iJRASET
International Journal For Research in
Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH
IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 8 Issue: IX Month of publication: September 2020

DOI: https://doi.org/10.22214/ijraset.2020.31365

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.429
Volume 8 Issue IX Sep 2020- Available at www.ijraset.com

Experimental Investigation to Produce Hybrid Fibre Reinforced Concrete

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Abstract: Cement concrete is good at providing reasonable compressive strength but it tends to be brittle in nature and is weak in tensile strength, and minimum resistance to cracking, poor toughness. To overcome the deficiencies of concrete, fibers are added to enhance the performance of concrete. In the present study hybrid fibers consists of two different types of fiber combinations i.e. steel and polypropylene fibers are used with conventional concrete. The combination of fiber proportions of 1% by weight of cement is used. (ie. S=0.5% P=0.5% , S=0.6% P=0.4% , S=0.7% P=0.3% , S=0.8% P=0.2%)
Strength parameters are compressive strength and split tensile strength will be tested and analyzed.
Keywords: Hybrid Fiber, Steel and Polypropylene Fibers, Compressive Strength, Tensile Strength.

I. INTRODUCTION

The concept of using fibres as reinforcement is not new. Fibres have been used as reinforcement since ancient times. Historically, Horsehair was used in mortar and straw in mud bricks. In the early 1900s, asbestos fibres were used in concrete, there was a need to find a replacement for the asbestos used in concrete and other building materials once the health risks associated with the substance were discovered. By the 1960s, steel, glass and synthetic fibres such as polypropylene fibres were used in concrete, and research into new fibre reinforced concretes continues today.

Hybrid Fibre Reinforced Concrete is composite can be termed as hybrid, if two or more types of fibers are rationally combined in a common matrix to produce a composite that derives benefits from each of the individual fibers and exhibits a synergetic response. Addition of short discontinuous fibres plays an important role in the improvement of mechanical properties of concrete. It increases elastic modulus; decreases brittleness controls crack initiation, and its subsequent growth and propagation. Deboning and pull out of the fibre require more energy absorption, resulting in a substantial increase in the toughness and fracture resistance of the material to cyclic and dynamic loads.

II. ADVANTAGES OF HYBRID FIBRE REINFORCED CONCRETE

A. To provide a system in which one type of fibre, which is stronger and stiffer, improves the first crack stress and the ultimate strength, and the second type of fibre, which is more flexible, and ductile leads to improved toughness and strain in the post cracking zone.

B. To provide hybrid reinforcement in which one type of fibre is smaller, so that it bridges the micro cracks of which growth can be controlled. This leads to a higher tensile strength of the composite. The second type of fibre is larger, so that it arrests the propagating macrocracks and can substantially improve the toughness of the composite.

C. To provide a hybrid reinforcement, in which the durability of fibre types is different. The presence of the durable fibre can increase the strength and/or toughness relation after age while the other type is to guarantee the short-term performance during transportation and installation of the composite elements.

III. EFFECT OF FIBRES IN CONCRETE

A. Resistance to thermal and moisture stresses.
B. Increased ductility.
C. Increased impact and abrasion resistance.
D. Increased tensile, flexural, and fatigue strength.
E. Decreased permeability.
F. Decreased mix-water bleed rate.
G. Decreased handling damage during transport of dry-cast products to curing areas.

