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Effect of Steel Fibres on Concrete with M-Sand as Replacement of Natural Sand

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Abstract: This paper describes the experimental study of fibre reinforced concrete with manufacturing sand (M-Sand) in addition of crimped steel fibres. Normally a huge quantity of concrete is required for the construction but we know that concrete is weak in tension and strong in compression and the fine aggregate that normally used for concrete is natural river sand but our aim is to replace the natural sand by artificial sand (manufactured sand) and to increase the compressive and tensile strength of the concrete by addition of steel fibre .To over-come the difficulties due to excessive sand mining, M-Sand is used as fine aggregate. M-Sand is uniformly in size, produced from gravel crushers. The main objective of this research is to investigate the effect of steel fibres on concrete manufactured by M-sand as fine aggregate and develop a concrete. It is proposed to determine and compare compressive strength, tensile strength and flexural strength of the concrete grades M30 having different percentage of steel fibre 1%, and 10%, 20%, 30%, 40% and 50% by weight of M-sand added by weight of fine aggregates. Concrete cubes, cylinders and beams are tested at the age of 3, 7 and 28 days of curing. Finally the strength performance of slag blended concrete is compared with the performance of conventional concrete.

Keywords : Steel fiber, M-sand, compression test and split tensile test, flexural strength.

1. INTRODUCTION

In the recent years, the Indian construction and infrastructure industry has seen rapid development. The main natural raw material used by the construction industry is natural river sand as fine aggregate in concrete. Construction diligence with sustainability is of great importance. Sustainability is a broad term describing a desire to carry out activities without depleting resources without compromising the ability of future generations to meet their own needs. The term sustainable development can be described as enhancing quality of life and to improve social, economic and environmental conditions for present and future generations. Natural or River sand are weathered particles from rocks which are of various shapes and sizes depending upon the weathering action of rivers. In the present scenario, natural sand with required properties is not easily/locally available. In most of the situations, the natural sand is being brought from faraway places to the construction site. Such type of transporting the river sand from faraway places will increase the construction costs.

Also these natural river sand is also becoming unavailable due to many reasons. Hence it is very essential to find an alternate material that can substitute the natural river sand either partially or fully. The new material should also have the similar properties of that of the natural river sand. Hence the research around the world is focusing towards the usage of manufactured sand as partial/full replacement for river sand. Manufactured sand (M-sand) best substitute for river sand for construction activities. This M-sand is obtained during the crushing of hard granite stone. The M-sand is of cubical shape with grounded edges, washed and graded to as a construction material. The M-Sand usually consists of particles from 150 microns to 4.75 mm in suitable proportions. The proportion of finer particles in the M-sand should be more so that the percentage of voids will be lesser. Thereby the quantity of cement required for the construction activities will be reduced. Hence by using such types of M-sand will make construction economical without depleting the natural resources. Hence demand for using the M-sand for making concrete is increasing day by day as river sand cannot meet the rising demand of construction sector. The formation of natural river sand is very slow process and takes several years. Because of the limited supply, the cost of river sand is very high and regular supply is also not available. Under these circumstances use of M-sand becomes essential. Also the silt content and organic materials in the river sand is high compared with that of the M-sand which affects the durability and life of concrete structures.

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2. LITERATURE REVIEW

Mr. V. Gokulnath.Et al .(2018). In this paper we study about strength obtained by adding river sand and replacement of river sand with M sand in self compaction concrete with addition of steel fibers. The investigation derives the following conclusion. By adding steel fibers to fresh concrete compressive strength increases by resisting cracks and their by increasing the durability. Replacement of river sand with m sand gives a satisfactory strength and can be used as alternate material for river sand.

M.Adams joe et al.(2013) In this paper it is concluded that the M-Sand can be used as a replacement for fine aggregate. It is found that 50% replacement of fine aggregate by M-Sand give maximum result in strength and durability aspects than the conventional concrete. The results proved that the replacement of 50% of fine aggregate by M-Sand induced higher compressive strength, higher split tensile strength, higher flexural strength. Thus the environmental effects, illegal extraction of sand and cost of fine aggregate can be significantly reduced.

