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A Study on the utilization of M- Sand (Manufactured Sand) in the Pavements

Gowhar Aziz[1], Prof. (Dr.) M. Raisinghani[2], Ms. Payal Bakshi[3]
[1]*M.Tech Student, Department of Civil Engineering, VGU Jaipur, 302017, India,* gowharaziz123@gmail.com
[2] *Vice Chancellor, VGU Jaipur, 302017, India,*
[3]*Assistant Professor, Civil Engineering, VGU Jaipur, 302017, India,* bakshi.payal@gmail.com

Abstract— ***India has a large road network covering an area of about 4 lakh million square kilometers including all types of pavements in urban as well as in rural areas. The availability of conventional material is becoming a challenge for engineers in construction of pavements. In this concern requirement of good materials for construction is there. In order to provide good alternative materials for construction of pavement layers, M- sand may be used as a replacement for conventional sand. In order to preserve the various natural resources the various types of wastes should have given keen attention in order to use them in the various road construction processes as a base and sub-base material. The utilization of the alternative material based on the industrial waste is the need of hour. This work is done in order to give utilization of crushed stone sand or M-sand by analysing various characteristics of the pavement material by using the crushed stone sand in their construction processes. The main aim of the research is to strengthen the surface layer of the rigid pavement. In this work, gradation of particles, moisture content, specific gravity, workability, compressive strength and flexural strength is determined in order to compare the various characteristics of natural sand and M- sand.***

Keywords— M- sand, physical properties, natural sand, compressive strength, flexural strength,

I. INTRODUCTION

M- Sand is a common by-product of mining and quarrying. Rather than being discarded it as a waste material it can be utilized in various construction processes of the pavements. The crusher dust is also known as the M-sand. The cost of M- sand is relatively low compared to other conventional materials. The price of M-sand ranges from Rs. 500 per ton as compared to natural sand which is Rs. 830 per ton. As accordance with the Kerala PWD, M- sand is 50% cheaper as compared to natural sand and provides 9% extra strength in the concrete. M- sand use less water than other alternatives and have excellent load bearing capabilities and durability. Rather than being discarded it as a waste material it can be utilized in various construction processes of the pavements. For this work various tests will be performed and by analysing various properties the characteristics of crushed stone sand as a pavement material are analysed. The objective of my work is to replace the conventional materials of construction by making the use of M- sand in the various pavement construction processes. The basic mix chosen for the analysis is M20.The M- sand is added for the replacement of the aggregates partially or fully. Test results indicate that fine aggregate should be replaced with the utilization of crushed stone sand

II. Materials

M- Sand or Crushed Stone Sand (CSS)

The material is collected from the local crusher, Ganpati Stone Crusher, Hatipura, Garh, Bassi, Rajasthan, 30 kms from Jaipur city. The crusher dust is also known as the M-sand. Crushed stone sand is a common by-product of mining and quarrying. Rather than being discarded it as a waste material it can be utilized in various construction processes of the pavements

Natural Sand

The material is collected from the Banas River, Tonk, Jaipur, Rajasthan, 100kms from Jaipur city. It is a naturally occurring granular material composed of finely divided rock and mineral particles.

III. Experimental Programme

In order to determine the gradation of the M- sand and natural sand sieve analysis test were performed as per IS code. In present investigation the moisture content test was performed by oven dry method, specific gravity was determined by pycnometer method as per IS: 2720 (Part III)-1980, the workability was determined by compaction factor test as per IS 1199, compressive strength test by compressive testing machine of capacity 2000 KN as per IS 516 – 1959 and flexural strength test by universal testing machine of capacity 600 KN as per IS 516 – 1959.

Iv. Results and Discussion

a) Gradation of Particles

The gradation of the particles of M- sand and natural sand was determined by the sieve analysis of fine aggregates. In this analysis 200 grams of the sample were taken and sieved for the period of 10 minutes. The test results were expressed in the tubular form.

