Comparative Study Between Natural and Artificial Fiber Reinforced Concrete by Partial Replacement of Fine Aggregate with Manufactured Sand

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Abstract **- This work investigates the strength properties of fiber reinforced concrete by a comparative study between Natural (sisal) and Artificial (steel) fiber reinforced cement concrete by partial replacement of fine aggregate with M-sand (Robo sand) at constant percentage of 50%. In our project, we would like to take the naturally available fiber named sisal fiber and artificially available fiber named steel fibers is taken as a substitute material to the reinforcement. The fibers of sisal and steel are used with same ratios comparatively by varying 0.25%, 0.5%, 0.75%, & 1% respectively to the weight of cement. Natural fibers are generally needed chemical treatment, so the sisal fibers are treated with Noah solution and both the fibers are taken in to 35mm length. The following tests are conducted by such as compressive strength test, split tensile strength test, flexural strength test using M30 grade of concrete. As per my calculation M30 target strength for the compressive strength, split tensile strength and flexural strength of 7days, 28days concrete is 31.72 & 43.44, 5.32 & 6.28, 5.96 & 7.09 at 1% sisal fiber and 33.47 & 49.96, 5.36 & 6.38, 6.12 & 7.28 at 1% steel fibers by 50% replacement of fine aggregate with m-sand. In this work, replacement of fine aggregate with manufactured sand has resulted in a considerable increasing the mechanical properties of concrete. M-sand at 50% and both fibers in the concrete were identified as optimum 1% in sisal fibers and 1% in steel fibers of M30 grade of concrete to a conventional concrete. As per test results sisal fiber reinforced concrete achieved nearly same mechanical properties compare to the steel fiber reinforced concrete and steel fiber reinforced concrete is achieved better mechanical properties compare to the sisal fiber reinforced concrete.**

Index Terms **- Manufactured sand, sisal fiber, steel fiber, compressive strength test, split tensile strength test, flexural strength test.**

1.INTRODUCTION

Concrete is the most generally utilized material in civil construction. It has the properties of high strength, low cost, structural stability & durability etc. Therefore, it is mandatory to include recycled materials as a replacement to construction materials are necessary to reduce the space occupied for landfill and also reduces the demand of natural sources. The generation of Waste materials increased now days with more population and most of these waste materials are non-degradable. The use of plastic in concrete improves the basic properties of concrete, so PET waste utilization in concrete is a strategy to take out destructive impacts of PET to condition thus less ecological debasement happens. Concrete is strong in compression and weak in tension. So, we will provide the reinforcement to the concrete. Majorly steel bars are used as the reinforcement. Many of the researches are in progress to find a substitute to this material. In this project we would like to take the naturally available fiber named sisal fiber and artificially available fiber named steel fibers is taken as a substitute material to the reinforcement and studied strength properties of sisal fiber reinforced concrete and steel fiber reinforced concrete by partial replacement of fine aggregate with M-sand by using different percentage of fibers to mix proportions of M30 grade of concrete.

2.LITERATURE SURVEY

2.1.SHIVANG D JAYSWALL, A.G.HANSORA et al In this paper describe the experimental study of F.R.C with m-sand in addition of crimped steel fibers. In this paper M25 & M30 grade of concrete mixes and different percentage of steel fibers are 0%, 1%, 1.5% and 2% using to determine the compressive strength and split tensile strength of the concrete. In this

investigation conduct the compressive strength and split tensile strength tests of both M25 & M30 grade of concrete is continuously increased the tensile strength the increasing the percentage of steel fibers. The reinforcing efficiency of fiber addition was dependent on the optimum dosage level of steel fibers up to 1% to 1.5% of crimped steel fibers since increased fiber addition resulted in loss in workability. C.S was decreased of both grades in the case of 2% steel fibers were used.

2.2. Ms. CHAITHRA T.P, ARPITHA B et al

In this paper concentrate about the behavior of concrete when ground nutshell ash and rice husk ash and sisal fibers are added in concrete and using the mix design of M30 grade. G.S.A & R.H.A are added in concrete of 2.5%, 5%, 7.5% and 10%, sisal fibers are 2% constant. In this investigation compressive and split tensile strength of concrete specimens are given optimum results with 2.5% replacement of cement by G.S.A & R.H.A at 7 days and 28days.finally the achieved compressive strength and split tensile strength was more in G.S.A than compared R.H.A.

