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EXPERIMENTAL INVESTIGATION OF CONCRETE COMPOSITE USING NYLON FIBRE

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ABSTRACT

Nylon fiber is not an absolutely new material, it is successfully applied in such fields as mostly found in garment interlinings, tooth brush, Fishing lines, Nets and building structures. At the present time very prospective directions of using nylon fiber is fiber-concrete and fiber-cement, reinforced with nylon fibers, using nylon fiber as post-tension or pretension reinforcing bars in reinforced concrete structures, applying polymeric and metal composites for structures. The main reason that nylon fiber is considered as construction material so rarely in India is non-availability and its high price on shipping, but the general trend of increasing product of nylon fiber and reducing its cost can said might change this situation in the construction industry. The effects of adding nylon fiber into the concrete matrix on compressive strength of cubes and split tensile strength of cylinders were evaluated in this work. Four test groups were constituted with the Nylon fiber percentages of 0.00%, 1%, 2% and 3%. The results showed the effect of Nylon fiber on concrete has a considerable amount of increase in compressive and split tensile characteristics; make a comparison of materials and about reasonability of applying nylon fiber in terms of operating conditions and economics.

KEYWORDS: compressive strength, split tensile strength, nylon.

INTRODUCTION

Since ancient times, fibers have been used to reinforce brittle materials. Straw was used to reinforce sun-baked bricks, and horsehair was used to reinforce masonry mortar and plaster. A pueblo house built around 1540, believed to be the oldest house in the U.S., is constructed of sun-baked adobe reinforced with straw. In more recent times, large scale commercial use of asbestos fibers in a cement paste matrix began with the invention of the Hatschek process in 1898.

Asbestos cement construction products are widely used throughout the world today. However, primarily due to health hazards associated with asbestos fibers, alternate fiber types were introduced throughout the 1960s and 1970s. In modern times, a wide range of engineering materials (including ceramics, plastics, cement, and gypsum products) incorporate fibers to enhance composite properties. The enhanced properties include tensile strength, compressive strength, elastic modulus, crack resistance, crack control, durability, fatigue life, resistance to impact and abrasion, shrinkage, expansion, thermal characteristics, and fire resistance.

Experimental trials and patents involving the use of discontinuous steel reinforcing elements—such as nails, wire segments, and metal chips - to improve the properties of concrete date from 1910. During the early 1960s in the United States, the first major investigation was made to evaluate the potential of steel fibers as reinforcement for concrete. Since then, a substantial amount of research, development, experimentation, and industrial application of steel fiber reinforced concrete has occurred.

Use of glass fibers in concrete was first attempted in the USSR in the late 1950s. It was quickly established that ordinary glass fibers, such as borosilicate E-glass fibers, are attacked and eventually destroyed by the alkali in the cement paste. Considerable development work was directed towards producing a form of alkali-resistant glass fibers containing zirconia. This led to a considerable number of commercialized products. The largest use of glass fiber reinforced concrete is currently for the production of exterior architectural cladding panels.

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Initial attempts at using synthetic fibers (nylon, polypropylene) were not as successful as those using glass or steel fibers. However, better understanding of the concepts behind fiber reinforcement, new methods of fabrication, and new types of organic fibers have led researchers to conclude that both synthetic and natural fibers can successfully reinforce concrete.

Considerable research, development, and applications of FRC are taking place throughout the world. Industry interest and potential business opportunities are evidenced by continued new developments in fiber reinforced construction materials. These new developments are reported in numerous research papers, international symposia, and state-of-the-art reports issued by professional societies.

In India the demand for the power is increasing day by day. As the result of this great demand the boiler industry is on boom. Increasing demand of power can be achieved only by the industrial boiler.

MATERIAL PROPERTIES OF CONCRETE

CEMENT

An OPC 53 grade sample was tested to obtain the following characteristics:

Table 1 Cement Test

1.	Specific Gravity	3.13
2.	Standard consistency	30%

COARSE AGGREGATE

In the present investigation, locally available crushed stone aggregate of size 20 mm and down, was used and the various tests, carried out on the aggregates, are given below.

Table 2 Coarse Aggregate Test

1.	Specific gravity	2.613
2.	Water absorption	1.25%
3.	Fineness modulus	2.273

FINE AGGREGATE

In the present investigation, the river sand, which was available at Chennai, was used as fine aggregate and the following tests were carried out on sand.

