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EXPERIMENTAL INVESTIGATION OF M30 GRADE FIBER REINFORCED CONCRETE USING POLYPROPYLENE FIBERS

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cementitious substances are one of the most required and used materials. These cement based materials are easily treated and prepared into required designed shapes and structural configurations at an early stage, i.e. earlier than the curing process. However the major weak spot of these cement based materials is their brittleness, associated with their rigid properties, which is responsible for the formation of cracks and in addition to propagation when subjected to stresses. Such weak spot leads to the deterioration of their mechanical properties, which suggests costly maintenance or even reconstruction of such materials in a relatively short existence time. Hence, new cement based substances with higher durability properties, for instance, that provide higher cracking resistance, are needed in the constructing industry. Since historic time, fiber reinforced concrete has been replaced with plain concrete which is brittle material. Although, the involvement of single type fiber may improve mechanical properties of concrete, the hybridization can compensate the disadvantages of 2 fiber types and represent their advantages. The impact of using glass fiber and polypropylene fiber for reinforcing the concretetoquantifythemechanicalpropertiesofco ncretematrixexploresinthisthesis.For this purpose, glass fiber reinforced concrete (GFRC) of 15 cubes and 15 cylinders with different percentages (0.2%, 0.4%, 0.6% , 0.8%, 1.0%, casted after curing specimens examined for maximum compressive and tensile strength obtained at 1%. After getting the maximum strength at optimum dosage of glass fiber, with combination of 2 fibers, cubes and cylinders are casted with different percentages of polypropylene fiber by keeping glass fiber constant, by this optimum dosage of hybrid fiber reinforced concrete strength is obtained at 1% of glass and 0.6 % of polypropylene fiber, The Flexural strength (70cm X 10cm X 15cm) are calculated from the optimum dosage of fibers. The experimental results show that the hybrid form of fiber increases in compressive, Tensile, Flexure and Shear values compare to the Nominal concrete.

Key words: Hybrid fiber reinforced concrete (HFRC)**,** Glass fiber, Polypropylene fiber, compressive strength test, Flexural, Split Tensile test, Shear behavior.

I INTRODUCTION

The term fiber reinforced concrete (FRC) is defined by ACI Committee 544 as a concrete made of hydraulic cements containing fine or fine and coarse aggregates and discontinuous discrete fibers. Inherently concrete is brittle under tensile loading. Mechanical properties of concrete can be improved by reinforcement with randomly oriented short discrete fibers, which prevent and control initiation, propagation, or coalescence of cracks. FRC can continue to sustain considerable loads even at deflections exceeding fracture deflections of plain concrete.

The character and performance of FRC changes depending on matrix properties as well as the fiber material, fiber concentration, fiber geometry, fiber orientation, and fiber distribution.

FRC can be regarded as a composite material with two phases in which concrete represents the matrix phase and the fiber constitutes the inclusion phase. Volume fraction of fiber inclusion is the most commonly used parameter attributed to the properties of FRC. Fiber count, fiber specific surface area, and fiber spacing are other parameters, which may also be used for this purpose. Another convenient numerical parameter describing a fiber is its aspect ratio, defined as the fiber length divided by its equivalent diameter.

It is possible to make several classifications among fiber types. Fibers can be divided into two groups; those with elastic moduli lower than the cement matrix, such as cellulose, nylon, and polypropylene and those with higher elastic moduli such as asbestos, glass, steel, and carbon. Another classification can be madeaccording to the origin of the fiber material such as metallic, polymeric, or natural.

The aim of this study is first to develop hybrid fiber reinforced concrete (HFRC), and then to characterize and quantify the benefits obtained by the concept of hybridization. Compressive strength, flexural tensile strength, split tensile strengthare the measured mechanical properties of the HFRC mixes in this study.

