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An Experimental Approach on Strength Parameters of Fibered Concrete with the Usage of Manufactured Sand

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ABSTRACT: Concrete is a construction material composed of cement, fine aggregate and coarse aggregates mixed with water which hardens with time. Investigations have started for the alternative materials of concrete due to its production and availability of materials. Due to depletion and scarcity of the natural resources and restrictions due to environmental considerations made to look for suitable alternative material for fine aggregates. One of such alternative material is manufactured sand. Manufactured sand (MS) is being considered as an appropriate alternative to replace river sand in concrete.

In this research, the mix design has prepared by the usage of manufactured sand as the replacement of fine aggregate and the fibres of steel and glass are used as additives to cement at an optimum of fine aggregate to improve the properties for M30 grade of concrete. Concrete mixers were produced, tested and compared in terms of strength parameters and workability conditions to conventional concrete.

KEYWORDS: Manufactured Sand, Steel fibres and Glass fibres, Workability, Compressive Strength Test and Split Tensile Strength Test.

I. INTRODUCTION

Concrete's versatility, durability, sustainability, and economy have made it the world's most widely used construction material. Conventionally concrete is proper mixture of cement, sand and aggregate. To meet the global demand of concrete in the future life, it is necessary to use an alternative material in construction which can fully or partially replaced for the natural aggregate without affecting the property of fresh and harden concrete. River sand, which is one of the constituents used in the production of conventional concrete, has become highly expensive and also scarce. In the backdrop of such a bleak atmosphere there is large demand for alternative materials from industrial waste. Hence an alternative material like utilization of quarry rock dust which can be called as manufactured sand has been accepted as a building material in the construction.

The use of manufactured sand has been increasing due to the scarcity of good quality Natural River sand. Manufactured sand is generally produced by feeding stones of varying sizes into VSI crusher to undergo crushing process, to achieve excellent quality and consistent gradation. M-sand produced from the above process is generally more angular and they have a rougher surface texture. This M-sand has been well defined in IS 383-1970 under clause 20. M-sand after undergoing the crushing process, are washed away in sand trap to remove the fines. This washing facility reduces the absorption rate of M-sand.

II. LITERATURE REVIEW

1. Boobalan S C, Nikeath D, Pragadesh M, (2019). Manufactured sand can be an alternative to the river sand since river sand is expensive due to excessive cost of transportation from natural sources and also large scale depletion of these sources creates environmental problems. In this work concrete prepared with 100% replacement of natural sand by manufactured sand had given best results with respect to the mechanical and durability properties. Typically, 60% replacement of naturally available river sand by manufactured sand in concrete manufacturing was recommended. Due to the scarcity and environmental considerations of natural river sand, we can use the 100% replacement of natural river sand by manufactured sand is feasible with slightly increased water-cement ratio and cement content..

2. Halesh Kumar B T, (2017). In this work, manufactured sand is a best alternative for natural river sand in terms of strength and durability. Replacing natural sand by manufactured sand induces higher strength in concrete than the conventional concrete. It has better control over gradation and free from impurities. The shape of the aggregates may be maintained and desired zone can be achieved.

3. Neeraj Kumar, Anjali Jaglan, (2020). The research studies show that inclusion of small closely spaced and uniformly distributed fibres to concrete increases its performance as compared to the conventional concrete. These fibres in concrete act as crack-arresters and increase its strength characteristics such as compressive strength, tensile strength.

III. METHODOLOGY

3.1. Natural Sand vs. Manufactured Sand:

Tremendous growth in the infrastructure and depletion of natural source of river sand seeks the vision in the direction of alternate product called Manufactured Sand. Manufactured sand is obtained from crushing of hard granite stones. The crushed sand particles are washed and also by attrition process to make them appropriate to naturally available river sand surface texture. The flexural and compressive strength of the concrete had improved by using the properly processed manufactured sand. Better quality control will be achieved in manufacture sand since it is manufactured in a controlled environment when compared to the river sand. Manufactured sand is made artificially so zero per cent over sized materials will be available and it is highly recommended for reinforced cement concrete, brick or block works.

