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Comparative Study on High Strength Hybrid Fiber Reinforced Concrete with Conventional Concrete

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***Abstract*—The purpose of this project is comparative study on high strength hybrid fiber reinforced concrete. Hybrid fiber reinforced concrete with different proportions was tested for compressive strength, split tensile and flexural strength for M40 grade of concrete. Normal concrete, M40 grade was taken as control. With the same grade of concrete hybrid fiber reinforced cubes, flexural beams specimens were cast in different volume proportions viz., 0.0%,0.5%, 1.0%, 1.5% and 3.0 % and the same were examined for compressive strength, flexural strength. Experiments were conducted to study the effect of crimped steel fiber and polypropylene fiber in different proportions in hardened concrete. Physical and chemical properties of steel fibers and polypropylene have been studied. A concrete mix has been designed to achieve the grade of M40 as required by IS 10262-2009.The investigation contains two phases. The phase one contains to study and determine the properties of the material. In the phase two contains to determine the Compressive Strength, Split Tensile Strength and Flexural Strength of the concrete All the specimens were cured for the period of 7, 14 and 28 days before testing and results are furnished here based on their strength**

Keywords*— Hybrir Fiber, Polypropylene fiber, crimped steel fiber, Hybrid fiber concrete

I. INTRODUCTION

Concrete made with Portland cement has certain characteristics. It is relatively strong in compression but weak in tension and tends to be brittle. These two weaknesses have limited its use. Another fundamental weakness of concrete is that cracks start to form as soon as concrete is placed and before it has properly hardened. These cracks are major cause of weakness in concrete particularly in large onsite applications leading to subsequent fracture and failure and general lack of durability.[1]The weakness in tension can be overcome by the use of conventional rod reinforcement and to some extent by the inclusion of a sufficient volume of certain fibers.[2]Latest developments in concrete technology now include reinforcement in the form of fibers, notably polymeric fibers as well as steel or glass fibers. Fiber-reinforcement is predominantly used for crack control and not structural strengthening.[3] Although the concept of reinforcing brittle materials with fibers is quite old; the recent interest in reinforcing cement based materials with randomly distributed fibers is based on research starting in the 1960's. Since then, there have been substantial research and development activities throughout the world.[4] It has been established that the addition of randomly distributed Polypropylene fibers reduced the plastic cracking and steel fibers increase their fracture toughness, ductility and impact resistance. Since fibers can be premixed in a conventional manner, the concept of polypropylene fiber concrete has added an extra dimension to concrete construction.[5] There is a hardly anyone type of fiber that can improve all the desired properties of fresh and hardened concrete. To improve all properties of concrete the combination of two or more types of fibers is required and the composite is known as “high strength hybrid fiber reinforced concrete”.[6] The basic purpose of using hybrid fibers is to control cracks at different size levels in different zones of concrete, stress levels and to enhance the properties of concrete by combining the benefits that each particular fiber type can impart.[7] In this project comparative study on compressive and flexural behavior of hybrid fiber reinforced concrete will be carried out using the combination of crimped steel and polypropylene fibers.[8].

II. METHOEDOLOGY

A total of 144 specimens have been casted to compare the strength of concrete cube containing hybrid fibres with volume proportions with (crimped steel-polypropylene) i.e.(0.5%-0.5%), (0.6%-0.4%), (0.7%-0.3%), (0.8%-0.2%), (0.9%-0.1%)of volume of the concrete with normal concrete cubes, cylinder and beams. Crimped steel fiber (CSF) and polypropylene fiber (PP) were added as admixture to increase the strength. The sand and cement were kept constant throughout the mix. The specific gravity and water absorption of aggregates were used to calculate mix design. The mix proportioning of m40 grade concrete has been calculated as per is 10262-2009 are: cement = 480kg/m3, fine aggregate= 640.46kg/m3, coarse aggregate = 1172.82kg/m3. W/c ratio has been found as 0.40. The methodology adopted in the study is shown in figure 1.