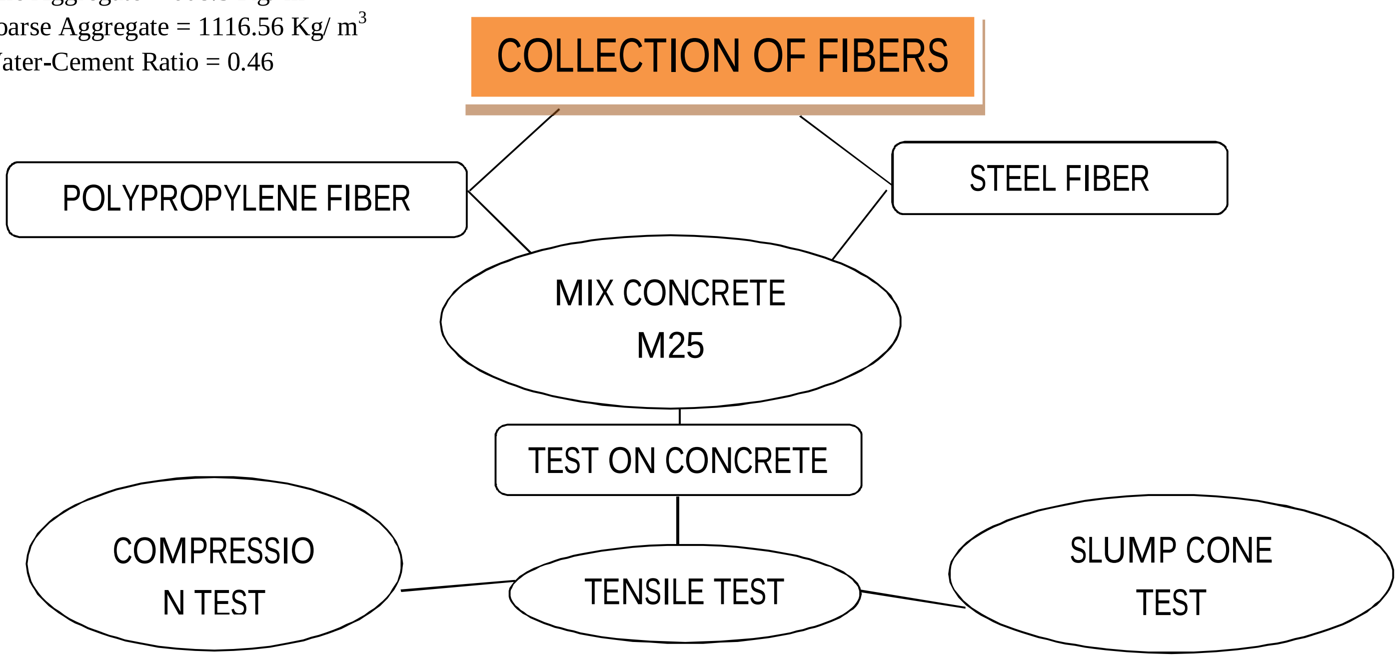
IV. TYPES OF FIBRE REINFORCED CONCRETE

1) *Steel Fibre Reinforced Concrete:* Steel fibre reinforced concrete is ultra-high-strength concrete with unique properties including high flexural and shear strength. It is also strong in compression, durable and has high impact resistance. Structures can be either precast or poured in place. It is possible to produce steel fibers in many ways. Round fibers are produced by cutting or chopping wires. Flat fibers may be produced either by shearing sheets or flattening wires.
2) *Polypropylene fibre Reinforced Concrete:* Polypropylene fibers are manufactured in various shapes and different properties. The polypropylene fibers are made of high molecular weight isotactic, a type of polymer chain configuration where in all side groups are positioned on the same side of the molecule, polypropylene. The macromolecule has a sterically regular atomic arrangement, thus polypropylene fibers can be produced in a crystalline form, and then processed by stretching to achieve a high degree of orientation, which is necessary to obtain good fiber properties.
3) *Glass fibre Reinforced Concrete:* Glass fiber-reinforced concrete consists of high-strength, alkali-resistant glass fiber embedded in a concrete matrix. The fibers provide reinforcement for the matrix and other useful functions in fiber-reinforced composite materials. Glass fibers can be incorporated into a matrix either in continuous or discontinuous (chopped) lengths. Durability was poor with the original type of glass fibers since the alkalinity of cement reacts with its silica. In the 1970s alkali-resistant glass fibers were commercialized.
4) *Carbon fibre Reinforced Concrete:* Carbon fiber is a synthetic fiber with Levy shape composed of carbon micro-crystal formed as a result Tlyev consisting acrylic processing distilled oil and coal resin at certain temperature. Carbon fibre reinforced concrete are composite materials. The composite consists of two parts: a matrix and a reinforcement. In CFRP the reinforcement is carbon fiber, which provides the strength. The matrix is usually a polymer resin, such as epoxy, to bind the reinforcements together
5) *Nylon fibre Reinforced Concrete:* Nylon fibers are imparted by the base polymer type, addition of different levels of additive, manufacturing condition and fiber dimensions. currently only two types of nylon fiber are marketed for concrete. Nylon is generic name that identifies a family of polymers. Nylon is heat stable, hydrophilic, relatively inert and resistance to a wide variety of materials. Nylon is particularly effective imparting impact resistance and flexural toughness and sustaining and increasing the load carrying capacity of concrete following first crack.

V. METHODOLOGY

A. *Proportion For M25 as PER IS 10262-2009*

Grade designation - M25
Cement = 428.26 Kg/m^3
Water = 197 Lit/ m^3
Fine Aggregate = 608.3 Kg/ m^3
Coarse Aggregate = 1116.56 Kg/ m^3
Water-Cement Ratio = 0.46



B. Fibre Specification

Speciation	*Polypropylene*	*Steel*
Specific gravity	0.91	7.85
Tensile strength	0.67 KN/mm^2	1.1 KN/mm^2
Young's Modulus	4.0 KN/mm^2	29 KN/mm^2
Melting point	>165°C	>=1450°C
Absorption	NIL	NIL
Bulk Density	910 Kg/m^3	7856 Kg/m^3
Fiber cut length	20mm	30mm
Diameter	-	0.6mm
Aspect Ratio	-	50

