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CONCRETE FILLED STEEL TUBULAR (CFST) BEAM COLUMN JOINTS AND IT'S BEHAVIOUR

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Abstract:

Concrete Filled Steel Tubular (CFST) members utilize the advantages of both steel and concrete. They comprise of a steel hollow section of circular or rectangular shape filled with plain or reinforced concrete. Steel members have the advantages of high tensile strength and ductility, while concrete members have the advantages of high compressive strength and stiffness. Composite members combine steel and concrete, resulting in a member that has the beneficial qualities of both materials. In this paper, an attempt was made with steel tubular beams column joint filled with different types of concrete using M-Sand and Recycled Course aggregate. The effects of steel tubes, compressive strength of concrete and the confinement of concrete are examined. Specimens were tested with strength of concrete as 20 MPa. The mechanical properties for various replacements of sand by M-Sand and course aggregate by Recycled Coarse Aggregate were studied. The different concrete mixes used were 40%, 50%, 100%. The cylinders were casted and tested for 28 days for all replacements and modulus of elasticity was calculated.

Keywords: CFST, M-sand, Recycled coarse aggregate, Compressive strength

INTRODUCTION

Concrete Filled Steel Tubular (CFST) members utilize the advantages of both steel and concrete. They comprise of a steel hollow section of circular or rectangular shape filled with plain or reinforced concrete. They are widely used in high-rise and multistory buildings as columns and beam-columns, and as beams in low-rise industrial buildings where a robust and efficient structural system is required.

Composite members consisting of square steel tubes filled with concrete are extensively used in structures involving very large applied moments, particularly in zones of high seismicity. Composite square Concrete Filled steel Tubes (CFT) have been used increasingly as columns, beams and beam-columns in braced and un-braced frame structures. Their use worldwide has ranged from compression members in low- rise, open floor plan construction using cold-

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formed steel rectangular tubes filled with pre-cast or cast-in-place concrete, to large diameter cast-in-place members used as the primary lateral resistance columns and beams in multi-storey buildings. Concrete filled steel box columns and beams have been used is some of the world's tallest structures. In addition, concrete filling is widely used in retrofitting of damages steel bridge piers after the 1995 Hyogoken-Nanbu earthquake in Japan and the Northridge earthquake in 1994 in the USA. The two main types of composite column are the steel-reinforcement concrete beam, which consists of a steel section encased in reinforced or unreinforced concrete, and the Concrete-Filled Steel Tubular (CFST) beams, which consists of a steel tube filled with concrete.

METHODOLOGY

From various literature reviews the type was selected as CFST beam column joint by replacement of M-sand and Recycled Coarse Aggregate.

The material was collected for replacement .the mix design used was M20. The mechanical properties of concrete by various up to were studied by casted of cylinders for spilt tinsel strength prism for flexural behaviour, compressive strength. The M-Sand was replaced by 40%, 50%, 100% and Recycled Coarse Aggregate 40%, 50%, 100% of coarse aggregate. The cylinders were cured for 28 days and tested for modulus of elasticity the CFST beam column joints were moulded of the 0.2 mm and column of length 600 mm and beam of length 1 m. The column is of rectangular of 200 x 200 mm and beam 200 x 150 mm.

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RESEARCH SIGNIFICANCE

The main objective of the present work was to systematically study the effect of water cement ratio and percentage replacement of manufactured sand by natural sand, coarse aggregate by recycled coarse aggregate as 0.5 and 0%, 10%, 20%, 30%, 40%, 50%, and 100% respectively on the strength propertiedof concrete. The study was carried out on M20 grade concrete with 0.5 water cement ratio. Manufactured sand can be used as fine aggregate, but it has to satisfy the technical requisites like workability and strength. On this aspect research on concrete with manufactured sand is scarce, so this paper investigates the concrete produced with manufactured sand.

