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A comparative study of compressive strength and split tensile strength on effect of size of coarse aggregate in hybrid fiber reinforced concrete with different grades

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Abstract

Concrete is one of the main materials of the structure and is widely used in the world. While advanced technology for concrete has recently focused on developing various properties of concrete by adding different materials. The voids in concrete are also one of the important factors in the rationalization of concrete strength. By reducing the porosity of concrete and improving the uniformity of concrete, it is one of the effective means to improve the strength of concrete. Coarse aggregate usually accounts for more than one third of the volume of concrete; studies have shown that coarse aggregate changes can change the strength and fracture properties of concrete. In order to predict the behavior of concrete under normal loads, it is necessary to understand the effects of aggregate type, aggregate size and polymer content. This understanding can only be achieved through extensive testing and observation. Polymer grading is an important part of concrete mixing, resulting in compressive strength. Experiments were conducted to determine the effect of aggregate size on the compressive strength of concrete. Adding the fiber to the concrete rather than increasing the tensile strength itself, but mainly controlling the crack, and changing the behavior of the cracked material by bridging the fiber across the crack. With a single type of fiber reinforced concrete, the desired performance can be increased to a limited level. In this study, the effects of different sizes of coarse aggregate on the properties of concrete, such as the workability of concrete in M30, M40 and M50 concrete, compressive strength, tensile strength and splitting tensile test and fine uniformity of UPV, were studied. For the standard combination to replace 12.5mm aggregate to 20mm aggregate to find the best mixture content. So, for the best mix of alternatives, we will study the effect of 10mm aggregates to find the best combination. In both cases, the replacement starts at 0%, and each mix increases by 5% to find the best combination. Polypropylene fibers are added (PPF) to the best mix and the results are compared with normal mix.

Keywords: compression strength, split tensile strength, polypropylene fiber, fiber reinforced concrete

Introduction

It is well known that coarse aggregate plays an important role in concrete. Coarse aggregate usually accounts for more than one third of the volume of concrete, studies have shown that coarse aggregate changes can change the strength and fracture properties of concrete. In order to predict the behavior of concrete under normal loads, it is necessary to understand the effects of aggregate type, aggregate size and polymer content. This understanding can only be achieved through extensive testing and observation.

There is strong evidence that aggregate type is a factor in concrete strength. Ezeldin and Aitcin (1991) [9] compared concrete with four different coarse aggregate types of the same mixing ratio. They conclude that in high-strength concrete, higher strength coarse aggregates usually produce higher compressive strength, whereas in normal strength concrete, coarse aggregate strength has little effect on compressive strength. Other studies have compared the effects of limestone and basalt on the compressive strength of high strength concrete (Giaccio, Rocco, Violini, Zappitelli and Zerbino, 1992). In basalt-containing concrete, load-induced fractures occur mainly at the matrix-aggregate interface, while in limestone-containing concrete, almost all of the coarse aggregate particles are broken. Darwin, Tholen, Idun and Zoo (1995, 1996) observed that concrete containing basalt coarse aggregates reinforced the bond strength of steel bars compared to limestone-containing concrete.

In normal strength of the concrete, the compression failure almost completely includes the cement slurry from the aggregate particles to be deblocked, and for the purposes of this report will be referred to as the matrix-aggregate interface. In contrast, in high-strength concrete, aggregate particles and interface failure, obviously contribute to the overall strength. As the strength of the concrete slurry component increases, the stiffness and strength of the coarser and stronger coarse aggregate and the surrounding mortar are generally greater. Thus, micro cracks tend to propagate through the aggregated particles because not only the matrix agglomeration bond strength is lower than that of concrete with lower strength, but also due to the stress loss caused by the elasticity mismatch. Therefore, the aggregate strength becomes an important factor in high strength concrete.

This report describes the work aimed at improving the understanding of the role of the polymer in concrete. The variables considered are the aggregate type, aggregate size and total content in normal and high strength concrete. Compression, test is used to better understand the specific effects of the polymer.

