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An Experimental Investigation on Strength Properties of Recron 3s Fiber and Sisal Fiber

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ABSTRACT
The aggregates both coarse and fine are bonded together by cement and mixed with water to form concrete. Fiber reinforced concrete is of high strength compared to normal concrete and also reduces the cracks due to shrinkage. Each type of fiber has its characteristic properties and limitations. Some of the fibers that could be used are Recron 3S Fiber, polypropylene, steel, nylon, asbestos, coir, glass, carbon fibers, etc. In this investigation we are using Recron 3S fiber and Sisal fiber. The advantage of Recron 3S fiber is to increase the compressive strength and tensile strength. Sisal fiber is one of the most widely used natural fibers and it can be easily harvested. The advantage of sisal fiber is high specific strength. Strength and durability are the important properties of sisal fiber. In this present investigation workability, strength properties of concrete with Recron 3S fiber and Sisal fiber in different proportions of 0%, 0.2%, 0.4%, 0.6%, 0.8% The workability parameters of M30 grade of concrete using flow test, slump cone test and compaction factor test. The strength parameters of M30 grade of concrete using Compressive strength test, Flexural strength test and Split tensile strength test. For strength parameters, each grade of concrete for each proportion, cubes and beams are casted for 7days, 14 days and 28 days.

Key words: Recron 3S Fiber, Sisal Fiber, Compressive strength, Flexural Strength, Split tensile strength.

INTRODUCTION:

Concrete is most widely used building material. It is versatile, has desirable engineering properties, can be moulded into any shape and more importantly, it is produced with cost-effective material. Although recent developments in plastics and other lighter material have resulted in the replacement of concrete in some applications, the use of concrete worldwide has increased phenomenally, especially and improved the performance and use of concrete in structures. Concrete technology has made a tremendous stride in the past decade. Concrete is now no longer a material consisting of cement, aggregates, water and admixtures but it is an engineered material with several new constituents performing satisfactorily under different exposure conditions. Concrete today can be tailor made for specific applications and it contains different material like micro silica, colloidal silica and many other binders, filler and pozzolanic materials. Cement and concrete are most

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constituents used in the concrete production. Cement and aggregate are inevitably led to continuous and increasing demand of natural materials used in the concrete production. Proper utilization of concrete and also for protecting the environment, alternate materials are to be considered. Alternate materials are nothing but waste materials. Concrete is a composite material made from several readily available constituents (aggregates, sand, cement, water). Concrete is a multipurpose material that can easily be mixed to meet a variety of particular needs and formed to virtually any shape. Workability, strength, and durability are the three basic properties of the concrete.

Review of Literature:

[1]S. Prem Kumar studied Polyester FRC. In this study, Recron 3s fiber is added as an additive to the concrete. This fiber is added as 1%, 2% by the weight of fine aggregate in order to improve its performance. The Compression strength, split tensile strength and flexure strength of M25, M60 and M80 grade concrete are tested for 14, 28 and 56 days of curing and compared to find the optimum dosage of Recron 3s. 1% Recron 3s in concrete provided better results than 2% Recron 3s in concrete.

[2]Korrapati Anil Kumar studied the strength properties of concrete with Recron 3s fiber in proportions of 0%, 0.2%, 0.3% and 0.4% for M25 and M40 grade concrete cubes, cylinders and prisms. The investigation is to study the workability parameters of M25 and M40 grades of concrete using slump cone test, Compaction factor test, and Vee-bee time test. For strength parameters, each grade of concrete for each proportion, cubes, cylinders, prisms were casted for 7days, 28days, 56days and 91 days strength. The Recron fiber of 0.3% showed better results for M25 and M40 grades of concrete.

[3]Rakesh Kumar discussed the effects of polypropylene fiber on the properties of a paving grade concrete mix of 48 MPa compressive strength at 28 days. Six concrete mixes with fiber dosages 0.05%, 0.10%, 0.15% by volume fraction besides the control concrete mix were manufactured. The study suggested a significant reduction in settlement and drying shrinkage without significant change in compressive strength for the concrete mixes reinforced with fiber.