III. MATERIALS

The materials used for this experimental work are cement, river sand, natural coarse aggregate, water, crimped steel fibers, and polypropylene fibre.

Cement: The cement used for this study is Ordinary Portland Cement conforming to IS 12269 – 1987 of grade 53. Table 1 shows the physical properties of cement.

Fine Aggregate: Locally available sand zone II with specific gravity 2.65, water absorption 2.46% and fineness modulus 3.14, conforming to I.S. – 383-1970.

Coarse aggregate: Crushed blue metals of 20 mm size having specific gravity of 2.85, fineness modulus of 8.05, impact value of 33% and water absorption of 0.70 conforming to IS 383-1970 have been used

Water: Potable water was used for the experimentation.

Fibers: Steel Fibers: In these experimentation Crimped Steel fibers with aspect ratio 50 has been used. The length and diameter of steel fiber is 50mm and 1mm respectively.

Fibres: Synthetic fibre: In this experimentation polypropylene with aspect ratio 12 has been used. The length and diameter of polypropylene fibre is 12mm and 6 denier respectively.

IV. RESULTS AND DISCUSSION

A. *Compressive strength*

Compressive strength gives the overall picture of quality of concrete and it is considered as the most important properties of concrete. From the table, it can be seen that the compressive strength increases by addition of crimped steel fibre and polypropylene fibre. It can be found that highest compressive strength has been obtained with 0.8(C.S)+0.2(PP)% OF concrete. So this can be seen as the optimum percentage hybrid fibre reinforced concrete.

Beyond which any additonal is observed to have detrimental effects on the compressive strength. The average compressive strength of various percentage for 28 days age. Using the results of compressive strength, the regression analysis has been carried out and the equation of best fit has been found for finding the compressive strength of high strength hybrid fibre reinforced concrete.

Compressive Strength = Failure Load / Cross sectional area

B. *Split tensile strength*

To measure the split tensile strength, cylinders were cast. From Table 5, it can be seen that the split tensile strength of concrete with addition of crimped steel fibre and polypropylene fibre 0.8(C.S)+0.2(PP)% of has the highest split tensile strength. This indicates that addition of crimped steel fibre and polypropylene fibre is the optimum percentage 0.8(C.S)+0.2(PP)% even for split tensile strength as it was for compressive strength.

The results obtained in split tensile test of cylinders are shown in the Table 5 for Natural Coarse aggregate and varying percentage of hybrid fibre reinforced concrete.

$$fct = 2\,p / \pi\, l\, d$$

Where,

p – Maximum load Newton applied to the specimen

l – Length of the specimen

d – Cross sectional dimension of the specimen

C. *Flexural strength*

It is measured by testing beams under 3 point loading including the reactions. Beam Dimensions: 700 mm length × 150 mm breadth x 150 mm height. Figure 2 shows the loading position of the beams. Table 6 shows the flexural strength obtained for concrete and different percentage of crimped steel fibre and polypropylene fibre . When the percentage of crimped steel fibre and polypropylene fibre is increased from 0.7(C.S)+0.3(P.P) to 0.8(C.S)+0.2(PP)% , high flexural strength has been obtained for by addition of hybrid fibre reinforced concrete.

$$fb = pl/bd2$$

Where,

b - width of specimen (cm)

d - failure point depth (cm) l - supported length (cm)

p - maximum Load (kg)

V. CONCLUSION

The Comparative study on the effect of hybrid fibers with different proportions an still is a promising work as there always a need to overcome the problem of brittleness of concrete.

The following conclusion could be drawn from the present investigation.

- The basic property of hybrid fibre reinforced concrete compressive strength, split tensile strength and flexural strength are studied. Addition of fibre in concrete reduces the formation of internal micro cracks.
- The compressive strength of M40 grade of concrete by addition of admixture as crimped steel fibre by concrete and polypropylene fibre by cement with different volumetric proportions of percentage (0.5%-0.5%), (0.6%-0.4%), (0.7%-0.3%), (0.8%-0.2%), (0.9%-0.1%).
- We conclude that the compressive, split tensile and flexural strength between (0.6%-0.4%), (0.7%-0.3%) is increase high as compare to other intervals.
- The high strength of hybrid fibre reinforced concrete is (0.8%-0.2%) of compressive strength 59.55 N/mm2 as compare with other proportions. Use of HFRC increases compressive strength.