Shafeeq Ahmad .et al (2017). The comparison was between normal and FRC-MS (with 1% steel fibers and 50% replacement of natural sand to that of Manufacturing sand) and the test results proved that the inducing of the fibers of crimped steel and natural sand replaced by M-Sand has a greater values on all the aspect of the study made compared to the normal M30 grade design mix concrete.

Murthy Dakshina N R et al (2005) , in their paper entitled 'Splitting tensile strength of high volume fly ash concretes with and without steel fibres in different grades' have discussed about the effect of combination of fly ash and random steel fibres in improving tensile strength of concrete in lower, medium and higher grades. They have studied M25, M50 and M60 grades of concrete. They have used steel fibres with aspect ratio of 75 and volume fraction of 1%. They have made following comments on their studies. In lower grades ductility of concrete can be increased by replacing the cement by fly ash upto 20%. At 40% replacement ductility can be achieved by adding steel fibres of 1%. In medium grade the split tensile strength of concrete has been increased upto 30% replacement. 1% addition of fibres can improve tensile strength even at 40% replacement of cement by fly ash. There is an improvement in ductile behavior of concrete when steel fibres are added to it. In higher grade concrete ductility has been increased upto 10% replacement of cement by fly ash. At higher percentage replacement the brittleness of concrete has been increased. With steel fibres ductility can be improved upto 20% replacement. There is a drop in the split tensile strength at 30% and 40% replacements. For all grades on concrete there is overall improvement in the ductility when 1% fibres are added.

3. MATERIALS PROPERTIES AND EXPERIMENTAL INVESTIGATION

3.1MATERIALS

Raw materials required for the concreting operations of the present work are M-SAND, steel fibers, cement, fine aggregate, coarse aggregate, and water.

3.2CEMENT

Ordinary Portland cement is the most common type of cement in general use around the world as a basic ingredient of concrete, mortar, stucco, and most non- specialty grout. Cement is the main ingredient in manufacturing of concrete. The characteristics of concrete will be greatly affected by changing the Cement content. The Cement used in this project is Ordinary Portland Cement of 53 grade confirming to IS 12269 – 2013.

S No	Properties	Values observed
1	Specific Gravity	3.15
2	Normal consistency	32%
3	Initial setting time	32 min
4	Final setting time	540 min
5	Soundness	7.3 mm

3.1 Physical properties of Ordinary Portland cement -53 Grade

3.3FINE AGGREGATE

Gradation refers to the particle size distribution of aggregates. Grading is a very important property of aggregate used for making concrete, in view of its packing of particles, resulting in the reduction of voids. This in turn influences the water demand and cement content of concrete.

Grading is described in terms of the cumulative percentages of weights passing a particular IS sieve. IS 383-1970 specifies four ranges or zones for fine aggregate grading. Table gives the range of percentage passing for each zone.

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S.No	Property	Result
1	Fineness Modulus	2.7
2	Specific Gravity	2.65

3.2 Physical properties of fine aggregates

3.4 COARSE AGGREGATE

The aggregate which is retained over IS Sieve 4.75 mm is termed as coarse aggregate. The normal maximum size is gradually 10-20 mm; however particle sizes up to 40 mm or more have been used in Self Compacting Concrete. Gap graded aggregates are frequently better than those continuously graded, which might expensive grader internal friction and give reduced flow.

Locally available coarse aggregate having the maximum size of 20 mm and minimum size of 12.5 mm was used in this work. The aggregates were washed to remove dust and dirt and were dried to surface dry condition. The aggregates were tested as per IS: 383-1970.