2.3. SHREYAS.K et al

Generally, the scarcity of fine aggregate alternatively use m-sand. In this investigation determine the characteristics of m-sand as a partial replacement of fine aggregate and the use M25 grade of concrete. The percentage of m-sand is varying from 0% to 40%, from this study it can be concluded that the m-sand can be used as replacement material for filler material and up to 40% replacement will gives excellent results both in strength and quality aspects.

OBJECTIVE OF THE PRESENT PROJECT

To determine the strength properties of sisal fiber reinforced concrete by 50% replacement of fine aggregate with manufactured sand." 2. To determine the strength properties of steel fiber reinforced concrete by 50% replacement of fine aggregate with manufactured sand." 3. To determine the comparative strength properties of sisal and steel fibers. 4. To conduct the tests of compressive strength test, split tensile test, and flexural test. 5. To determine the influence of manufactured sand in a concrete and conclude which fiber is more suitable for the addition of R.C.C.

3.MATERIALS USED

3.1 MANUFACTURED SAND

Manufactured sand (M.S) is one of the best replacement materials in fine aggregate. Manufactured sand is produced by crushing hard granite rock to a powder form by used vertical shaft impact crusher. Generally, the size of manufactured sand is in-between 4.75mm to 150µ is used for R.C.C. The shape of manufacture sand is angular and has a regular texture. The physical properties of manufactured sand are nearly same to the natural (river) sand. In India Karnataka is mostly produced the manufacture sand with a 120+ m-sand plants.

Manufactured (Robo) sand

Properties of Manufactured sand

S.NO.	PARTICULARS OF TEST	VALUE	RELEVANT IS CODE
1	Specific gravity	2.62	IS 2386 (Part III):1963
2	Water absorption	1.75%	IS 2386 (Part III):1963
3	Bulk density(Kg/m^3)	1680	IS 2386 (Part III):1963
4	Fineness modulus	3.10	IS 2386 (Part I):1963
5	Clayand silt content	1.78	IS 383: 1970

3.2 SISAL FIBER

Sisal fiber is one of the natural fibers. It is plant-based fiber to obtain from the sisal plant name formally known as agave sisalana. It is easily cultivated and grows easily. Fiber is exacted from the leaves of sisal plant. A sisal plant is produces about 200 ± 250 leaves and each leaf contains 1000 ± 1200 fiber bundles, Nearly 4.5 million tons of sisal fiber is produced every year. Sisal fiber is commercially used in composites has increased due to strength, low density, eco-friendliness and cost effectiveness. Sisal fibers are light in weight, so it is used in R.C.C to reduce the weight of concrete.

Sisal fiber

Chemical and physical properties of sisal fiber

S. No	Chemical Properties	value	Physical properties	Value
1	Cellulose	65%	Average length (mm)	300
2	Hemicelluloses	12%	Average diameter (mm)	0.12
3	Lignin	9.9%	Density (g/cm^3)	1.45
4	Waxes	2%	Average tensile strength (N/ mm^2)	1090
5	Total	100%	Elongation (%)	18.2%
6			Water absorption (%)	76.7%

3.3 STEEL FIBERS

Steel fibers are one of the artificial fibers. It is normally named as man-made or metallic fibers. These fibers are manufactured in industries, but manufacturing process is very dangerous to compare natural fibers. They are easily available in market so it is the most used fibers in fiber reinforced concrete. It is used in a R.C.C to improve impact and abrasion resistance. The strength properties of steel fiber reinforced concrete are depends on the steel fiber aspect ratio, length, hooking and diameter.

Steel fibers (hooked)

Physical properties of steel fiber

S. No	Physical properties	Value
1	Average length (mm)	35mm
2	Average diameter (mm)	0.56
3	Density (g/cm^3)	780
4	Average tensile strength (N/ mm^2)	>1100
5	Ultimate elongation (%)	<2
6	Specific gravity	7.80
7	Aspect ratio (l/d)	62.5

4.RESULTS

SLUMP CONE TEST

The test was conducted for fresh concrete prepared before the molding process. In this study total of 27 concrete mixes are prepared at different times. Workability Results obtained from slump cone test for M30 grade of concrete is shown.