C. 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. The compression test is carried out on specimens cubical or cylindrical in shape. Prism is also sometimes used, but it is not common in our country. Sometimes, the compression strength of concrete is determined using parts of a beam tested in flexure. The end parts of beam are left intact after failure in flexure and, because the beam is usually of square cross section, this part of the beam could be used to find out the compressive strength. The cube specimen is of the size 15 x 15 x 15 cm. If the largest nominal size of the aggregate does not exceed 20 mm, 10 cm size cubes may also be used as an alternative. Cylindrical test specimens have a length equal to twice the diameter. They are 15 cm in diameter and 30 cm long. Smaller test specimens may be used but a ratio of the diameter of the specimen to maximum size of aggregate, not less than 3 to 1 is maintained.

D. Tensile Strength

Direct measurement of tensile strength of concrete is difficult. Neither specimens nor testing apparatus have been designed which assure uniform distribution of the ―pull‖ applied to the concrete. While a number of investigations involving the direct measurement of tensile strength have been made, beam tests are found to be dependable to measure flexural strength property of concrete. The standard size of the specimens is 15 x 15 x 70 cm. Alternatively, if the largest nominal size of the aggregate does not exceed 20 mm, specimens 10 x 10 x 50 cm may be used. The mould should be of metal, preferably steel or cast iron and the metal should be of sufficient thickness to prevent spreading or warping. The mould should be constructed with the longer dimension horizontal and in such a manner as to facilitate the removal of the mould specimens without damage. The tamping bar should be a steel bar weighing 2 kg, 40 cm long and should have a ramming face 25 mm square.

E. Slump Cone Test

Slum cone test is the most commonly used method of measuring consistency of concrete which can be employed either in laboratory or at site of work. It is not a suitable method for very wet or very dry concrete. It does not measure all factors contributing to workability, nor is it always representative of the place-ability of the concrete. However, it is used conveniently as a control test and gives an indication of the uniformity of concrete from batch to batch. Repeated batches of the same mix, brought to the same slump, will have the same water content and water cement ratio; provided the weights of aggregate, cement and admixtures are uniform and aggregate grading is within acceptable limits. Additional information on workability and quality of concrete can be obtained by observing the manner in which concrete slumps. Quality of concrete can also be further assessed by giving a few tamping or blows by tamping rod to the base plate. The deformation shows the characteristics of concrete with respect to tendency for segregation. The apparatus for conducting the slump test essentially consists of a metallic mould in the form of a frustum of a cone having the internal dimensions as under:
Bottom diameter: 20 cm, Top diameter: 10 cm, Height: 30 cm

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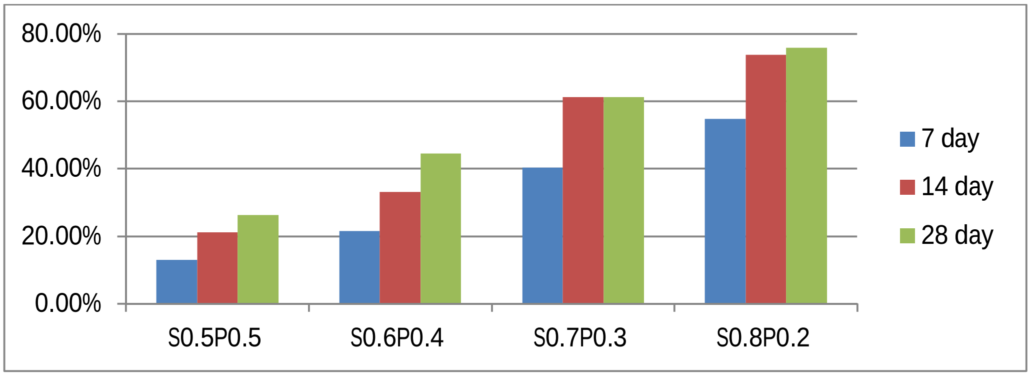
VI. RESULTS AND COMPARISON

1) S0.5P0.5= Steel fiber 0.5% Polypropylene fiber 0.5% by weight of cement
2) S0.6P0.4= Steel fiber 0.6% Polypropylene fiber 0.4% by weight of cement
3) S0.7P0.3= Steel fiber 0.7% Polypropylene fiber 0.3% by weight of cement
4) S0.8P0.2= Steel fiber 0.8% Polypropylene fiber 0.2% by weight of cement