Mechanical Properties of SFRC

Typically, the polypropylene fibers are used as a concrete at a relatively low content (0.1 to 0.3% by volume) as a secondary reinforcement for controlling and reducing the plastic shrinkage cracking of the concrete. Polypropylene is hydrophobic due to its chemical structure, which results in a decrease in adhesion to cement and adversely affects its dispersion in the matrix. In addition, polypropylene has a relatively high Poisson's ratio. Under the tensile load, the cross section of the polypropylene fiber is rapidly reduced and the fiber surface is deblocked from the substrate. On the other hand, the dynamic elastic modulus of polypropylene is much higher than that of electrostatic value. Therefore, under dynamic loading, PPFRC can be executed successfully.

If the fiber inclusions are limited by very low volume percent, the compressive strength and tensile strength of the concrete reinforced with polypropylene fibers have no significant effect. However, at higher fiber content, the strength is adversely affected. This is actually because a considerable part of the matrix is replaced by a weaker material. In addition, compaction due to reduced slump may be the reason for the decrease in intensity. Polypropylene fibers can increase the flexural strength, which is due to their ability to increase the carrying capacity of the post-crack zone, but this increase is not significant.

Polypropylene fiber enhances energy absorption rather than static strength. The effect of polypropylene fiber inclusions on the toughness of concrete is shown in Figure 3.8. The increase in toughness caused by polypropylene fiber inclusions increases with increasing fiber content.

Materials Used

Cement: Ordinary Portland cement of 53 grade was used. The Cement used has been tested for various proportions as per IS IS 4031-1988 and found to be confirming to various specifications of 12269-1987.

Fine aggregate

The material which passes through BIS test sieve number 4 (4.75mm) is termed as fine aggregate usually natural sand is used as a fine aggregate at places where natural sand is not available crushed stone is used as fine aggregates. In our region fine aggregate can be found from bed of Krishna River. It conforms to IS: 383 1970 comes under zone II.

Coarse aggregate

Coarse aggregate crushed angular granite metal of 20mm size was used.

Fig 1

Experimental program

Mix proportions were adopted as per IS-10262-2009. For test specimens 53 grade port land cement, natural river sand and coarse aggregate. The experimental program was designed to the study of mechanical properties of concrete with the addition of Hybrid fibers to the concrete & also by adding 12.5mm size of aggregates in percentages for M30, M40, M50 grades of concrete.

Compressive Strength of Cubes

The compressive strength of concrete was determined by conducting tests on 150 mm x 150 mm x 150 mm cube specimens were casted and cured for 7, 14 and 28 days. The test was carried out in the compression testing machine of 2000kN capacity. The cubes were placed in the compression testing machine and the load was applied until the failure of the specimen. The average values of three samples were taken as strength.

Split Tensile Strength of Cylinders

The determination of tensile strength of concrete is necessary to determine the load at which the concrete members may crack. The cracking is a form of tension failure. Split tensile strength is an indirect method of finding out the tensile strength of concrete. Tensile splitting strength of 150 mm diameter and 300 mm height cylinders tested. The test is carried out by placing the cylindrical specimens horizontally between the loading surfaces of the compression testing machine and the load is applied until the failure of the cylinder.

Fig 2

Results and Discussions

Compression strength results for M30 grade of concrete:

Table 1

S. No	% of replacement of 12.5mm aggregate	7 Days	14 Days	28 Days
1	0	28.10	32	35.4
2	5	29.21	33.27	36.8
3	10	30.24	34.44	38.1
4	15	31.19	35.53	39.3
5	20	30.32	34.53	38.2

Compression strength results for M40 grade of concrete

Table 2

S. No	% of replacement of 12.5mm aggregate	7 Days	14 Days	28 Days
1	0	35.4	40.32	44.6
2	5	36.43	41.49	45.9
3	10	37.62	42.85	47.4
4	15	38.73	44.11	48.8
5	20	38.89	44.29	49

Compression strength results for M50 grade of concrete:

Table 3

S. No	% of replacement of 12.5mm aggregate	7 Days	14 Days	28 Days
1	0	42.3	46.2	52.1
2	5	43.9	47.8	55.8
3	10	45.2	49.2	57.1
4	15	46.9	50.2	60.2
5	20	46.1	48.7	58.8

Graphs showing the compression strength results

Variation of compression strength results with the usage of 12.5mm aggregate with different percentages for 7, 14, 28 days for M30 grade of concrete.

