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A Research Paper on the Performance of Synthetic Fibre Reinforced Concrete

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Abstract - *When fibrous materials are used in manufacturing, then it is known as Fibre Reinforced Concrete. Different types of fibres may be used in concrete such as steel fibres, glass fibres, synthetic fibre and even natural fibre. Synthetic fibre reinforced concrete uses plastic and nylon fibres for enhancement of the strength of concrete. Synthetic fibres have a wide range of benefits over other fibres. The usage of Synthetic fibres gives higher compressive strength, high tensile strength and high flexural strength. Besides, there are other benefits like improving ductility, reduction in steel reinforcement requirements, increased resistance to plastic shrinkage during curing, improving impact resistance and abrasion resistance.*

***Key Words*: synthetic fibres, concrete, compressive strength, tensile strength, flexural strength,**

1.INTRODUCTION

Concrete is one of the most important materials used in modern civil engineering. It is composite of coarse and fine aggregates which are bound together by means of hydration of cement acting as binding material. Concrete has many good properties such as high compressive strength, durability and fire resistance with cheaper construction as compared to the steel structures. However, it has its own share of disadvantages such as low tensile strength, long curing period to gain required strength and cracking. Many of the disadvantages of concrete can be overcome and its efficiency can be increased.

Using fibre reinforced concrete can enhance the tensile behaviour of the concrete. Furthermore, the toughness and crack assessment properties can also be increased. Fibres also lower the permeability of concrete which can reduce bleeding of water.

In this research the performance of synthetic fibre reinforced concrete has been assessed. Although synthetic fibres are not as strong as steel fibres, they help in improving the cement pump-ability by not letting the concrete stick in the pipes. Since the synthetic fibres do not expand in heat or contract in the cold, it helps in preventing the cracks formation. Synthetic fibres also help the concrete to withstand the impacts and fires. Synthetic fibres can also improve the durability of the concrete due to the reduction and control of crack width. Furthermore, the ductility and abrasion resistance are also increased.

To measure the amount of fibres added to concrete mix the percentage of the total volume of composite is taken. This percentage is termed as volume fraction(V_f). Volume fraction may range from 0.1 to 3 percent. We also have to take into account the aspect ratio of the fibre. Aspect ratio (l/d) is calculated by dividing fibre length by its diameter. The modulus of elasticity of the fibre also should be higher than the concrete matrix so that the tensile strength of the concrete can be increased.

2. OBJECTIVES

The objectives of this research are to study the performance of synthetic fibre reinforced concrete by measuring its main mechanical properties like compressive strength, specific tensile strength and flexural strength after curing the sample for 28 days. Also, the mechanical properties have to be tested by using different proportions of fibres. With help of this we can know about the optimum proportion of the fibres to enhance the mechanical properties of concrete.

3. LITERATURE REVIEW

Kolli. Ramujee (2013) studied the performance of Polypropylene as the fibrous material along with the other types of fibres and suggested that the specimen with polypropylene fibre of 1.5 % gives out better results than other proportions.

K. Dharunsankar (2016) used steel fibres along with the coir(synthetic) fibres to study the their impact on plain concrete. He studied the physical and chemical properties of steel and coir fibres. He suggested that the steel fibres can be used to increase the tensile strength and the cracks present in the concrete can be controlled by adding coir fibres to the concrete.

J. Chris Caroll & Nicholas Helminger(2016) studied the use of recycled materials and found out that fibre- reinforced concrete and concrete containing rubber particles have increased levels of toughness in comparison with plain concrete. The paper focused on the properties of fibre-reinforced rubber concrete.

Patil Shweta & Rupali Kavilkar (2014) compared the properties of plain concrete against the fibre-reinforced concrete and concluded that the latter has higher flexural strength, better tensile strength and better crack resistance.

4. Experimental Design and Procedure

Raw materials used for the research were: Pozzolana Portland Cement, Class-F fly ash, natural river sand, continuous grading limestone for coarse aggregate(size5-20mm), Polypropylene as synthetic fibre with diameter 5mm and length 37.5mm, high range water-reducing admixture, tap water.

After concrete mixing the synthetic fibre reinforced concrete was mould into 30 samples of cubes of 150mm x 150mm x 150 mm for the compressive strength test. Cubes are cast for each type of concrete for different percentage of fibres.

For split tensile strength test, 20 cylindrical samples (150 mm diameter and 300 mm height) were mould. 2 cylindrical moulds are cast for various percentages of fibres.

For flexural strength test 20 beam samples(500mm x 100mm x 100 mm) were casted and 2 beam moulds are cast for different percentage of fibres.

After 48 hours the specimens were de-moulded and were cured in standard curing tank maintained at a temperature of 20^0C and 80-100% relative humidity for 28 days.

After 28 days the compressive strength was measured using compression testing machine. Following equation was used:

Compressive strength(CS) (N/mm^2)= Ultimate compressive load(N)/ Area of cross-section of specimen(mm^2).

The tests were carried out on triplicate specimens and the average compressive strength value was taken.

Percentage of fibre	S 1	S 2	S 3	Average	Compressive strength(N/mm^2)
0.5	702	710	714	708.67	31.5
1	723	735	737	731.7	32.5
1.5	697	690	686	691.0	30.7
2	691	685	683	686.3	30.5
2.5	688	677	670	678.3	30.1

Table 1- Observation of CS for different proportion of fibres

For Split tensile strength following equation was used:
Split tensile strength (STS) (N/mm2)= $2P/\pi LD$
Where, P= Ultimate load at failure(N), L= Length of specimen(mm), D= Diameter of specimen(mm)

The following results were obtained for two set of samples

Percentage of fibre	S 1	S 2	Average	Split tensile strength(N/mm^2)
0.5	210	224	217.0	3.1
1	261	266	263.5	3.7
1.5	249	241	245.0	3.5
2	208	214	211.0	3.0
2.5	202	198	200.0	2.8

Table 2- STS for different proportion of fibres

For flexural strength test the load was applied on the beam specimens through two similar roller mounted at the third point of the supporting span. The test results for the two sets of samples was:

Percentage of fibre	S 1	S 2	Average	Flexural strength (N/mm^2)
0.5	117	126	121.5	5.4
1	131	136	133.5	5.9
1.5	138	144	141.0	6.3
2	153	152	152.5	6.8
2.5	159	159	159	7.1

Table 3- Flexural strength for different proportion of fibres

3. CONCLUSIONS

1. 1% addition of Synthetic fibres give high compressive strength. The maximum strength was observed to be 32.5 N/mm^2.
2. 1% addition of synthetic fibres give high tensile strength. It was observed to be 3.7N/mm^2.
3. With increase in proportion of fibres, flexural strength goes on increasing.
4. Therefore, the optimium proportion of fibre is 1%.

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BIOGRAPHY

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