Type of Sieve analysis: Dry (passing 4.75mm sieve)

Total weight of crushed stone sand = 200g

Weight of dish = 2888g

Table 1: Sieve analysis of crushed stone sand

IS Sieve Opening, mm,µ	Wt. of dish, g	Wt. of (dish+ CSD) retained, g	Wt. of CSD retained, g	Cum. wt. retained, g	Cum. % retained	Cum. % finer
4.75	375	376	1	1	0.5	99.50
2.36	311	313	2	3	1.5	98.50
1	397	482	85	88	44	56.00
600	415	438	23	111	55.50	44.50
300	373	398	25	136	68.00	32.00
150	352	368	16	152	76.00	24.00
75	336	352	16	168	84.00	16.00
Pan	327	363				

In this analysis 200 grams of crushed stone sand were taken and kept for drying in an electrical oven for a period of 24 hours. After 24 hours of drying the sample were taken from the oven and kept for cooling in a tray. After the cooling of the sample, the materials placed in the IS sieves arranged as per the order as shown in the table. The whole assembly is placed on the sieve shaker for sieving for a time period of 15 minutes. After sieving the weight of the each sieve is taken and recorded for further calculation.

Type of Sieve analysis: Dry (passing 4.75mm sieve)

Total weight of natural sand = 200g

Weight of dish = 2888g

Table 2: Sieve analysis of natural sand

IS Sieve Opening, mm,µ	Wt. of dish, g	Wt. of (dish+ sand) retained, g	Wt. of sand retained, g	Cum. wt. retained, g	Cum. % retained	Cum. % finer
4.75	375	375	0	0	0	0
2.36	311	312	1	1	0.50	99.50
1	397	414	17	18	9.00	91.00
600	415	438	23	41	20.00	80.00
300	373	456	83	123	61.50	38.50
150	352	412	60	183	91.50	8.50
75	336	351	15	198	99	1.00
Pan	327	330				

Due to the uniformity in the gradation of the particles of the crushed stone sand, it is concluded that the crushed stone sand can be utilized for the replacement of the natural sand.

b) Moisture Content

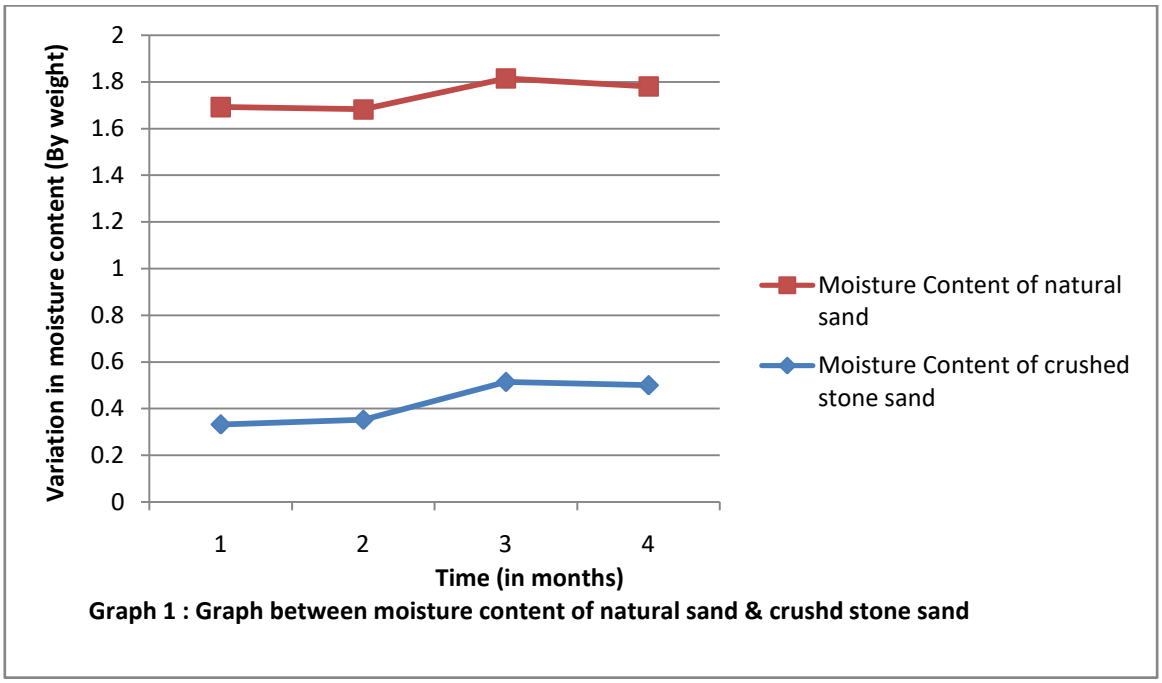
Moisture content of crushed stone sand was determined by oven dry method. The weight of the sample of crushed stone sand and natural sand was taken as 30 grams by determining the moisture content of the crushed stone sand and natural sand at certain intervals, behavior of the crushed stone sand and natural sand with respect to water content can be analyzed.

