NATURAL SAND VS. CRUSHED STONE SAND: A COMPARATIVE ANALYSIS

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ABSTRACT

Natural sand which is known as river sand, has been used in construction form since old times. Due to various ecological reasons, today it is indeed our need to use manufactured sand as an alternative to natural sand. The more consumption of natural sand also causes an ecological change to our environment. Unavailability and shortage of natural sand can also be balanced by using crushed stone. Manufactured sand is also known as crushed sand and stone dust and it is made by crushing and grading suitable granite stones and rocks. As we all know that river beds are used to obtain natural sand. Now the depletion of natural sand has become a very big environmental issue, that's why many Indian state government has placed restrictions on sand excavation and therefore it is resulting a significant increase in its price (Natural sand vs Manufactured sand, 2017). Alternative materials, such as M sand, can be used in concrete to meet the requirement for fine aggregates (natural sand). The reason behind using river sand in very large amounts is that because of its spherical shape and smooth texture, which provides excellent workability and strength in the concrete(Gour, Choudhary and Nagar, 2019). The majority of manufactured sand has an uneven shape and a rough texture which causes a little reduction in workability and as well as in concrete strength. The stone industry in Rajasthan forms the backbone of its economy. From mining to processing, the state holds a key position in the national as well as international stone market especially in the case of granite (20% of total national production)(Singh and Rana, 2015).It can be very helpful to provide an alternative to natural sand.

Keywords: Natural sand, Manufactured sand, stone dust, River sand, properties of concrete.

INTRODUCTION

Concrete has become the most widely and commonly used construction material in the world due to rapid growth in global infrastructure. This has put a lot of pressure on the concrete industry to produce a lot of concrete to meet the rising demand for infrastructure development. Manufactured sand is a by-product of stone which is produced from mining and quarrying. Rather than being thrown away as a waste

product, stone dust can be used in many of the construction processes as well as in many types of structures and road pavements (Aziz, Bakshi and Chaudhary, 2018; Pandey et al., 2010; Pandey et al., 2013; Singh and Pandey, 2014; Bhatt et al., 2017; Sharma and Kanga 2020). Crushed stone sand is inexpensive when compared to other types of construction materials and natural sand. M-sand costs between Rs. 500 and Rs. 830 per tonne, whereas natural sand costs Rs. 830 per tonne. Several studies have been conducted in the past, to see how manufactured sand would effect on the properties of concrete by partially replacing the natural river sand. According to Celik and Marar (2018), partial replacement of up to 30% of the slump value results in a decrease in slump value. However, there is a significant difference. There was an improvement in compressive strength, flexural, and impact resistance. There has been a significant reduction in the cost of concrete without compromising its strength. According to Sahu et al. (2003),Manufactured sand concrete gieven very good result in the view of tensile strength, compressive strength and modulus of rupture(Nadimalla *et al.*, 2018; Kanga et al., 2017a, b; Rather et al., 2018; Hassanin et al., 2020; Kanga et al., 2021). According to Sahul Hameed and Sekar (2009), the compressive strength, split tensile strength, and durability properties of manufactured concrete are nearly 14 percent higher than traditional concrete which are made by the mixing of natural sand (Mundra *et al.*, 2016; Singh et al., 2017b; Kanga et al. 2020a, b).

According to a review of the literature, numerous studies on the use of manufactured sand as fine aggregates in concrete have been conducted in the past. However, there no comprehensive research has been conducted to determine the use of manufactured sand at optimum level. In this study, the M30 grade of concrete mix was chosen as the basic mix for the analysis. The manufactured sand is used to partially or completely replacement of the natural sand as the fine aggregates. In this study, the results showed that manufactured sand can be the substitute for natural sand as the fine material.

The motive of this research is to provide a comparative analysis of waste crushed stone sand with effectively replaces the natural sand in concrete.

To know the similarities in the properties of M-sand and natural sand.

To find the maximum strength in the concrete by the optimum replacement of M-sand.

OBJECTIVES

The objective of this research are as follow:-The primary objective of the study is to find an alternative of natural sand so that it can minimize the extraction of natural sand from the river beds.

The secondary objective is to find the maximum strength of concrete by usingof the stone dust as the fine material(replacement of natural sand) .