TABLES

TABLE.1 PHYSICAL PROPERTIES OF CEMENT

Property	Value
Initial setting time (min)	33
Fineness modulus (%)	3
Specific gravity	3.10

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TABLE.2 PHYSICAL PROPERTIES OF CRIMPED STEEL FIBRE

Fibre Type	Steel Fibre
Shape	Crimped
Length(mm)	50mm
Equivalent Diameter(mm)	0.75
Tensile Strength(Mpa)	1100
Density (kg/m3)	7850
Specific Gravity	7.84

TABLE.3 Physical Properties of Polypropylene Fibre

Fibre Type	**Polypropylene**
Shape	Mono filament
Length(mm)	12mm
Equivalent Diameter(mm)	0.6
Tensile Strength(Mpa)	550
Density (kg/m3)	910
Specific Gravity	0.91

TABLE.4 Compressive Strength of Concrete

Batch	Cube strength (N/mm^2) for 28 days
CC	48.8
0.5 CS+0.5 PP	52.00
0.6 CS+0.4 PP	53.77
0.7 CS+0.3 PP	58.22
0.8 CS+0.2 PP	59.55
0.9 CS+0.1 PP	57.77

TABLE.5 Split Tensile Strength of Concrete

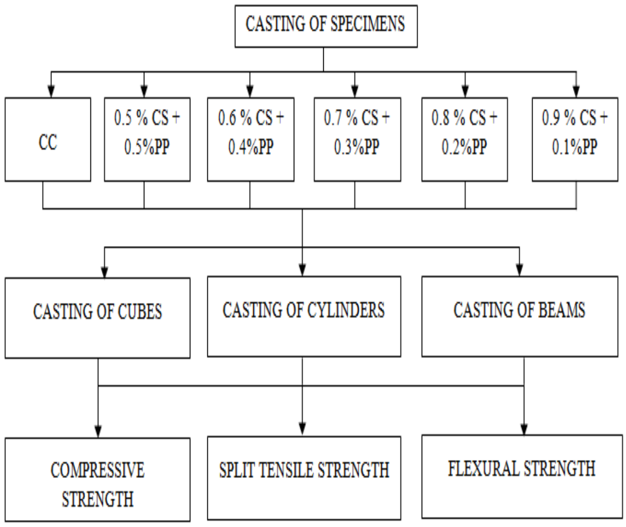
Batch	Cylinder strength (N/mm^2) for 28 days
CC	4.68
0.5 CS+0.5 PP	4.95
0.6 CS+0.4 PP	5.12
0.7 CS+0.3 PP	5.48
0.8 CS+0.2 PP	5.94
0.9 CS+0.1 PP	5.65

TABLE.6 Flexural Strength of Concrete

Batch	Deflection(mm)	Flexural Strength (N/mm^2) for 28 days
CC	08	45.51
0.5 CS+0.5 PP	05	39.29
0.6 CS+0.4 PP	07	43.58
0.7 CS+0.3 PP	11	47.38
0.8 CS+0.2 PP	15	49.87
0.9 CS+0.1 PP	13	46.75