S.No	Property	Result
1	Fineness Modulus	8.04
2	Specific Gravity	2.72

3.3 Physical properties of coarse aggregates

3.4 M-SAND

Manufactured sand (M-Sand) is an additional of river sand for concrete structures. Manufactured sand is created as rigid granite stone by crushing The crushed sand is of cubical form with grounded boundaries, washed and classified as a building material. The extent of manufactured sand (M-Sand) is a reduced amount of 4.75 mm. M-Sand is artificial sand manufactured from crushing hard gravel into minor sand-sized angular molded units, wash away as well as excellently graded to be used as building aggregate. It is a greater substitute for River Sand for building purposes., a

Parameters	Size
Shape	Cubica
Gradation	Controlled.
Particle passing 75 micron	15 percent
Impurities	Absent
Grading Zone	II
Water Absorption	2.7
Soundness	Relatively Sound
Alkali-Silica Reactivity	0.006

Table 3.4 Physical properties of M-SAND

3.5 STEEL FIBER

Steel fiber is a metal reinforcement. Steel fiber for reinforcing concrete is defined as short, discrete lengths of steel fibers with an aspect ratio (ratio of length to diameter) from about 20 to 100, with different cross-sections, and that are sufficiently small to be randomly dispersed in an unhardened concrete mixture using the usual mixing procedures. A certain amount of steel fiber in concrete can cause qualitative changes in concrete's physical property, greatly increasing resistance to cracking, impact, fatigue, and bending, tenacity, durability, and other properties . Basically, steel fiber can be categorized into five groups, depending on the manufacturing process and its shape and/or section: cold-drawn wire, cut sheet, melt-extracted, mill cut, and modified cold-drawn wire.

type	Single hooked
Specific gravity	7.85
Diameter	0.5
Length	30
Aspect ratio (l/d)	60

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Tensile strength (MPa)	1100
Elastic modulus (GPa)	205

Table 3.5 physical properties fibers of steel

4. MIX DESIGN

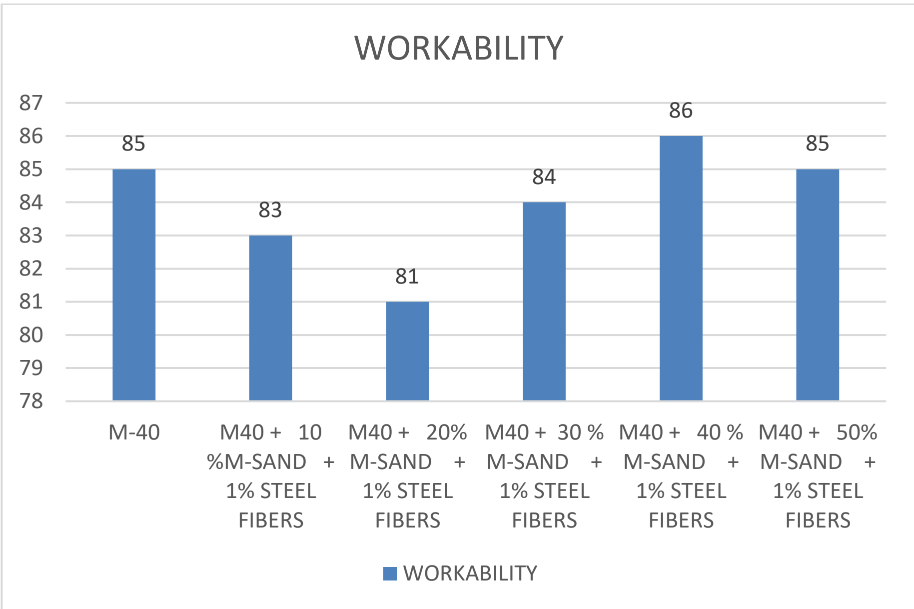
Cement	Fine aggregate	Coarse aggregate	Water
562.85	653.32	1018.53	197.16
1	1.16	1.80	0.35

Table no 4.1 mix proportion for m40 grade

5. RESULTS

5.1 SLUMP CONE TEST

The strength of concrete of a given mix proportion is seriously affected by the degree of its compaction. It is therefore important that the consistency of the mix is such that the concrete can be transported, placed and finished sufficiently easily and without segregation. A concrete satisfying these conditions is said to be workable. Workability is a physical property of the concrete depending on the external and internal friction of the concrete matrix; internal friction being provided by the aggregate size and shape and external friction being provided by the surface



