0.0	100	100
2.	2.0 mm	0	0.0	0.0	100	100
3.	1.18mm	0	0.0	0.0	100	100
4.	600 μ	0	0.0	0.0	100	100
5.	300	6	0.60	0.60	99.4	99.4
6.	150	964	96.4	97.00	3.00	3.00
7.	75	30	3.0	100.00	0.0	0.0
8.	PAN	0	0.0	100.00	0.0	0.0

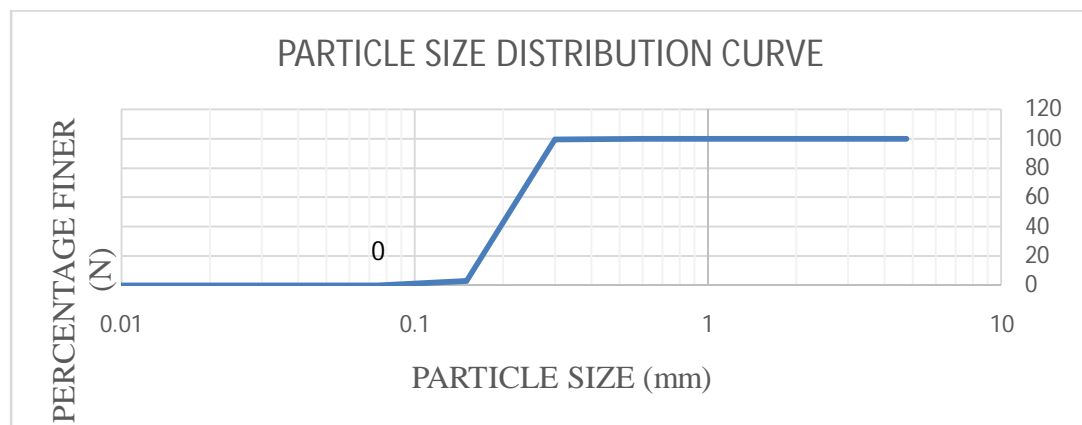


Figure 4: Particle Size Distribution Curve

Table 4: Results of Particle Size Distribution

S. No.	Property	Test Media (Fine Sand)
1	Coefficient of uniformity(C_u)	1.43
2	Coefficient of curvature(C_c)	0.88
3	Particle size D_{60}	0.23 mm
4	Mean Diameter (D_{50})	0.21 mm
5	Particle size D_{30}	0.18 mm
6	Effective size (D_{10})	0.16 mm

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4.1.2 Standard Proctor Test

Standard proctor covers the determination of the relationship between the moisture content and density of soils. The standard proctor test was performed in accordance with IS 2720 (Part VII) on fine sand. In this test, a standard mould of 100 mm internal diameter and an effective height of 127.3 mm, with a capacity of 1000 ml are used. The mould had a detachable base plate and a removable collar of 50 mm height at its top. The soil was compacted in the mould in 3 equal layers; each layer was given 25 blows of 2.6 kg rammer falling through a height of 310 mm.

The result tabulated in table 5 and figure 5 shows that on increment of moisture content, dry density first decrease and then increase. In the curve dry density first decrease due to bulking of sand. After reaching maximum dry density on optimum moisture content, dry density decreases.

Table 5: Dry Density Variation with Water Content for Soil Remains after Cutting of Sand Stone Mixed with White Cement

S. No.	% WATER ADDED (BY WEIGHT)	DRY DENSITY (gm/cc)
1	8	1.56
2	10	1.57
3	12	1.61
4	14	1.63
5	16	1.65
6	18	1.67
7	20	1.62
8	22	1.6
9	24	1.52
10	26	1.5

