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Investigation on Strengthening of RCC Element by Using Steel Fibre and Partial Replacement of Fly with Cement

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ABSTRACT: In this project, the use of Steel fibre and partially replacement of fly ash with cement is carried out. While using the crimped type steel fibre, the concrete will possess high strength when compare to conventional concrete. By utilization of steel fibres in concrete not only provides optimum utilization of materials but also the reduce the cost of construction. The main purpose of this investigation is to study the effects of steel fibre on the mechanical properties of concrete. The concrete mix adopted is M25 grade with varying percentage of fibres. The specimens are casted without fibres and with fibres of 0%, 1.0%, 1.50% and 2.0%. The specimens are tested for 7 days, 14 days and 28 days strength. Tests are conducted for investigation the compressive strength test, flexural strength test for both conventional and steel fibre reinforced concrete.

KEYWORDS: Steel Fibre, Fly Ash, Compressive Strength, Flexural Strength.

I. INTRODUCTION

Construction is a major part of development plan of developing countries including India. To meet the large require for infrastructure development, maintenance and life enhancement of structures are very important. Concrete is mostly used construction material. It has been good compressive strength, fire resistance, durabilityand also can be cast to fit any structural shape. As an improvement to Reinforced Cement Concrete, the reinforced cement concrete with randomly distribute fibres provides an ideal two phase composite material. The steel fibre (SFRC) has enhanced resistance against cracking and a better micro-crack arrest mechanism. Fibre reinforced concrete is found to have improved strengths against shear, flexure, tension and increased resistances against impact, fatigue, wear and enhanced toughness and ductility over that of RCC.

II. CONVENTIONAL REINFORCED CONCRETE

Tensile strength of concrete is typically 8 to 15% of its compressive strength. This weakness has been dealt with over many decades by using a system of reinforcing bars (rebar's) to create reinforced concrete; so that concrete primarily resists compressive stresses and rebar's resist tensile and shear stresses. The longitudinal rebar in a beam resists flexural (tensile stress) where as the stirrups wrapped around the longitudinal bar resist shear stresses. In a column, vertical bars resist compression and buckling stresses while ties resist shear and provide confinement to vertical bars. Use of reinforced concrete makes for a good composite material with extensive applications. Steel bars, however, reinforced concrete against tension only locally. Tracks in reinforced concrete members extend freely until encountering a rebar. Thus need for multidirectional and closely spaced steel reinforcement arises. That can't be practically possible. Stainless steel fibre reinforced gives the solution for this problem.

III. STEEL FIBRE REINFORCED CONCRETE

The important properties of steel fibre reinforced concrete (SFRC) are its superior resistance to cracking. Fibre composites possess increased extensibility and tensile strength, both at first crack and at ultimate crack, particular under Flexural loading and the fibres are able to hold the matrix together even after extensive cracking. The net result of all these impart to the fibre composite pronounced post cracking ductility which is unheard of in conventional concrete. The transformation from a brittle to a ductile type of material would increase substantially the energy absorption characteristics of the fibre composite and its ability to withstand repeatedly applied, shock or impact loading.

IV. BRIDGING ACTION

Pullout resistance of steel fibres dowel action is important for efficiency. Pullout strength of steel fibres significantly improves the post-cracking tensile strength of concrete. As an SFRC specimen or other structural element is loaded, steel fibres bridge the cracks. Such bridging action provides the SFRC specimen with greater ultimate tensile strength and, more importantly, larger toughness and better energy absorption. An important benefit of this fibre behaviour is material damage tolerance. In this fig Bridging action of steel fibres is shown.

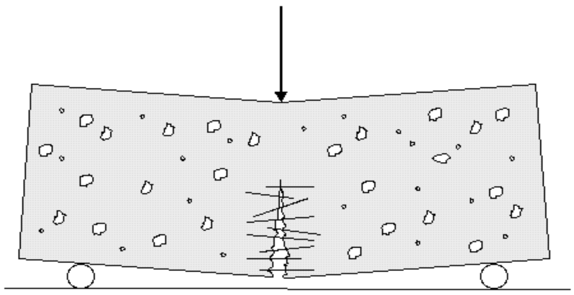

Fig. 1 Bridging Action of Steel Fibre

V. APPLICATIONS OF SFRC

The use of SFRC over past thirty years has been so varied and so widespread, that it is difficult to categorize them. The common applications are pavements, tunnel linings, shortcrete work, bridge deck slab repairs. Support of underground opening in tunnels and mines. Industrial flooring ,road pavements, warehouses, foundation slabs. Channel linings, product bridge abutments. There has also been some recent experimental work on roller compacted concrete reinforced with steel fibres. The fibres themselves are unfortunately, relatively expensive; a 1% steel fibre addition will approximately double the material cost of concrete, and this has tended to limit the use of SFRC to special applications.

