

Review on Performance of Concrete by Use of Manufactured Crushed Sand as a Fine Aggregate

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Abstract – In the last 15 years, it has become clear that the availability of good quality natural sand is decreasing. Existing natural sand deposits are being emptied at the same rate as urbanization and new deposits are located either underground or too close to already built-up areas or too far away from the areas where it is needed. Environmental concerns are also being raised against uncontrolled extraction of natural sand. The arguments are mostly in regards to protecting riverbeds against erosion and the importance of having natural sand as a filter for ground water. The above concerns, combined with issues of preserving areas of beauty, recreational value and biodiversity, are an integral part of the process of most local government agencies granting permission to aggregate producers across the world [3,9]. This paper discusses literature review on performance of concrete by use of manufactured crushed sand as a fine aggregate.

I- INTRODUCTION

Increasing extraction of natural sand from riverbeds causing many problems such as losing water retaining sand strata, riverbank slides, lowering the underground water table etc. In order to compensate the lack of natural resources and to find alternative solution for conserving the environment, and to make the construction industry sustainable, the natural sand was

replaced by Manufactured Sand (M-Sand). Concrete is a composite material composed of fine and coarse aggregate bonded together with water in proportions that hardens over time. Aggregates are generally thought of as inert filler within a concrete mix, but a closer look reveals the major role and influence aggregate plays in the properties of both fresh and hardened concrete [1,5]. Changes in gradation, maximum size, unit weight, and moisture content can all alter the character and performance of your concrete mix. Generally river sand used as fine aggregate in concrete but due to administrative reasons, sand mining is restricted due to which scarcity of sand arises which effects the construction project sites and financial aspect [9].

Heavy demand in construction activities forces to find suitable substitutes which are the cheapest and easy way of getting substitute for natural sand. This paper presents literature to see the feasibility of artificial sand in concrete for replacement of natural sand by artificial sand. Approximately 80% of total volume of concrete is made up of aggregates. Aggregates characteristics (size, shape, texture, grading) influence the workability, finish ability, bleeding, and segregation of fresh concrete and durability of hardened concrete [3,11].

II- LITURATURE REVIEW

Sr. No.	Paper Title and Author(s)	Name of Journal/Conference	Findings of work
1	“An Experimental investigation on the properties of concrete containing manufactured sand” by Priyanka A. Jadhava and Dilip K. Kulkarni	International Journal of Advanced Engineering Technology (E-ISSN 0976-3945 IJAET/ Vol. III/ Issue II/April-June, 2012/101-104)	i) The compressive, split tensile and flexural strength of concrete with 60% replacement of natural sand by manufactured sand reveals higher strength as compared to reference mix.
2	“Study on the Fluidity and Strength Properties of High Performance Concrete Utilizing Crushed Sand” by Sangjun Park	International Journal of Concrete Structures and Materials Vol.6, No.4, pp.231–237, December 2012 (DOI 10.1007/s40069-012-0020-1 ISSN 1976-0485 / eISSN 2234-1315)	i) Blended aggregate met the range of optimal fineness modulus for concrete when the bending ratio of CS was below 30 %. ii) The shape index of pure CS was 52.7 % and was closed to the specification requirement of 53 %
3	“Feasibility of Artificial Sand In Concrete” by Rajendra P. Mogre , Dr. Dhananjay K. Parbat , Dr. Sudhir P. Bajad	International Journal of Engineering Research & Technology (IJERT) (Vol. 2 Issue 7, July - 2013 IJERT/IJERT ISSN: 2278-0181)	i) Replacement of natural sand with 60 % to 80% by artificial sand is found feasible. ii) For M20 grade of concrete, the percentage increase in compressive strength and tensile strength by 29.44% and 5.39 % respectively by replacing natural sand. iii) Artificial sand can be recommended as a good and competitive substitute for natural sand.
4	“Strength And Durability Studies On High Performance Concrete With Manufactured Sand As Fine Aggregate” by T. Shanmugapriya , Dr. R.N.Uma	International Journal of Applied Engineering Research (ISSN 0973-4562 Vol. 10 No.2 (2015) pp. 1919-1924)	1) The High Performance Concrete with M-sand can be used as an alternative material to natural sand in the presence of silica fume. 2) The Compressive strength of concrete showed gradual increase as the percentage of M-Sand upto 60% after which the strength for further replacement level decreases. The same pattern was also observed for split tensile and flexural strength tests.
5	“Investigation on Durability Properties of Concrete Using Manufactured Sand and Admixtures” by S. Murali Krishnan, Dr. T.Felix Kala	International Journal of Mechanical Civil and Control Engineering Vol.1, Issue.4, September 2015	i) When the percentage of replacement of M sand goes beyond 50%, the strength is considerably reduced. ii) It concluded with a remarks of the optimum percentage of M sand to obtain when replaced with natural sand with 50% of M-sand
6	“Use of M Sand in High Strength and High Performance Concrete” by V. Umamaheswaran, C. Sudha, P. T. Ravichandran and P. R. Kannan Rajkumar	Indian Journal of Science and Technology, Vol 8(28), (DOI: 10.17485/ijst/2015/v8i28/84018, October 2015)	1) The usage of M. sand for high strength high performance concrete provides stronger and durable concrete structures which can be economical as well as environment friendly by preserving natural resources such as river sand. 2) Drying Shrinkage was marginally higher in M.sand, however later age behaviour in this aspect needs to be studied further.