Table 3 Moisture content of crushed stone sand
(Oven dry method)

Sample no.	Wt. of empty container , g	Wt. of empty container + sample, W_1 g	Oven dried weight, W_2 g	% moisture content W_1– W_2/W_2 X 100
W_1	44	74	73.92	0.125
W_2	44	74	73.80	0.313
W_3	43	73	72.65	0.558
AVERAGE				0.332

Table 4 Moisture content of sand
(Oven dry method)

Sample no.	Wt. of empty container , g	Wt. of empty container + sample, W_1 g	Oven dried weight, W_2 g	% moisture content W_1– W_2/W_2 X 100
W_1	44	74	73	1.36
W_2	44	74	73	1.36
W_3	43	73	72	1.36
AVERAGE				1.36

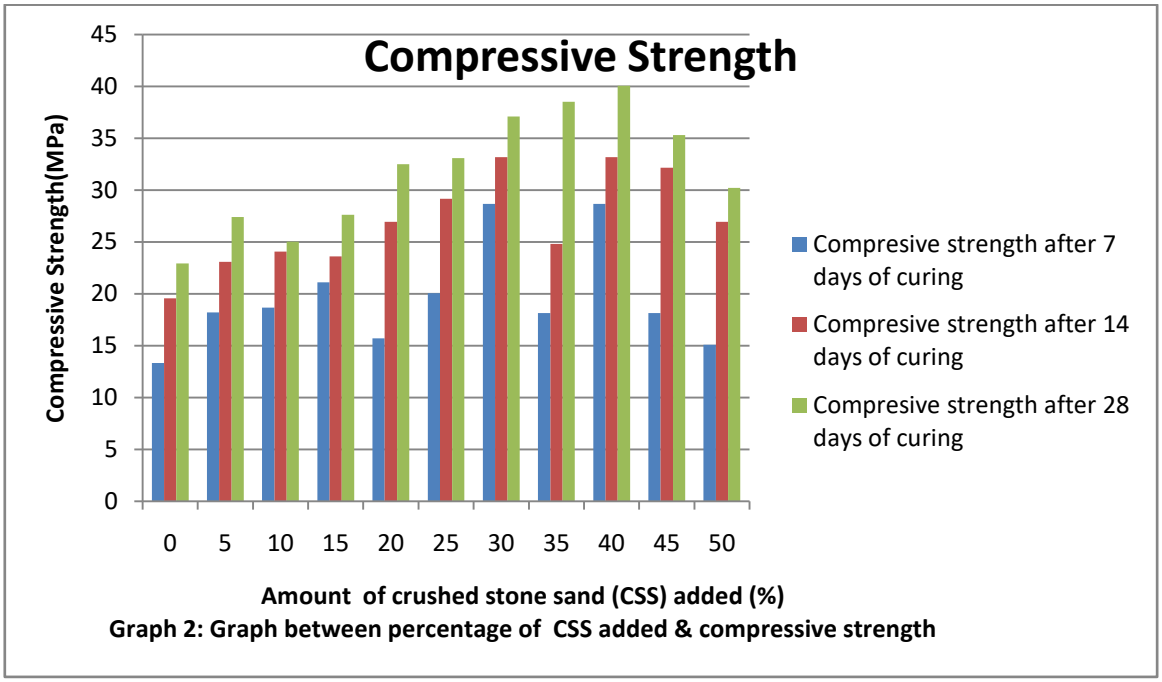