S. No.	% of mix	Slump (mm) Sisal fibers	Slump (mm) Steel fibers
1	0.25%	65	75
2	0.5%	60	70
3	0.75%	55	65
4	1%	50	60

Observations for slump test value

COMPRESSIVE STRENGTH TEST

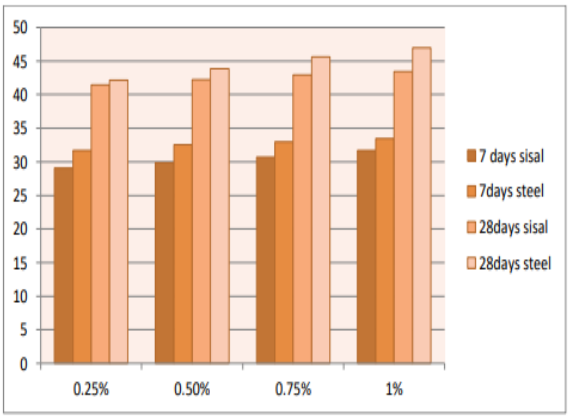
Compressive strength is obtained by applying crushing load on the cube surface. So it is also called as Crushing strength. A total of 54 cubes of size 150 x 150 x 150mm were casted and tested for 7 days, and 28 days testing each of 6 specimens.

S. No	% of sisal fiber	Compressive strength (N/mm²)		Average compressive strength (N/mm²)	
		7 days	28 days	7 days	28 days
1	C.C (0)	26.08	37.58	26.95	39.46
		27.42	40.24		
		27.35	40.56		
2	0.25%	28.11	40.28	29.05	41.48
		29.24	42.24		
		29.80	41.92		
3	0.5%	29.52	41.92	29.88	42.26
		28.79	42.88		
		30.61	41.98		
4	0.75%	31.88	42.62	30.67	42.92
		28.76	43.36		
		31.37	42.78		
5	1%	32.76	42.74	31.72	43.44
		30.10	44.44		
		32.30	43.14		

Compressive strength test results for sisal fiber

S. No	% of steel fiber	Compressive strength (N/mm²)		Average compressive strength (N/mm²)	
		7 days	28 days	7 days	28 days
1	C.C (0)	26.08	37.58	26.95	39.46
		27.42	40.24		
		26.08	37.58		
2	0.25%	29.88	42.02	31.68	42.16
		31.12	40.80		
		33.04	43.66		
3	0.5%	31.88	44.06	32.52	43.88
		32.96	42.98		
		32.72	44.60		
4	0.75%	31.94	45.98	32.98	45.62
		33.48	46.40		
		33.52	44.48		
5	1%	32.48	46.24	33.47	46.96
		33.97	46.86		
		33.96	47.78		

Compressive strength test results for steel fiber



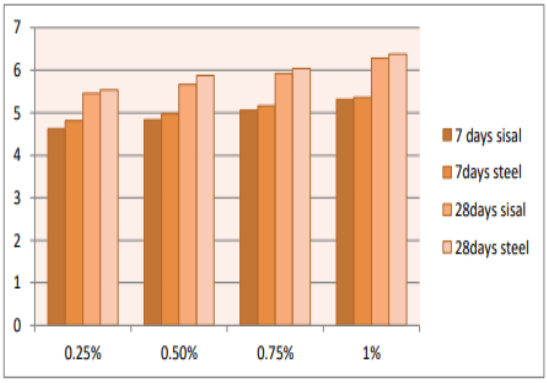
Compressive Strength M30 grade of concrete at 7days and 28days

SPLIT TENSILE STRENGTH TEST

The split tensile strength obtained by testing of the150mm dia and 300mm length cylindrical specimen for M30 grade of concrete to all the mixes designed for various replacements are given below:

S. No	% of steel fiber	Split tensile strength (N/mm^2)		Average split tensile strength (N/mm^2)	
		7 days	28 days	7 days	28 days
1	C.C (0)	4.28	5.08	4.51	5.05
		4.59	4.93		
		4.66	5.14		
2	0.25%	4.68	5.38	4.81	5.54
		4.94	5.96		
		4.81	5.28		
3	0.5%	4.82	5.78	4.98	5.88
		5.16	6.16		
		4.96	5.70		
4	0.75%	4.88	5.88	5.16	6.04
		5.36	6.29		
		5.24	5.95		
5	1%	5.48	6.28	5.36	6.38
		5.92	6.76		
		4.68	6.10		

Split Tensile Strength test results for steel fiber



Split Tensile Strength M30 grade of concrete at 7days and 28days

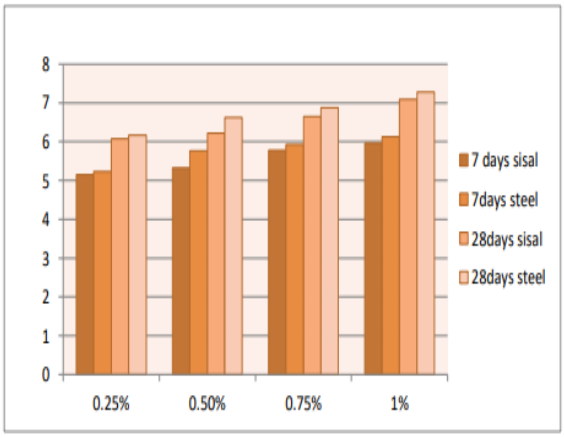
FLEXURAL STRENGTH TEST

Flexural test was performed on beams by placing them on ASTM find out the flexural strength. 150mm x 150mm x 500mm length specimen beams are using to find out the flexural strength of the M30 grade of fiber reinforced concrete. The test results are given by a tabular form in below:

S. No	% of sisal fiber	Flexural strength (N/mm^2)		Average flexural strength (N/mm^2)	
		7 days	28 days	7 days	28 days
1	C.C (0)	4.68	5.45	4.98	5.68
		5.12	5.98		
		5.14	5.61		
2	0.25%	5.02	5.88	5.15	6.07
		5.28	6.24		
		5.15	6.09		
3	0.5%	4.98	5.83	5.32	6.22
		5.45	6.48		
		5.53	6.35		
4	0.75%	5.60	6.34	5.78	6.65
		6.02	6.88		
		5.72	6.73		
5	1%	5.42	6.74	5.96	7.09
		6.18	7.48		
		6.32	7.05		

Flexural Strength test results for sisal fiber

S. No	% of steel fiber	Flexural strength (N/mm^2)		Average flexural strength (N/mm^2)	
		7 days	28 days	7 days	28 days
1	C.C (0)	4.68	5.45	4.98	5.68
		5.12	5.98		
		5.14	5.61		
2	0.25%	5.08	5.88	5.23	6.17
		5.56	6.32		
		5.05	6.31		
3	0.5%	5.48	6.54	5.76	6.62
		5.99	7.01		
		5.81	6.31		
4	0.75%	5.64	6.76	5.92	6.88
		6.18	7.08		
		5.94	6.80		
5	1%	5.88	6.84	6.12	7.28
		6.42	7.48		
		6.06	7.52		



Flexural strength M30 grade of concrete at 7days and 28days

CONCLUSION

In this work, replacement of fine aggregate with manufactured sand has resulted in a considerable increasing of the mechanical properties of concrete. M-sand at 50% and both the fibers were identified as optimum 1% in sisal fibers and also 1 % in steel fibers of M30 grade of concrete to a conventional concrete.

In this comparative study to the sisal (natural) fiber reinforced concrete to steel (artificial) fiber reinforced concrete, as per test results sisal fiber reinforced concrete achieved nearly same mechanical properties compare to the steel fiber reinforced concrete and steel fiber reinforced concrete is achieved better mechanical properties compare to the sisal fiber reinforced concrete.

Finally, in this comparative study concludes both the natural fibers and artificial fibers are suitable for fiber reinforced concrete but artificial fibers are more suitable for fiber reinforced concrete compare to the natural fibers. And also, in this comparative study test results are concludes the manufactured sand is more suitable for replacement of natural (fine aggregate) river sand in the concrete.

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