7	“Study on the Strength and Durability Properties of Concrete with Manufactured sand” by B. Vijaya and S. Senthil Selvan	Indian Journal of Science and Technology, Vol 8(36), (DOI: 10.17485/ijst/2015/v8i36/88614, December 2015)	i) M-sand replaced concrete have 30% more compressive strength for M30 grade, 19% more compressive strength for M40 grade and 18% more strength for M50 grade concrete up to 60% replacement of M-sand and further increase in the percentage of M-sand showed reduced the strength. ii) Split tensile strength of concrete increased by 28%, 20% and 9% for M30, M40 and M50 grade concrete, when compared with conventional concrete up to 60% replacement of M-sand with river sand.
8	‘Strength and Durability Studies On High Performance Concrete With Manufactured Sand As Fine Aggregate’ ‘T. Shanmugapriya’, Dr. R. N. Uma	International Journal of Applied Engineering Research, ISSN 0973-4562 Vol. 10 No.2 (2015) pp. 1919-1924	i) The Compressive strength of concrete showed gradual increase as the percentage of M-Sand is increased up to 60% after which decreases the strength for further replacement level. ii) The same pattern was also observed for split tensile and flexural strength tests. iii) The optimum percentage of natural sand replacement by M-Sand is 60% in presence of replacement of cement by 7.5% of silica fume for achieving maximum compressive, split tensile and flexural strength
9	“Comparative Analysis of Natural and Crushed Sand” by D. R. Naxine, S. S. Kapgate, C. N. Gawali	International Journal of Management, Technology And Engineering Volume IX, Issue I, January 2019 (ISSN NO : 2249-7455)	i) Sand requirement in concrete made with natural sand is lower than the quantity required in crushed sand. ii) If compared with rates crushed sand cost almost 75% less than natural sand. iii) Since the crushed sand has higher strength than natural sand, coarse aggregate of 10mm and 20mm size is relatively lower in quantity in concrete made with crushed sand.
10	“Replacement of River Sand by Crushed Sand and its Effect on Concrete Parameters” by Mohd Arham Siddiqui	International Research Journal of Engineering and Technology (IRJET) Volume: 06 Issue: 05, May 2019 (e-ISSN: 2395-0056)	i) 70% replacement of river sand, compressive strength of concrete has increased up to 5.94% and slump value is within control limit as specified in IS 4926 and on further replacement of sand is not having much effect on compressive strength but subsequently increases the workability of concrete.
11	“Study of Concrete Properties by Replacing Natural Sand with Artificial Sand” by Aadil Jawaid, Kumar Nihal, Devraj Singh, R. H Jadhav, Md. Shakir J. Arzoo	International Journal of Engineering Research & Technology (IJERT) Vol 8, Issue 06 (June - 2019) ISSN: 2278-0181	1) The optimum value of compressive strength is obtained at 75% replacement of natural sand with artificial sand and 1% addition of admixture. 2) The percentage increase in the compressive strength of 75% replacement of natural sand along admixture with 100% natural sand with is 31%.
12	“Experimental Studies on concrete by partial replacement of sand by crushed sand and cement by flyash” by Akash Thakre, M. M. Joshi	International Research Journal of Modernization in Engineering Technology and Science Volume: 03/Issue: 05/May-2021	i) Mortar mixtures with sand gradation showed a difference in compressive strength for 1: 3 cement sand solution. ii) M31 (100% CS + 0% FS) have the lowest strength of 7, 28 and 90 days as 10.46, 17.35 and 18.19 N / mm ² . iii) M34 (60% C + 40% FS) showed a maximum strength of 28 days 28.67 N / mm ²