Graph 1 : Graph between moisture content of natural sand & crushd stone sand

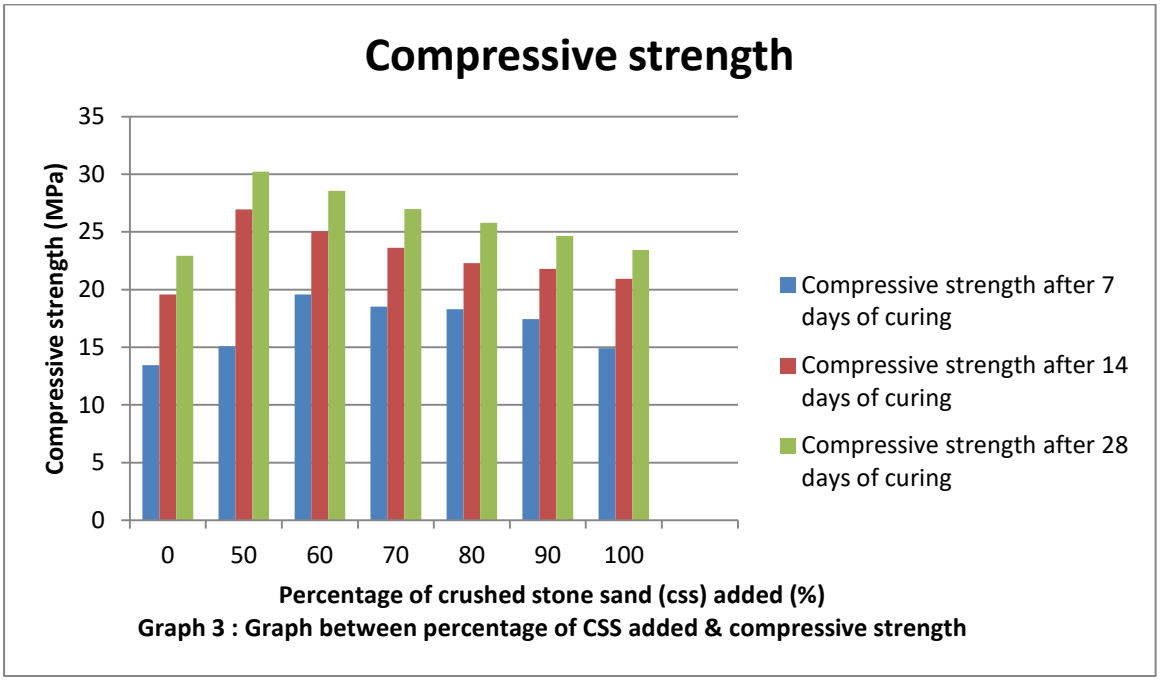
In the interval of one month the moisture content of both the natural sand and crushed stone sand were calculated by oven dry method. The moisture content of crushed stone sand is less than that of the natural sand in every observation which is 0.332**,** 0.352, 0.514 and 0.50 in case of crushed stone sand and 1.36, 1.33, 1.30 and 1.28 in case of natural sand respectively. Therefore it is concluded that there is a n increase of moisture content of crushed stone sand 0.08 grams by weight and slight decrease in the natural sand by 0.02 respectively.

