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An Experimental Study on Steel-Nylon Hybrid Fibre Reinforced Concrete for M-25 Grade

Sachin Gupta[1], Vikram[2]

[1] Research Scholar, Civil Engineering, JCDMCOE, Sirsa, Haryana, India

[2]Assistant Professor, Civil Engineering, JCDMCOE, Sirsa, Haryana, India

Abstract: ***Concrete Plays A Vital Role As A Construction Material In The World. But The Use Of Concrete As A Structural Material Is Limited To Certain Extent By Deficiencies Like Brittleness, Poor Tensile Strength And Poor Resistance To Impact Strength, Fatigue, Low Ductility And Low Durability. Critical Investigation For M-25 Grade Of Concrete With Water Cement Ratio of 0.43 To Study The Compressive Strength, Flexural Strength, Split Tensile Strength Of Fibre Reinforced Concrete (Frc) Containing Fiber Of 0.75% Volume In Different Proportions. End Hook Steel Fibres(Novocon He0630) With Aspect Ratio Of 50 & Nylon 6 Fibre With Aspect Ratio Of 150 were used. The Total Volume Of Fiber Was Taken 0.75% Of Total Volume Of Concrete With Steel-Nylon Proportion Of 100-00%, 75-25%, 50-50% & 25-75%. A Result Data Obtained Has Been Analyzed And Compared With A Control Specimen (0% Fiber). Result Data Clearly Shows Compressive Strength, Flexural Strength And Split Tensile Strength For M-25 Grade Of Concrete For 7 & 28 Days With Graphical Representation.***

Keywords: Compressive Strength, Flexural Strength, Split Tensile Strength, Steel Fibres(Novocon He0630), Nylon 6 Fibre etc

1. Introduction

Concrete is most widely used construction material in the world due to its ability to get cast in any form and shape. It also replaces old construction materials such as brick and stone masonry. The strength and durability of concrete can be changed by making appropriate changes in its ingredients like cemetitious material, aggregate and water and by adding some special ingredients. Hence concrete is very well suitable for a wide range of applications. However concrete has some deficiencies as listed below:
1) Low tensile strength
2) Low post cracking capacity
3) Brittleness and low ductility
4) Limited fatigue life
5) Incapable of accommodating large deformations
6) Low impact strength

The presence of micro cracks in the mortar-aggregate interface is responsible for the inherent weakness of plain concrete. The weakness can be removed by inclusion of fibres in the mixture. Different types of fibers, such as those used in traditional composite materials can be introduced into the concrete mixture to increase its toughness, or ability to resist crack growth. The fibres help to transfer loads at the internal micro cracks. Such a concrete is called fibre reinforced concrete (FRC). The introduction of the paper should explain the nature of the problem, previous work, purpose, and the contribution of the paper. The contents of each section may be provided to understand easily about the paper.

2. Experimental Programme

2.1 Materials Used 1

The material used for this experimental work are cement, fine aggregates, coarse aggregates, water, steel fibres, synthetic fibres and superplasticizers.

Cement: Ordinary Portland cement of 43 grade confirming to IS 12269-1987 with specific gravity 3.12 was used.

Fine aggregates: Locally available river sand conforming to IS: 383-1970 was used as fine aggregate with specific gravity 2.72 and fineness modulus was 2.86.

Coarse aggregates: Broken stone from the local quarry confirming to IS: 383-1970 was used as coarse aggregate having specific gravity of 2.74, fineness modulus of 6.66.

Water: Potable water was used for the experimentation.

Steel fibres : end hook steel fibres were used (NOVOCON HE0630).

Synthetic fibres: nylon 6 fibres were used.

Superplasticizers: A commercially available super-plasticizer (SIKA 150) was used. The super plasticizer was added 0.6 % by weight of cement to all mixes conforming to IS 9103:1999.

2.2 Experimental Methodology 2

The aim of the present investigation is to investigate the mechanical properties of steel-nylon hybrid fibre reinforced concrete for different steel-nylon fibres percentages. The total volume of fiber was taken 0.75 % of total volume of concrete with steel-nylon proportion of 100-00%, 75-25%, 50-50% and 25-75%.In order to study the effect of mixing steel (hooked end) and nylon fibres with concrete under compression, flexure and split tension, 30 cubes, 30 beams and 30 cylinders were casted respectively. The experimental program was divided into five mixes. Each mix consists of 6 cubes, 6 cylinders and 6 beams of 15x15x15cm, 15(dia) x30cm and 10x10x50cm respectively.

Compressive strength test : For compressive strength test, cube specimens of dimensions 150 x 150 x 150 mm were cast for M25 grade of concrete. Superplasticized (0.6% by weight of cement) was added to this. The moulds were filled with fibres i.e. 0.75% by volume of concrete in different proportions. Vibration was given to the moulds using table vibrator. The top surface of the specimen was levelled and finished. After 24 hours the specimens were demoulded and were transferred to curing tank where in they were allowed to cure for 7 & 28 days. After 7 & 28 days of curing, these cubes were tested on digital compression testing machine as per I.S. 516-1959. The failure load was noted. In each category three cubes were tested and their average value is reported. The compressive strength was calculated as follows.
Compressive strength (MPa) = Failure load / cross sectional area.

