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An Experimental Study on Compressive Strength of Fiber Reinforced High Strength Concrete Using Recycled Coarse Aggregate

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Abstract:- The use of Recycled Concrete Aggregate (RCA) is gaining importance throughout the globe due to the depleting sources of natural aggregate and disposal problem of demolished waste. The advancement in the prestressed concrete technology and multistoried structures has given impetus for making concrete of high strength. Also, it is well established that the fibers make concrete ductile. The aim of this research work is to determine the suitability of glass fibers for use in structural recycled aggregate concrete of high strength. The fresh and hardened state properties of partially replaced recycled aggregate concrete, with varying percentages of glass fibers, are compared with the corresponding conventional aggregate concrete. The compressive, split tensile and flexural strengths of M50 grade concrete with various replacement levels of coarse aggregate were done . The maximum values of all these strengths were obtained at 1.5% of fiber content

Keywords:- High Strength Concrete, Recycled Coarse Aggregate, Glass Fiber Reinforced Concrete

I. INTRODUCTION

Recycled aggregates are comprised of crushed, graded inorganic particles processed from the materials that have been used in the constructions and demolition debris. The aim for this on – going project is to determine the strength characteristic of recycled aggregates for application in high strength structural concrete, which will give a better understanding on the properties of concrete with recycled aggregates, as an alternative material to coarse aggregate in structural concrete.Recycling is the act of processing the used material for use in creating new product. The usage of natural aggregate is getting more and more intense with the advanced development in infrastructure area. In order to reduce the usage of natural aggregate, recycled aggregate can be used as the replacement materials. Recycled aggregate are comprised of crushed, graded inorganic particles processed from the materials that have been used in the constructions and demolition debris. These materials are generally from buildings, roads, bridges, and sometimes even from catastrophes, such as wars and earthquakes. Due to the critical shortage of natural aggregate, the availability of demolished concrete for use as recycled concrete aggregate (RCA) is increasing. Using the waste concrete as RCA conserves natural aggregate, reduces the impact on landfills, decreases energy consumption and can provide cost savings. Recycled aggregates are the materials for the future. The application of recycled aggregate has been started in many countries for construction projects.

1.1 Applications of Recycled Aggregates

Traditionally, the application of recycled aggregate is used as landfill. Nowadays, the applications of recycled aggregate in construction areas are wide. The applications are different from country to country.

- Concrete Kerbs
- Granular Base Course Materials
- Embankment Fill Materials
- Paving Blocks
- Backfill Materials
- Building Blocks

II. LITERATURE REVIEW

Chetna M.Vyas, Prof. Jayesh kumar Pitroda (2013) [1] have studied about the sustainability of Fly Ash and Recycled Coarse Aggregate in Concrete. In their study Fly Ash is used as a replacement to cement and they obtained good results when compared to conventional concrete.

Muthupriya et al., (2011) [2] studied the behavior of short columns produced from High Performance Concrete (HPC). In the investigation HPC grade M60 was manufactured with usual ingredients such as cement, fine aggregate, coarse aggregate, water and mineral admixtures such as silica fume and fly ash at various replacement levels and the super plasticizer(1.5% by weight of cement). The water binder ratio adopted was 0.3. Specimens such as cubes, cylinders and prisms were casted and tested for various mixes viz., seven mixes M1 to M7 are casted with 0%,5%, 7.5% and 10% replacement of silica fume to cement and another replacement of fly ash to study the mechanical properties such as compressive strength, split tensile strength and flexural strength at different ages of concrete 3,7,28,56 and 90 days. The result showed that the optimum replacement of silica fume is at 7.5%.

Neela Deshpande et al., (2011) [3] have studied the Effectiveness of using Coarse Recycled Concrete Aggregate in Concrete. In their study concrete mixes were designed with 28 day compressive strength as 25MPa .The concrete mixes were designed using IS 10262:2009 with conventionally used coarse aggregates and 100% replacement of coarse recycled aggregate. With reference to the experimental results, analysis of important properties of both the types of concrete is done and the suitability of use of recycled concrete aggregate for new concrete is judged.

Y. V. Akbari et al., (2011) [4] have studied the effect on recycled aggregate on concrete properties. The experimental program includes variation in water cement ratio and replacement of natural aggregates by recycled aggregates. Three different water ratios 0.60, 0.52 and 0.43 and aggregate replacement of 0%, 15% , 30% , 50% were accounted in experimental program. Experimental results shows up to 25% reduction in compressive strength, 23% reduction in flexural strength, 26% reduction in split tensile strength and a noticeable reduction in workability was observed with the increase in percentage of aggregate replacement.