Table 4 Fine Aggregate Test

1.	Specific gravity	2.631
2.	Water absorption	1.94%
3.	Fineness modulus	3.752

NYLON FIBRE

Nylon fibre is not widely used in India

i. Length of fiber - ¾ inch
ii. Elongation - 20%
iii. Resistance to salt & acid - Good
iv. Specific gravity - 1.15
v. Resistance to alkali - Excellent
vi. Water absorption - 4 %
vii. Color - White

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viii. UV resistance - High
ix. Tensile strength - 300 Mpa

Fig.1 Nylon Fibre

METHODOLOGY

In our study M_{20} Grade of concrete are used for casting the Cube & Cylinder specimens. This study is concern with adding Nylon fiber product of 1% to 3% to the concrete mix. The cubes and cylinders are used for calculating compressive strength and splitting tensile strength respectively. The following test is to be conducted for various proportions of Nylon Fiber.

Table 5 Number of Specimens

S.NO	Item	Nylon Quantity %	Cube (Nos)	Cylinder (Nos)
1	Normal mix	0	6	12
2	NFM-1	1	6	12
3	NFM-2	2	6	12
4	NFM-3	3	6	12
Total quantity			24	48

RESULTS AND DISCUSSIONS

COMPRESSIVE STRENGTH TEST ON CUBE SPECIMENS

It is well known that fibres usually have effect on compressive strength, which slightly increasing or decreasing the test results. These test results showed the same tendency. From cube results it was found that compressive strength of the cubes keeps on increasing with the percentage of nylon fiber getting added up.

TABLE 6 28$^{th\ Day}$ Compressive Strength for Cube

Items	NYLON FIBER CONTENT	ULTIMATE LOADS (KN)	AVERAGE ULTIMATE LOADS (KN)	COMPRESSIVE STRENGTH (N/mm$^{2)}$
Normal mix	0.00%	590	613.33	27.25
		610		
		640		
NFM-1	1%	725	745	33.11
		745		
		765		
NFM-2	2%	590	621.66	27.69
		625		
		650		
NFM-3	3%	475	495	22.0

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		485		
		525		

COMPRESSIVE STRENGTH TEST AND SPLIT TENSILE STRENGTH TEST ON CYLINDER SPECIMENS

The substantial increase in splitting-tensile strength can contribute to the bridging action of the fibres. Once the splitting occurred and continues, the fibres bridging across the split portions of the matrix acted through the stress transfer from the matrix to the fibres and, thus, gradually supported the entire load. The stress transfer improved the tensile strain capacity of the two fibre-reinforced concretes and, therefore, increased the splitting tensile strength of the reinforced concretes over the unreinforced control counterpart.

TABLE 7 28th Day Compressive Strength for Cylinder

Items	NYLON FIBER CONTENT	ULTIMATE LOADS (KN)	AVERAGE ULTIMATE LOADS (KN)	COMPRESSIVE STRENGTH (n/mm$^{2)}$
Normal mix	0.00%	620	631.33	28.07
		650		
		625		
NFM-1	1%	615	628.33	35.56
		630		
		640		
NFM-2	2%	575	531.66	30.0
		495		
		525		
NFM-3	3%	475	443.66	25.08
		380		
		475		

TABLE 8 28th Day Split Tensile Strength for Cylinder

Items	NYLON FIBER CONTENT	ULTIMATE LOADS (KN)	AVERAGE ULTIMATE LOADS (KN)	SPLIT TENSILE STRENGTH (n/mm$^{2)}$
Normal mix	0.00%	120	133.33	1.88
		150		
		130		
NFM-1	1%	290	280	3.96
		270		
		280		
NFM-2	2%	210	225	3.18
		240		
		225		
NFM-3	3%	180	190	2.68
		200		

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		190		

CONCLUSION

Finally we have come to a conclusion that Nylon Fibre Reinforced Concrete has far better strength than normal concrete. We took four mix designs of concrete including Nylon Fibre Reinforced of 1%, 2%, 3% and Normal Concrete and also found that adding 1% Nylon of total volume of concrete achieves more strength than that of normal concrete.

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