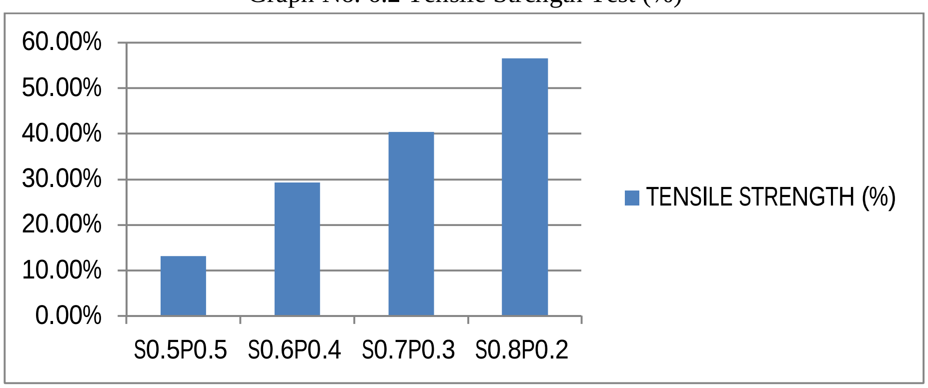
A. Compressive Strength Test

Graph No.6.1 Compressive Strength Test (%)



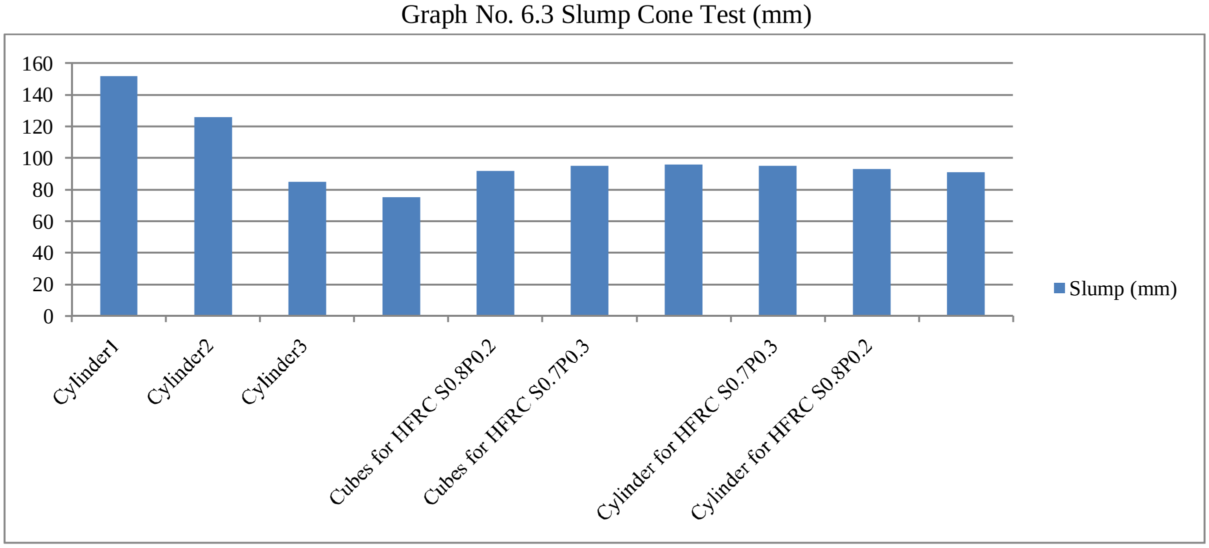
B. Tensile Strength Test

Graph No. 6.2 Tensile Strength Test (%)



C. Slump Cone Test

Graph No. 6.3 Slump Cone Test (mm)



VII. CONCLUSION

A. Compressive Strength

For hybrid combination of fibres for S0.5P0.5, S0.6P0.4, S0.7P0.3, S0.8P0.2, Average compressive strength for

1) 7 days is Increase by 12.97%, 21.58%, 40.39% and 54.70% respectively to that of Conventional Concrete.
2) 14 days is Increase by 21.24%, 33.16%, 61.30% and 73.76% respectively to that of Conventional Concrete.
3) 28 days is Increase by 26.23%, 33.16%, 61.30% and 75.00% respectively to that of Conventional Concrete.

From Graph no. 6.1 we can conclude that the compressive strength between S0.6P0.4 and S0.7P0.4 is increasing very high as compare to other interval.

B. Tensile Strength

For hybrid combination of fibres for S0.5P0.5, S0.6P0.4, S0.7P0.3, S0.8P0.2, Average Tensile strength for 14 day is increased by 13.10%, 29.25%, 40.43% and 56.55% respectively to that of Conventional Concrete. From Graph no. 6.2 We can conclude that the Tensile strength between S0.6P0.4 and S0.7P0.4 is increasing very high as compare to other interval.

C. Slump Value

From Graph no. 6.3 we have observed that by increasing the percentage of steel fibre in Hybrid Combination reduces the slump value, to maintain the constant slump we have to increase the super plasticizers dose in concrete.In conventional concrete the value of slump is between 150mm to 175mm wheareas in case of HFRC it is 80mm to 100mm. (IS102622009)

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