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Experimental Study on the Properties of Concrete with Complete Replacement of Sand by Manufactured Sand

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Abstract: ***In general concrete is a combination of cement, fine and course aggregate. These days, natural river sand is difficult to acquire and extraction of sand from river has represented an awesome threat to environment.The government has also placed restrictions on the removal of sand from riverbeds. Due to a lack of natural river sand and rising demand, research is being done to find an alternative fine aggregate. This search shifts the focus of the research to the efficient use of manufactured sand (MS) for commercial purposes. By examining compressive strength.***
Keywords: Manufactured sand (MS), Concrete, Durability, Natural River Sand, Compressive strength.

I. INTRODUCTION

In current world, the world is observer of extremely difficult civil work in developments and frameworks. In civil work concrete is the most valuable material.The cement concrete is the biggest manufactured item by human society and the fundamental ingredient for the construction business. The current downturn in global wealth is causing concrete production expenditure to increase. The cost of conventional production equipment is clearly rising. Concrete is typically made of a mixture of cement, sand, and gravel.Because aggregate characteristics affect concrete's appearance and durability, fine aggregate is a crucial part of concrete. The majority of the time, natural river sand is used as a fine aggregate. Fine aggregate is a key component of building cement, and its qualities from workability to strength and durability can have an impact on the characteristics of concrete. Yet,River sand compromises bridge safety and causes ecological problems. However, because of the high cost of transportation, river sand from natural sources is expensive. It has become essential to look for options for river sand. The literature revealed that manufactured sand, recycled aggregates, industrial byproducts (such as some varieties of slag and bottom ash), and other materials are available as alternatives to river sand. As a replacement for river sand among these materials, manufactured sand is currently receiving a lot of attention.Whatever the case, there is now a greater need for natural or river sand as a result of the increased usage of concrete in a variety of construction projects. Sand resources are being depleted due to excessive quarrying of riverbeds to meet the construction industry's need for sand. The solution to this problem is manufactured sand, especially in light of the fact that certain jurisdictions have virtually banned the use of river sand for construction.In order to produce fine aggregate, which has a rougher surface roughness than river sand particles and typically more angular, manufactured sand is produced by crushing rock fragments.Concrete has been built using manufactured sand, also known as crushed stone sand or machine-made sand, which is made from stone or rock.

To checked the feasibility of manufactured sand for making concrete , Detailed literature survey is done . And following observation are made.

1) Use of manufactured sand for making of concrete.
2) Study of property of ingredients of concrete.
3) Mix designed by using IS 10262-2016 for M25 grade of concrete .
4) Testing of concrete for working and hardening property study.

In this study the concrete is made by using river sand and in second part of concrete is made by using a manufactured sand and its feasibility its checked by using

a) Compression strength test. (7,14,28 days).
b) Workability test (slump cone test).
c) Accelerated curing test.
d) (RCPT) Rapid chloride permeability test.

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II. METHODOLOGY

Before proceeding for the concrete mix design we have to check the physical properties of ingredients of concrete, the following properties are experimentally found :

A. Cement (53 grade) :- (IS 12269 (1987)

Cement used for the project is ultra-tech OPC 53 grade confirming to IS12269-1987. Tests are Conducted to find the properties of the cement.Cement assumes crucial part in concrete ordinary Portland cement (OPC) is by far the most important type of cement used in constructions. Generally, OPC are classified into three types viz., 33 Grade, 43 Grade and 53 Grade depending upon the strength of the cement at 28 days but grade 33 was stopped by government. In this project the grade that we used 53 grade cement.