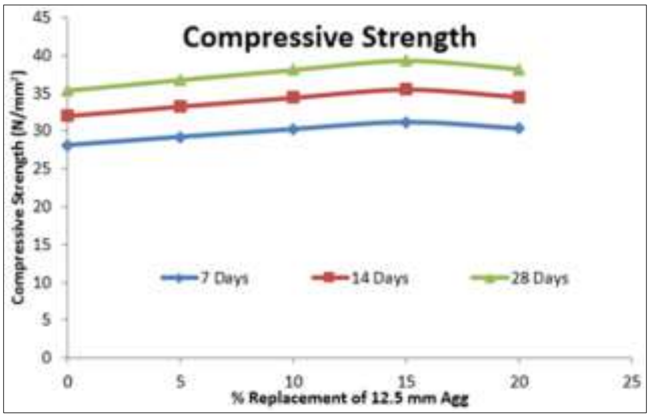

Fig 3

Variation of compression strength results with the usage of 12.5mm aggregate with different percentages for 7, 14, 28 days for M40 grade of concrete.

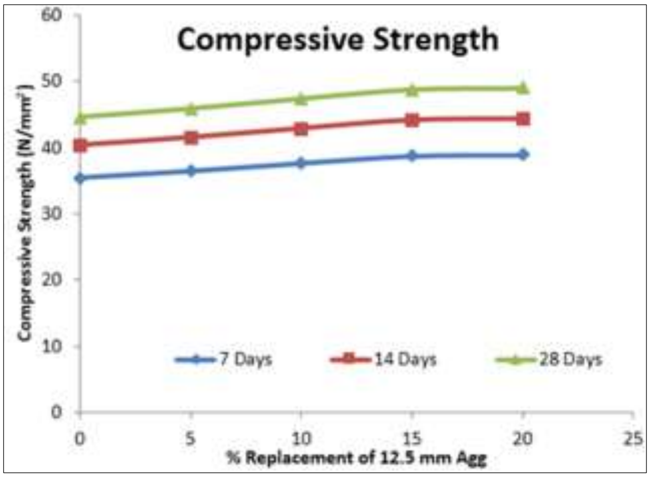

Fig 4

Variation of compression strength results with the usage of 12.5mm aggregate with different percentages for 7, 14, 28 days for M50 grade of concrete.

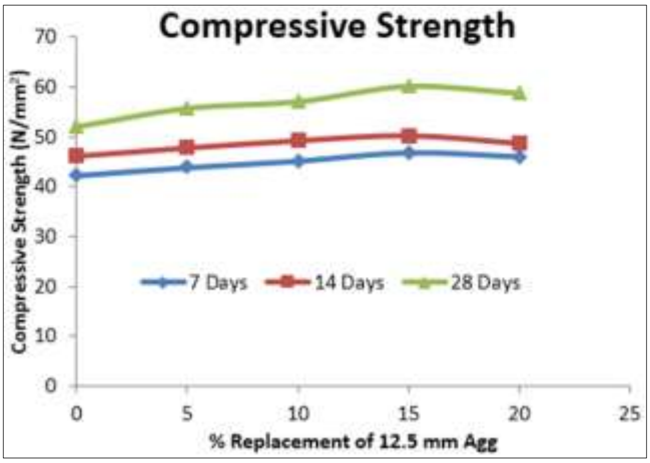

Fig 5

Split tensile strength results for different grades of concrete

Split tensile values for M30 grade of concrete

Table 4

S. No	% of replacement of 12.5mm aggregate	14 Days	28 Days
1	0	3.27	3.92
2	5	3.46	4.15
3	10	3.53	4.24
4	15	3.64	4.37
5	20	3.69	4.43

Split tensile values for M40 grade of concrete

Table 5

S. No	% of replacement of 12.5mm aggregate	14 Days	28 Days
1	0	3.41	4.09
2	5	3.48	4.18
3	10	3.55	4.26
4	15	3.68	4.41
5	20	3.66	4.39

Split tensile values for M50 grade of concrete

Table 6

S. No	% of replacement of 12.5mm aggregate	14 Days	28 Days
1	0	4.22	4.87
2	5	4.35	4.93
3	10	4.52	5.24
4	15	4.69	5.43
5	20	4.11	5.12

Graphs showing the split tensile strength results

Variation of split tensile strength results with the usage of 12.5mm aggregate with different percentages for 14, 28 days for M30 grade of concrete.