EXPERIMENTAL INVESTIGATION

Materials

Aggregate: Coarse aggregate (12 mm [70%] and 10 mm [30%] [0.5 and 0.4 in]) was used, which was manufactured from locally available rock. Summary of material properties were presented in Table 1 according to Indian Standard. Locally available river sand as fine aggregate (4.75 mm to 75 micron [0.2 to 0.003 in]) was used. Manufactured sand (4.75 mm 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 Zeghichea and Chaouib (2005).Sieve analysis and material properties were presented in Table 1 and 2 according to IndianStandards (Zeghichea and Chaouib, 2005; and Fan Hong and Lihua Xu, 2012).

Cement: The cement used was 53 grade (Ordinary Portland Cement).

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Table 1: Physical Properties of Materials

Property	Fine Aggregate		Coarse Aggregate
	Natural Sand	Manu-factured Sand	
Specific Gravity	2.6	2.84	2.75
Fineness Modulus	2.89	2.84	–
Water Absorption	6.50%	5.60%	2.50%

Table 2: Details of Sieve Analysis of Natural Sand and Manufactured Sand

Sieve Designation	Percentage Passing of Zone II Sand		Grading Lmits for Zone II Sand
	Natural Sand	Manu-factured Sand	
4.75 mm	94.75	100	90-100
2.36 mm	88.5	88.1	75-100
1.18 mm	71.25	68.8	55-90
600 micron	42.5	37.3	35-59
300 micron	11.5	15	8-30
150 micron	1.75	6	0-10

Table 3: Workability of Fresh Concrete

S. No.	Slump mm (in)	Compacting Factor
0% M-Sand	85(3.35)	0.886
10% M-Sand	84.5(3.33)	0.885
20% M-Sand	84(3.31)	0.885
30% M-Sand	84.5(3.33)	0.860
40% M-Sand	85(3.35)	0.860
50% M-Sand	80(3.14)	0.851
100% M-Sand	75(2.92)	0.816

The strength [flexural, split tensile and compressive] and workability [slump and compacting factor] were studied on concrete with partial replacement of natural sand by manufactured sand. This paper extends the previous study (Priyanka Jadhav and Dilip Kulkarni, 2013) toward the change of water cement ratio from 0.5. Present the M20 grade

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concrete mix design for concrete and six trial mix series based on partial replacement of natural sand by m-sand. All of the experimentswere performed in normal room temperature.

The concrete ingredients namely coarse aggregate, fine aggregate and cement were first mixed in dry state, then calculated amountof water was added and mix it thoroughly to get a homogeneous concrete mix. Workability of fresh concrete was determined by the slumpand compacting factor test according to Indian standers (Hyungu Jeong, 2009).

Compressive strength was measured on 150 mm (5.9 in) measured on 150 mm (5.9 in)diameter and 300 mm (9.9 in) height cylinder that were cured in water for 28 days and it tested at 28 day's on compression testing machine of 20 ton. Universal Testing Machine(UTM) of 40 ton, Table 3 presented the summary of workability and strength test results of concrete respectively. The percentage increases in all three strength ascompared with reference mix were seen in Table 3. For each trial mix three cube, three beam and three cylinders were casted.

RESULTS AND DISCUSSION

Fresh Concrete

Workability: Increasing percentage replacement of manufactured sand decreased the workability. As compared to previous work Priyanka Jadhav and Dilip Kulkarni, 2013), as water cement ratio decreases workabilitydecreases as seen in Table 3. Manufactured sand consumes higher amount of water to satisfy the workability.

Hardened Concrete: Concrete mixes revealed an increase of up to 12.61% in

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Figure 1: Compressive Strength of Concrete