To open new application areas, FRC should be designed so as to perform with adequate strength, sufficient ductility, high durability, and adequate workability. Utilizing the concept of hybridization, a concrete with superior properties can be developed. Ductility and strength of concrete can be improved at lower fiber contents, where fibers are used in combination rather than reinforcement with a single type of fiber. Limiting the high aspect ratio fiber content, without compromising the ductility and the strength of the concrete, problems associated with workability can be eliminated. Durability problems concerning one type of fiber may be offset with the presence of a second type of fiber.

Results obtained from this study are expected to contribute to the efforts made to characterize the mechanical properties of HFRC. With the appropriate interpretation of the obtained results, it can be possible to make various optimization analyses like optimization for a desired mechanical property or optimization for a certain fiber type and content.

Polypropylene Fiber Reinforced Concrete (PPFRC)

Synthetic fibers have attracted more attention for reinforcing cementitious materials in the recent years. In this part emphasis is given on polypropylene fibers, as they were used throughout the experimental program. Polypropylene fibers were suggested as an admixture to concrete in 1965 for construction of blast-resistant buildings for the U.S Corps of Engineers. Results of this research work showed that polypropylene fibers could be practical for reinforcing concrete, since polypropylene is cheap, abundantly available, and possess a consistent quality. Considerable improvements in strain capacity, toughness, impact resistance, and crack control of concrete can be obtained through the use of polypropylene fibers.

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.

Fibrillated polypropylene fibers

The polypropylene fibers can be produced in three different geometries, monofilaments, film, or extruded tape. The polypropylene film consists of amorphous material and crystalline micro fibrils. However these films are weak in the lateral direction. Thus using specially designed machines, splits are induced in the longitudinal direction and fibrillation is facilitated. It is used at present as discontinuous fibrillated material for the production of FRC by the mixing method, or as a continuous mat for production of thin sheet elements. The modulus of elasticity of both the monofilament and the fibrillated polypropylene is usually about 3.5 GPa, and the tensile strength is about 560 to 770 MPa. The geometry of fibrillated polypropylene is difficult to quantify. It can be described in terms of film thickness and the width of the individual filaments, or alternatively by measuring the specific surface area by adsorption techniques.

II LITERATURE REVIEW

Senali (2014) et al. This research paper explains the “Influence of hybrid fiber on reinforced concrete”. The Compressive strength of HFRC (S0.7P0.25) was increased by 75% and 25% over NC. The Split tensile strength of HFRC (S0.7P0.5) shows slight increase in strength.

B.Barr (1987) et al. This research paper explains the Shear performance of fiber reinforced concrete materials.Threetypesoffibers(steel,polypropyleneandglassfiber)havebeenusedto study the shear performance of fiber reinforced concrete specimens using double notched specimens. Shear performance of fiber reinforced concrete has been increased by the addition of fibers byweight.

T Ch Madhavi, L Swamy Raju, Deepak Mathur. This paper is done on research work of Polypropylene Fiber Reinforced Concrete is an embryonic construction material which can be described as a concrete having high mechanical strength, stiffness and durability. In this research work by utilization of polypropylene fibers in concrete not only optimum utilization of materials is achieved but also the cost reduction is achieved. This paper presents a comprehensive review on various aspects Polypropylene Fiber Reinforced Concrete concerning the behaviour, applications and performance of Polypropylene

III METHODOLOGY

Experimental program is carried out in different stages. First preliminary tests are conducted on fine aggregate, coarse aggregate and cement. The tests include particle size distribution of fine aggregate and coarse aggregate, specific gravity of cement, specific gravity of fine aggregate, specific gravity of coarse aggregate. With the test of the material obtained, the concrete mix design for M30 grade concrete is designed using IS codes: IS 10262:2009, IS 1026:1982, IS 456:2000.

Compressive strength test, Split tensile and flexural strength test are conducted to determine the properties of normal concrete of M30 grade by using normal sand and M-sand as fine aggregate.

