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A STUDY ON NYLON FIBER REINFORCED HIGH TENSILE CONCRETE

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Abstract - *Concrete is a composite material. Normal concrete is strong in competition but it has very low tensile strength and also micro cracks developed due to shrinkage. This paper presents and experimental examination of how the different combinations of nylon fiber percentage influence the tensile strength, compressive strength and flexural strength of concrete. It includes laboratory tests on normal concrete and nylon fiber reinforced concrete cylinder to investigate the behavior of specimens subjected to compressive and tensile loading. An experimental investigation on the flexural behavior of rectangular concrete beam specimens reinforced with and without nylon fiber under flexural loading is presented. The laboratory tests were conducted on specimens with seven different percentages of nylon fibers with three trials of each combinations. It was observed that nylon fiber reinforced concrete specimens shows enhanced strength properties compared to the normal concrete.*

Keywords: Concrete, Nylon fiber, Compressive strength, Flexural strength, Split tensile strength.

1. INTRODUCTION

In this modern world there is a need of a economical and technology based construction. Which needs to rectify the disadvantages provided by older generation of construction. As we know the concrete is good in compression resistance but weak in tension resistance, hence with application of nylon fiber we try to improve the quality of strength property of concrete.

Fiber reinforcement has adequate strength and durable property to reduce the steel requirement in construction [1]. By experiment it has been observed that there are two mechanisms that could cause crack widening in FRC they are fiber creep and fiber pull-out **[2].** The nylon fibers are known for its strength durability and resilience. When nylon fiber used in concrete the strength properties enhance the quality of concrete [3]. Addition of fly ash with nylon fiber in cement improve the characteristics of strength of concrete [4]. Different percentage of nylon fiber used in fiber reinforced concrete gives different workability characteristics which influence the strength properties of concrete [5]. Nylon fiber reinforced concrete gives 26.96% enhancement in compression strength, 89.47% and 55.81% enhancement in flexural strength and tensile strength respectively then normal concrete [6]. The cost of construction is reduced by compared with the normal concrete and nylon fiber reinforced concrete for availability of nylon fiber materials [7]. The development of cracks due to shrinkage can be reduced by using of nylon fiber in concrete [8]. The small fibers of nylon are randomly distributed inside the concrete and also distributed along the micro cracks and helps to transfer load to the internal micro cracks. Fiber reinforced concrete has more flexural tensile strength impact resistance and excellent permeability and frost resistance as compared to conventional cement concrete. The use of nylon fiber in construction works gives good alternative to the disposal and also impart enhance strength properties of concrete.

It was found that at a constant water to cement ratio the compressive and flexural strengths were higher in concretes with micro Nylon fiber, it has a diminishing effect on the shrinkage of concretes, but it was found that the use of micro Nylon fibers is more effective for mitigating autogenous shrinkage of concrete, especially at early ages. The improvements stemmed from the nylon fibers registering a higher tensile strength and due to its better distribution in concrete. A brief description of the experimental work is presented in the subsequent section.

2. EXPERIMENTAL INVESTIGATION

The materials selected for this experimental study includes normal natural coarse aggregate, river sand as fine aggregate, cement, nylon fiber and water. The physical and chemical properties of each ingredient has considerable role in the desirable strength properties of concrete.

2.1 Compressive Strength test of concrete cubes

Place the prepared concrete mix in the steel cube mould for casting. Once it sets, After 24 hours remove the concrete cube from the mould. Keep the test specimens submerged underwater for stipulated time. As mentioned the specimen must be kept in water for 7 or 14 or 28 days and for every 7 days the water is changed. Ensure that concrete specimen must be well dried before placing it on the UTM. Weight of samples is noted in order to proceed with testing and it must not be less than 8.1Kg. Testing specimens are placed in the space between bearing surfaces. Care must be taken to prevent the existence of any loose material or grit on the metal plates of machine or specimen block. The concrete cubes are placed on bearing plate and aligned properly with the center of thrust in the testing machine plates. The loading must be applied axially on specimen without any shock and increased at the rate of 140kg/sq cm/min. till the specimen collapse. Due to the constant application of load, the specimen starts cracking at a point & final breakdown of the specimen must be noted.

2.2 Compressive strength of concrete cylinder

The concrete cylinder is cast for standard size and allowed to cure for 28 days. Three specimens of the same dimension are cast for testing. Takeout the specimen from the curing tank. Wipe out the excess water from the surface of the specimen. Place the specimen vertically on the platform of compression testing machine. Uniform load application and distribution is facilitated by having pad caps at the ends of the cylinders. Before starting to apply the load, make it sure that the loading platforms touch the top of the cylinder. Apply the load continuously and uniformly without shock at the rate of 315 KN/min. And continue the loading until the specimen fails. Record the maximum load taken. The test is repeated for the remaining two specimens.