Kenai and Debieb (2010) [5] examined the possibility of using crushed clay bricks as coarse and fine aggregate for a new concrete and found out that with the percentage of recycled aggregates limited to 25% and 50% for the coarse and fine aggregates respectively produce concrete with similar characteristics to those of natural aggregates concrete. A substitution of coarse aggregate with crushed fine clay brick up to 40% in concrete at 28 days curing had a higher mechanical strength compared to the natural aggregate concrete . The applications of recycled aggregate as partial replacement of coarse aggregate in the range of 20 to 40% have been reported to be successful.

K. Jagannadha Rao and T. Ahmed Khan (2009) [6] examined the suitability of glass fibers in High Strength Recycled Aggregate Concrete. In this study the fresh and hardened state properties of partially replaced recycled aggregate concrete, with varying percentages of glass fibers, are compared with the corresponding conventional aggregate concrete. The compressive, split tensile and flexural strengths of M50 grade concrete with 0% RCA and 50% RCA have increased as the fiber content increased. The maximum values of all these strengths were obtained at 0.03% of fiber content for both the concretes of 0% RCA and 50% RCA. Large deflections of beams before failure indicated improved ductility with the addition of fibers.

III. EXPERIMENTAL INVESTIGATION

3.1Materials

a) Cement

In the experimental investigations ordinary Portland cement (OPC) of 53 grade is used. The cements procured were tested for physical properties in accordance with IS: 4031-1988 and IS: 8112-1989.

b) Fine Aggregate

Fine aggregate (river sand) obtained from local market was used in this study.

c) Coarse Aggregate

The properties of coarse aggregate like size of aggregate, shape, grading, surface texture etc play an important role in workability and strength of concrete. These properties were determined as per IS: 2386-1963.

d) Water

Potable water confirming to IS: 456-2000 was used in the investigations for both mixing and curing.

3.2 Experimental Programme

In this experimental work the concrete specimens were casted. The specimens considered in this study consisted of 150 mm x 150 mm x 150 mm cubes. The mix design of concrete was done according to Indian standard guidelines for target mean strength 53 N/mm^2 and the water cement ratios is 0.3. The present study was carried out on Natural coarse aggregates by replacing with Recycled Coarse Aggregate. Recycled aggregate was procured from an old demolished building of age 60 years. Silica Fume is used as an mineral admixture.

The experimental work is divided into three phases. First phase consists of casting and testing of cubes with recycled coarse aggregate content of 20%.The second phase was aimed to get an optimum recycled coarse aggregate content and it was found to be at a replacement of 50% replacement of RCA. In the third phase of work glass fiber was added to the above said mix and the compressive strengths were studied.

In the first phase of work the following procedure was adopted: The cement has been replaced by silica fume accordingly in the range of 0%, 5%, 7.5% & 10 accordingly and also the recycled aggregate in the same ratios. Concrete mixtures were produced, tested and compared in terms of compressive strengths with the Conventional concrete. These tests were carried out to evaluate the compressive strength properties for the test results of 7, 28 days compressive strengths In the second phase of work the recycled coarse aggregate contents were increased upto 100% replacements and the compressive strengths were studied after 7 days and 28 days. In the third phase of work the glass fiber is used to produce the sustainable high strength concrete by using recycled coarse aggregate.

IV. RESULTS AND DISCUSSIONS

4.1 Test Results of compressive strength High Strength Concrete using RCA at 7 days & 28 days

S.No	Mix Designation	% of Recycled Coarse Aggregate	Compressive Strength (MPa) 7 days	Compressive Strength (MPa) 28 days
1.	M50 CM	0	34.66	58.22
2.	M50 5%S.F+5% RCA	5	35.55	55.11
3.	M50 (5%+10%)	10	35.11	53.77
4.	M50 (5%+15%)	15	34.66	53.33
5.	M50 (5%+20%)	20	33.77	52.44
6.	M50 (7.5%+5%)	5	37.77	54.22
7.	M50 (7.5%+10%)	10	36.44	54.66
8.	M50 (7.5%+15%)	15	36.88	53.77
9.	M50 (7.5%+20%)	20	37.33	56.88
10.	M50 (10%+5%)	5	36.44	48.94
11.	M50 (10%+10%)	10	35.55	47.11
12.	M50 (10%+15%)	15	34.66	45.77
13.	M50 (10%+20%)	20	31.11	42.66