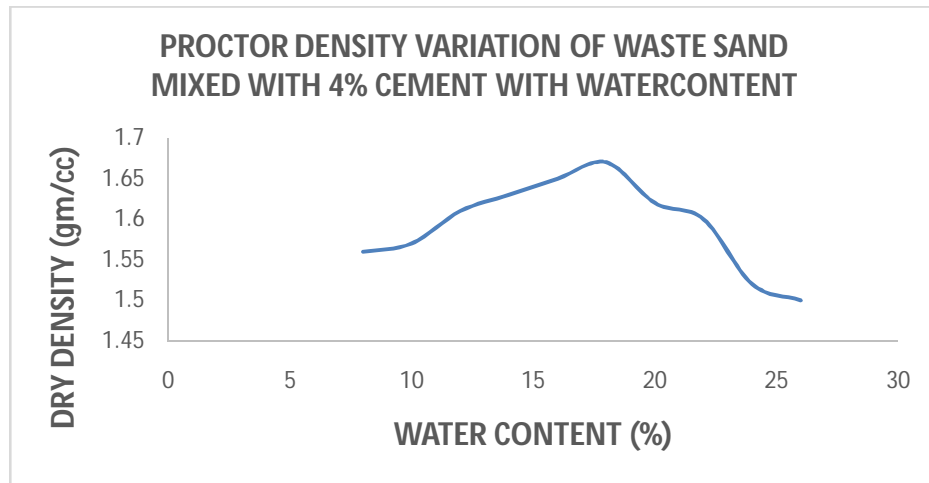


Figure 5: Proctor Density Variation of soil remains after cutting of sand stone mixed with white cement with water content

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4.1.3 California Bearing Ratio (C.B.R.) Test

In CBR test, 5 kg of soil was taken and mixed with water corresponding to required dry density and proportion of square pieces of plastic waste. The mix was compacted in 2250 ml CBR (150 mm diameter and 127.3 mm height) using light compaction. The mix was compacted in three equal layers; each layer being given 56 uniformly distributed blows of 2.6 kg hammer. Top surface of the specimen was finished properly to make it for even loading test. For the soaked condition, the samples were tested for the determination of CBR values on the next day.

For obtaining the CBR values of unsoaked samples, penetration tests were done. The mould, containing the specimen was mounted on the testing machine and a surcharge weight equal to 5 kg (two spacer discs) was placed on the top of specimen before starting the penetration test. After setting the plunger on the surface of specimen, setting the load and penetration measuring dial gauge to read zero, the load was applied. Load readings at every 0.5 mm penetration were noted and a graph was drawn between the actual load (ordinate) and penetration (abscissa). In most of the tests the curve was either straight or convex upwards in the initial portion. In such cases the test load corresponding to 2.5 mm and 5.0 mm were read from the curve. In the case of the initial upward concavity, the corrected zero is obtained by drawing a tangent to the curve at the point of the greatest curvature. The corresponding to 2.5 mm and 5.0 mm penetration are measured from the corrected zero.

Test results obtained show that CBR value increases with increase in dry density of sand. The CBR value also increases with increase in percentage of white cement for same dry density sand. The test results are shown in tables and graph.

4.1.3.1 Comparative Study

The variation in CBR values have been tabulated and graphically represented in table 6, figure 6, for unsoaked condition. On the graph, at abscissa (X-axis) dry density of stone waste sand varying 1.63 gm/cc, 1.65 gm/cc and 1.67 gm/cc has been marked and on ordinate (Y-axis) CBR values in % have been plotted for mix compositions of white cement of different percentage 6%, 8%, 10%, 14% and 14%.

It can be seen that on increment of dry density, the CBR value of the mix composition increases. The CBR value of the mix composition also increases as the percentage of admixture increases for unsoaked conditions. Hence it can be concluded that to use the mix compositions in base and sub base construction and manufacturing of bricks, the CBR values can be increased or decreased as needed.

Figure 6: CBR Value Variation in Mix Compositions in Unsoaked Conditions

Dry Density (gm/cc)	CBR (%)					
	Mix Composition					
	0% Admixture	0.15% Admixture	0.25% Admixture	0.50% Admixture	0.75% Admixture	1% Admixture
1.63	2.384	2.86	2.623	3.099	6.437	6.286
1.65	2.384	2.861	3.099	3.338	7.153	7.868
1.67	3.815	4.292	4.386	4.53	7.51	8.226

