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Experimental Investigation on the Flexural Strength of Hybrid Fiber Reinforced Concrete Made With M-Sand

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ABSTRACT: Performance of conventional concrete is enhanced by addition of fibers in concrete. The brittleness in concrete is reduced and the adequate ductility of concrete is ensured by the addition of fibers in concrete. In this paper the behavior of RC beam structures strengthened by using hybrid fiber reinforced concrete is analyzed. The concrete beams are casted for a grade of M25 as per IS: 10262-2009. The fibers used are steel (hooked end) and polypropylene fibers in various volume fractions. The main reasons for adding steel fibers to concrete matrix is to improve the post-cracking response of the concrete i.e., to improve its energy absorption capacity and apparent ductility and to provide crack resistance and crack control. The hybrid fibers of various ratios [0.5 to 1.25%] steel and (0.05 to 0.125)polypropylene fibers to the volume of concrete were used in the concrete mixes. Beams were cast and tested under flexural.

KEYWORDS:Cement mortar, Steel Fiber ,polypropylene Fiber.

I. INTRODUCTION

Concrete is still the most widely used construction material, the ability of concrete itself can be cast in any shape ,resistance to water and high temperature. Generally concrete is a brittle material and associated with creep and shrinkage properties , which induce to cracking problems and concrete deterioration. In order to overcome these problems using fibers in construction are followed from very olden days. they are many type of fiber that can be used in concrete reinforcement .the concrete produced through the addition of more than one type of fibers is called hybrid fiber concrete. The steel and polypropylene fibers of hybrid concrete used increase the flexural strength, impact strength and toughness properties of concrete. It is an economical way to reinforced concrete compared to regular steel.

SCOPE AND OBJECTIVE

- The fibers of different volume fractions to be added to the concrete and find the saturation point of maximum strength.
- The hybrid fiber concrete of 150mm cubes were casted for different ratios of steel and polypropylene fibers of[0.5:0.05%,0.75:0.075%,1:0.1%,1.25:0.125] respectively.
- To get the optimum value of hybrid fiber concrete and cast the beam of size 3200 mm length, breadth 200 mm and depth 150mm.
- The beams are tested under flexural behavior. Comparing the test results between conventional reinforced concrete beams and hybrid fiber reinforced concrete beams.

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II. METHODOLOGY

PROPERTIES OF STEEL FIBER REINFORCEMENT NOVOCON 1050.

Material: Cold-drawn steel wire, with deformed ends.
Conformance: ASTM A 820/A 820M, Type I. Fire Classification: UL Report File No. R14701 (N).
Tensile Strength: Minimum 152,000 psi (1,050 MPa).
Fiber Length: 2 inches (50 mm).
Equivalent Diameter: 0.039 inch (1.0 mm).
Aspect Ratio: 50.
Appearance: Bright and clean wire.



1. Steel fiber

PROPERTIES OF POLYPROPYLENE FIBER

Product :Fibrillated (mash)
Polymer :100% virgin polypropylene homo polymer
Fiber Length:10-12mm
Melting Range:165 degree celsius
Thermal and electrical conductivity : low
Colour :Natural
Specific Gravity: 0.91



2. Polypropylene fiber

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III. EXPERIMENTAL STUDY

The experimental program consisted of static test . Four reinforced SFRC beams, divided into two groups, were fabricated and tested under various loading rates to investigate the effect of steel fibers polypropylene fibers and shear reinforcement in RC beams. The details of the specimens are listed in Table 1. The fiber volume fraction and details of shear reinforcement were considered as variables. As illustrated in Fig. 1, all specimens were 150mm in width, 200mm in height, and 1200mm in length, and longitudinal reinforcements, which consisted of two deformed steel reinforcing bars of diameter of 16mm (denoted as D19). Two specimens of each test series incorporated shear stirrups that were designed according to the minimum shear requirements of 12mm and hook end steel, polypropylene fiber. The compressive strength test, cube specimens of dimensions 150 mm × 150 mm × 150 mm and 100x100x500mm height cylinders were cast using M25 grade of concrete with 0.5%, 0.25%, 0.75%, 1%, 1.25% steel fiber, and 0.05%, 0.075%, 0.01%, 0.125% polypropylene fiber hybrid weight of cement, separately. The specimens were placed in compressive testing machine capacity of 3000KN and tested for compressive strength. The flexural strength of concrete beam was determined by using beam specimens of size 1200 mm x 150 mm x 200 mm were casted using M20 and M25. The samples were demoulded after 24 hours from casting and kept in a water tank for 28 days curing. The specimens were placed in flexural testing machine capacity of 200 Ton and tested for flexural strength.