Table 1. Properties of cement

Sr no	Property	Obtained Values	Codal Provision
1	Grade	OPC 53 Grade	IS 12269 (1987)
2	Specific Gravity	3.15	IS 2720 (part -III)
3	Fineness	7 %	IS 4031(part -I) 1996 (clause 4.4)
4	Initial setting time	85 min	IS 4031 (part -V) - 1988 Revised (clause 5.1)
5	Final setting time	345 min	IS 4031 (part -V)- 1988 (REVISED)
6	Standard consistency	32 %	IS 4031 (part -V)- 1988 REVISED (clause 5.21)
7	Soundness	1.2mm	IS 4031 (part -III) - 1988 REVISED (clause-5.2.1)

B. Fine Aggregate

M sand used for the project was brought from wathoda, Nagpur. The gradation was as per IS:2386(part-2). Fine aggregate is the important material used in the concrete mixture. Fine aggregate used in this research is M-sand as purely replacement to the natural sand.

Fine aggregates are the aggregates whose size is less than 4.75 mm and passed through the 4.75 mm sieve. The M-sand that is used in this work is taken from the nearby quarry and it is free from organic impurities. Manufactured sand is characterized as a reason made smashed fine total created from an appropriate source material. Generation for the most part includes crushing, screening and potentially washing, partition into discrete portions, recombining and mixing. The different properties of M-Sand are tabulated in Table 2.

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Table 2. Properties of fine aggregate (M-Sand)

S.No	Property	Obtained Value (MS)	Obtained values (Natural sand)	Codal provision
1.	Grading of Sand	Zone II	Zone II	IS 1026- 2009 and 1982(clause - 4.4)(Table -3)
2.	Specific Gravity	2.95	2.34	IS 2386 (Part-III)-1963
3.	Water absorption	2.3%	1.18 %	IS 2386(Part-III)-1963
4.	Fineness Modulus	2.91	2.44	IS 2386(Part-I)-1963

C. Coarse Aggregate

Crushed material of 20 mm size is chosen from the local source is as the coarse aggregate and tests to determine the different physical properties as per IS 383-1970. Test results conform to the recommendations of IS 383 (PART III). This coarse aggregate is free from dust, clay particles and organic matter. The properties of 20 mm, 12 mm & 6 mm sizes coarse aggregate are tabulated in Table 3.

Table 3 Properties of Coarse Aggregate (20 mm).

S.No	Property	Obtained value	Codal provision
1.	Specific Gravity	2.65	IS 2386 (part-III)-1963
2.	Water Absorption	0.80%	IS 2386 (part-III)-1963
3.	Impact Value	15.3	IS 2386 (part-IV)-1963
4.	Bulk Density	1560 Kg/m3	IS 2386 (part-III)-1963
5.	Fineness Modulus	7.408	IS 2386 (part-I)-1963

D. Water

Water is the least expensive but the most important component of concrete. Locally available fresh bore well water confirming to the requirements of IS: 456 - 2000 was used for mixing concrete and curing the specimens as well and this water is free from impurities.

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III. MIX-DESIGN

Mix design was carried out using IS 10262-2009 for M25 grade of concrete. In the design mix, natural river sand was fully replaced by M-sand. Crushed angular aggregate with sizes of 20mm confirming to IS: 383-1970 was used and having bulk density of 1728 kg/m3 & loose density of 1527 kg/m3. The coarse aggregate was tested with reference to IS: 2386 -1963.The specific gravity was found to be 2.65 for 20mm aggregate and fineness modulus is 2.75. Water absorption of coarse aggregates with reference to IS: 2386 (Part III)-1963 was determined as 20.6%. The impact test was performed to determine the toughness of the aggregate sample and the impact value obtained was 46.5%. The crushing test was carried out to find the compressive strength of the aggregate and found to be 30.3%. M-sand having bulk density of 1750 kg/m3 and specific gravity of 2.95 was used. The Fineness modulus of river sand is 2.91. Ordinary Portland Cement of 53 grade confirming to IS 12269-2013 was used in the experimental investigation. Laboratory tests were conducted on cement to determine standard consistency, initial setting time, final setting time and fineness modulus.

