UTILIZATION OF RICE HUSK ASH AND FOUNDRY SAND AS PARTIAL REPLACEMENT MATERIALS IN FIBER REINFORCED CONCRETE

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Abstract - *Concrete is homogeneous mixture of cement, sand, coarse aggregate and water. Cement production gives rise to CO2 emissions and being responsible for about 5% of the CO2 emissions in the world. The availability of the natural river sand is decreasing due to the over exploitation of river sand. In order to reduce the usage of cement and river sand, partial replacement can be done with Rice Husk ash and Waste Foundry sand. Fiber reinforced concrete is one of the recent trends in construction industry, using of the fibers reduces cracks in the concrete and improves tensile strength. The present study focuses on enhancing mechanical properties of fiber reinforced concrete in which cement and sand are partially replaced with different percentages of Rice Husk Ash (RHA) and Waste Foundry Sand. Initially the optimum fiber content is found by testing 0, 0.25, 0.5, 075 and 1 percentage of fibers in conventional concrete. Then the partial replacement of 5, 10, 15 and 20 percentages of RHA and the partial replacement of 10, 20, 30 and 40 percentages of waste foundry sand are done in the casting of optimum fiber reinforced concrete. The various test specimens are casted and compressive strength test, split tensile test and flexural strength test are carried out. The test results are compared and the optimum percentage of partial replacement of RHA and waste foundry sand which produces high strength concrete is found.*

Key Words: **Concrete, Fiber reinforced Concrete, Rice Husk ash, Foundry sand, partial replacement.**

1.INTRODUCTION

Concrete is a composite material composed of gravels (coarse aggregate), sand (fine aggregate) and cement (binder). Concrete have inherently brittle nature and have some dramatic disadvantages such as poor deformability and weak crack resistance in the practical usage. Also their tensile strength and flexural strength is relatively low compared to their compressive strength. Fiber-reinforced concrete (FRC) is concrete containing fibrous material which increases its structural integrity. It contains short discrete fibers that are uniformly distributed and randomly oriented. Fibers are usually used in concrete to control cracking due to plastic shrinkage and to drying shrinkage. They also reduce the permeability of concrete and thus reduce bleeding of water. Some types of fibers produce greater impact, abrasion and shatter resistance in concrete.

The worldwide consumption of sand as fine aggregate in concrete production is very high and several developing countries have encountered some strain in the supply of natural sand in order to meet the increasing needs of infrastructural development in recent years. Therefore, it is necessary to replace natural sand in concrete by an alternate material either partially or completely without compromising the quality of concrete. Foundry sand which is a byproduct that is obtained from the metal industries is a good alternative for the natural sand as it is produced in abundant quantities and is used only for the landfilling purpose which may also pollute the land. Thus the partial replacement of the natural sand with foundry sand maybe a good alternative for the reducing the usage of natural sand and also reduces the causes of dumping of the foundry sand.

Cement being one of the main ingredients in the concrete is used in a large quantity in the construction industry. The production process of the cement leads to the rise of CO2 emissions generated by the calcinations of CaCO3 and being responsible for about 5% of the CO2 emissions in the world. Thus it causes a great threat to the environment by increasing the global warming. Rice Husk Ash (RHA) is one of these waste products which are generated as a by-product of rice paddy milling industries. When it is properly brunt it has high SiO2 content and can be used for cement replacement. Rice husk ash exhibits high pozzolanic characteristics and contributes to high strength and high impermeability of concrete.

2. MATERIAL TESTING

2.1 Cement

The Ordinary Portland Cement of 43 Grade conforming to IS 12269 – 1987 was used in this study. The specific gravity and initial setting of OPC 43 grade were 3.15 and 35 minutes respectively.

2.2 Fine Aggregate:

Locally available river sand conforming to grading zone II of IS 383 –1970. Sand passing through IS 4.75mm Sieve will be used with the specific gravity of 2.65.

2.3 Coarse Aggregate

Machine crushed angular granite metal of 20mm nominal size from the local source was used as coarse aggregate. The specific gravity and water absorption of coarse aggregate were investigated as 2.68 and 1.17%. The impact value and abrasion factor of coarse aggregate were 14.13% and 24.6%.