[4]V.Prahatheswaranstudied comparison of Recron 3s fiber reinforced concrete elements with the conventional concrete specimens. Recron 3s fiber reinforced specimens having different fiber -volume fractions will be investigated. The parameters of investigation include compressive strength, split tensile strength and flexural strength. The specimens will be incorporated with 0.5 and 1% volume fraction of Recron 3S fibers in different proportions. It was found that both the compressive strength and the split tensile strength of the Recron 3S fiber reinforced concrete are more than that of the conventional concrete specimens.

[5] Ridha Nehvi describes the enhancement in the strength of the M35 grade concrete mix by the addition of Polypropylene fibers (recron 3S) in the proportion of 0.0%, 0.1%, 0.2%, 0.3%, 0.4%, and 0.5% by volume of concrete. Compressive strength, split tensile strength and flexural strength were carried on hardened concrete. Recron 3s showed improved

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tensile strength of concrete from 2.65MPa to 3.4MPa and flexural strength from 5.13MPa to 6.83MPa after 28 days of curing. Increase in concentration of recron 3s beyond 0.3% showed decline in flexural strength from 6.83MPa to 5.7MPa.

[6]MohammedSafiuddin compared Fiber Reinforced Concrete with the Plain Cement Concrete. Recron 3s at various at dosages of 0.25%, 0.50%, 0.75% and 1.00% by weight of cement in the mix design is studied to find the optimum dosage of Polyester fiber for concrete. The strength of concrete increased for 0.25%, 0.5% and 0.75% and the strength decreased when the Recron fiber was increased to 1%.

[7]Dr. Vagheesha studied the effects of Polyester fiber on concrete. This work deals with results of experimental investigation of effect of use of Recron 3S polyester fiber on compressive strength of concrete. This has resulted into casting, curing and testing of 27 cube specimen of size (150 x 150 x 150) mm. Recron 3s of 0.2-0.4% by weight of cement is sufficient for getting better compressive strength of concrete.

[8] **Kolli.Ramujee** studied the strength properties of Polypropylene fiber reinforced concrete. The compressive strength, splitting tensile strength of concrete samples made with different fibers amounts varies from 0%, 0.5%, 1%, 1.5% and 2.0% were studied. The samples with added Polypropylene fibers of 1.5 % showed better results in comparison with the others.

[9] **Damayanti G Badagha**studied Polyester Fiber Reinforced mortar as a cement concrete pavement material. Specimens containing fiber of 0.0, 0.3, 0.4, 0.5, 0.6, 0.8 and 1.0 % are prepared and tested. It is demonstrated that certain amount of fibers enhances the compressive as well as split tensile capacity of the fiber reinforced cement mortar. The Compressive strength of mortar was increased to 17.68 % at 7 days and Split tensile strength was increased by 32.58 % at 7 days and 70.37 % at 28 days.

[10] **Venkateswaranswaminathan**

studied the natural fiber increase the strength of concrete. The optimum percentage of sisal fiber for maximum strength was 1% for compressive strength and 1.5% for split tensile strength. Workability decreses with increase in percentage of sisal fiber replaced with 0.5%, 1%, 1.5% of volume of cement. The flexural strength of the sisal fiber replaced beam the strength attained is higher than normal strength concrerte. The initial crack load value is increased it indicates strength of concrete is improved than conventional concrete. The maximum ultimate flexural strength of beam was attained at 1% replacement of sisal fiber concrete.

[11] **Dr. P. Srichandana** studied the sisal fibers are mostly used fiber for fiber reinforced concrete out of available natural fibers in market. It is confirmed that the compressive and flexural strength of concrete can be significantly improved using external sisal fiber wraps. In addition, the ductility of the concrete is increased significantly. The final failure of the confined concrete cylinder is provoked by the onset of rupture of the composite wrap whereas the final failure of the beam is also triggered by the rupture of the SFRC. Addition

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of fibers not only increases tensile strength but also increases bond strength, decreases permeability, also resists seismic loading as well through its ductility.