Proportion of the glass fiber and details of casting

S. No	% of Glass fiber	14days	28 days
1	0	3	3
2	0.2	15	15
3	0.4	15	15
4	0.6	15	15
5	0.8	15	15
6	1.0	15	15
7	1.2	15	15

Casted cubes and cylinders from above proportions are tested for Compression and Tensile test from that optimum content of glass fiber is noted. After that hybrid fiber reinforced concrete cubes and cylinders are casted by keeping glass fiber constant with varying percentages of polypropylene fibers.

Proportion of HFRC and details of casting

S. No	Hybrid fiber %	No of cubes	No of cylinders
1	0.0 GF & 0.0 PP	3	3
2	1.0 GF & 0.2 PP	3	3
3	1.0 GF & 0.4 PP	3	3
4	1.0 GF & 0.6 PP	3	3
5	1.0 GF & 0.8 PP	3	3
6	1.0 GF & 1.0 PP	3	3

Fresh concrete tests such as Slump flow value, Compaction factor value are investigated and hard concrete tests such as compressive strength for cube of standard size 150mm x 150mm x 150mm (length x breadth x depth), split tensile strength for cylinder of size 150mm x 300mm (diameter x height) and flexural strength for prism of size 500mm x 100mm x 100 mm (length x

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breadth x depth) were tested for 3, 7 & 28 and 56 days.

IV. EXPERIMENTALINVESTIGATION

Materials used

Cement ZAURI OPC Cement of 43 Grade was used.

Fine aggregate
River sand River sand of zone II was used.

Manufactured sand Manufactured sand of Zone-II was used.

Coarse aggregate Crushed granite metal with 60% passing 20 mm and retained on 10 mm sieve and 40 % passing 10mm and retained on 4.75 mm sieve was used.

Glass fibers Glass fiber has roughly comparable mechanical properties to other fibers such as polymers and carbon fiber. Although not as rigid as carbon fiber, it is much cheaper and significantly less brittle when used in composites. Glass fibers are therefore used as a reinforcing agent for many polymer products; to form a very strong and relatively light weight fiber-reinforced polymer (FRP) composite material called glass-reinforced plastic (GRP), also popularly known as "fiberglass". This material contains little or no air or gas, is more dense, and is a much poorer thermal insulator than is glass wool.

Glass fibers

Polypropylene

Polypropylene fibers were first suggested as an admixture to concrete in 1965 for the construction of blast resistant buildings for the US Corps of Engineers. The fiber has subsequently been improved further and at present it is used either as short discontinuous fibrillated material for production of fiber reinforced concrete or a continuous mat for production of thin sheet components. Since then the use of these fibers has increased tremendously in construction of structures because addition of fibers in concrete improves the toughness, flexural strength, tensile strength and impact strength as well as failure mode of concrete. Polypropylene twine is cheap, abundantly available, and like all manmade fibers of a consistent quality.

Water Potable fresh water, which is free from concentration of acids or organic substances, was used for mixing the concrete.
Admixture PEG 400 type is used.

V TESTS ON CONCRETE

Tests on fresh concrete

Workability
Workability is one of the physical parameters of concrete which affects the strength and durability as well as the cost of labor and appearance of the finished product. It is defined as the relative ease with which concrete can be mixed, transported, moulded and compacted.

Slump cone test
A Slump test is a method used to determine the consistency of concrete. The consistency

or stiffness indicates how much water has been used in the mix. The stiffness of the concrete mix should be matched to the requirements for the finished product quality.

Slump cone test

Compaction factor test

Compacting factor of fresh concrete is done to determine the workability of fresh concrete by compacting factor test as per IS: 1199 – 1959. The compacting factor test works on the principle of determining degree of compaction achieved by a standard amount of work done by allowing the concrete to fall through a standard height.

Compaction factor test

Tests on hardened concrete

1. Cube compressive strength

The test set up for conducting cube compressive strength test is depicted in figure. Compressive test on the cubes is conducted on the 200T compressive testing machine. The cube was placed in the compression testing machine and the load on the cube is applied at a constant rate upto the failure of the specimen and the ultimate load is noted. The cube compressive strength of the concrete mix is then computed.