VI.ADVANTAGES ON STEEL FIBRES

1. Creates more ductile concrete with reduced cracking.
2. Reduce the effect of shrinkage curling.
3. More economical than conventional steel solutions.
4. Fast installation thereby reducing schedule time.
5. Easy material handling.
6. Supported by large manufactures.
7. Very durable
8. Does not interfere with guide wire signals.
9. Does not cause concrete delimitations.
10. Can replace wire mesh in most elevated slabs.

VI. EXPERIMENTAL PROGRAMME

The experimental work involved casting and testing of conventional reinforced concrete specimens and steel fibre reinforced concrete specimens. The work was carried out in following steps:

1. Designing of a workable mix of M25 grade using graded coarse aggregate of 20 mm maximum size.
2. Fabrication of test cubes, cylinders, prism and beam.
3. Testing of specimens.

Comparing test results of conventional and steel fibres reinforced concrete specimens and beam in terms of First crack load, Load-deflection behaviour, Ultimate load carrying capacity.

VII. MATERIAL USED

The material used for this experimental work are cement, fine aggregates, coarse aggregates, water, fly ash, steel fibres and reinforcing steel.Ordinary Portland Cement of 53 grade with specific gravity 3.19 was used for the preparation of test specimen. Fly ash is added as partial replacement of cement at 20 % by weight of cement in order to get high performance concrete. The specific gravity of fine aggregate used for concrete is determined and found to be 2.50. The specific gravity of coarse aggregates were found to be 2.68.The portable water from the tap is used formixing and curing the concrete. The main reinforcement used for four beams were TMT bars of (Fe 415)10 mm diameter attop and 12 mm diameter at bottom. 8mm diameter mild steel bars were used for stirrups at 120mm c/cspacing.The crimped Steel fibers of 1% to 2% by volume of concrete having 0.45 mm diameter, 25mm length and aspect Ratio 55 was used in this work.

Water:

Potable water was used in the experimental work for both mixing and curing purposes.

Mix Proportioning: M25 grade concrete mix was designed as per IS 10262-2009. Proportion of concrete should be selected to make the most economical use of available materials to produce concrete of required quality. The mix ratio for casting the specimen used is 1:1.38:2.52 and water cement ratio of 0.45 is used.

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Fig2, Crimped steel fibre

Mould Details: The wooden beam mould of (200x200) mm in cross section and 1500mm long was selected for the casting of beam specimen.

Reinforcement Details: All the four beams were cast with the following reinforcement details. Two numbers of 10mm diameter rods at top and two numbers of 12mm diameter rods at bottom & 8mm diameter stirrups spaced at 120mm centre to centre as shear reinforcement grill before casting.

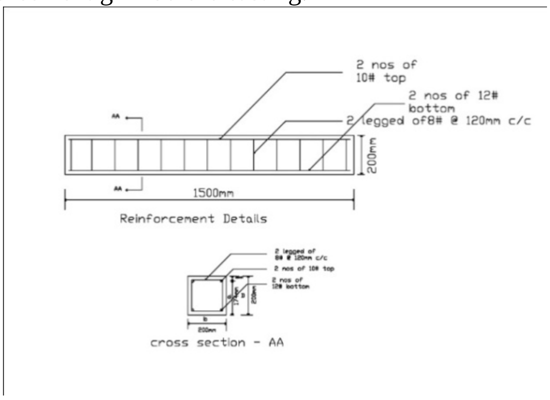

Fig 3, Reinforcement details

Testing Of Beams: The beam specimen was placed on the loading frame . All the beams were tested under two-point loading condition. The forward and reverse cyclic load was applied by using screw jack. The beam was gradually loaded by increasing the load level in each cycle. The deflection observed at mid span was measured by using Dial gauge. The deflection values are noted.

Fig 4, RCC beam testing

DEFLECTION DIAL GAUGES: Baty dial gauges with magnetic bases were used to measure deflection at different points of the specimen. The least count of the gauges was 0.01mm.

VIII. RESULT

In this test results will be comparative study with steel fibre and Conventional reinforced concrete Specimens test results.