RECRON 3S FIBER:

Reliance industry limited (RIL) has launched Recron 3s fibers with the objective of improving the quality of plaster and concrete. Recron 3s is a triangular polyester fiber in cross section with cut length of 6mm & 12mm which is being widely used in the Indian construction industry market. It is much cheaper than any other imported construction fibers. At the specified dosage of 0.25% by wt of cement there are millions of fibers which form a mesh in the concrete. The spacing is approx less than 1mm between any two fiber filaments in any coordinate of the matrix.

This describes the general properties and application of recron 3s fiber reinforced concrete used in construction. The thinner and stronger elements spread across entire section, when used in low dosage arrests cracking.

ROLE OF RECRON 3S FIBER:

Controls cracking Recron 3S prevents the micro shrinkage cracks developed during hydration, making the structure inherently strong. Further, when the loads imposed on concrete approach that of failure cracks will propagate, sometimes rapidly. Addition of Recron 3S to Concrete and plaster arrests cracking caused by volume change, simply because 1kg of recron 3s offers millions of fibers which support mortar or concrete in all directions. Recorn 3S fiber reduces rebound splattering of concrete and shotcrete. The modules of elasticity of Recron 3S is high with respect to the modules of elasticity of concrete or mortar binder. Recron 3S fiber helps in increasing flexural strength. Recron 3S fibers can be used in concrete elements such as RC and PC lintel, beam, column, flooring and wall plastering, foundation, tanks, tiles, plastering, roads and pavements, hollow blocks and precasts.

ADVANTAGES OF RECRON 3S FIBERS IN REINFORCED CONCRETE:

1. Increases tensile strength
2. Reduces permeability
3. Greater impact resistance
4. Easy to use and mix

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5. Arrest drying shrinkage
6. Controls cracking
7. Increases flexibility
8. Increases abrasion resistance

APPLICATIONS OF RECRON 3S FIBER REINFORCED CONCRETE:

1. Used in footings, foundations and tanks
2. Plain concrete and wall plastering
3. Pipes, pre-stressed beams
4. Roads and pavements
5. Bridges and dams

SISAL FIBER :

The most important reason for integrating the sisal fiber into the cement matrix is to increase the toughness, tensile strength and the bend features of the resulting composite. In recent times, the sisal fibers have been employed as reinforcement in concretes.

Agave Sisalana Perrine popularly known as sisal is a monocotyledonous plant from Mexico. Sisal represents the first natural fiber in commercial application, in which it is estimated in more than half of the total of all natural fibers used. Sisal can be cultivated in most soil types except clay and has low tolerance to very moist and saline soil conditions. Strength , durability and ability to stretch are some of the important properties of sisal fibers. Sisal fiber is one of the most widely used natural fibers and it can be easily harvested.

SCOPE OF THE WORK:

The properties of recron 3s fiber and sisal fiber reinforced concrete mixes and various factors such as w/c ratio, type of fiber, volume, aspect ratio and its effect on strength has now been well established and much research has been carried up to date. The improvement in strength of recron reinforced concrete is accompanied by a relatively greater increase in flexural toughness & impact resistance, which are important factors. The

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structural behavior of recron fiber reinforced concrete and sisal fiber reinforced concrete needs to be examined.

CONCRETE MIX DESIGN:

(a)Stipulations for Proportioning:

a) Grade designation - M30
b) Type of cement - OPC 53 Grade conforming to IS12269
c) Type of mineral add mixture - Recron 3S fiber and Sisal fiber
d) Maximum nominal size of aggregate - 20mm
e) Minimum cement content - 300kg/m^3
f) Maximum water cement ratio- 0.45
g) Workability- 75mm
h) Exposure condition - severe(for plain conctrete)
i) Method of concrete placing -hand placing
j) Degree of supervision -good
k) Type of aggregate - rounded
l) Maximum cement content -450kg/m^3

(b) Test data for material:

a) Cement used - OPC 53 grade
b) Specific gravity of cement - 3.10
c) Specific gravity of coarse aggregate - 2.72
d) Specific gravity of fine aggregate - 2.66
e) water absorption of
coarse aggregate - 0.5%
fine aggregate - 1.0%
f) free(surface) moisture
coarse aggregate nill
fine aggregate nill
g) sieve analysis
coarse aggregate nominal max size of aggregate 20mm asper IS383
fine aggregate conforming to grading zone II of table 4 of IS383

(c) Target Strength for Mix Proportioning

Fck=fck+1.65S

From table I, Standard deviation S=5N/mm^2

Target mean strength=30+1.65 x5=38.25N/mm^2.

