PERFOMANCE OF HYBRID CONCRETE BY USING STEEL AND NYLON FIBER

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ABSTRACT

When fibers like steel, glass, polypropylene, nylon, carbon, aramid, polyester, jute, etc are mixed with concrete known as fiber reinforced concrete. To overcome the deficiencies of concrete; fibers are added to improve the performance of concrete. In this research hybrid reinforced concrete is made by using steel and nylon 6 fibers. The inclusion of both steel and nylon 6 fibers are used in order to combine the benefits of both fibers; structural improvements provided by steel fibers and the resistance to plastic shrinkage improvements provided by nylon fibers. So the aim of this project is to investigate the mechanical properties (compressive strength, flexure strength and split tensile strength) of hybrid fiber reinforced concrete under compression, flexure & tension. The total volume of fiber was taken 0.75 % of the total volume of concrete. In this experimental work, four different concrete mix proportions were cast with fibers and one mix without fibers. Four different mix combinations of steel- nylon 6 fibres were 100-00%, 75-25%, 50-50% and 25-75%. Superplasticizer was used in all mixes to make concrete more workable. The results show that compressive, split tensile and flexural strength of hybrid fiber reinforced concrete increase by increasing the quantity of steel and nylon 6 fibers. The increase in compressive and tensile strength due to the incorporation of steel fiber is greater than that of using nylon fiber. For the nylon 6 fibers, adding more fibers into the concrete has a limited improvement on splitting tensile strength. Inclusion of nylon 6 fibers along with steel fibers results in considerable improvement in flexural strength as compared to solo steel fiber.

1 INTRODUCTION

The cracking of the concrete may be due to economic structural, environmental factors, but most of the cracks are formed due to inherent internal microcracks and the inherent weakness of the material to resist tensile forces. Drying shrinkage in the concrete may also result in the formation of cracks. To overcome these deficiencies, extra materials are added to improve the performance of concrete. Fibre reinforced concrete provides solutions for these shortcomings. Inclusion of fibers as reinforcement to concrete results as crack arrestor and improves its static and dynamic properties by preventing the propagation of cracks as well as increases the tensile strength of concrete. Extensive research work on FRC during the last two decades has established that a combination of two or more types of fibers such as metallic and non-metallic fibers increase overall performances of concrete. It is obvious that the behaviour of HFRC depends on the aspect ratios, orientations, geometrical shapes, distributions and mechanical properties of fibres in concrete mixtures. Fiber-reinforced concrete is mostly used for on ground floors and pavements but can be considered for a wide range of construction parts (beams, pliers, foundations, etc) either alone or with hand-tied rebars. In this research, therefore, an attempt has been made to study the feasibility of using two kinds of fibers for making FRC.

The beneficial effects of non-metallic fibers like nylonConcrete, usually Portland cement concrete is a composite material composed of fine and coarse aggregate bonded together with a fluid cement that hardens over time most frequently a lime-based cement binder, such as Portland cement, but sometimes with other hydraulic blocks of cement, such as a calcium aluminates cement. Concrete has relatively high compressive strength, but much lower tensile strength. For this reason, it is usually reinforced with materials that are strong in tension (often steel).

II. LITERATURE SURVEY

This study aims to characterize and quantify the mechanical properties of hybrid steel-nylon fiber reinforced concrete. In order to achieve and verify that, 0.5%, 1% and 1.5% fiber percentage by volume of concrete are used in this study with five different mixes of 100-0%, 70-30%, 50-50%, 30-70% and 0-100% for each fibers percentage (nylon to steel).28-day compressive strength, split tensile strength and modulus of rupture (MOR) tests have been performed in the hardened state. The total tested specimen are 144 specimens. Superplasticizer and silica fume are used in all the mixes to enhance the FRC mechanical properties. When compared to the control sample that contains no fibers, with the increase of fiber ratio, compression strength, split-tensile strength and flexural strength of concrete increase up to 242%, 182%, and 181% respectively. The result showed that the steel fibers improve the concrete properties better than the nylon fiber due to their higher tensile strength.

2.1 TEST : Unsoundness of cement may appear after several years, so tests for ensuring soundness must be able to determine that potential.