3.2. Factors Affecting Fibre Selection:

a) Volume of Fibre:

The fibre volume is an important factor influencing the properties of the concrete mix. Higher volume may cause decrease in workability of the concrete mix and lower volume may not fulfil the requirements of the design mix for which fibres are being used in concrete. So, suitable volume of fibre is to be selected for getting the desirable outcomes. Generally, fibre volume up to 2% is used in the concrete mix.

b) Aspect Ratio of Fibre:

Aspect ratio of fibre is defined as the ratio of length of the fibre to its diameter. Higher the aspect ratio, the more flexible the fibre. The fibres with lower aspect ratio yield higher compressive strength, a highly energy absorptive material.

c) Orientation of Fibre:

Generally, the fibres are randomly distributed during concrete mixing. However, they can be oriented in the direction of load application and can also be aligned in the direction perpendicular to the load application. However, it is observed that fibres aligned parallel to load offered more tensile strength than the randomly distributed and perpendicularly aligned fibres.

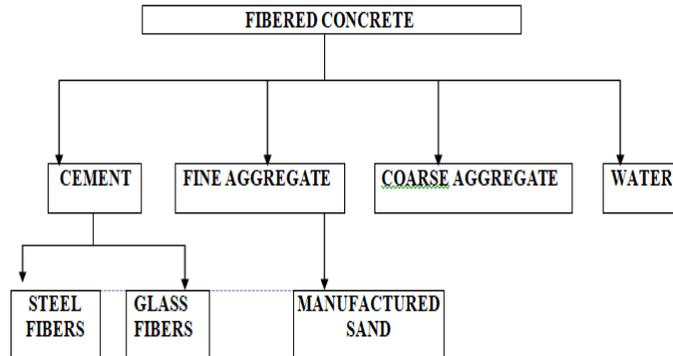


Figure 1: Block Diagram of Preparation of Fibered Concrete

3.3. Preparation of Concrete Mixes:

Preparation of fibered concrete is similar to that of cement concrete. The cement, river sand, manufactured sand; coarse aggregates were mixed in dry state. Then add prepared mixture water with binder ratio and mix thoroughly for 3–4 min so as to give homogeneous mix. At the optimum condition of the manufactured sand, we can add steel and glass fibres as additives to the homogeneous mix.

It was found that the fresh concrete was viscous, Cohesive and dark in colour. After making the homogeneous mix, workability of Fresh concrete was measured by flow table apparatus as per IS 5512-1983 and IS 1727-1967. Concrete cubes of size 150 mm& cylinders of 300mm long&100 mm diameter are casted in three layers for M-30 grade. Each layer is well compacted by tamping rod of diameter 16 mm. All cubes& cylinders were place on table vibrator and vibrated for 2 min for proper compaction of concrete. After compaction of concrete, the top surface was levelled by using trowel.

After 24 h of casting, all cubes were de moulded and then placed in an oven for thermal curing (The curing is at 600c for 24hrs). To avoid the sudden variation in temperature, the concrete cubes were allowed to cool down up to room temperature in an oven. Three cubes & cylinders were cast and tested for compressive strength& split tensile strength for each curing period.

3.4. Mix Design for M30 Grade:

- Cement content - 366.66 kg/m³
- Fine aggregate –733.33 kg/m³
- Coarse aggregate – 1283.31kg/m³
- Water content – 165 litres
- Water cement ratio - 0.45

Mix proportion = 1:2:3.5

IV. EXPERIMENTAL RESULTS

4.1. Workability:

Workability is a property of raw or fresh concrete mixture. In simple words, workability means the ease of placement and workable concrete means the concrete which can be placed and can be compacted easily without any segregation. Workability is a vital property of concrete and related with compaction as well as strength.

