Strength Evaluation of Natural Fiber Reinforced Concrete

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***Abstract*—** Fiber Reinforced cement can offer an advanta-geous, reasonable and prudent technique for de-feating micro cracks and comparable kind of in-sufficiencies. The fiber built up solid implies that in the solid some kind of materials (filaments) is uti-lized to expand the strength of cement, since con-crete powerless in strain and more in compressive strength. So increment the rigidity for adding the filaments to concrete in light of the fact that the strands are solid in elasticity. For the most part the strands are characterized in to two sorts; they are fake filaments and regular strands. In the counter-feit filaments steel, asbestos, glass, carbon, fabri-cated materials and so forth are utilized and in the common strands horse hair, sisal, coir, bamboo, jute, mindful, elephant grass, coconut filaments and so on are utilized. Also, in this human hair was utilized as a fiber. Hair, sisal, coir, bamboo, jute are characteristic strands and they are solid in pressure, they can be utilized as a fiber support materials. These are substitute non-degradable issue. And further more accessible in modest expense. The hair breaking down is troublesome; it likewise makes ecological issues for its deteriorations. Pre-sent investigations has been attempted to examine the impact of human hair, sisal, coir, bamboo, jute on plain concrete show based on its compressive, split elasticity and breaking control to streamline concrete and to decrease ecological issues and di-minish the miniature breaks in concrete. Investiga-tions were directed on solid 3D squares with differ-ent rates of hair fiber, sisal, coir, bamboo, jute I.e. 0%, 1%, 1.5%, 2%, 3%, by weight of concrete for M20, M25 and M30 grade cements. For every mix of extents of solid three blocks are tried for their mechanical properties.

Keywords: Fiber Reinforced Concrete, Hair Fiber, Sisal, Coir, Bamboo, Jute, Compressive Strength, Split Ten-sile Test

I. INTRODUCTION

Concrete cement is described by fragile disappointment, the almost complete loss of stacking limit, whenever disappointment is started. This trademark, which restricts the use of the material, can be overwhelmed by the consideration of a limited quantity of short arbitrarily dispersed filaments (steel, glass, engineered and regular) and can be rehearsed among others that cure shortcomings of concrete, for example, low development obstruction, high shrinkage breaking, low strength, and so on The strength and solidness of cement can be changed by rolling out suitable improvements in its fixings like cementitious material, total and water and by adding some exceptional fixings. Consequently concrete is very appropriate for a wide scope of utilizations. Anyway concrete has a few lacks as low rigidity, low post breaking limit, and fragility and low pliability, restricted weariness life, not fit for obliging huge misshapenness, low effect strength. The presence of miniature breaks at the mortar-total interface is liable for the inborn shortcoming of plain concrete. The shortcoming can be taken out by incorporation of filaments in the blend.

Various kinds of strands, for example, those utilized in customary composite materials have been acquainted into the solid combination with increment its sturdiness, or capacity to oppose break development. The strands help to move loads at the inner miniature breaks. A particularly concrete is called fiber supported cement (FRC). Consequently fiber-built up concrete is a composite material basically comprising of customary cement or mortar supported by fine filaments. The filaments can be envisioned as a total with a limit deviation fit as a fiddle from the adjusted smooth total. The filaments interlock and trap around total particles and significantly decrease the functionality, while the blend turns out to be stronger and less inclined to isolation.

II. LITERATURE REVIEW

1) Harish et al. [1] Created coir composite and mechanical properties were assessed. Checking electron micrographs got from crack surfaces were utilized for a subjective assessment of the interfacial properties of coir/epoxy and contrasted and glass strands.
2) Wang and Huang [2] had taken a coir fiber stack, characters of the filaments were examined. Length of the strands was in the reach somewhere in the range of 8 and 337 mm. The filaments sum with the length scope of 15~145 mm was 81.95% of all deliberate strands. Weight of filaments with the length scope of 35~225 mm represented 88.34% of all estimation. The normal fineness of the coir filaments was 27.94 tex. Longer filaments typically had higher breadths. Composite sheets were created by utilizing a warmth press machine with the coir fiber as the support and the elastic as grid. Elasticity of the composites was researched
3) Nilza et al. [3] utilize three Jamaican characteristic cellulosic strands for the plan and assembling of composite material. They took biogases from sugar stick, banana trunk from banana plant and coconut coir from the coconut husk. Tests were exposed to government sanctioned tests, for example, debris and carbon content, water ingestion, dampness content, rigidity, natural investigation and synthetic examination.
4) Rahman et al. [4] examined the surface treatment of the coir fiber and its mechanical properties. Fiber surface change by ethylenee dimethyl acrylate (EMA) and relieved under UV radiation. Pretreatment with UV radiation and mercerization were done prior to uniting so as to improve the physicomechanical execution of coir filaments. The impacts of mercerization on shrinkage and fiber weight misfortunes were observed at various temperature and salt focus. They saw that, fiber shrinkage is higher at low temperature and 20% salt treated coir strands yielded greatest shrinkage and weight