) Selection of Water-Cement Ratio

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From Table 5 of IS 456, maximum water-cement ratio (see Note under 4.1) =0.45. Based on experience, adopt water-cement ratio as 0.45.

d) Selection of Water Content:

From Table 2, maximum water content

For 20mm aggregate =186 lit

e) Calculation of Cement:

Water-cement ratio= 0.45

Cement content= 186/0.45 =413.33 kg/m^3

From durability conditions, the minimum cement content is 320 kg/m^3

Take higher value, therefore cement content =413.33 kg/m^3

f)Calculation of Coarse Aggregates:

For 20 mm size,% of coarse aggregate

P=0.62

V= [W.C+(C.C/Spe.gr of cement) + (1/P)(C.A/Spe.gr C.A)](1/1000)

1-0.02= [186+ (413.3/3.18) + (1/0.62) (C.A/2.7)](1/1000)

980=315.97+ C.A/1.674

C.A=1111.58kg/m3

g)Calculation of Fine Aggregates:

V= [W.C+(C.C/Spe.gr of Cement) + (1/ (1-P)) (F.A /Spe.gr of F.A)](1/1000)

1-0.02= [186 + (413.3/3.18) + (1/ (1-0.62)) (F.A/2.65)](1/1000)

980=315.97+ F.A/1.007

F.A=668.67kg/m3

Mix design=Cement:FA:CA:Water

Ratio=1:1.61:2.68:0.45

EXPERIMENTAL INVESTIGATION:

It is related with results which are obtained by testing beam and cube with the different % of fiber and at different periods of curing like 7,14 and 28 days.

The percentage of fiber added is 0.0%, 0.2%,0.4%,0.6% and 0.8% in the mix by using M30 grade of mix proportion.

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COMPRESSIVE STRENGTH TEST RESULTS:

Cube with different % of fiber

% of Recron 3S fiber & Sisal fiber	Compressive strength for 7 days of curing in (N/mm^2)
0.0%	27.25
0.2%	28.46
0.4%	29.73
0.6%	33.08
0.8%	30.24

Table 1 : Compressive Strength of M30 Grade of concrete with recron 3s fiber and sisal fiber after 7 days of curing

From below graph we found that the compressive strength of the concrete for 7days of curing increases with increases in % of recron 3s fiber & sisal fiber up to 0.6% of fiber. After that addition of fiber beyond the 0.6% decreases the compressive strength of concrete.

% of recron 3s fiber& Sisal fiber	Compressive strength for 14 days of curing in (N/mm^2)
0.0%	32.48
0.2%	33.25
0.4%	35.81
0.6%	37.59
0.8%	36.24

Table 2:Compressive Strength of Concrete with different % of recron 3s fiber and sisal fiber after 14 days of curing.

From below graph we found that the compressive strength of the concrete for 14 days of curing increases with increases in % of recron 3s fiber & sisal fiber up to 0.6% of fiber. After that addition of fiber beyond the 0.6% decreases the compressive strength of concrete.