MATERIAL AND METHODS

In this study, the cursed stone was used as the M-sand to replace the natural sand in concrete mix. For this research work M30 grade of the concrete mix prepared.M30 grade of concrete being consume at a very high rate Because nowadays minimum grade of concrete in RCC work is M25 so M30 grade of concrete will be suitable for the many civil engineering structures. Physical properties of stone dust, such as sieve analysis and specific gravity, were determined by the doing of the lab test. The mix proportioning for M30 grade concrete was carried out following IS 10262-2009 after testing the aggregates, cement, and crushed stone. The following materials are used as raw materials in the preparation of the M30 garde of concrete.

Cement: For this research 53 grades of Portland cement are used as a fine material and the properties of 53 grades of cement are determined by the IS Code which is as follows in Table1.

S.No	Properties		Result
1	Setting time	Initial(Min.)	32
		Final(Min.)	421
2	Compressive Strength(MPa)	7 days	31
		28 days	52
3	Specific Gravity		3.08
4	Standard Consistency		31%

Table 1 Properties of Cement

Stone Dust: Stone dust was collected from Tirupati Stone Crusher's local stone crushing units. When it was collected, it was dry and had to be sieved before being mixed into concrete. Table 2 shows the results of the sieve analysis of stone dust. Stone dust had a specific gravity of 2.50 and water absorption of 1- 1.40 percent.

Figure No 1 is showing the result of sieve analysis of stone dust which were performed for the grain size distribution.

Properties	Quarry Dust	Natural Sand
Specific gravity	2.50	2.60
Bulk density (kg/m3)	1720- 1810	1460
Absorption (%)	1- 1.40	Nil
Moisture Content (%)	Nil	1.50
Fine particles less than 0.075 mm (%)	12-15	6
Sieve analysis	Zone-II	Zone-II

Table No. 2 Properties of stone Dust

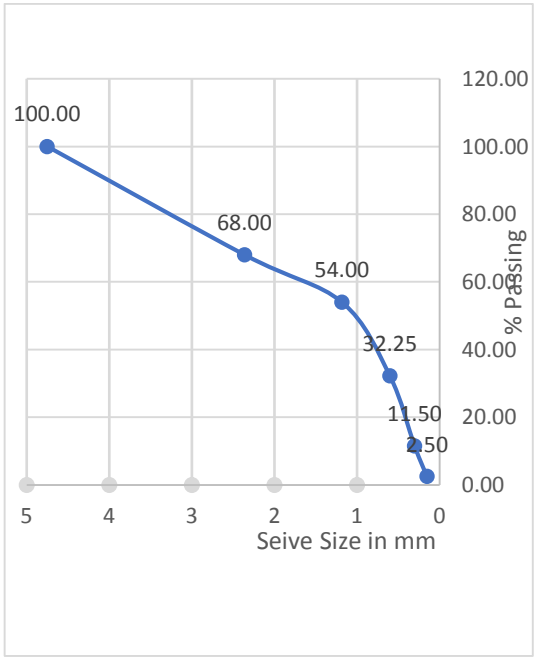

Figure.1: Grain size distribution of M Sand

Water: For mixing and curing of concrete (Stone dust used as a fine material), potable water was used as prescribed in IS:456-2000.

RESULTS AND DISCUSSIONS

There is the table-3 which is showing result of the compressive strength on the different percentages of replacement natural sand by the stone dust. It has been noted that up to 30% replacement level both at 7 days and 28days, the strength is decreased, but at 40% replacement, the 28 days strength is increased while the 7 days strength is also increased marginally.

Cube designation	Average compressive strength (N/mm2)		% replacement of Natural sand
	07 days	28 days	
CS-1	24.80	34.20	0.00
CS-2	26.10	32.60	30.00
CS-3	25.70	34.80	40.00
CS-4	21.80	31.60	50.00
CS-5	21.50	30.90	60.00
CS-6	19.80	30.00	70.00

Table No.3: Compressive strength of concrete mix at a different level of replacement.