2.3 Split tensile strength of concrete cylinder

A method of determining the tensile strength of concrete using a cylinder which splits across the vertical diameter. It is an indirect method of testing tensile strength of concrete.

Initially, take the wet specimen from water after 7, 28 days of curing; or any desired age at which tensile strength to be estimated. Then, wipe out water from the surface of specimen. After that, draw diametrical lines on the two ends of the specimen to ensure that they are on the same axial place. Next, record the weight and dimension of the specimen. Set the compression testing machine for the required range. Place plywood strip on the lower plate and place the specimen. Align the specimen so that the lines marked on the ends are vertical and centered over the bottom plate. Place the other plywood strip above the specimen. Bring down the upper plate so that it just touch the plywood strip. Apply the load continuously without shock at a rate within the range 0.7 to 1.4 MPa/min (1.2 to 2.4 MPa/min based on IS 5816 1999) Finally, note down the breaking load(P).

2.4 Flexural strength of concrete beams

The flexural strength of a material is defined as the maximum bending stress that can be applied to that material before it yields. The most common way of obtaining the flexural strength of a material is by employing a transverse bending test using a three-point flexural test technique.

The test should be conducted on the specimen immediately after taken out of the curing condition so as to prevent surface drying which decline flexural strength. Place the specimen on the loading points. The hand finished surface of the specimen should not be in contact with loading points. This will ensure an acceptable contact between the specimen and loading points. Center the loading system in relation to the applied force. Bring the block applying force in contact with the specimen surface at the loading points. Applying loads between 2 to 6 percent of the computed ultimate load. Employing 0.10 mm and 0.38 mm leaf-type feeler gages, specify whether any space between the specimen and the load-applying or support blocks is greater or less than each of the gages over a length of 25 mm or more. Eliminate any gap greater than 0.10mm using leather shims (6.4mm thick and 25 to 50mm long) and it should extend the full width of the specimen. Capping or grinding should be considered to remove gaps in excess of 0.38mm. Load the specimen continuously without shock till the point of failure at a constant rate (Indian standard specified loading rate of 400 Kg/min for 150mm specimen.

2.5 Design mix

In this project we have done 21 trial mixes. We used seven combinations for the trial mix as per the percentage of nylon fiber used. We did three trial mixes with zero percentage of nylon fiber, two trial mixes with 0.25% of nylon fiber, three trial mixes with 0.5% of nylon fiber, four trial mixes with 0.75% of nylon fiber, two trial mixes with 1% of nylon fiber, four trial mixes with 1.25% of nylon fiber, three trial mixes with 1.5% of nylon fiber. In this project we used M30 grade of concrete.

3. Results

This paper presents an experimental investigation to determine the effect of fiber by examining the compressive strength, split tensile strength and flexural strength of the cylinder and beam samples. The compression test and splitting tension test were conducted by the same compression testing machine for cylinder and flexural testing machine for beam.

3.1 Effect on compressive strength of cubes

To study the 3 and 28 days compressive strength of concrete mixes, three concrete cubes for each nylon fiber percentage combination were casted and tested in a set itself. The cube specimens were of size 150 mm x 150 mm x 150 mm and were prepared and tested. Different compressive strength for different nylon fiber percentage combination is shown in graphical representation given below.

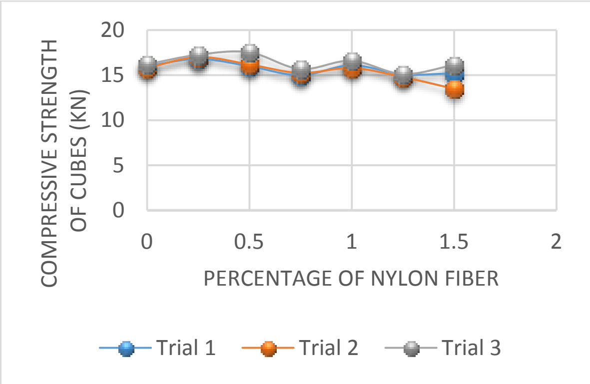

Chart 1: COMPRESSIVE STRENGTH OF CUBES AFTER 3 DAYS OF CURING

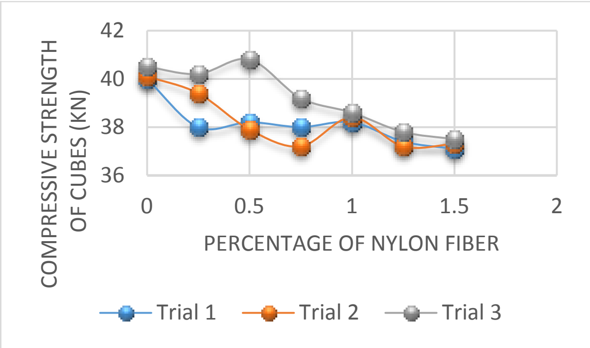

Chart 2: GRAPHICAL REPRESENTATION OF CUBES AFTER 28 DAYS OF CURING

3.2 Effect on compressive strength of cylinders

To study the 28 days compressive strength of concrete mixes, three concrete cylinders for each nylon fiber percentage combination were casted and tested in a set itself. The cylinder specimens were of size 150 mm x 300 mm and were prepared and tested. Different compressive strength for different nylon fiber percentage combination is shown in graphical representation given below.