A. Obtained Mix Proportion

Water/Cement Ratio	Cement	Sand	Coarse aggregate
0.45	437.78	714.93	1108.548
	1	1.63	2.53

Workability
IS 456:2000
Degree of workability and slump value
(clause 8.2.2.1)

The concrete mix proportions chosen should be compacted with the means available. Suggested such that the concrete is of adequate workability for ranges of workability of concrete measured in the placing conditions of the concrete and can properly accordance with IS 1199 are given below:

Table 3 Degree of workability and slump value.

Placing condition	Degree of workability	Slump (mm)
1	2	
Building concrete; Shallow section; Pavement using pavers;	Very low	See 7.1.1
Mass concrete; Lightly reinforced; Sections in slab; Beams,walls,columns; Floors; Hand placed; pavements; Canal lining; Strip footings;	Low	25.75
Heavily reinforced section in slabs; Beams,columns,walls; Slipform work; Pumped concrete;	Medium	50 - 100 75 - 100
Trench fill; In-situ piling; Tremic concrete	High Very high	100 - 150 See 7.1.2

Slump cone test
Manufactured sand -82mm
Natural sand-100mm

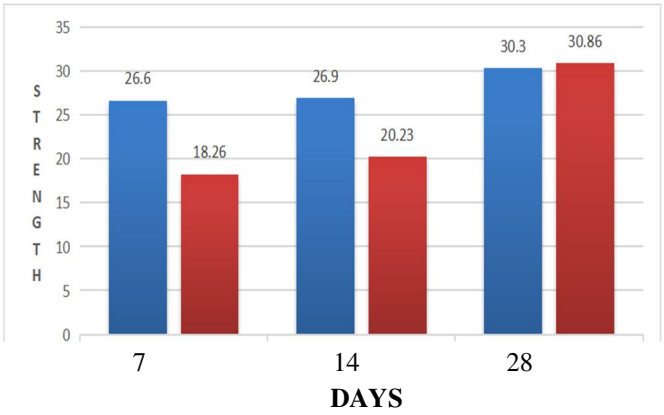
IV. TESTS CONDUCTED

The tests were done on concrete cubes for testing compression strength. Nine cube of coarse aggregate and river sand replaced by M-Sand were tested to determine the 7, 14 and 28 days compressive strength using a 2000 KN Compression Testing Machine. The compressive strength test of cubes is conducted as per standards. Figure 1 and 2 shows that the 150 mm x 150 mm x 150 mm cubes and compressive strength testing on cubes respectively. The results are tabulated in Table 4. It is seen that 7, 14 and 28 days compression strength fully replacement of coarse aggregate and the figure 3 also drawn to show the differences between the compressive strengths.

Table 4. compressive strength of natural sand and manufactured sand.

Manufactured sand			Natural sand		
Days	Load KN	Strength N/mm^2	Days	Load KN	Strength N/mm^2
7	600.0	26.6	7	412.2	18.26
14	629.2	26.9	14	455.9	20.23
28	681.0	30.3	28	481.0	30.86

V. RESULTS AND DISCUSSION



1) The 7 days strength of M-Sand is 80% . And The 7 days strength of River sand is 54.92 %
∴The 7 days of M-Sand is found more than rive sand. Hence within permissible limit
2) The 14 days strength of M-Sand is 27.9 . And The 14 days strength of River sand is 20.23
∴The 14 days of M-Sand is found more than rive sand. Hence within permissible limit
3) The 28 days strength of M-Sand is 30.26 And The 28 days strength of River sand is 30.86

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Fig 1 - Cube (150 X 150 X 150)

Fig 2 - Testing of compression strength cube.

VI. CONCLUSION

The main conclusion arrived from this general review are as follows:

1) Physical properties of manufactured sand found within permissible code provision .

2) Due to higher internal friction between particles of manufactured sand , workability of manufactured sand found approximately lower than natural sand

3) Rough texture surface of MS , result 5% higher compressive strength when compare to river sand at 7 days and 14 days age.

4) The compressive strength of MS concrete is equal to river sand concrete at 28 days age.