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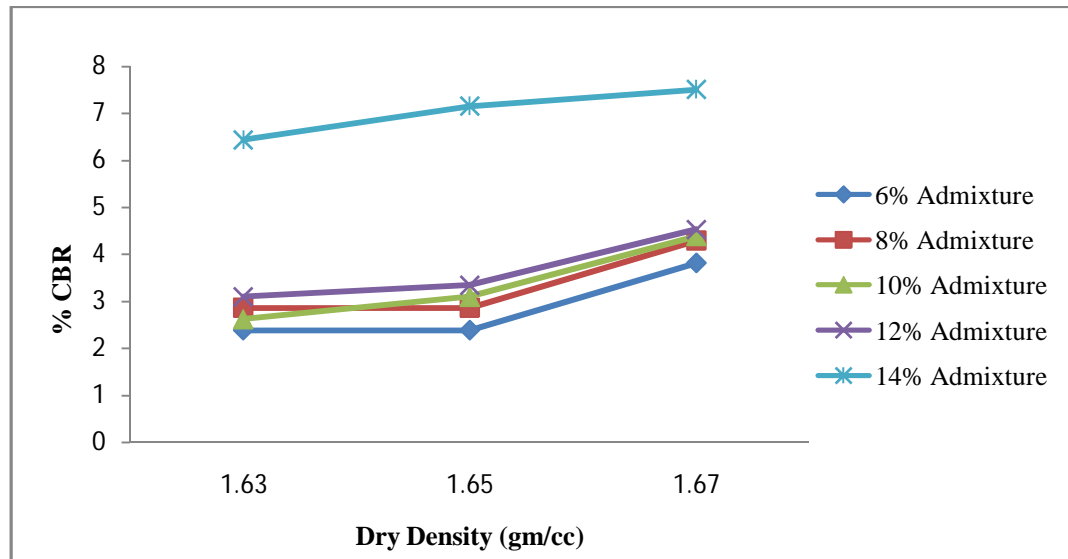


Figure 6: CBR Value Variation in Mix Compositions in Unsoaked Conditions

4.1.4 Compressive Strength Test of Specimen Cubes (Bricks)

For cube test has mould 10cm X 10cm x 10cm is used. This cube (sand mixed with cement) is poured in the mould and tempered properly so as not to have any voids. After 24 hours these moulds are removed and test specimens are put in water for curing. The top surface of these specimens should be made even and smooth. This is done by putting Cement paste and spreading smoothly on whole area of specimen.

These specimens are tested by compression testing machine after 1day, 3day, 7 days curing or 28 days curing. Load should be applied gradually at the rate of 140 kg/cm² per minute till the Specimens fails. Load at the failure divided by area of specimen gives the compressive strength of concrete. Below figure 7 show the setup of Compression Testing Machine and table 7 show the Mix Compositions and Symbols for C.S.T Soil Remains after Cutting of Sand Stone.



Figure 7: Compression Testing Machine

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Table 7: Mix Compositions and Symbols for C.S.T Soil Remains after Cutting of Sand Stone

CEMENT %	6%	8%	10%	12%	14%
STRENGTH					
1 st DAY	2.4	2.4	4.9	4.9	5.8
3 rd DAY	4.90	5.10	5.25	7.20	7.35
7 th DAY	5.0	5.25	5.35	7.30	7.40
14 th DAY	5.25	5.35	5.45	7.45	7.55
28 th DAY	5.50	5.65	5.85	7.50	7.65

Above results shows that the waste soil remaining of sandstone industries is used in building materials mixed with cement as partition wall, decorative wall etc. The strength of this type of bricks is at 12% cement on 28days is 7.05 N/mm² which is equal strength of second class bricks is 7.00 N/mm² so it can be used at palace of second class bricks. Further the cost of second class fly ash brick is 5 Rs. per unit as compared to high as sand waste bricks (3.75Rs.per unit).

V. CONCLUSIONS

In this investigation we have used stone waste sand and white cement as admixture in different proportions to study its effect on various geotechnical properties of Stone waste sand obtained from stone industries. The results of the testing program clearly show that the engineering properties of the stone waste sand improved considerably due to stabilizing with white cement. In the present investigation, as we are increasing the quantity of admixture of white cement, the compressive strength increases. So we have stopped the further increment of admixture. Further study can be done by addition of more amount of admixture.

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