Workability Properties:

TABLE 1: PROPERTIES OF FRESH CONCRETE

S.NO	SLUMP (MM)	COMPACTION FACTOR
Nominal mix	45	0.9
10% of manufactured sand	53	0.9
20% of manufactured sand	54	0.9
30% of manufactured sand	53	0.9
40% of manufactured sand	52	0.9



4.2. Compressive Strength Test:

Compression test is the most common test conducted on hardened concrete, partly because it is an easy test to perform and partly because most of the desirable characteristic properties of concrete are qualitatively related to its compressive strength.

Table 2: compressive strength test results

MIX	COMPRESSIVE STRENGTH(N/mm ²)		
	7DAYS	14 DAYS	28DAYS
Conventional mix	24.60	30.30	38.30
10%Manufactured sand	24.87	31.23	38.97
20% Manufactured sand	25.52	32.60	39.54
30%Manufactured sand	26.14	34.50	40.26
40% Manufactured sand	26.03	33.21	38.20

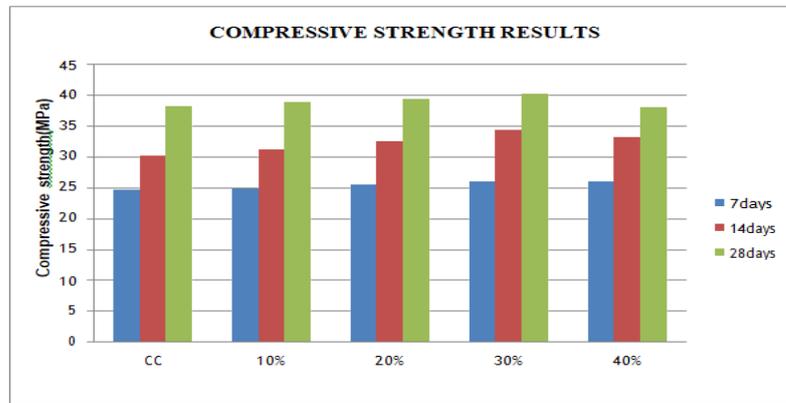


Figure 2: compressive strength results

4.3 SPLIT TENSILE TEST:

Cylinder splitting tension test: this is also sometimes referred as, “Brazilian test”. The test is carried out by placing a cylindrical specimen horizontally between the loading surfaces of a compression testing machine and the load is applied until failure of the cylinder, along the vertical diameter.

Table 3: split tensile test

MIX	SPILT TENSILE STRENGTH(MPA)		
	7 DAYS	14DAYS	28DAYS
Conventional	2.2	2.8	2.93
10%	2.4	2.9	2.98
20%	2.43	2.95	3.20
30%	2.9	3.15	3.28
40%	2.5	2.98	2.92

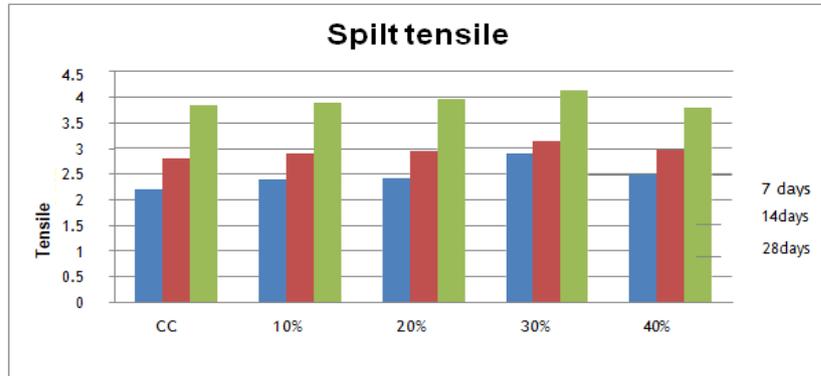


Figure 3: split tensile test result

5.4 COMPARASION OF COMPRESSIVE STRENGTH TEST RESULTS OF FIBERED CONCRTE WITH CONVENTIONAL CONCRETE:

Table 4: Compressive Strength Test Results of Fibered Concrete with Conventional Concrete