Graph no 5.1 workability results

5.2 COMPACTION FACTOR TEST

Scope and Significance Compaction factor test is adopted to determine the workability of concrete, where nominal size of aggregate does not exceed 40mm, and is primarily used in laboratory. It is based upon the definition, that workability is that property of the concrete which determines the amount of work required to produce full compaction. The test consists essentially of applying a standard amount of work to standard quantity of concrete and measuring the resulting compaction. To find the workability of freshly prepared concrete, the test is carried out as per specification of IS: 1199-1959.

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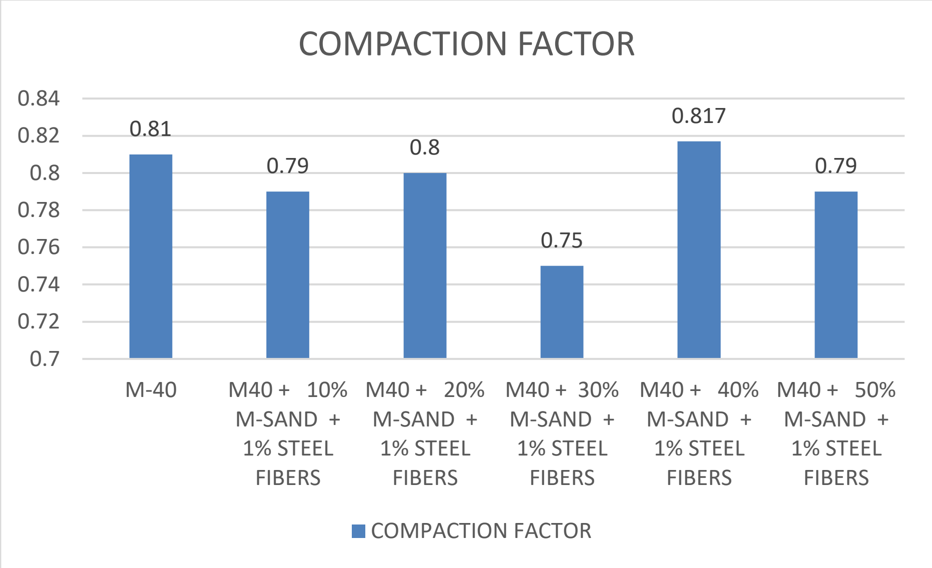
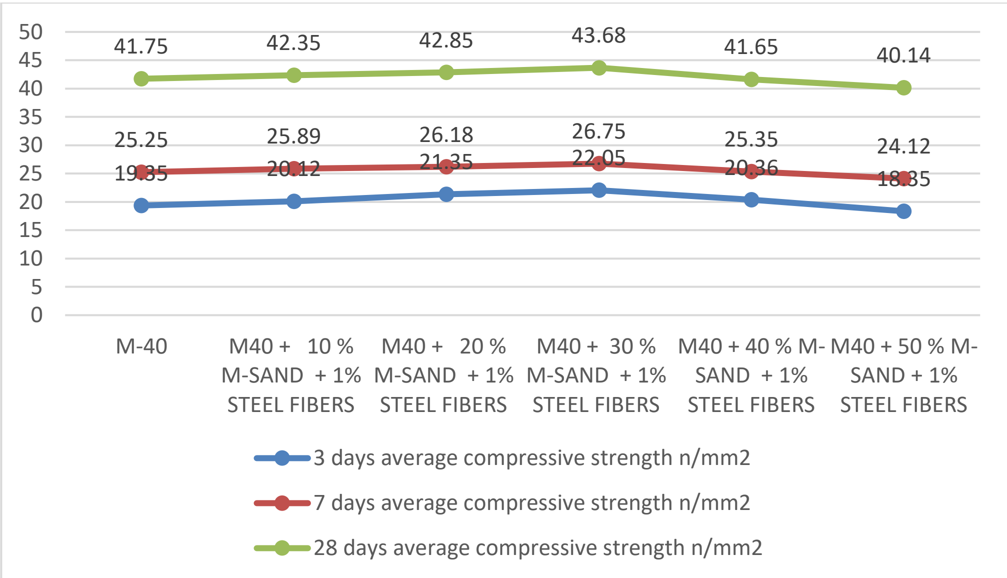