FIGURES

Fig.1 Methodology adopted



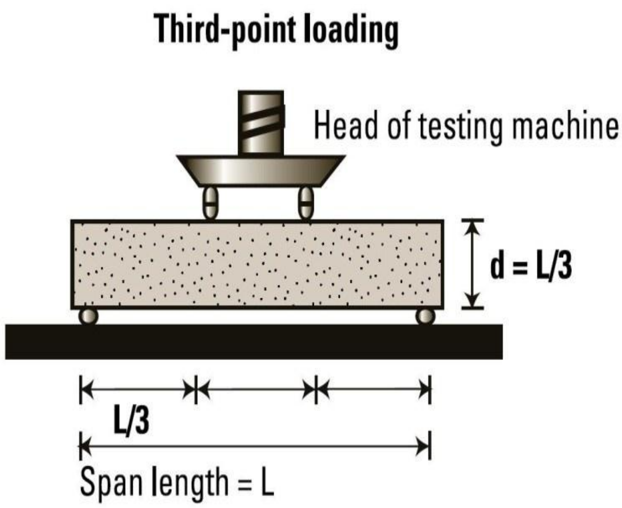


Fig.2 Loading Frame

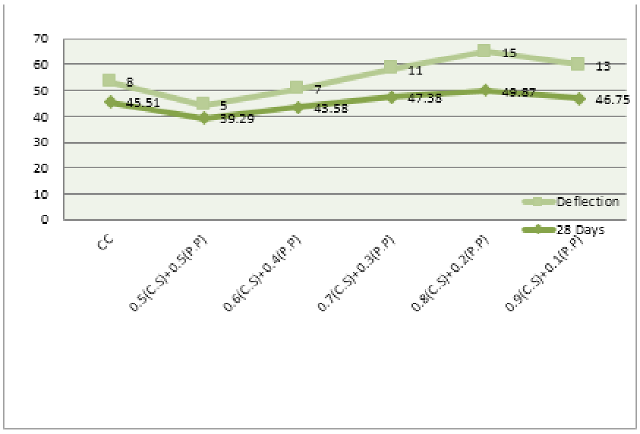


Fig.3 Load vs. Deflection

Fig.4 Crack Pattern

Fig.5 Polypropylene Fiber

REFERENCES

[1] Eswari .S and Suguna.K (2008) “Ductility Performance of Hybrid Fibre Reinforced Concrete”, - American Journal of Applied Sciences 5 (9): 1257-1262, 2008 ISSN 1546-9239

[2] Kavita S. Kene (2015) “Experimental Investigation on Hybrid Fiber Reinforced Concrete”, - International Journal of Engineering Research and Applications (IJERA) ISSN: 2248-9622 Vol. 2, pp.1037-1041.

[3] S.Kirankumar and Dr.S. Siddiraju,(2016) “Effect of Steel and Polypropylene Fiber on Mechanical Properties of Concrete”, - International Journal of Civil Engineering and Technology, 7 (3),2016,pp.342-346

[4] Mtasher R.,A. , and Abass , A.M. (2011) ,"Strength Prediction of Polypropylene Fiber Reinforced Concrete" - Journal , Vol. 29 , No. 2,pp.412-416.

[5] Nitin Kumar (et,al)., (2015) “High Performance of Hybrid Fibre Reinforced Concrete”, International Journal of Engineering Research and Applications (IJERA) ISSN: 2249-6149 Vol. 2, pp.365-368.

[6] K.Ramadevi and L.Venkatesh Babu., (2012) “Experimental Investigations on Hybrid Fibre Reinforced (HFRC) Concrete Columns”- IJERA) ISSN: 2250-0588 Vol. 2, pp.131-137.

[7] Selina ruby G, Geethanjali C, Jaison Varghese, Muthupriya P, 2014, “Influence of Hybrid Fiber on Reinforced Concrete”, International Journal of Structures and Geotechnical Engineering, ISSN 2319-5347, vol-03, pp 40-43.

[8] IS: 12269-1987, Specification for 53 grade ordinary Portland cement Bureau of Indian standards, New Delhi, India.

[9] IS: 456-2000, Plain and reinforced concrete- code of practice, Bureau of Indian standards, New Delhi, India.

[10] IS 383:1970, Specification for coarse and fine aggregates from natural sources for concrete (second revision), Bureau of Indian standards, New Delhi, India.

[11] IS: 12269-1987, Specification for 53 grade ordinary Portland cement Bureau of Indian standards, New Delhi, India.