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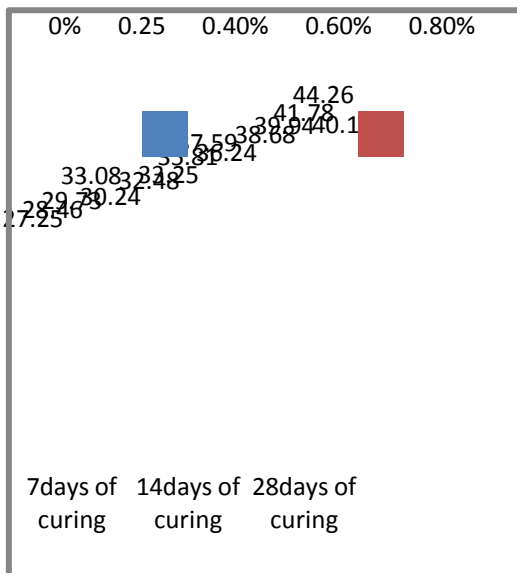
Table 3: Compressive strength of concrete with different % of Recron 3S fibers and Sisal fiber after 28 days of curing.

% of recron 3s fiber & Sisal fiber	Compressive strength for 28 days of curing in (N/mm^2)
0.0%	38.68
0.2%	39.94
0.4%	41.78
0.6%	44.26
0.8%	40.13

From below graph we found that the compressive strength of the concrete for 28 days of curing increases with increases in % of recron 3s fiber& sisal fiber up to 0.6% of fiber. After that addition of fiber beyond the 0.6% decreases the compressive strength of concrete.

Figure 1 : Compressive strength of concrete with different % of Recron 3S fibers and Sisal fiber after 7days,14days&28 days of curing.



FLEXURAL STRENGTH TEST RESULTS:

- **Test Result for Beam**

Beam is tested for flexural strength by using two points load and flexural strength is determined for different % of fiber at different periods of curing.

- **Beam with different percentages of fibers**

% of recron 3s fiber&Sisal fiber	Flexural strength for 7 days of curing in (N/mm^2)
0.0%	3.54
0.2%	3.67
0.4%	3.73
0.6%	3.84
0.8%	3.62

Table 4 : Flexural strength of M30 Grade Concrete with different % of Recron 3S fiber and Sisal fiber after 7 days of curing.

From below graph we found that the flexural strength of the concrete for7days of curing increases with increases in % of recron 3s fiber & sisal fiber up to 0.6% of fiber. After that addition of fiber beyond the 0.6% decreases the flexural strength of concrete

Table 5 : Flexural strength of M30 Grade Concrete with different % of Recron 3S fiber and Sisal fiber after 14 days of curing.

% of recron 3s fiber&Sisal fiber	Flexural strength for 14days of curing in (N/mm^2)
0.0%	3.68
0.2%	3.94
0.4%	4.28
0.6%	4.32
0.8%	4.19

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% of recron 3s fiber& Sisal fiber	Flexural strength for28 days of curing in (N/mm^2)
0.0%	3.97
0.2%	4.23
0.4%	4.49
0.6%	4.93
0.8%	4.52

Table 6:Flexural strength of M30 Grade Concrete with different % of Recron 3S fiber and Sisal fiber after 28 days of curing.

From below graph we found that the flexural strength of the concrete for 14 days of curing increases with increases in % of recron 3s fiber & sisal fiber up to 0.6% of fiber. After that addition of fiber beyond the 0.6% decreases the flexural strength of concrete.

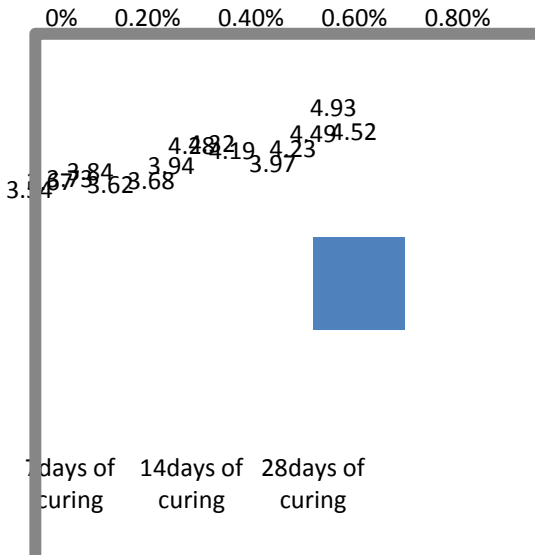

Figure 2 : Flexural strength of M30 Grade Concrete with different % of Recron 3S fiber and Sisal fiber after7days,14 days and 28 days of curing.