misfortunes. It was tracked down that higher shrinkage of the polymer united fiber showed upgraded physico-mechanical properties. The joining of salt treated fiber shows an increment of polymer stacking (about 56% higher) and rigidity (about 27%) than half EMA united fiber. The fiber surface geography and the pliable break surfaces were portrayed by checking electron microscopy and were discovered improved interfacial attaching to the altered fiber–grid interface

III. MATERIALS

The Ordinary Portland Cement of 53 grades which is readily available in the market is used in the project. The better coarse aggregates of 20mm and 12mm from the nearby quarry and the fine aggregate of zone II are used in the project. SNF based super plasticizer is used

A. *Cement:*

It is mixture of calcareous, siliceous, aluminous substances and crushing the clinkers of a fine powder. The ordinary Portland cement of 43 Grade is used. The specific gravity of cement is 3.15. For ordinary Portland cement, the initial setting time is 45 minutes and the final setting time is 600 minutes. The oxide contents are as follows: 60-67% CaO, 17-25% SiO2, 3-8% Al2O3, 0.5-0.6% Fe2Oand 0.1-0.4% MgO.

B. *Fine Aggregate:*

The sand used for the experimental programmed was locally procured and confirmed to grading zone II. The sand was sieved first through 4.75mm sieve to remove any particles greater than 4.75mmand was then washed to remove dust. The properties of fine aggregates are as follows: Specific gravity – 2.65and Fineness Modulus – 3.35.

C. *Coarse Aggregate:*

The material whose particles are of size as are retained on I.S. Sieve No. 480 (4.75 mm) is termed as Coarse Aggregate. The size of coarse aggregate depends upon the nature of work. The coarse aggregate used in this experimental investigation are of 20mm (60%), 16mm (20%) and 12mm (20%) sizes, crushed angular in shape. The aggregates are made free from dust before being used in the concrete. Its specific gravity is 2.74.

D. *Sisal:*

The plants look like giant pineapples, and during harvest the leaves are cut as close to the ground as possible. The soft tissue is scraped from the fibers by hand or machine. The fibers are dried and brushes remove the remaining dirt, resulting in a clean fiber. Sisal produces sturdy and strong fibers.

Sisal FIBER is one of the prospective reinforcing materials that its use has been more experiential than technical until now. The use of 0.2% volume fraction of 25mm sisal FIBERs leads to free plastic shrinkage reduction. Sisal FIBERs conditioned in a sodium hydroxide solution retained respectively 72.7% and 60.9% of their initial strength after 420 days. As for the immersion of the FIBERs in a calcium hydroxide solution, it was noticed that original strength was completely lost after 300 days. According to those authors the explanation for the higher attack by Ca (OH) 2 can be related to a crystallization of lime in the FIBERs pores.

Presently, 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. The Sisal plant is a monocotyledonous, whose roots are fibrous, emerging from the base of pseudo stem. The FIBERs of Sisal are made of elementary FIBERs of 4 to 12 µm diameter that are aggregated by natural bound forming small cells of 1 to 2 µm. Such arrays are placed along the length of the plant on a regular shape, with lengths of 45 to 160 cm.

The leaves of Sisal are an example of natural composite with lignocellulosic material presenting in 75 to 80% of the total weight of the leaves, reinforced by helical micro FIBERs of cellulose, which represent about 9 to 12 % the total weight. The composition of Sisal FIBER is basically of cellulose, lignin and hemicelluloses. The failure strength and the modulus of elasticity.

IV. RESULTS AND COMPARISON

A judicious combination of two or more materials that produces a synergistic effect. A material system composed of two or more physically distinct phases whose combination produces aggregate properties that are different from those of its constituents. Composites are hybrid materials made of a polymer resin reinforced by fibers, combining the high mechanical and physical performance of the fibers and the appearance, bonding and physical properties of polymers, the short and discontinuous fiber composites are responsible for the biggest share of successful applications, whether measured by number of parts or quantity of material used. A composite in thisrespect is a compound between a polymer (such as polyester or PP) and a fibrous material (such as glass, carbon or natural fibers). Composite products have good mechanical properties per unit weight, are durable and their technologies allow the manufacture of complex and large shapes. For these applications the substitution of industrial fibers with natural fibers could be considered.