III- MATERIALS USED

Aggregate of Coarse aggregate (12mm [70%] and 10mm [30%] [0.5 and 0.4 in]) was used, which was manufactured from locally available rock [1]. Summary of material properties were presented in Table 1 according to Indian Standards. Locally available river sand as fine aggregate (4.75mm to 75 micron [0.2 to 0.003 in]) was used. Manufactured sand (4.75mm to 75 micron [0.2 to 0.003 in]) was used for partial replacement to natural sand. Both fine aggregate, natural and manufactured sand were from zone II according to Sieve analysis and material properties were presented in Table 1,2 and 3 according to Indian Standards . Cement: - The cement used was 53 grade (Ordinary Portland Cement) [1].

Table 1: Physical properties of river sand and manufactured crushed sand [9]

Property	Natural Sand	M- Sand
Specific Gravity	2.69	2.86
Bulk Density kg/m ³	1726	1748
Fineness Modulus	2.63	2.65

Table 2: Sieve analysis for river sand and manufactured crushed sand (IS grading limits for Zone II) [9]

IS Sieve	Natural Sand % Passing	M-Sand % Passing
4.75 mm	97	99.2
2.36 mm	92.2	93.6
1.18 mm	77	56.6
600 micron	52.2	38.6
300 micron	10.6	18.4
150 micron	2	7.4

(The sieve analysis details are given in table 1 and 2 . Both types of fine aggregate are confirming to zone II of IS 383-1970.)

IV-ADVANTAGES OF MANUFACTURED SAND

1. From the mechanical properties (compressive, split tensile, flexural and Modulus of Elasticity) there is an increase in strength properties for high performance concrete with 5% silica fume and 100% manufactured sand [8].
2. Inclusion of M - Sand decreased the value of Sorptivity and chloride ion penetration in high performance concrete, which indicates that

concrete, has become denser and impermeable [8].

3. Industrial by products silica fume and manufactured sand can be advantageously used in producing High Performance concrete[8].
4. Manufactured Sand can be suitably used in making structural grade concrete by replaced 100% with natural sand [8].

V- CONCLUSION

From the literature review, various authors have summarized that:

1. The compressive, split tensile and flexural strength of concrete with 60% replacement of natural sand by manufactured sand reveals higher strength as compared to reference mix.
2. The overall strength of concrete linearly increases from 0%, 20%, 40% and 60% replacement of natural sand by manufactured sand as compared with reference mix (mix 1).
3. Manufactured sand has a potential to provide alternative to natural sand ,maintaining the environment as well as economical balance.
4. 4.Non-availability of natural sand at reasonable cost, forces to search for alternative material. Manufactured sand qualifies itself as suitable substitute for river sand at reasonable cost. The manufactured sand found to had good gradation and nice finish.
5. 5.This had been resulted in good cohesive concrete. This sand is considered as an ideal for concrete.

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