MIX	COMPRESSIVE TENSILE STRENGTH(MPA)		
	7 DAYS	14DAYS	28DAYS
Conventional	24.6	30.3	38.3
Manufactured sand+ fibers	26.6	34.4	40.26

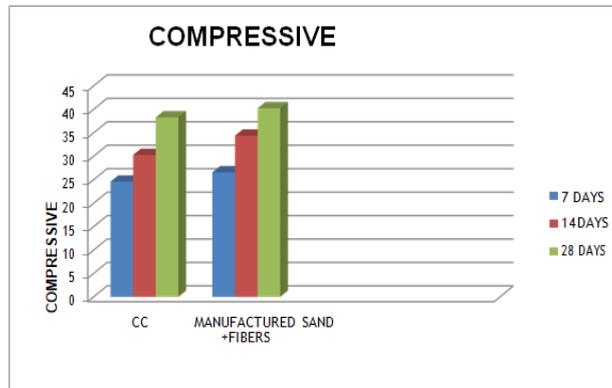


Figure 4: Compressive Strength Test Results of Fibered Concrete with Conventional Concrete

5.5 COMPARASION OF SPILT TENSILE STRENGTH TEST RESULTS OF FIBERED CONCRETE WITH CONVENTIONAL CONCRETE

Table 5: Spilt Tensile Strength Test Results of Fibered Concrete with Conventional Concrete

MIX	SPILT TENSILE STRENGTH(MPA)		
	7 DAYS	14DAYS	28DAYS
Conventional	2.2	2.8	3.84
Manufactured sand+ fibers	2.5	3.1	4.2

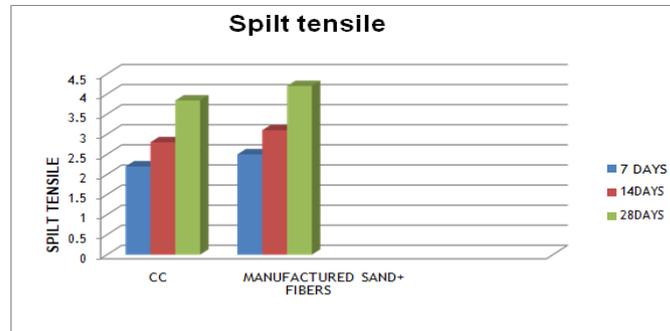


Figure 5: Spilt Tensile Strength Test Results of Fibered Concrete with Conventional Concrete

V. CONCLUSIONS

- Finally we concluded that the compressive strengths of the fibered concrete increases as compared to the conventional concrete with the replacement of manufactured sand and fibres from 0%, 10%, 20%, 30%, &40%.
- Finally we concluded that the split tensile strengths of the fibered concrete increases as compared to the conventional concrete with the replacement of manufactured sand and fibres from 0%, 10%, 20%, 30%, &40%.
- The replacement of sand with manufactured sand is done from 0% to 40%. The maximum compressive strength for 28 days is achieved for 30% replacement of sand by manufactured sand. The percentage increase in compressive strength for 30% replacement than the normal concrete.
- Hence, it can be concluded that fibered concrete is good enough to satisfy the requirements for compressive strength and flexural strength.
- From the experimental study, it is concluded that the manufactured sand can be used as a replacement for fine aggregate. It is found that 30% replacement of sand by manufactured sand & fibres gives maximum result in strength compared to normal concrete.

VI. FUTURE SCOPE

- Comparison of the strength parameters for different grades of concrete.
- Applicable for high strength concrete materials.
- Durability characteristics can be studied.
- Various types of fibres can be replaced.

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