A. *M20 Mix Specimens Results:*

1) *Concrete Mix Design:*

M-20 grade of concrete was designed by I.S 10262-2009 method. The natural coarse aggregates used were crushed granite. The test results were analyzed and compared with theoretical values, obtained from various codes. Fibers (1%, 1.5 %, 2 %) were added during mixing in varying percentages.

2) *Indian Standard Mix Design*

a) Requirements
   1) Specified Minimum Strength = 20 N/Sq Mm
   2) Durability Requirements
      a) Exposure Moderate
      b) Minimum Cement Content = 300 Kgs/Cum
   3) Cemenrt
      a) Type Opc
      b) Grade 43
   4) Workability
      a) Compacting Factor = 0.7

5) Degree Of Quality Control Good

b) Test Data for Materials Supplied

1) Cement
   a) Specific Gravity = 3.05
   b) Avg. Comp. Strength 7 Days = 46.5 More Than 33.0 Ok 28 Days = 55.0 More Than 43.0 Ok
2) Coarse Aggregate
   a) 20mm Graded
      Type Crushed Stone Aggregate
      Specific Gravity = 2.68
      Water Absorption = 1.46
      Free (Surface) Moisture = 0
3) Fine Aggregate (Coarse Sand)
      Specific Gravity = 2.6
      Water Absorption = 0.5
      Free (Surface) Moisture = 1.4

Sieve Analysis Results

IS Sieve Size	Percenrt retained	Cumulative% retained	Percent Passing
10mm	0.00	0.00	100.00
4.75	5.20	5.20	94.80
2.36mm	3.00	8.20	91.80
1.18 microns	8.60	16.80	83.20
600 microns	25.80	42.60	57.40
300 microns	32.80	75.40	24.60
150 microns	20.70	96.10	3.90

Note: Conforming to grading zoneII of table IS: 383-1970

c) Target Mean Strength (TMS)
1) Statistical Constant K=1.65
2) Standard Design S= 4.6(AS Per Is10262 Table)
   Thus, Tms= 27.59N/Sqmm

d) Selection of W/C Ratio
1) As Required For TMS = 0.5
2) As Required For 'Moderate' Exposure = 0.55
   Assume W/C Ratio Of 0.5

e) Determination of Water & Sand Content

For W/C = 0.5
C.F. = 0.8
Max. Agg. Size Of 20 Mm
1) Water Content = 186 Kg/Cum (As Per Is10262 Table 4)
2) Sand As Percentage Of Total Aggregate By Absolute Volume = 35 %

Thus,Net Water Content = 180.42 Kg/Cum
Net Sand Percentage = 33 %

f) Determination Of Cement Content

W/C Ratio = 0.5
Water Content = 180.42 Kg/Cum
Thus, Cement Content = 360.84 Kg/Cum Adequate For Moderate Exposure Say 360Kg/Cum.

g) Determination of Coarse and Fine Aggregate Content

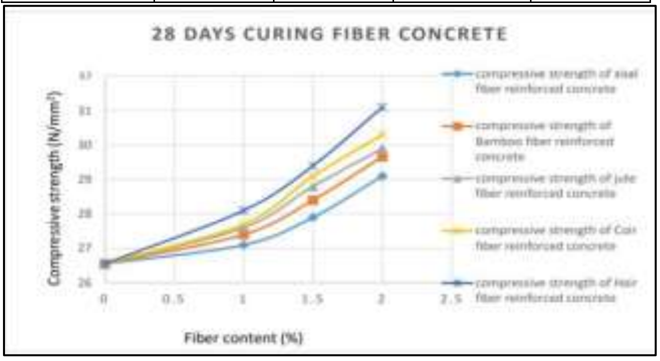
Assume Entrapped Air As 2 %
Thus,
0.98 Cum = [180.42+360/3.05 + {1/0.33}*{Fa/2.6}]/1000&
0.98 Cum = [180.42+360/3.05 + {1/0.67}*{Ca/2.68}]/1000

Hence,
Fa = 584 Kg/Cum
Ca = 1223.8 Kg/Cum
The Final Mix proportions of M-20 Grade of concrete become:-

3) Compressive strength for 28 days:

Compressive strength of fibres(28 days curing cubes M20) concrete(N/mm2)

FIbres	0%Fibres	1%Fibres	1.5%Fibres	2%Fibres
Compressive strength of sisal fiber reinforced concrete	26.55	27.1	27.9	29.1
Compressive strength of Bamboo fiber reinforced concrete	26.55	27.4	28.4	29.66
Compressive strength of Jute fiber reinforced concrete	26.55	27.6	28.8	29.9
Compressive strength of Coir fiber reinforced concrete	26.55	27.7	29.1	30.1
Compressive strength of Hair fiber reinforced concrete	26.55	28.1	29.4	31.1



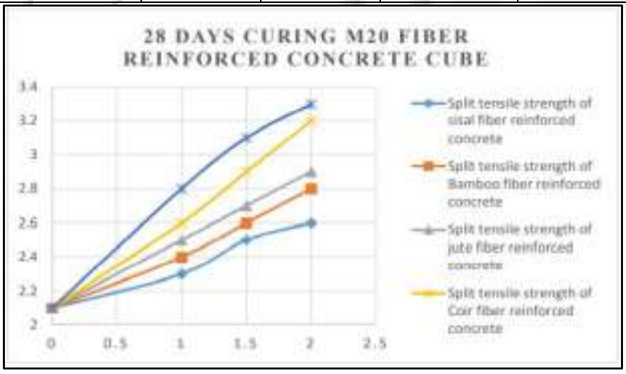
Compressive strength of fiber reimforced concrete of 28 days curing specimens (M20)

4) Split tensile strength 28 Days Curing M20 Fiber Reinforced Concrete:

Split tensile strength (28 Days Curing cubes M20) Concrete (N/mm2)

FIbres	0%Fibres	1%Fibres	1.5%Fibres	2%Fibres

Split tensile strength of sisal fiber reinforced concrete	2.1	2.3	2.5	2.6
Split tensile strength of Bamboo fiber reinforced concrete	2.1	2.3	2.6	2.8
Split tensile strength of Jute fiber reinforced concrete	2.1	2.3	2.7	2.9
Compressive strength Split tensile strength h of Coir fiber reinforced concrete	2.1	2.3	2.9	3.2
Split tensile strength of Hair fiber reinforced concrete	2.1	2.3	3.1	3.3



Split tensile strength 28 days Curing M20 concreete

V. CONCLUSIONS:

According to the IS 516-1959 for compressive strength of concrete cube and IS 5816-1999

Tensile strength of cylinder test are performed, from the above test results it is observed that that there is increase in compressive strength and tensile strength of concrete by the percentage of Fibers increases from 0% to 2% (weight of cement). Tensile strength of cylinder is increased more than the compressive strength of concrete.

– Split tensile strength of Hair fiber reinforced concrete is more at 2% but the percentage increase in strength is more at 1.5% for hair fiber reinforced concrete
– Split tensile strength of Coir fiber reinforced concrete is more at 2% but the percentage increase in strength is more at 1% for Coir fiber reinforced concrete
– Split tensile strength of jute fiber reinforced concrete is more at 2% but the percentage increase in strength is more at 1.5% for jute fiber reinforced concrete
– Split tensile strength of Bamboo fiber reinforced concrete is more at 2% but the percentage increase in strength is more at 1.5% for Bamboo fiber reinforced concrete
– Split tensile strength of sisal fiber reinforced concrete is more at 2% but the percentage increase in strength is more at 1% for sisal fiber reinforced concrete.

The compressive strength of sisal fiber is more than bamboo, coir, jute, hair fiber reinforcements. But the tensile strength of hair fiber is more than bamboo, coir, jute and sisal fiber reinforced concrete.

– It was observed that when the raw jute is added in concrete by 1% weight of cement then the compressive strength of concrete cube increased by 1.75%.
– It was observed that when the raw jute is added in concrete by 1% weight of cement then the split tensile strength of concrete cylinder increased by 4%.
– It was observed that when the hair is added in concrete by 1% weight of cement then the compressive strength of concrete cube increased by 2%
– It was observed that when the hair is added in concrete by 1% weight of cement then the split tensile strength of concrete cylinder increased by 3.7%
– It was observed that when the raw coir is added in concrete by 1% weight of cement then the compressive strength of concrete cube increased by 1.5%
– It was observed that when the raw coir is added in concrete by 1% weight of cement then the split tensile strength of concrete cylinder increased by 2.5%
– It was observed that when the raw bamboo fiber is added in concrete by 1% weight of cement then the compressive strength of concrete cube increased by 1.5%
– It was observed that when the raw bamboo fiber is added in concrete by 1% weight of cement then the split tensile strength of concrete cylinder increased by 3%
– It was observed that when the raw sisal is added in concrete by 1% weight of cement then the compressive strength of concrete cube increased by 1.8%
– It was observed that when the raw jute is added in concrete by 1% weight of cement then the split tensile strength of concrete cylinder increased by 4.5%