From above graph we found that the flexural strength of the concrete for 28 days of curing increases with increases in % of recron 3s fiber & sisal fiber up to 0.6% of fiber. After that addition of fiber beyond the 0.6% decreases the Flexural strength of concrete.

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SPLIT TENSILE STRENGTH TEST:

Test results for cylinder:

The cylindrical specimens are placed horizontally between the loading surfaces of a compression testing machine. The load is increased until the specimen fails and maximum load applied to the specimen during the test is recorded, and the figure shows the split tensile strength testing machine for the concrete cylinder. The cylinder is testing by split tensile strength test and this strength is determined for different percentages of recron 3s fiber and sisal fiber at different periods of curing.

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% of recron 3s fiber and sisal fiber	load in KN	Split tensile strength (N/mm^2)
0.00%	110	3.64
0.20%	130	3.72
0.40%	150	3.87
0.60%	170	3.94
0.80%	190	3.81

Table: 7Split tensile strength of M30 Grade Concrete with different % of Recron 3S fiber and Sisal fiber after 7 days of curing.

Table 8: Split tensile strength of M30 Grade Concrete with different % of Recron 3S fiber and Sisal fiber after 14 days of curing.

% of recron 3s fiber and sisal fiber	load in KN	Split tensile strength (N/mm2)
0.00%	110	3.95
0.20%	130	4.19
0.40%	140	4.28
0.60%	160	4.54
0.80%	180	4.36

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% of recron 3s fiber and sisal fiber	load in KN	Split tensile strength (N/mm^2)
0.00%	160	4.94
0.20%	180	5.27
0.40%	200	5.42
0.60%	220	5.86
0.80%	240	5.64

Table 9:Split tensile strength of M30 Grade Concrete with different % of Recron 3S fiber and Sisal fiber after 28 days of curing.

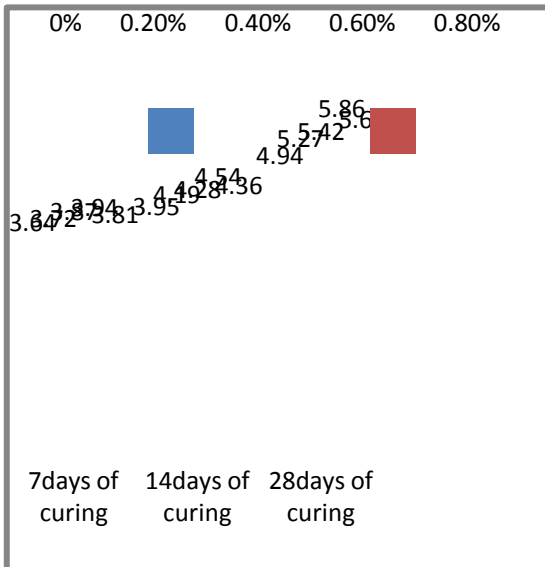

Figure 3:Split tensile strength of M30 Grade Concrete with different % of Recron 3S fiber and Sisal fiber after 7days, 14days and 28 days of curing.

CONCLUSION:

From the above experimental program the following conclusions were made:

The material properties of the cement, fine aggregates and coarse aggregates are within the acceptable limits as per IS code recommendations so we will use the materials for research.

Slump cone value of the RECRON 3S fiber and SISAL fiber reinforced concretes increase with increasing in the percentages of fibers.

Compaction factor value of the RECRON 3S fiber and SISAL fiber reinforced concretes decreases with the increase in the percentage of fibers and the maximum values of compaction factor was observed at 0.6% of recron 3s fiber and sisal fiber.

The compressive strength of the concrete is maximum at 0.6% of recron 3s fiber and sisal fiber reinforced concrete and is the optimum values for 7 days curing, 14 days curing and 28 days curing.

The flexural strength of the concrete is maximum at 0.6% of recron 3s fiber and sisal fiber reinforced concrete and is the optimum values for 7 days curing, 14 days curing and 28 days curing.