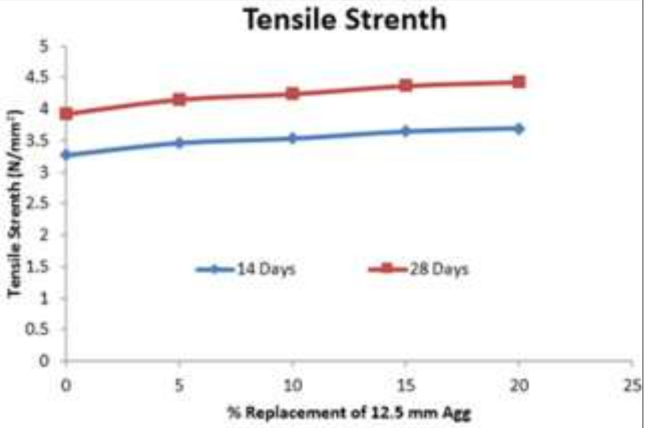

Fig 6

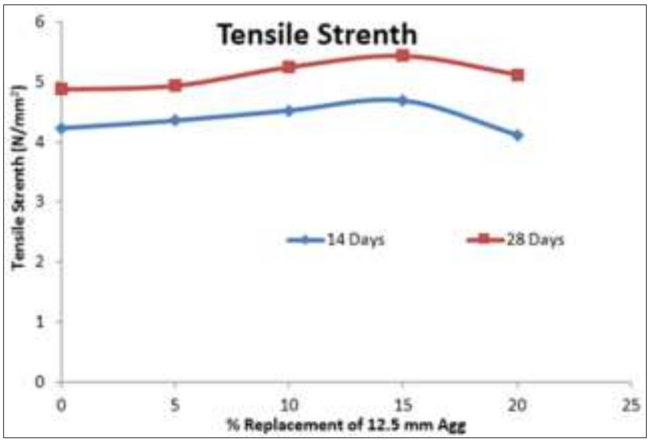

Fig 7

Variation of split tensile strength results with the usage of 12.5mm aggregate with different percentages for 14, 28 days for M40 grade of concrete.

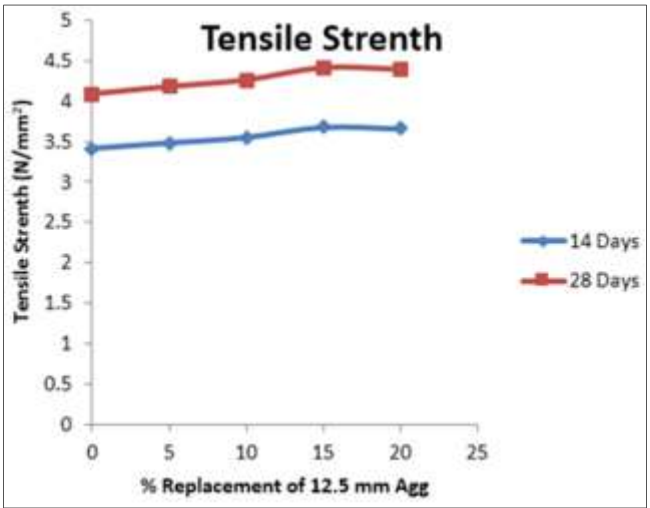

Fig 8

Conclusion

The following are the conclusions made based on the laboratory experiments carried out in this investigation for various tests with various % replacements of Coarse aggregate and addition of Fibre.

1. It is clear that the Improvement in Slump values is increase with increase in grade of concrete for replacement of 12.5mm Aggregate to 20mm Aggregate. Improvement in the slump for M50 compared to M30 is 96% where it is 26.23% when compared with M40.
2. Compressive Strength also improved for each grade at 15% replacement and also increases with increase in grade of concrete. Compared to M30 improvement in compressive strength for M40 and M50 are 17.27% and 41.27% respectively.
3. Split Tensile strength is improved for all grades for every type of replacement at optimum conditions and for addition of PPF the improvement is high compare to remaining mix proportions.
4. Poly Propylene Fiber is very effectively work for arrest the micro cracking and it improves the tensile strength as well as UPV results i.e we can said that cracks were minimized due to this fiber.

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