2.4 Waste Foundry Sand

Waste foundry sand (WFS) was obtained locally from shanthi casting, Coimbatore. WFS were used as a partial replacement of fine aggregate (natural river sand). Metal poured in the foundry is grey iron. The sand was tested for various properties like specific gravity, water absorption etc., and in accordance with IS 2386-1963.

2.5 Polyester Fiber

Table -1: Properties of fibers

S.No	FIBER PROPERTIES	POLYESTER
1	Length (mm)	6
2	Shape	Straight
3	Size/Diameter(mm)	0.035
4	Aspect Ratio	171.42

3. MIX PROPORTIONS

In this study, the control specimen (MCS) was designed as per IS 10262-2009 to achieve M30 grade of concrete with w/c ratio of 0.44. The mix ratio for the M30 concrete is 1: 1.467: 2.5

4. EXPERIMENTAL PROGRAMME

Total 18 different mixtures of concrete were prepared in the laboratory. First is the conventional concrete without any additives. Next with the concrete containing Fibres of 0.25,0.5,0.75,1.0 % is prepared. The optimum fiber content is found by testing the specimens. Then the partial replacement of 5, 10, 15 and 20 percentages of RHA and the partial replacement of 10, 20, 30 and 40 percentages of waste foundry sand are done with the optimum fiber reinforced concrete.

4.1 SLUMP CONE TEST

. The experimental work gives the slump value of concrete initially as 30 mm which gradually decreased to 15 mm. The slump value of concrete is very low and it indicates that the concrete slumps evenly and has true slump.

Table -2: Slump value for various FRC

S.No.	Mix ID	Fiber percentage	Slump value in mm
1	M1	0	24
2	M2	0.25	27
3	M3	0.5	29
4	M4	0.75	29
5	M5	1	30

Table -3: Slump value for 0.5% Fiber reinforced concrete

S.No.	Mix ID	Percentage of RHA (%)	Percentage of FS (%)	Slump value in mm
1	M6	5	10	29
2	M7	5	20	27
3	M8	5	30	27
4	M9	5	40	26
5	M10	10	10	25
6	M11	10	20	24
7	M12	10	30	24
8	M13	10	40	23
9	M14	15	10	23
10	M15	15	20	23
11	M16	15	30	22
12	M17	15	40	21
13	M18	20	10	21
14	M19	20	20	20
15	M20	20	30	20
16	M21	20	40	20

4.2. COMPRESSIVE STRENGTH TEST

The comparison of the 7th and 28th day cube compressive strength results shows an increase in compressive strength of fiber reinforced concrete upto 0.5% of addition of fibers when compared with conventional concrete, after 0.5% of addition of fiber the strength decreases. In the RHA and foundry sand replaced concrete the compressive strength was higher for 10% replacement of RHA and 20% replacement of foundry sand. The maximum compressive strength of 40.22N/mm2 was obtained for10% replacement of RHA and 20% replacement of foundry sand.