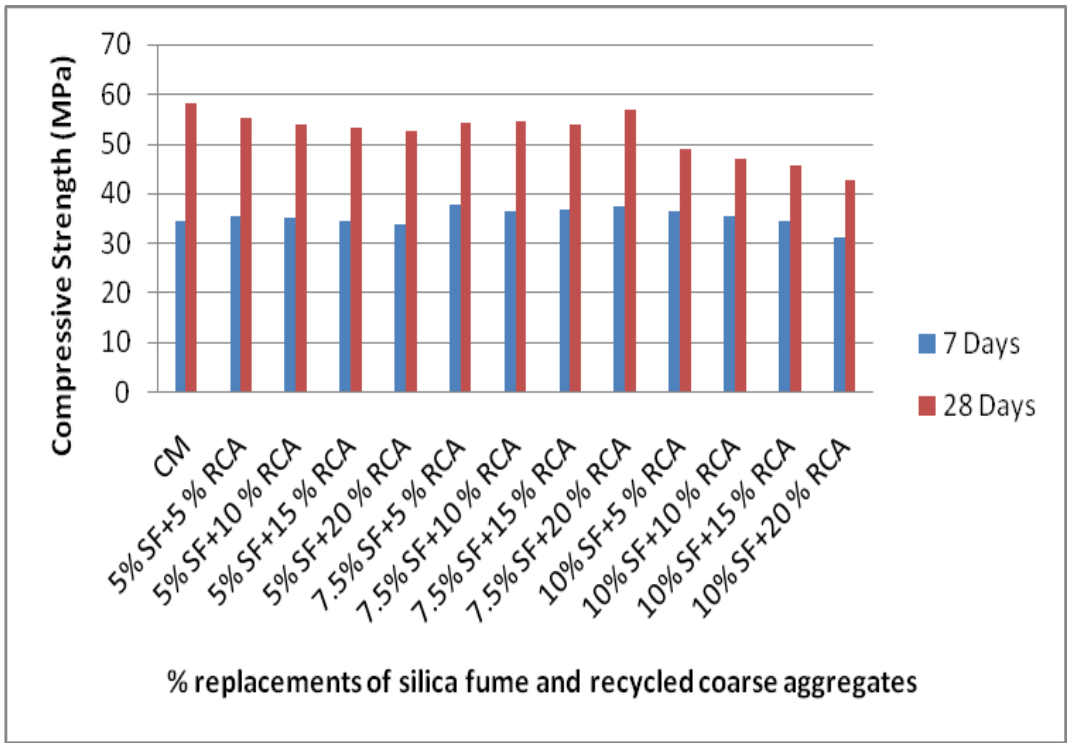

Fig.1 Graph showing variations in compressive strengths

(i) From the above table & graph it is concluded that the 7 days maximum strength is obtained at partia replacement of silica fume at 7.5% with 5% recycled coarse aggregate and the percentage increase is 10.80% when compared with the control mix.
(ii) It is seen that, at 28 days the compressive strengths are decreasing with the increase in mineral admixture content and recycled aggregate content.

4.2 Test Results of compressive strength of High Strength Concrete using Recycled Coarse Aggregate

S.No	Mix Designation	% of Recycled Coarse Aggregate	Compressive Strength (7 days) Mpa	Compressive Strength (28days) Mpa
1.	M50 7.5%S.F+1.5%SP 30% RCA	30	36.88	55.11
2.	M50 7.5%S.F+1.5%SP 40% RCA	40	36.00	54.22
3.	M50 7.5%S.F+1.5%SP 50% RCA	50	34.66	52.00
4.	M50 7.5%S.F+1.5%SP 75% RCA	75	33.33	48.94
5.	M50 7.5%S.F+1.5%SP 100% RCA	100	31.55	41.22