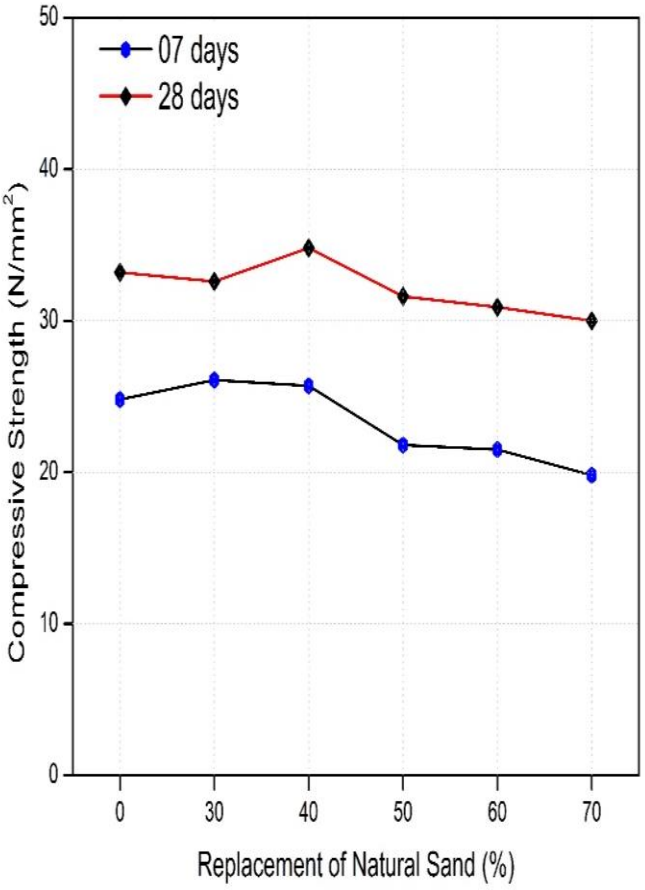

Figure No-3 07 and 28days results of compressive strength by the different replacement level.

The flexural strength of the specimen was measured at 07 days and 28 days as shown in Table 4. The variation of flexural strength with replacement level is shown in Table 3. It has been noted that
the flexural strength increases marginally at 07 days with a replacement level of 40 %. It also increased 28 days, the flexural strength increases significantly with replacement 40%.

Beam designation	Average flexural strength (N/mm^2)		% replacement of Natural sand
	07 days	28 days	
FS-1	4.1	4.65	0
FS-2	4.5	4.9	30
FS-3	4.4	5.5	40
FS-4	4.2	5.1	50
FS-5	4.2	5.4	60
FS-6	4.6	6.8	70

Table No.4: Results of flexural strength by the different replacement level.

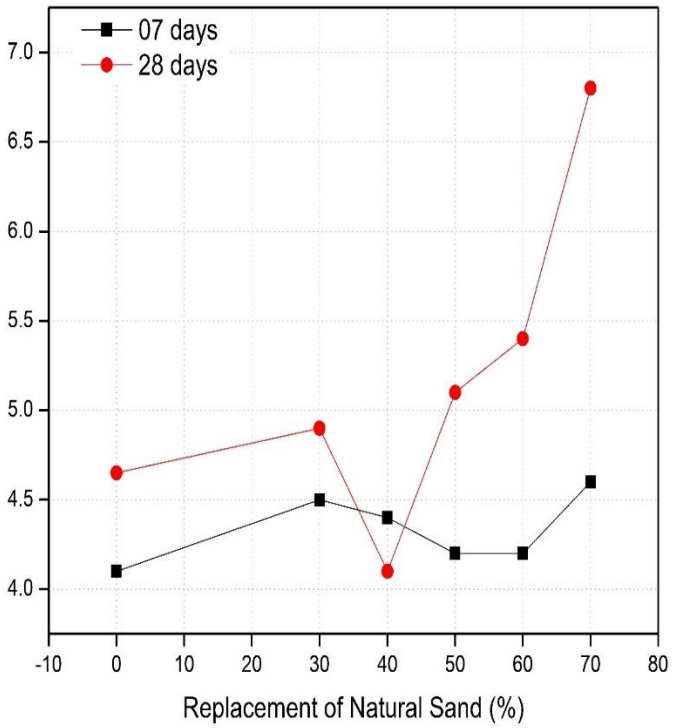

Figure No 4- 07 and 28 days results of flexural strength by the different replacement level.

CONCLUSION

The following conclusions were drawn from the above research:-

- Crushed stone sand can be used as M-sand for the partial replacement for the natural sand in concrete due to the similar particle gradation. Workability of concrete increasing till 40 % replacement of natural sand with the stone dust, and it decreased above the 40% replacement.

- Replacing fine aggregate with stone dust has no effect on compressive strength up to a replacement level of 40%, irrespective of the number of days. The replacement of natural sand with stone dust improved the flexural strength considerably, especially at 28 days.

- This research showed that the use of natural sand in the concrete mix can minimize the mining of natural sand from the river bed which will help to maintain the ecosystem of our environment.

- Further improvement may be possible in the terms of compressive strength, flexural strength, and workability by using different materials with the stone dust.

ACKNOWLEDGMENT

I would like to express my gratitude to my supervisor, Dr. Suraj Kumar Singh, as well as Dr. Shruti Kanga, for their help with this research paper.

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