Cube compressive strength test

***2.* Split tensile strength**

This test is conducted on 200T compression testing machine as shown in figure. The cylinders prepared for testing are 150mm in diameter and 300mm height. Diametrical lines are drawn on the two ends, such that they are in the same axial plane. Then the cylinder is placed on the bottom compressive plate of the testing machine and is aligned such that the lines marked on the ends of the specimen are vertical. Then the top compression plate is brought into contact at the top of the cylinder. The load is applied at uniform rate, until the cylinder fails and the load is recorded.

Industrial Engineering Journal
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Volume : 53, Issue 9, September : 2024

Split tensile strength test

3. FLEXURAL STRENGTH TEST

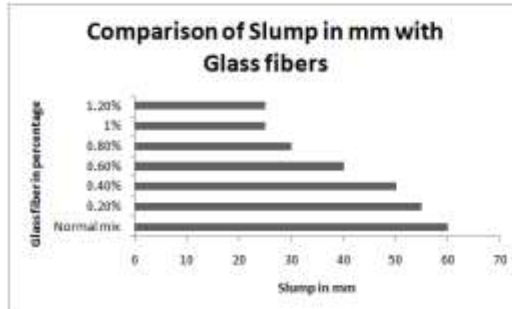
This test is conducted on 10T Universal Testing Machine (UTM). The loading arrangement to test the concrete beam specimens for flexure is shown in figure. The beam element is simply supported on two steel rollers of 38mm in diameter these rollers should be so mounted that the distance from center to center is 400mm for 10cm specimens. The load is applied through two similar rollers mounted at the third points of the supporting span, which is spaced 1.3 cm center to center.