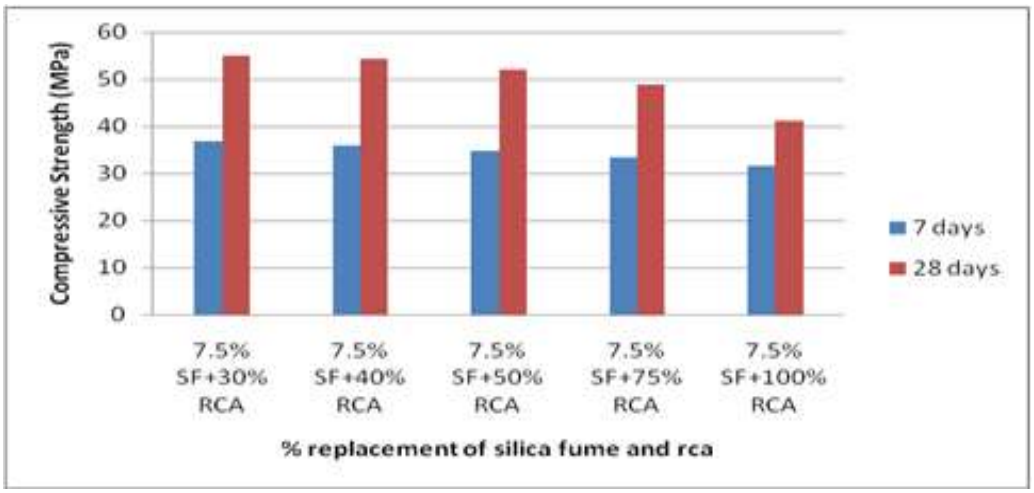

Fig.2 Graph showing variations in compressive strengths

4.3 Test Results of compressive strength of High Strength Concrete using Recycled Coarse Aggregate at 7 & 28 days with glass fibers

S.No	Mix Designation	% of glass fibers	Compressive Strength (7 days) MPa	Compressive Strength (28 days) MPa
1.	M50 7.5%S.F+1.5%SP 50% RCA	0	34.66	52.00
2.	M50 7.5%S.F+1.5%SP 50% RCA	0.5%	36.88	56.00
3.	M50 7.5%S.F+1.5%SP 50% RCA	1.0%	39.55	58.66
4.	M50 7.5%S.F+1.5%SP 50% RCA	1.5%	41.33	60.88
5.	M50 7.5%S.F+1.5%SP 50% RCA	2.0%	40.44	60.00

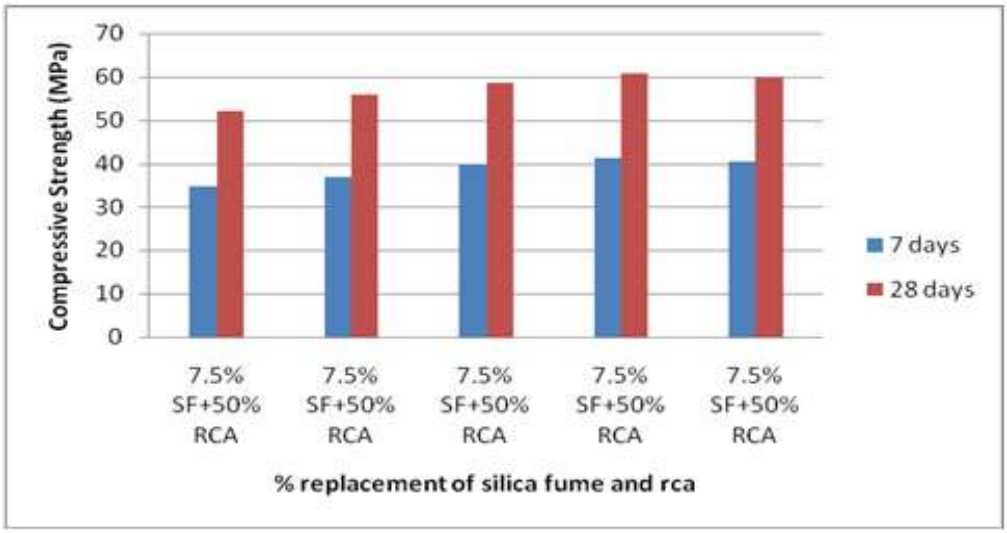

Fig.3 Graph showing variations in compressive strengths

Fig.4 High Strength Concrete Mix

Fig.5 Slump Cone Test

Fig.6 Curing of Cubes

Fig.7 Cube failure after testing

V. CONCLUSIONS

(i) With the increase in recycled coarse aggregate content, the compressive strength is decreasing.

(ii) Of all the trial mixes, M50 (7.5% SF) with a replacement of 20% RCA has showed better results and it is taken as reference for the next phase of work.More than 50 MPa compressive strength has been achieved by using 50% of recycled coarse aggregate with the trail mix M50 (7.5% SF).

(iii) It can be concluded that usage of 50% of recycled coarse aggregate in high strength concrete yields better economy without using glass fibers and in aspect of reducing environmental pollution & it is taken as reference for the next phase of work.

(iv) With the addition of glass fibers it was found to be an increase in compressive strength of the high strength concrete with recycled coarse aggregate.

(v) Of all the trial mixes with glass fibers, the mix M50(7.5% SF) and 1.5% glass fiber, showed an increase in compressive strength and the percentage increase was found to be 11.7% when compared with the mix without glass fiber i.e M50(7.5% SF) (50% RCA).

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