Graph no 5.2 compaction factor results

5.3 COMPRESSION TEST ON CONCRETE CUBES

The determination of the compressive strength of concrete is very important because the compressive strength is the criterion of its quality. Other strength is generally prescribed in terms of compressive strength. The strength is expressed in N/mm2. This method is applicable to the making of preliminary compression tests to ascertain the suitability of the available materials or to determine suitable mix proportions. The concrete to be tested should not have the nominal maximum size of aggregate more than 20mm test specimens are either 15cm cubes or 15cm diameter used. At least three specimens should be made available for testing. Where every cylinder is used for compressive strength results the cube strength can be calculated as under. Minimum cylinder compressive strength = 0.8 x compressive strength cube (10 cm x 10 cm) The concrete specimens are generally tested at ages 3 days 7 days and 28 days. The cubes are generally tested at 3 days 7 days and 28 days



Graph no 5.3 compressive strength results for 3, 7 and 28 days

3.4 SPLIT-CYLINDER TEST

It is the standard test, to determine the tensile strength of concrete in an indirect way. This test could be performed in accordance with IS : 5816-1970.A standard test cylinder of concrete specimen (300 mm X 150mm diameter) is placed horizontally between the loading surfaces of Compression Testing Machine. The compression load is applied

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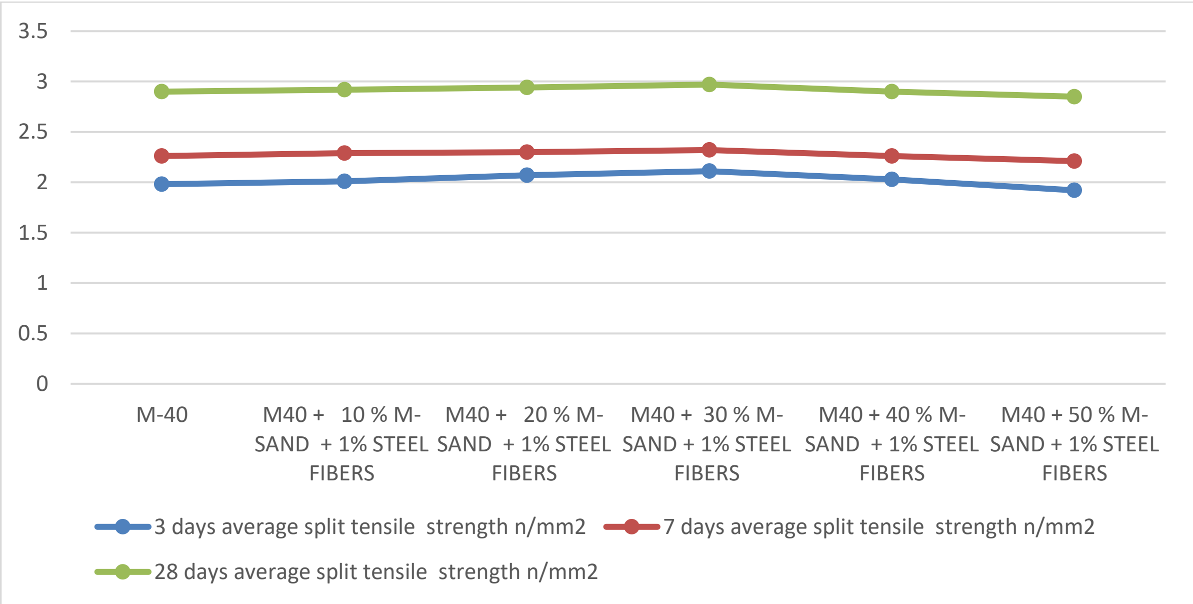
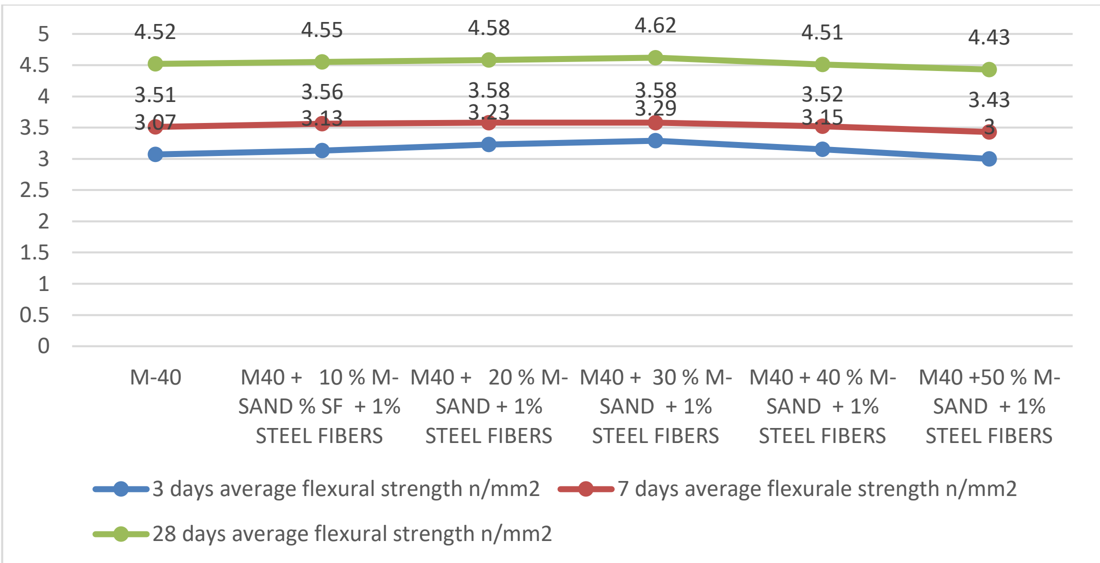
diametrically and uniformly along the length of cylinder until the failure of the cylinder along the vertical diameter. To allow the uniform distribution of this applied load and to reduce the magnitude of the high compressive stresses near the points of application of this load,