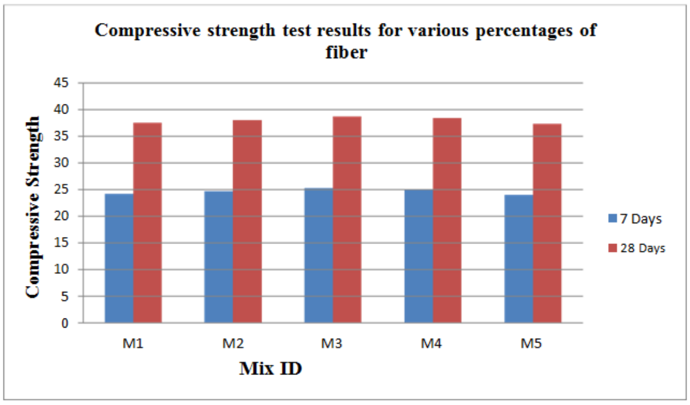

Chart -1:Compressive strength test results for various percentages of fiber

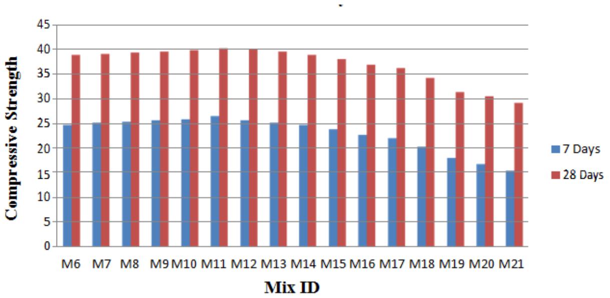

Chart -2: Compressive strength test results for Different Mix Ratio

4.3. SPLIT TENSILE STRENGTH TEST

The comparison of the 7th and 28th day split strength results shows an increase in split tensile strength upto 0.5% of addition of fibers when compared with conventional concrete, after 0.5% of addition of fiber the strength decreases. In the RHA and foundry sand replaced concrete the maximum split tensile strength of 4.32 N/mm2 was obtained for 10% replacement of RHA and 20% replacement of foundry sand.

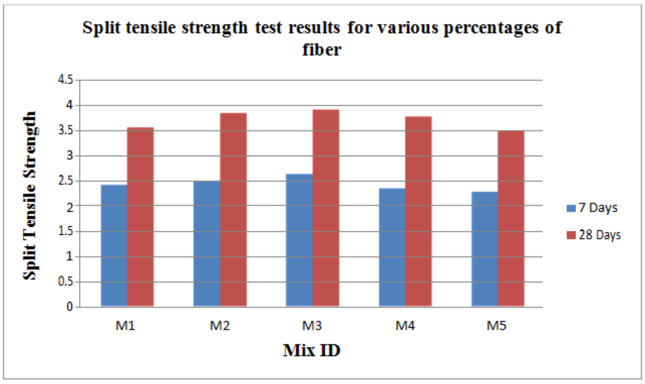

Chart -3: Split tensile strength test results for various percentages of fiber

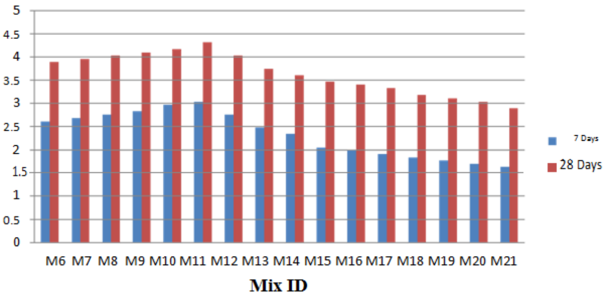

Chart -4: Split tensile strength test results for various 4percentages of RHA and foundry sand

4.4.FLEXURAL STRENGTH TEST

The comparison of the 7th and 28th day flexural strength results shows an increase in flexural strength of fiber reinforced concrete upto 0.5% of addition of fibers when compared with conventional concrete, after 0.5% of addition of fiber the strength decreases. The maximum flexural strength of 8.79 N/mm2 was obtained for 10% replacement of RHA and 20% replacement of foundry sand.

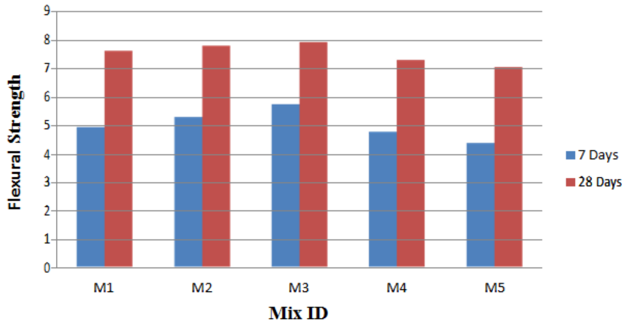

Chart -5: Flexural strength test results

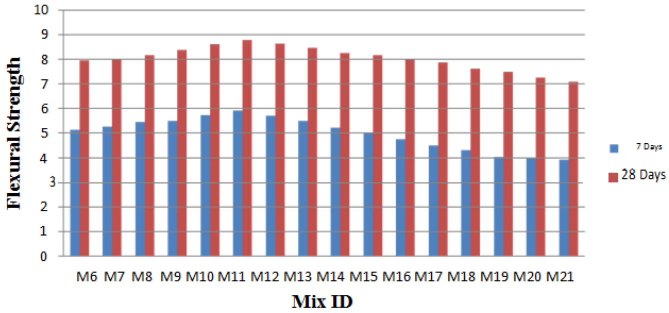

Chart -6: Flexural strength test results for various percentages of RHA and FS

4.5. FLEXURAL STRENGTH TEST FOR BEAM

The comparison of flexural beam test results shows that the deflection for the concrete specimen replaced with 0.5% fiber, 10% RHA and 20% foundry sand is less when compared to the deflection of the concrete specimen with 0.5% of fiber added concrete and the conventional concrete specimen.