2.2 AUTOCLAVE TEST: Cement paste (of normal consistency) is placed in an autoclave (high-pressure steam vessel) and slowly brought to 2.03 MPa, and then kept there for 3 hours. The change in length of the specimen (after gradually bringing the autoclave to room temperature and pressure) is measured and expressed in percentage. The requirement for good quality cement is a maximum of 0.80% autoclave expansion

2.3 COARSE AGGREGATE: Broken stone from the local quarry of size 20 mm and 10 mm in the ratio of 60:40 respectively confirming to IS: 383-1970 was used as coarse aggregate. The specific gravity of 10 mm and 20 mm coarse aggregate were taken as 2.72 and 2.74 respectively. Water absorption for 10 mm and 20 mm aggregate were 0.17 and 0.15 % respectively. Fineness modulus of 10 mm and 20 mm were 2.31 and 2.65 respectively coarse aggregate specific gravity test is used to calculate the specific gravity of a coarse aggregate sample by determining the ratio of the weight of a given volume of aggregate to the weight of an equal volume of water.

1. Fine sand : Range 0.075 - 0.425 mm,
2. Medium Sand : Range 0.425 - 2.00 mm,
3. Coarse Sand : Range 2.00 - 4.75 mm.

III. EXPREMENTAL WORK

TABLE 1 DIFFERENT PROPROPOTION OF FIBER USED

Mix	Fibre by % of volume	% contribution of Steel-nylon
MS0N0 0 0-0	0	0-0
MS100N0	0.75	100-0
MS75N25	0.75	75-25
MS50N50	0.75	50-50
MS25N75	0.75	25-75

3.1 MIX DESIGN: Concrete for M25 grade were prepared as per I.S.10262:2009 with w/c 0.43. Mix proportion for M25 grade concrete for material was as follows:

TABLE 2 QUANTITES OF MATERIALS

Material	**Quantity**
Cement	380.91 Kg/ m3
Sand	701.29 Kg/ m3
Course Aggregates	1237.37 Kg/ m3
Water	163.71 Kg/ m3

3. 2 MIXING AND CASTING OF CUBES:

After the sample has been remixed, immediately fill the cube moulds and compact the concrete, either by hand or by vibration. Any air trapped in the concrete will reduce the strength of the cube. Hence, the cubes must be fully compacted. However, care must also be taken not to over compact the concrete as this may cause segregation of the aggregates and cement paste in the mix. This may also reduce the final compressive strength.

3. Fig. mixing sand, stone, cement and water

4. Fig. put in the cubes

1V. TESTING

4.1 COMPRESSIVE STRENGTH:

Compressive strength is the ability of material or structure to carry the loads on its surface without any crack or deflection. A material under compression tends to reduce the size, while in tension, size elongates.

30 cube moulds of size 150 x 150 x 150 mm were casted and allowed for curing in a curing tank for 28 days and they were tested at 7 days and 28 days. These cubes were tested on compression testing machine as per I.S. 516-1959. Cube compressive strength (fck) in MPa = P/A Where, P= cube compression load, A= area of the cube

The results of compressive strength test at 7 days & 28 days are given in table no. 3 and are plotted in figure no. 4. The maximum compressive strength obtained from mix (MS100N0) made with steel only. The compressive strength made with solo steel fibre increases by 37.09 % and made with mix MS75N25 (75-25%) increases by 28.52 % with respect to reference mix without fibre. It is observed that compressive strength of all hybrid fibreof reference mix (without fibre). Compressive strength is directly influenced by steel fibre and increases by increasing quantity of steel fibre. Because of high strength, stiffness and modulus of elasticity of steel fibres, metallic fibers (steel) are more capable to arrest the macro cracks hence provide ductility to the concrete.

4.2 COMPRESSIVE STRENGTH TEST:

5. Fig. compressive strength before test

6. Fig. compressive strength test

V. CONCLUSION

The results of slump test are plotted in figure. It states that slump decreases with adding fibre in concrete with respect to reference mix. Maximum slump loss was obtained for mix MS50N50. Super plasticizer was added to reduce the slump loss. The results of compressive strength test at 7 days & 28 days are given in table no. 3 and are plotted in figure . The maximum compressive strength obtained from mix (MS100N0) made with steel only. The compressive strength made with solo steel fibre increases by 37.09 % and made with mix MS75N25 (75-25%) increases by 28.52 % with respect to reference mix without fibre. It is observed that compressive strength of all hybrid fibre reference mix (without fibre).Compressive strength is directly influenced by steel fibre and increases by increasing quantity of steel fibre. Because of high strength, stiffness and modulus of elasticity of steel fibres, metallic fibres (steel) are more capable to arrest the macro cracks hence provide ductility to the concrete.

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