REFERENCES

[1] IS 383:1970, Specification for coarse and fine aggregates from natural sources for concrete (second revision), Bureau of Indian standards, New Delhi, India
[2] IS: 10262-2009, Recommended guidelines for concrete mix design, Bureau of Indian standards, New Delhi, India
[3] IS: 516-1959, Indian standard methods of tests for strength of concrete, Bureau of Inidian Standard

[4] Satyanarayana KG, Kulkarni AG, Rohatgi PK. Structures and properties of some vegetable fibers. J Sci Ind Res 1981;40:222
[5] Yetgin, S., Cavdar, O. & Cavdar, A. (2008). The effects of the fiber contents on the mechanic properties of the adobes. Constr. Build. Mat., 22(3), 222-227
[6] K. Murali Mohan Rao, K. Mohana Rao (2007) Extraction and tensile properties of natural fibers: Vakka, date and bamboo. Composite Structures, 77, 288-295.
[7] K. Murali Mohan Rao, K. Mohana Rao, A.V. Ratna Prasad, (2010) Fabrication and testing of natural fibre composites: Vakka, sisal, bamboo and banana. Journal of Materials and Design, 31, 508-513.
[8] ACI Committee 544, State-of-The-Art Report on Fiber Reinforced Concrete, ACI 544 1.R-96.
[9] Mehul J. Patel, S. M. Kulkarni (2012-2013) „Effect of Polypropylene Fibre on The High Strength Concrete", Journal of Information, Knowledge And Research in Civil Engineering Volume 2, Issue 2, Page 127.
[10] Thirumurugan.S, Siva Kumar.A (2013), „Compressive Strength Index of Crimped Polypropylene Fibers in High Strength Cementitious Matrix" World Applied Sciences Journal, 2013, 24 (6), 698-702
[11] Vinod Kumar.M, Muthukannan.M. 2014 Experimental Investigation on Mechanical Properties of Hybrid Fiber Reinforced Concrete, In Proceedings of International Conference ACECIM"14, SRM University, Ramapuram, pp. 597-.602.
[12] K.Murahari, Rama mohan Rao p (2013) „Effects of Polypropylene fibres on the strength properties Of fly ash based concrete", International Journal of Engineering Science Invention, Volume 2 Issue 5 ‖ May. 2013, PP.13-19.
[13] Mahendra Prasad, Chandak Rajeev and Grover Rakesh, „A Comparative Study of Polypropylene Fibre Reinforced Silica Fume Concrete with Plain Cement Concrete".
[14] International Journal of Engineering Research and Science & Technology, Vol2 , No 4, Nov. 2013, pp 127-136.
[15] Peng Zhang and Qingfu Li (2013) „Fracture Properties of Polypropylene Fiber Reinforced Concrete Containing Fly Ash and Silica Fume", Research Journal of Applied Sciences, Engineering and Technology 5(2): 665-670, 2013.
[16] Jianzhuang Xiao, H. Falkner, On residual strength of high-performance concrete with and without polypropylene fi bres at elevated temperatures, Fire Safety Journal, 41,115–121, 2006
[17] Priti A. Patel., Dr. Atul K. Desai., and Dr. Jatin A. Desai., "Evaluation Of Engineering Properties for Polypropylene Fibre Reinforced Concrete", International Journal of Advanced Engineering Technology, Vol. 3, Issue 1, January-March 2012, pp. 42-45
[18] Gowthami ., Murali Mohan Rao K., Ratna Prasad A.V., Mohan Rao K., Mater. Des.31 (2010) 508. J. Mater. Environ. Sci. 4 (2) (2013) 199-204. ISSN : 2028-2508 CODEN: JMESCN
[19] Hemalata Jena, Mihir Ku. Pandit, and Arun Ku. Pradhan, International Journal of Environmental Science and Development, Vol. 3, No. 5, October 2012
[20] Amar Patnaik , Alok Satapathy, Sandhyarani Biswas, Malaysian Polymer Journal, Vol. 5, No. 2, p 37-48, 2010