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Review on comparison of energy absorption in Steel Fibre Reinforced Conrete; Polypropylene Fibre Reinforced Conrete;Hybrid Fibre Reinforced Conrete.

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ABSTRACT---*The objectives of the current research is to study the durability properties of M30 grade of concrete reinforced individually with 4 per cent of steel and polypropylene fibres, respectively, as well as with hybrid fibres consisting of 2 per cent steel and 2 per cent polypropylene fibres, respectively, and to evaluate their strength at 7, 14, 21 and 28 days. It has been observed that many investigators have used a maximum dosage of 2 per cent by volume of cement for a single fibre. The investigation here pertains to hybrid fibres consisting of two classes of fibres, namely, steel and polypropylene. As per the literature evidence, for each fibre a dosage of 2 per cent has been adopted. Therefore in hybrid fibre-reinforced concrete the fibre content was 4 per cent. For comparison the same dosage of 4% was adopted in individual cases too. Also, addition of more fibres reduces cracking and improves corrosion resistance. Moreover, fibre reinforcement also serves to improve the shear resistance of concrete. In the recent past, investigators attempted to enhance the mechanical properties of fibre reinforced concrete using fibre hybridization. Different types of fibres in various combinations have been employed with varying sizes of concrete specimens. Though enhancement in the mechanical properties of HyFRC has been reported through fibre hybridization, but there exists little understanding of hybrid fibre composites and the information obtainable at present is still scanty. Hence, this investigation was planned to study the flexural behavior of Hybrid FRC containing hybrids of steel and polypropylene fibres. Addition of different proportions of steel and polypropylene fibres to concrete has been investigated to evaluate the mechanical properties of Hybrid FRC. Tests under compression and flexure have been conducted on concrete specimens containing different percentages of combination of steel and polypropylene fibres.*

Keywords— energy absorption Steel Fibre Reinforced Conrete; Polypropylene Fibre Reinforced Conrete;Hybrid Fibre Reinforced Conrete.

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1. INTRODUCTION

Fibre reinforced concrete (FRC) was developed to overcome the problems associated with cement based materials such as low tensile strength, poor fracture toughness and brittleness of cementitious composites. FRC was primarily used for pavements and industrial floors (Hoff, 1986). But currently, the

1

Volume: 3, Issue: 1,Special Issue: 1 ,Mar,2017 ,ISSN_NO: 2320-723X

FRC composites are being used for a variety of applications including tunnel linings, bridges, canal linings, hydraulic structures, pipes, etc., (Balaguru and Shah, 1992). To improve properties of concrete like low tensile and strain capacity, fiber reinforced concrete (FRC) has been developed which is defined as concrete containing dispersed randomly oriented fibers (Johnston, 1974). Mechanical properties such as compressive strength, splitting tensile strength and flexural strength were compared for concrete containing different combinations of steel, carbon and polypropylene fibres at a fibre volume fraction of 0.5% (Yao et al., 2003). It was observed that concrete reinforced with the carbon-steel combination achieved the highest strength.The research mainly focuses on separate use of steel, polypropylene and combined polypropylene and steel (crimped) fibres as hybrid in concrete system. In this system steel fibre is strong and stiffer, improves the first crack strength, while polypropylene fibre which is more flexible and ductile, leads to improved toughness and strain capacity in the post cracking zone (Ramadevi and Venkatesh Babu, 2012). A reinforced concrete member with hybrid fibres is formed by a combination of different types of fibres with different material properties bonded together when added in concrete and retain their properties. Three types of hybrid composites have been used by the researchers using the combinations of Polypropylene – carbon fibre, carbon - steel fibre and steel - polypropylene fibre (Patodi and Kulkarani, 2012). Fibres suppress the formation of cracks. In order to improve the mechanical properties it is good to mix cement with fibre which have good tensile strength (Yu et al., 2011). Adding fibres to concrete greatly increases the toughness of the material.

2. EXPERIMENTAL INVESTIGATION

To determine the strength properties of fibre reinforced concrete the following experimental tests were planned and conducted.

2.1 MATERIAL USED AND METHODS

2.1.1 Cement

Ordinary Portland Cement of 53 grade available in local market is used in the investigation. The cement used has been tested for various properties as per IS: 4031 [12] and found to be confirming to various specifications of IS: 12269 [13]. The specific gravity of cement was 3.15 and fineness was 3200/cm^2/gm.

2.1.2 Coarse aggregate

Crushed angular granite metal of 20 mm size from a local source was used as coarse aggregate. The specific gravity of 2.71 and fineness modulus of 4.07 was found from testing [14].

2.1.3 Fine aggregate

River sand was used as fine aggregate. The specific gravity of 2.60 and fineness modulus 2.65 was found in the investigation.

Volume: 3, Issue: 1,Special Issue: 1 ,Mar,2017 ,ISSN_NO: 2320-723X

2.1.4 Steel fibre

Typically steel fibres have equivalent diameters of 0.15 mm to 2 mm and length from 7 mm to 75 mm Fig. 1 (a). Aspect ratio generally ranges from 20 to 100. Aspect ratio is defined as the ratio between fibre length and its equivalent diameter, which is the diameter of a circle with an area equal to the cross section area of the fibre. Steel fibres have high tensile strength ranging from 0.5 - 2.0 GPa with modulus of elasticity of 200 GPa.