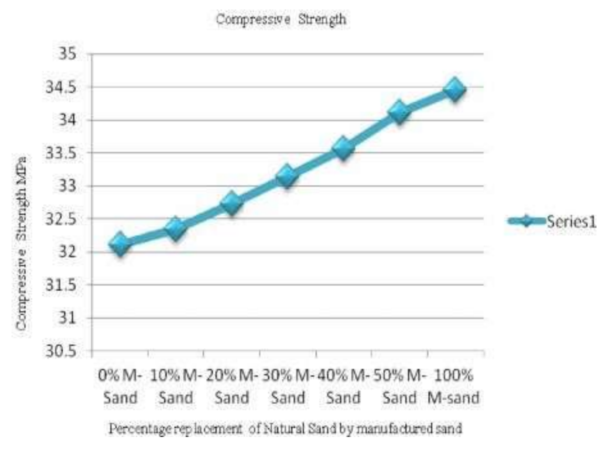


Figure 2: Split Tensile Strength of Concrete

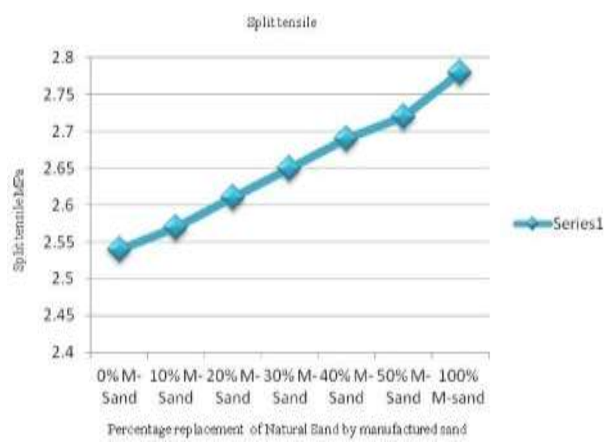
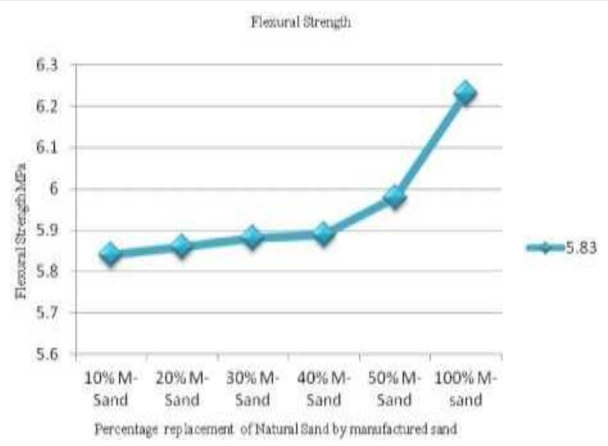


Figure 3: Variation in Flexural Strength of Concrete



compressive strength, 11.44% in split tensile strength and 14.60% in flexural strength as a result of replacement of manufactured sand up to 100% as seen in Table 3 and Figures 1, 2 and 3 respectively.

Concrete with manufactured sand gives better surface finishes as seen in Figure 4. It has been observed that the compressive, split tensile and flexural strength of concrete with replacement of natural sand by manufactured sand goes on increasing up to 100% replacement. This may be due to the fact that 100% replacement of natural sand by manufactured sand may show the optimum reaction with optimum filler capacity. It can be concluded that 100% replacement of natural sand by manufactured sand will yield the maximum strengths for concrete. In this study we observe that the overall strength of concrete is higher and workability is lower if results are compared with reference mix.

Figure 4: Comparison of Surface Finishes

CONCLUSION

The effect of concrete with partial replacement of manufactured sand on the properties of normal strength concrete with water cement ratio of 0.5 and 28 day's compressive, split tensile and flexural strength of 20 Mpa (2900 psi) and workability (slump and compacting factor) were studied. The effect of percentage replacement of manufactured sand on strength property and workability were evaluated and compared with reference mix of 0% replacement of natural sand by manufactured sand.

The compressive, split tensile and flexural strength of concrete with 100% replacement of natural sand by manufactured sand reveals higher strength as compared to reference mix.

The overall strength of concrete linearly increases from 0%, 20%, 40% and 100% replacement of natural sand by manufactured sand as compared with reference mix (mix 1). These results were compared with previous work then found that, present study gives better strength and higher water cement ration gives better workability.

Manufactured sand has a potential to provide alternative to natural sand and helps in Maintaining the environment as well as economical balance. 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 (see Figure 4), which was lacking in natural sand. This had been resulted in good cohesive concrete. This sand is considered as an ideal for concrete.

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