5) Literature survey strongly recommended the use of MS for making concrete our experimental investigation also confirmed the use or MS for making concrete for sustainable development.

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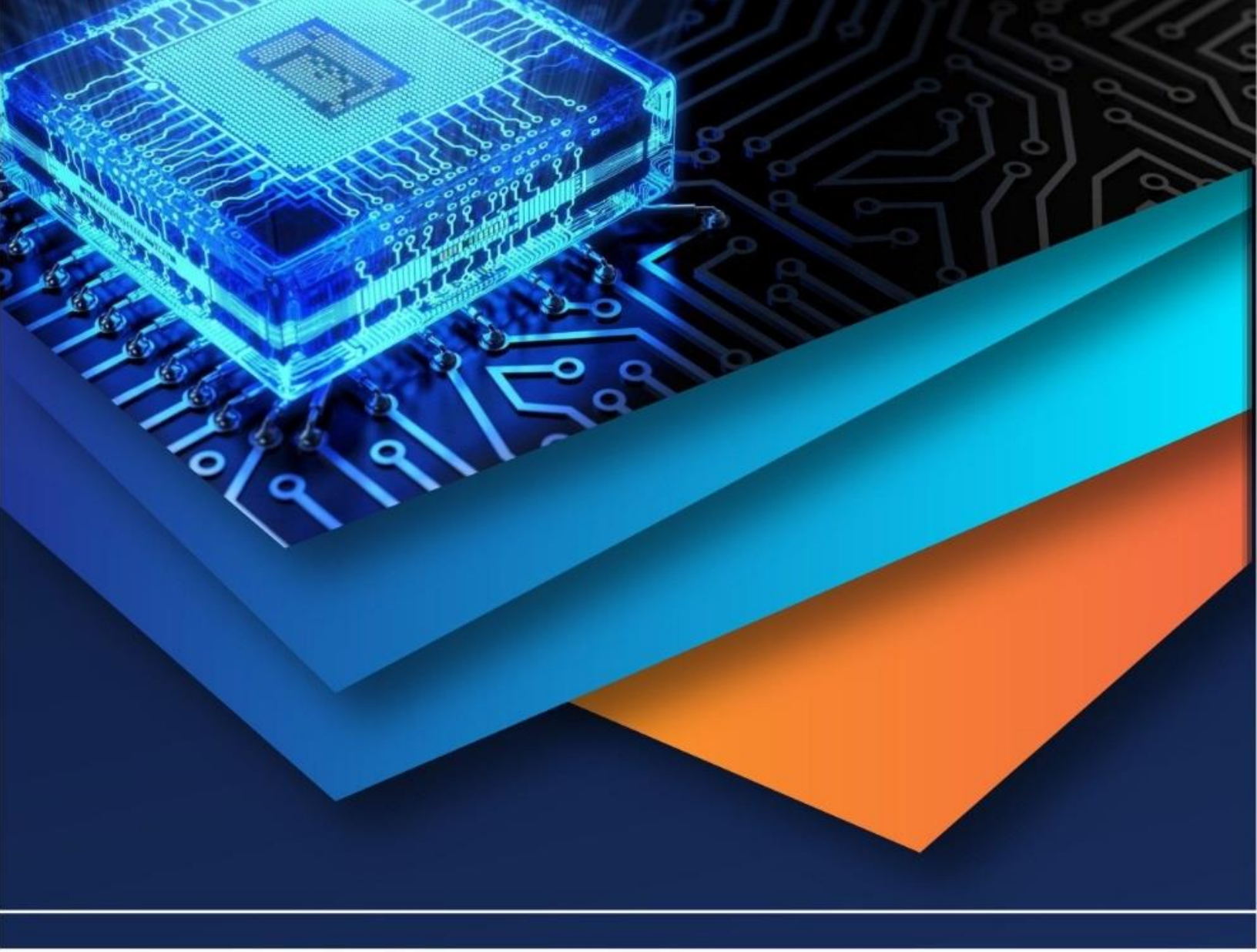

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