c) Compressive strength

The variation in the compressive strength of the concrete is shown in graph as



Graph 2: Graph between percentage of CSS added & compressive strength

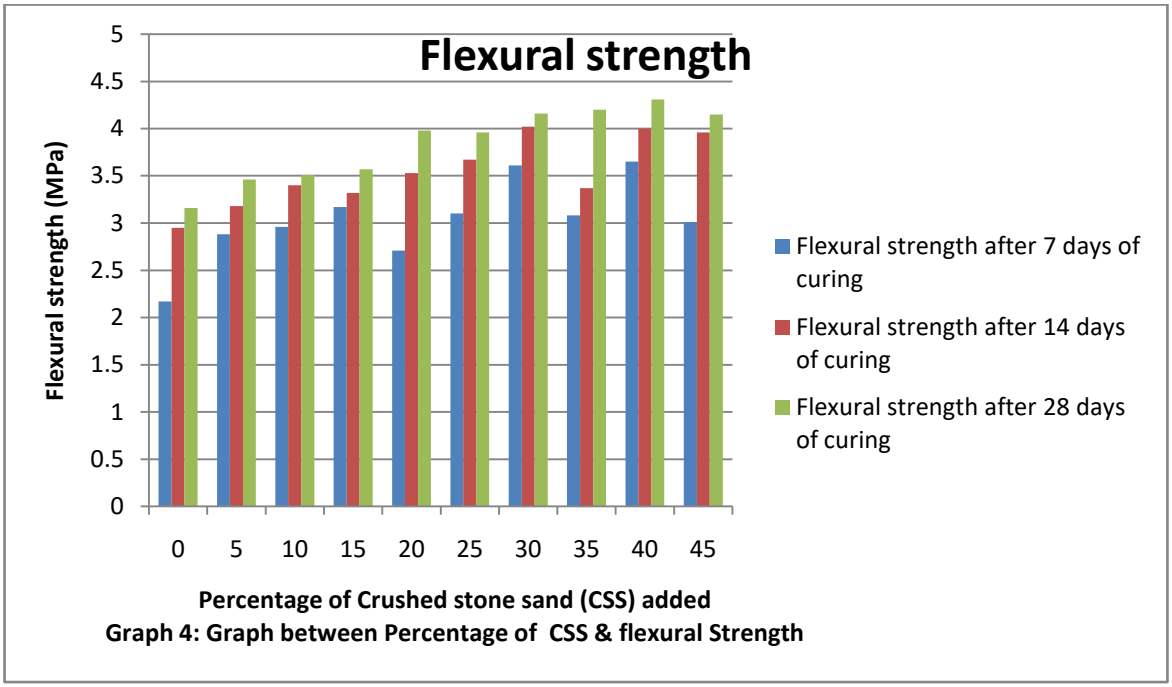


Graph 3 : Graph between percentage of CSS added & compressive strength

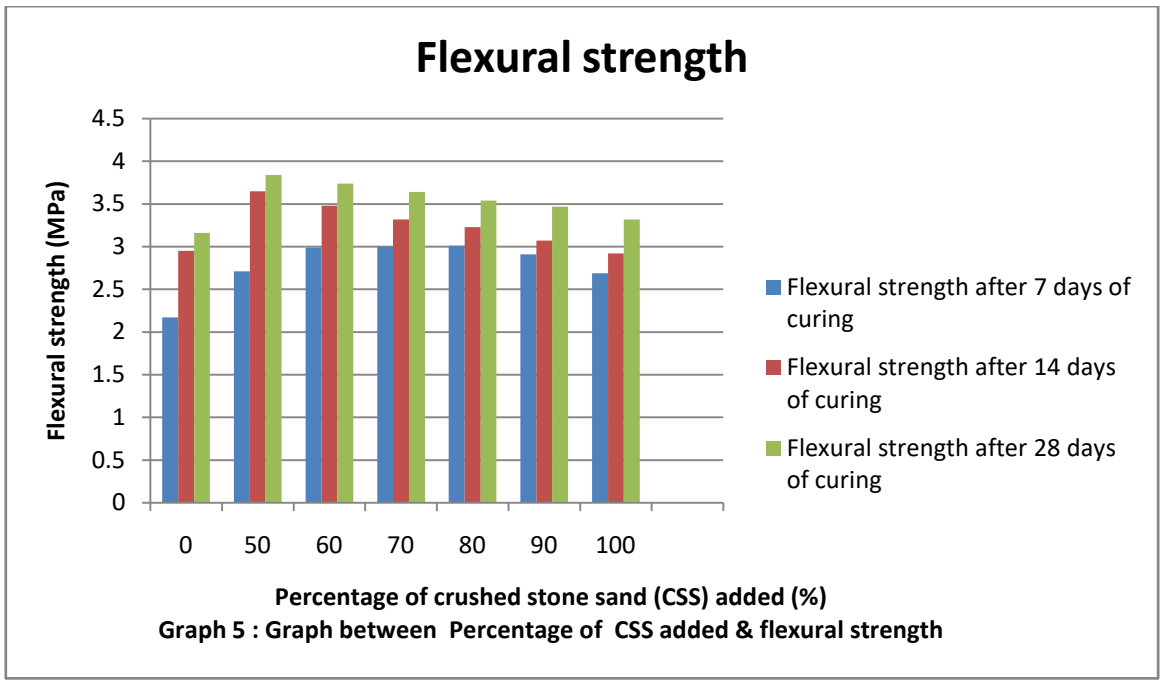
As we are increasing the percentage of M-sand in pavement concrete, the compressive strength is increasing and the results are comparable up to 100% replacement of natural sand by M-sand with a water cement ratio of 0.5%. At 15% replacement the water cement ratio is increased from 0.47 to 0.5 so as to make a mix of proper workability after that the water cement ratio is kept constant. The compressive strength after 7, 14 and 28 days curing of concrete with 100% replacement by M-sand is respectively 14.92 MPa, 20.94 MPa and 23.44 MPa , which is comparable and higher than the concrete using natural sand having compressive strength after 7, 14 and 28 days curing of 13.44 MPa, 19.58 MPa and 22.93 MPa respectively. As expressed in the graph M-sand can replace natural sand 100%.