2.1.5 Polypropylene fibre

Polypropylene fibre, a synthetic carbon polymer, is produced as continuous mono – filaments, with circular cross section that can be chopped to required length (or) tape of rectangular cross section (Fig. 1(b)). Polypropylene fibres are tough but with low tensile strength and modulus of elasticity. They have plastic stress-strain characteristics. Furthermore, their ability to cause interference with the capillary forces by which water bleeds to the surface of concrete reduces the risk of plastic settlement due to water evaporation. A blend of steel and polypropylene fibres can combine structural elements with plastic cracking in fresh concrete and drying shrinkage cracking in hardened concrete and to improve post-cracking toughness. Micro synthetic fibres also increase resistance to spalling in fire situation.

2.2 CONCRETE MIX DESIGN

Concrete mix of grade M30 was designed as per the recommendation of IS: 383 (1970) and IS: 10262 (2009).

2.3 MIXING AND CURING

The procedures for mixing the fibre reinforced concrete involved the following. Firstly, the crushed granite and sand were placed in a concrete mixer and dry mixed for 1 min. Secondly, the cement was spread and dry mixed for 1 min. After which, the specified amount of fibres were distributed and mixed for 3 min in the mix. This was followed by the addition of water with mixing time of 5 min. After pouring the mix into oiled moulds, a poker vibrator was used to decrease the amount of air bubbles in the mix. The specimens were demoulded after 1 day and then placed in a curing tank. Beams are casted as singly and doubly reinforced concrete beam and tested after 28 days curing.

2.4 TESTING PROCEDURES

For each mixture (Conventional Concrete, Steel Fibre Reinforced Concrete, Poly Propylene Fibre Reinforced Concrete, and HYBRID - both Steel and Poly Propylene fibre) eight numbers 150 × 150 × 700 mm beams wit singly and doubly reinforcement was prepared. A total of 16 specimens were casted. The single-point load flexural tests were carried out at a loading rate of 0.05 mm/min on the 150 mm × 150 mm × 700 mm beams according to the requirements of IS: 519 (1959). During the flexural tests, the load and the mid span deflection were recorded and the flexural load was obtained.

3. RESULT, DISCUSSION AND CONCLUSIONS

Volume: 3, Issue: 1,Special Issue: 1 ,Mar,2017 ,ISSN_NO: 2320-723X

3.1 GENERAL

In this chapter the ultimate load of singly and doubly reinforced with fibre reinforce concrete beams of M30 grade after 28 days curing are tested in the laboratory. Results are tabulated and charts are presented.

3.2 SLUMP CONE TEST

A slump test is a method used to determine the consistency of concrete. The consistency, or stiffness, indicates how much water was used in the mix. The stiffness of the concrete mix should be matched to the requirements for the finished product. A slump test was performed when the concrete was delivered to double-check the stiffness of the mix. A separate test was administered to each load of concrete. The test was carried out using a mould known as a slump cone or Abrams cone. The cone was placed on a hard non-absorbent surface. This cone was filled with fresh concrete in three stages, each time it was tamped using a rod of standard dimensions. At the end of the third stage, concrete was struck off flush to the top of the mould. The mould was carefully lifted vertically upwards, so as not to disturb the concrete cone. Concrete subsided. This subsidence was termed as slump. The slumped concrete took various shapes, and according to the profile of slumped concrete, the slump was termed as true slump, shear slump or collapse slump. If a shear or collapse slump is achieved, a fresh sample should be taken and the test repeated. A collapse slump is an indication of too wet a mix. Only a true slump is of any use in the test. A collapse slump will generally mean that the mix is too wet or that it is a high workability mix, for which slump test is not appropriate.

3.3 LOAD AND DEFLECTION TEST RESULT

Characteristics of concrete containing steel, polypropylene and hybrids of steel and polypropylene fibers. Out of each batch of concrete, three specimens were tested in load the specimen used for standard prisms of size 150 mm × 150 mm × 750 mm were used for flexural strength tests. In fact, this paper forms a part of a larger investigation being conducted to investigate the flexural deflection. This paper reports the results of the load deflection tests. The load deflection test of plain concrete was also listed for reference and comparison. The load deflection test was calculated as follows IS: 516 (1959). These prisms were tested on digital Universal Testing machine.

The flexural testing of beams was done by two point loading test by using universal testing machine of 60 kN capacity. The end conditions of beam were kept simply supported. The dial gauges (L.C-0.01 mm) were fixed under loading points and centre point of the beam to measure deflection of the beam. Load was applied at the rate of 5 kN up to failure of beam. First crack load, ultimate load and deflection at each 2.5 kN load increment were recorded. The test setup is shown in Figure Control Beam (CB) is taken common in all groups for comparison. Figure 5 shows load deflection curve for steel, polypropylene and hybrid FRC beam.

4. CONCLUSIONS

Based on the experimental results, the following conclusions were drawn. Using three types of fibers with 4 per cent by volume of cement the results were compared with the conventional concrete specimen. The concrete mix with 4 per cent steel fiber showed that the concrete was stiff and difficult to compact. The concrete mix with 4 per cent Polypropylene fiber showed that concrete was more slippery and difficult to compact.Increase in the energy absorption in singly reinforced concrete PPFRC is observed in

4

the range of 2% for the 28 days of curing. Decrease in the energy absorption in singly reinforced concrete SFRC is observed in the range of 49% for the 28 days of curing. Decrease in the energy absorption in singly reinforced concrete Hybrid FRC is observed in the range of 3% for the 28 days of curing. Increase in the energy absorption in doubly reinforced concrete PPFRC is observed in the range of 58% for the 28 days of curing. Decrease in the energy absorption in doubly reinforced concrete in SFRC is observed in the range of 6% for the 28 days of curing. Decrease in the energy absorption in doubly reinforced concrete hybrid FRC is observed in the range of 20% for the 28 days of curing. An increase in energy absorption is better, in this investigation out of the three type of concrete PPFRC is highest energy absorption and this concrete is very much suitable for earthquake resistant structures.

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