Compressive Strength: Test Result at 7 and 28 days

Table 1- compressive strength details

Specimen no	Added % of fibre	Compressive strength of concrete N/mm2		
		7 days	14 days	28 days
N.C-1	0.0	20.65	24.54	31.25
S.F.W.FA-2	1.0	24.33	29.40	37.91
S.F.W.FA-3	1.5	27.22	33.51	39.52
S.F.W.FA-4	2.0	25.10	31.28	38.55

In this result comparison steel fibre 1.5% gives higher value compare conventional concrete.

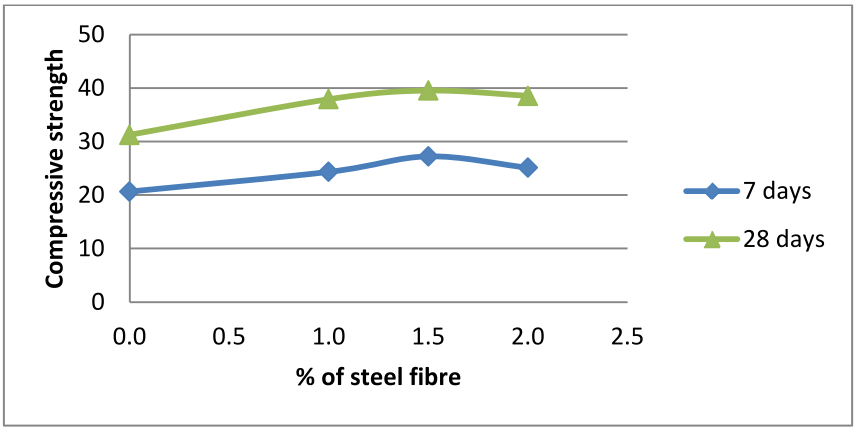

Fig5, Fibre Vs Compressive strength

Flexural strength for RCC Beam: Test Result at 28 days,

Table 2 - Flexural strength and deflection for RC beam

Specimen No	Added % of Fibre	Max load (KN)	Deflection (mm)	Flexural strength (N/mm2)
				28 days
N.C-1	0.0	36	4.8	8.92
S.F.W.FA-1	1.0	50	6.0	12.39
S.F.W.FA-2	1.5	63	8.2	15.61
S.F.W.FA-3	2.0	57	7.1	14.12

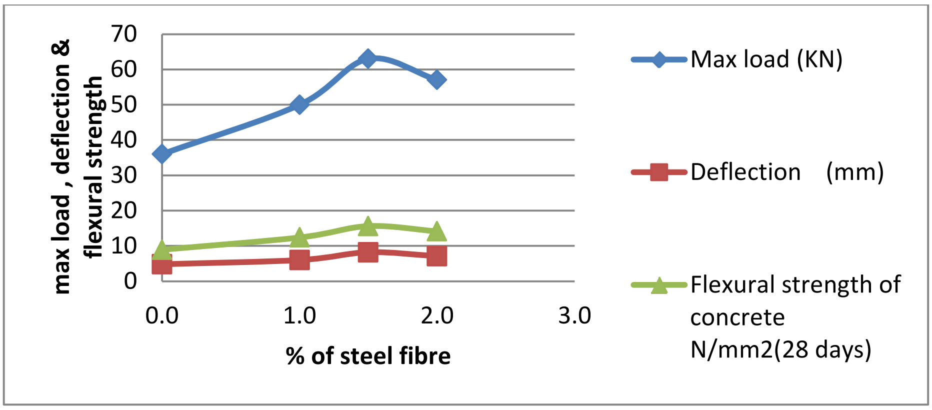

Fig 6, fibre Vs max load , Deflection and flexural strength

IX. CONCLUSIONS

The present study was undertaken to investigate the behaviour of steel fibre reinforced concrete beams and cubes with conventional concrete. Based on the experimental results obtained from the present study, the conclusions have been drawn on the behaviour of fibre reinforced concrete specimen and are reported in this study. The following conclusions can be drawn:

1. Theaddition of steel fibres improved structural performance , measure in ultimate load carrying capacity, crack widths, deflection of specimens and first crack was delay with post cracking is improved.
2. The compressive strength of the S.F.W.FA-3 is increased up to 26.5% (1.50% of fibre of aspect ratio 55) compare to conventional concrete.
3. The Ultimate load carrying capacity of the S.F.W.FA-3 increased up to 75% (1.50% of fibre of aspect ratio 55) compare to conventional concrete.
4. Micro cracks will be controlled in this strengthening system.

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