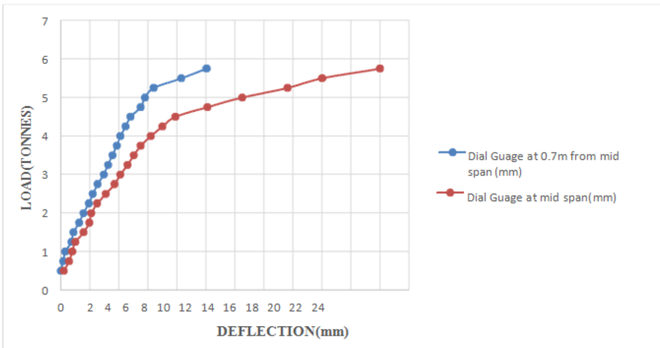

Chart -7: Flexural beam strength of conventional concrete

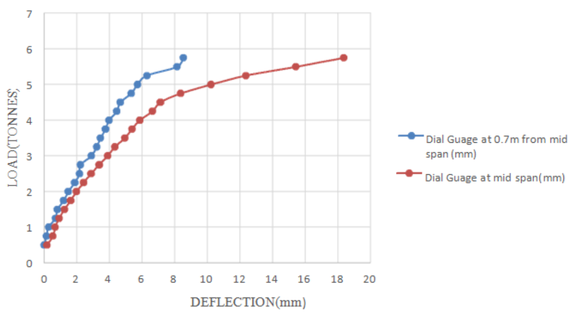

Chart -8: Flexural beam strength of 0.5% fiber added concrete

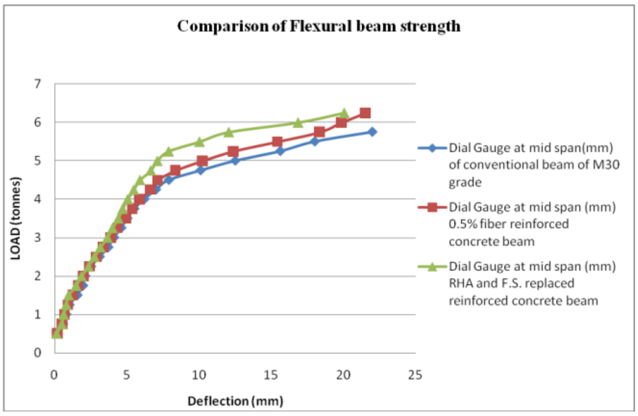

Chart -9: Flexural beam strength of concrete comparison

5. CONCLUSION

By the experimental study on the replacement of RHA and foundry sand in fiber reinforced concrete, it could be observed that major cracks were not found on the specimen after the loading was done. Only minor cracks were found on the specimen. The optimum percentage of addition of polyester fiber in concrete was found to be 0.5% thus Compressive, Split Tensile and Flexural Strength increased by 2.9%, 9.9% and 3.83% respectively. Further increasing the content of polyester fibers leads to decrease in compressive strength due to loss of workability and Cohesiveness. By keeping 0.5% as constant polyester fiber content, replacement of cement by 10% of RHA and replacing sand by 20% of foundry sand in M30 mix the Compressive strength increases by 7.08 %, the split tensile strength increases by 22 % and the Flexural Strength increased by 15.96 % respectively. In flexural beam test, the load carrying capacity of RHA and foundry sand replaced fiber reinforced concrete beams strengthens more than conventional beam. The contribution of the fibers leads to the increase on ultimate load carrying capacity and resists initial cracks of the beams. The deflection values for the RHA and foundry sand beams were found to be decreased when compared to the control specimen. Thus an environment friendly concrete can be produced by partially replacing the cement and sand with RHA and foundry sand.

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