3.2 Material properties

The concrete properties and mix proportions are summarized in Tables 1 and 2. All specimens were fabricated with an identical mixture that had a water-to-cement ratio of 0.5, sand-to-aggregate ratio of 0.88, and maximum aggregate size of 20 mm. Moreover, 50mm hooked-end steel fibers 10-12mm, polypropylene fiber were used in the concrete, and the fiber content varied among 0, 0.5, 1, 1.5 and 2%. The compressive and flexural strengths were measured based on ASTM C39 [23] and C1609 [24], on cylinders with a diameter of 100mm and height of 200 mm, and beams with a cross-section of 150×200mm and a length of 1200 mm.

| WATER | CEMENT | FINE .AGG | COARSE. AGG | STEEL FIBRE(1%) | POLY PROPYLENE | |
|-------|--------|-----------|-------------|-----------------|----------------|--|
| 192 | 384 | 685 | 1155 | 0 | 0 | |
| 192 | 384 | 685 | 1155 | 0.5 | 0.05 | |
| 192 | 384 | 685 | 1155 | 0.75 | 0.075 | |
| 192 | 384 | 685 | 1155 | 1 | 0.1 | |
| 192 | 384 | 685 | 1155 | 1.25 | 0.125 | |

3.3 Test procedure

3.3.1. Static test

static two-point flexural tests were carried out on the five specimens with quasi-static loading rate of 0.02 mm/s. As part of the tests, deflections and strains were measured, and crack patterns were also examined. The pure mid-span deflection, excluding the support settlement, was measured by linear variable differential transducers (LVDTs). Electrical resistance strain gauges were glued to the centers of all the longitudinal reinforcements.

3. 4. REINFORCEMENT DETAILS

Main reinforcement: 2 nos of 12 mm dia HYSD bars, Secondary reinforcement: 2 nos. of 16 mm dia HYSD bars,
Shear reinforcement: 2 nos of 16 mm dia at 300 mm c/c.

The yield strength of steel reinforcement used in this experimental program was determined by performing the flexural test on the four specimens of each grade of concrete.

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Fig 1 Reinforcement cage



Fig 2 Applying on the concrete



Fig 3 curing of concrete

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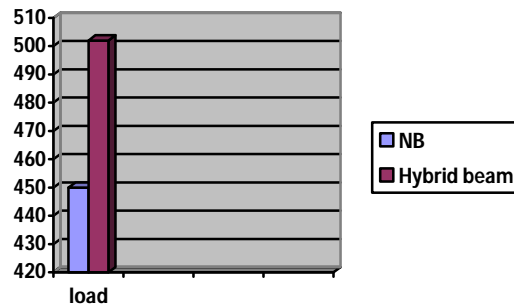
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IV. EXPERIMENTAL RESULTS AND DISCUSSION

4.1 Static response

SFRC-0% sustained a maximum reaction force of 450 kN and exhibited brittle-shear failure at a relatively marginal load and deflection. The addition of 1.0 vol% of fibers resulted in an increase of 40% in the maximum load (F_{max}): $F_{max} = 502$ Kn The maximum force of shear-deficient specimens, which implies twice the shear strength ($F_{max} = 2V$), increased monotonously. The shear strength of the RC beams increased with increase in the volume fraction of steel fibers, because of the enhanced fiber bridging capacity at the crack surface. Although several studies reported that a fiber content of 1% is typically sufficient to avoid shear failure, the addition of 2% fibers was not adequate to cause flexural-failure in this test.



| Sl.no | Concrete type(25) | Flexural failure load(kn) |
|-------|----------------------|---------------------------|
| 1. | Normal concrete beam | 450 KN |
| 2. | Hybrid concrete beam | 502KN |

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V. CONCLUSION

The following conclusions are drawn based on the test results

- M25 grade concrete mix is designed based on IS: 10262-2009 guide lines and the mix proportion obtained as 1: 1.78: 3.03 with w/c ratio of 0.5 to obtain 75 mm slump.
- The compressive strength of M25 grade concrete for 28 days is 32.01 N/mm² and Compressive strength of optimum dosage of HYFRC 1% is 38.16 N/mm² will be increased.
- Two identical beams are cast in control beam as well as HYFRC beams. The first crack load observed in control beams are 200 KN and the same observed in HYFRC beams are 220kN. The HYFRC beam shows 10% increase in first crack load.
- The flexural strength of conventional beam of M25 grade of concrete for 28 days is 450KN and hybrid reinforced concrete beams 502KN.

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