The split tensile strength of the concrete is maximum at 0.6% of recron 3s fiber and sisal fiber reinforced concrete and is the optimum values for 7 days curing, 14 days curing and 28 days curing.

The sisal fibers are mostly used fiber for fiber reinforced concrete out of available natural fibers in market. It is confirmed that the compressive strength of concrete and flexural strength of concrete can be significantly improved using external sisal fiber wraps.

Concrete is strong in compression and weak in tension. The tensile property of the concrete can be improved by the addition of small volume of fibers.

Addition of fibers not only increases tensile strength but also increases bond strength, and decreases permeability, and also resists seismic loading.

The properties of fiber reinforced concrete are mainly affected by the type of fiber, fiber volume and distribution of fibers.

REFERENCES:

[1]. S. Prem Kumar, A. J. Jeyaarthi, “Experimental Investigation of Reinforced Concrete Using Recron 3s”, International Journal of Latest Engineering and Management Research, Vol.02, pp.45-52, 2017.

[2]. Concrete technology by M.S.Shetty, s.chand publications.

[3]. Korrapati Anil Kumar, Dr. Shaik Yajdani, “Study on Properties of Concrete using Recron 3s Fibre”, International Journal of Science Technology & Engineering, Vol.4, pp.54-62, 2017.

[4]. Rakesh Kumar Gupta, MohdZiaulhaq, “Study of Properties of Polypropylene- Natural fiber composite”, International Research Journal of Engineering and Technology, Vol.4, pp.3507-3511, 2017.

ISSN: 2233-7857 IJFGCN

[5]. V.Prahatheswaran ,Dr.P.Chandrasekaran, "Study On Structural Behaviour Of Fiber Reinforced Concrete With Recron 3s Fibres", SSRG International Journal of Civil Engineering- (ICRTECITA-2017) – Special Issue, 2017.
[6]. RidhaNehvi, Prashant Kumar and Umar Zahoor Nahvi, "Effect of Different Percentages of Polypropylene fiber (Recron 3s) on the Compressive, Tensile and Flexural Strength of Concrete", International Journal of Engineering Research & Technology, Vol.5, pp.124- 130, 2016.
[7]. U. Bhavitha, Mohammed Safiuddin, "Study of Strength Properties of Polyester Fibre Reinforced Concrete", Journal for Research, Vol.2, pp.12-16, 2016.
[8]. Huang, L., Yang, X., Yan, L., He, K., Li, H., & Du, Y. "Experimental study of polyester fiber-reinforced polymer confined concrete cylinders" Textile
[9]. Dr. Vagheesha S. Mathda , Ms. Hemali K. Khaire, "Study of Effects of Polyester Fibers on Compressive Strength of Concrete", International Journal for Research in Applied Science & Engineering Technology, Vol.4, pp.53-56, 2016.
[10]. SamanKhanPRoohul Abad Khan, Amadur Rahman Khan, Misbahul Islam, Saman "Mechanical Properties of Polypropylene Fibre Reinforced Concrete for M25 and M30 mixes: A Comparative study", International Journal of Scientific Engineering and Applied Science,Vol.1, pp.327-340, 2015.
[11]. A. P. Sathe, A. V. Patil, "Experimental Investigation on Polypropylene Fiber Reinforced Concrete with Artificial Sand", International Journal of Science and Research, Vol.4, pp.1209-1213, 2015.
[12]. Damyanti G Badagha, C D Modhera, "Studies on Harden Properties of Mortar Using Polyester Fibre", International Journal of Advances in Engineering & Technology, Vol.2, pp-42-46, 2013.
[13]. IS:456 code of practice for plain and reinforced concrete.
[14]. IS:383 specifications for fine and coarse aggregate from natural sources of concrete.
[15]. IS:2386 methods of tests for aggregate for concrete.
[16]. IS:269-2015 specifications for 33,43 and 53 grade OPC.
[17]. IS:456,10262,SP23 codes for designing concrete

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