d) Flexural strength

The variation in the compressive strength of the concrete is shown in graph as



Graph 4: Graph between Percentage of CSS & flexural Strength



Graph 5 : Graph between Percentage of CSS added & flexural strength

As we are increasing the percentage of M-sand in pavement concrete, the flexural strength is increasing and the results are comparable up to 100% replacement of natural sand by M-sand with a water cement ratio of 0.5%. At 15% replacement the water cement ratio is increased from 0.47 to 0.5 so as to make a mix of proper workability after that the water cement ratio is kept constant. The flexural strength after 7, 14 and 28 days curing of concrete with 100% replacement by M-sand is respectively 2.69 MPa, 2.92 MPa, and 3.32 MPa , which is comparable and higher than the concrete using natural sand having flexural strength after 7, 14 and 28 days curing of 2.17 MPa, 2.95 MPa, and 3.16 MPa respectively. As expressed in the graph M-sand can replace natural sand 100%.

V. Conclusions

- The compressive strength is increasing and the results are comparable up to 100% replacement of natural sand by M-sand with a water cement ratio of 0.5%. At 15% replacement the water cement ratio is increased from 0.47 to 0.5 so as to make a mix of proper workability after that the water cement ratio is kept constant. The compressive strength after 7, 14 and 28 days curing of concrete with 100% replacement by M-sand is respectively 14.92 MPa, 20.94 MPa and 23.44 MPa , which is comparable and higher than the concrete using natural sand having compressive strength after 7, 14 and 28 days curing of 13.44 Mpa, 19.58 MPa and 22.93 MPa respectively.
- The flexural strength is increasing and the results are comparable up to 100% replacement of natural sand by M-sand with a water cement ratio of 0.5%. At 15% replacement the water cement ratio is increased from 0.47 to 0.5 so as to make a mix of proper workability after that the water cement ratio is kept constant. The flexural strength after 7, 14 and 28 days curing of concrete with 100% replacement by M-sand is respectively 2.69 Mpa, 2.92 Mpa, and 3.32 MPa , which is comparable and higher than the concrete using natural sand having flexural strength after 7, 14 and 28 days curing of 2.17 Mpa, 2.95 Mpa, and 3.16 MPa respectively.
- Due to the increase in the percentage of the crushed stone sand the workability decreases at the percentage of 15%, after addition of 15% of crushed stone sand the W/C ratio was changed from 0.47 to 0.50 and kept constant up to replacement of 100% of crushed stone sand.
- The moisture content of crushed stone sand is less than that of the natural sand in every observation which is 0.332**,** 0.352, 0.514 and 0.50 in case of crushed stone sand and 1.36, 1.33, 1.30 and 1.28 in case of natural sand respectively. Therefore it is concluded that there is a n increase of moisture content of crushed stone sand 0.08 grams by weight and slight decrease in the natural sand by 0.02 respectively.

- Due to the uniformity in the gradation of the particles of the crushed stone sand, the crushed stone sand can be utilized for the replacement of the natural sand.
- Due to the less cost of the crushed stone sand, the overall cost of the construction of pavement is minimised.
- The utilization of the crushed stone sand prevents threat to the natural resource such as natural sand.
- The utilization of the crushed stone sand does not impact on environment hence it is environmentally feasible.

V. References

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