Graph no 5.4 split tensile strength results for 3, 7 and 28 days

5.5 FLEXURAL STRENGTH OF CONCRETE

The flexural strength would be the same as the tensile strength if the material were homogeneous. In fact, most materials have small or large defects in them which act to concentrate the stresses locally, effectively causing a localized weakness. When a material is bent only the extreme fibers are at the largest stress so, if those fibers are free from defects, the flexural strength will be controlled by the strength of those intact 'fibers'. However, if the same material was subjected to only tensile forces then all the fibers in the material are at the same stress and failure will initiate when the weakest fiber reaches its limiting tensile stress. Therefore, it is common for flexural strengths to be higher than tensile strengths for the same material. Conversely, a homogeneous material with defects only on its surfaces (e.g., due to scratches) might have a higher tensile strength than flexural strength.



Graph no 5.5flexural strength results for 3, 7 and 28 days

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6. CONCLUSION

1. We gain the highest compressive strength at the percentage of different admixtures added in M-40 grade concrete (M40 + 30 % M-SAND + 1% STEEL FIBERS) – 43.68 N/mm2
2. We gain the highest split tensile strength at the percentage of different admixtures added in M-40 grade concrete (M40 + 30 % M-SAND + 1% STEEL FIBERS)– 2.97 N/mm2
3. We gain the highest flexural strength at the percentage of different admixtures added in M-40 grade concrete (M40 + 30 % M-SAND + 1% STEEL FIBERS) – 4.62 N/mm2

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