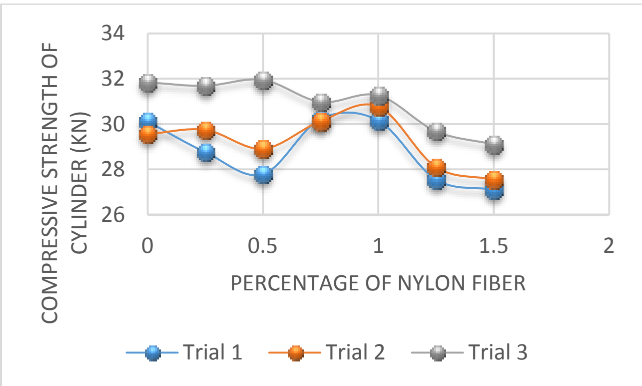

Chart – 3: GRAPHICAL REPRESENTATION OF COMPRESSIVE STRENGTH OF CYLINDERS

3.3 Effect on tensile strength of cylinders

To study the 28 days tensile strength of concrete mixes, three concrete cylinders for each nylon fiber percentage combination were casted and tested in a set itself. The cylinder specimens were of size 150 mm x 300 mm and were prepared and tested. Different tensile strength for different nylon fiber percentage combination is shown in graphical representation given below.

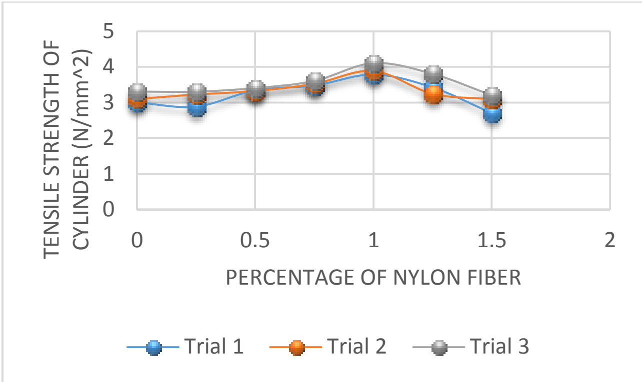

Chart – 4: GRAPHICAL REPRESENTATION OF TENSILE STRENGTH OF CYLINDERS

3.4 Effect on flexural strength of beams

To study the 28 days flexural strength of concrete mixes, three concrete beams for each nylon fiber percentage combination were casted and tested in a set itself. Different flexural strength for different nylon fiber percentage combination is shown in graphical representation given below.

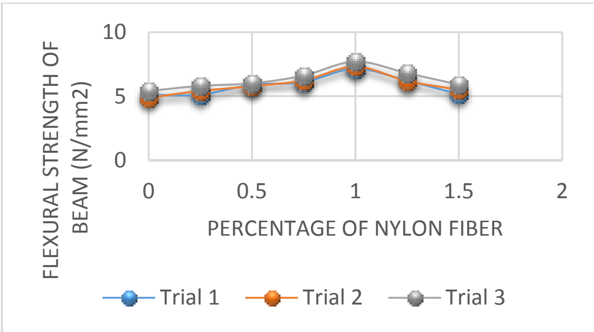

Chart – 5: GRAPHICAL REPRESENTATION OF FLEXURAL STRENGTH OF BEAMS

4. Conclusions

The main objective of this study is to investigate the compressive, tensile and flexural property of concrete with the addition of nylon fiber. After conducting experimental analysis following conclusions are made:

The study of the compressive behavior of normal concrete and nylon fiber reinforced concrete, it is found that the compressive property of nylon fiber reinforced concrete is higher for few different percentage of nylon fiber than normal concrete but for other combinations it achieved target strength as per IS specification.

The study of the tensile behavior of normal concrete and nylon fiber reinforced concrete, it is found that the tensile property of nylon fiber reinforced concrete is higher than normal concrete in case of using 1% nylon fiber in concrete.

The study the flexural behavior of normal concrete and nylon fiber reinforced concrete, it is found that the flexural property of nylon fiber reinforced concrete is higher than normal concrete in case of using 1% nylon fiber in concrete.

The study suggests that using of nylon fiber enhance the strength properties of concrete and it also helps to restrict the development of cracks due to shrinkage.

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