Flexural strength test

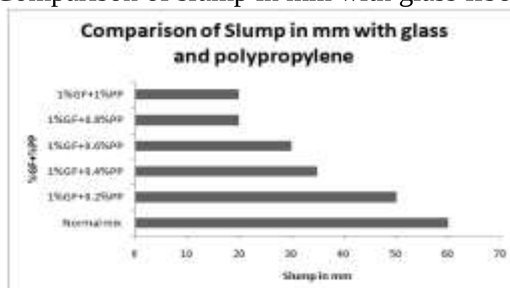
VI RESULTS AND DISCUSIONS

Results of workability

Slump cone test

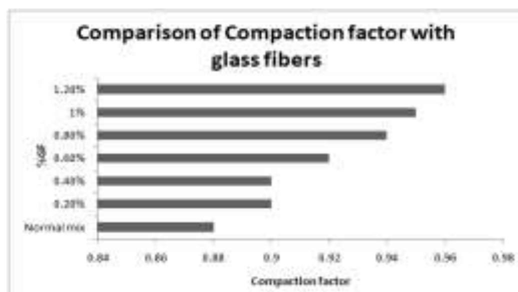


Comparison of slump in mm with glass fibers

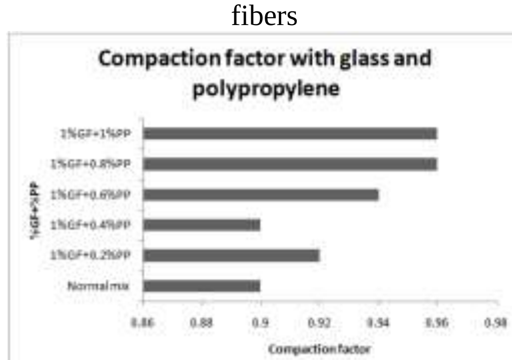


Comparison of Slump cone test with glass fibers and polypropylene fiber

Compaction factor test



Comparison of compaction factor with glass fibers



Comparison of compaction factor with glass fibers and polypropylene fiber

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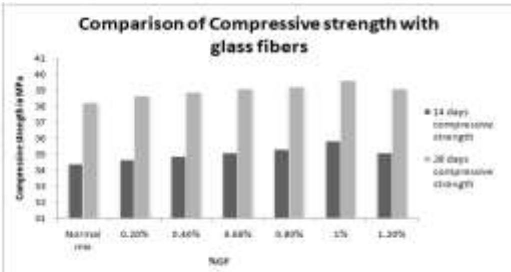
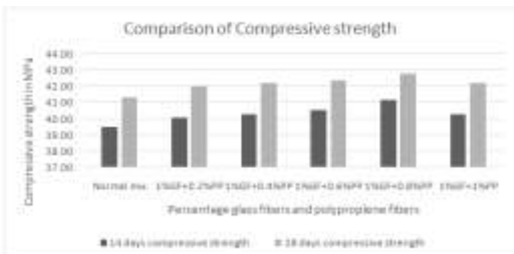
Compressive strength

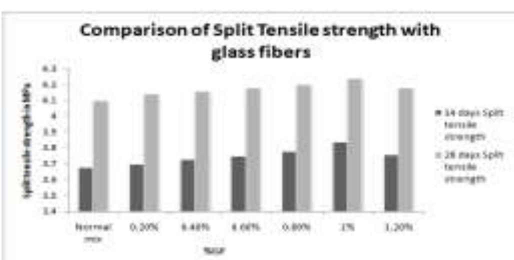


Comparison of 14 days and 28 days compressive strength values with glass fibers

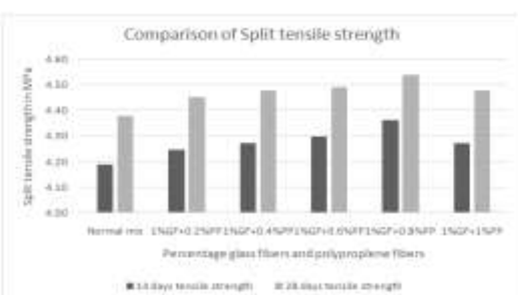


Comparison of 14 days and 28 days compressive strength values with glass fibers and polypropylene fiber

Split tensile strength

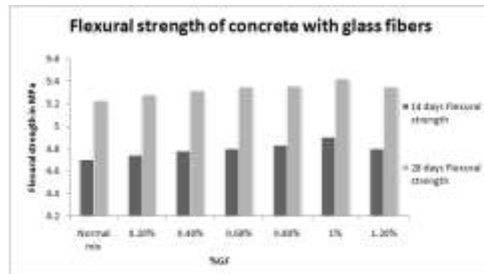


Comparison of 14 days and 28 days tensile strength values with glass fibers

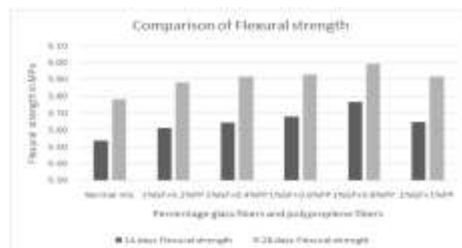


Comparison of 14 days and 28 days split tensile strength values with glass fibers and polypropylene fiber

Flexural strength of concrete



Comparison of 14 days and 28 days flexural strength values with glass fibers



Comparison of 14 days and 28 days flexural strength values with glass fibers and polypropylene fiber

VII CONCLUSIONS

From this experimental study the following conclusions were made

1. A 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.
2. FRC can be regarded as a composite material with two phases in which concrete represents the matrix phase and the fiber constitutes the inclusion phase.

3. The slump cone value is decreases with increasing the percentage of fibers in concrete. The compaction factor values are increases increasing the percentage of fibers.
4. The optimal values of compressive strength, split tensile strength and flexural strength is obtained at 1% glass fibers for all the 14 days and 28 days curing.
5. By using polypropylene fibers the compressive strength is increases the optimal value is obtained again for 1% glass fibers with 0.8% of polypropylene fibers.

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