Flexural strength test: For flexural strength test beam specimens of dimension 100x100x500 mm were cast. The specimens were demoulded after 24 hours of casting and were transferred to curing tank where in they were allowed to cure for 7 & 28 days. These flexural strength specimens were tested under two point loading as per I.S. 516-1959, over an effective span of 400 mm on Flexural testing machine. Load and corresponding deflections were noted up to failure. In each category three beams were tested and their average value is reported. The flexural strength was calculated as follows.
Flexural strength (MPa) = (P x L) / (b x d2),
Where, P = Failure load, L = Centre to centre distance between the support = 400 mm,
b = width of specimen=100 mm, d = depth of specimen= 100 mm.

Split Tensile strength test : For Split tensile strength test, cylinder specimens of dimension 150 mm diameter and 300 mm length were cast. The specimens were demoulded after 24 hours of casting and were transferred to curing tank where in they were allowed to cure for 7 & 28 days. These specimens were tested under compression testing machine. In each category three cylinders were tested and their average value is reported. Split Tensile strength was calculated as follows as split tensile strength:

Split Tensile strength (MPa) = 2P / π DL, Where, P = failure load, D = diameter of cylinder, L = length of Cylinder.

2.3 Experimental Results 3

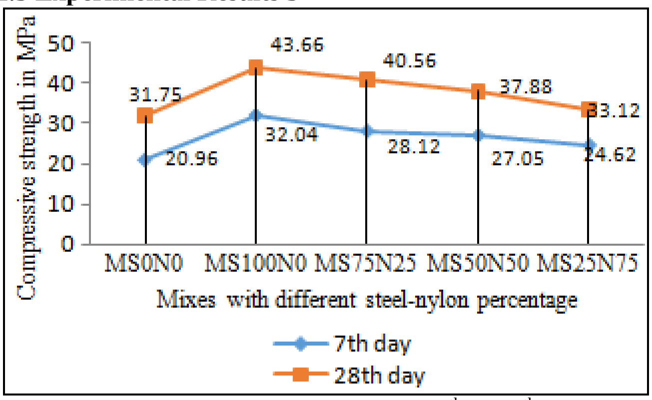

Figure 1: Compressive strength at 7th & 28th day

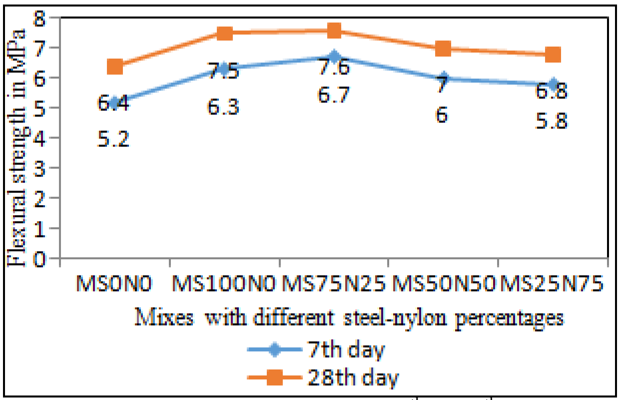

Figure 2: Flexural strength at 7th & 28th day

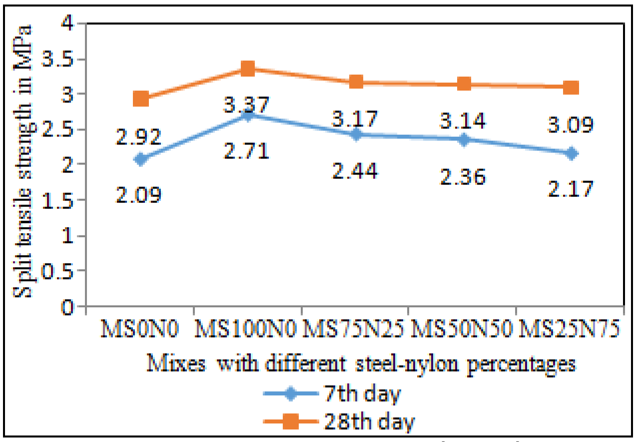

Figure 3: Split tensile strength at 7th & 28th day

3. Conclusions

Slump value: Slump decreases with adding fibre in concrete with respect to reference mix. Maximum slump wasrecorded for mix ($MN_{100}S_0$) having 100% steel & 0 % nylon. Maximum slump loss was obtained for mix $MS_{50}N_{50}$ having 50% steel & 50 % nylon. Slump loss is not appreciable because superplasticizer was used for maintaining workability.

Compressive strength: It is seen that at 0.75% volume fraction of fibers by volume of concrete, the compressive strength of hybrid fiber reinforced concrete with 100-0% (Steel-nylon) is maximum.

Flexural strength: Maximum flexural strength is obtained for mix MS75N25 having 75-25% (steel-nylon).
Split tensile strength : Maximum increase in split tensile strength is for mix (MS100N0) having 100-0% (steel-nylon).

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