A STUDY ON CHARACTERISTICS STRENGTH OF HYBRID FIBRE REINFORCED SELF COMPACTING CONCRETE INCORPORATING RICE HUSK ASH

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ABSTRACT

Now a day's usage of cement is increasing day by day which has to be reduced since production of cement emits approximately equal quantity of co2. For environmental purpose it is our responsibility to find a supplement for cement. Rice husk ash has been employed as an additive in many materials, including refractory brick, light weight concrete. It's highly porous, light weight and has a high specific area. It contains 90% of amorphous silica and 5% alumina which make its highly pozzolanic. Use of rice husk ash improves the durability of concrete, economical and eco-friendly. Self-compacting concrete (SCC) is a flowing concrete mixture that is able to consolidate under its own weight. The highly fluid nature of SCC makes it suitable for placing in difficult conditions and in sections with congested reinforcement. And also addition of fibers in concrete which increases the duration of generating initial crack and reduces the initial shrinkage. Thus the project deals with addition of steel fiber as 0.75% and polypropylene as 0.25% incorporating rice husk ash as a partial replacement for cement in varying percentages up to 30% with increment of 5%. The main objective is to study the characteristics strength of hybrid fiber reinforced self-compacting concrete incorporating rice husk ash.

Key words: SCC, Rice husk ash, hybrid fiber, characteristics strength.

1. INTRODUCTION

Rice husk ash (RHA) is an agricultural by-product obtained from burning of the husk day under controlled temperature of below 800 ºC. The process produces about 25% ash containing 85% to 90% amorphous silica plus about 5% alumina, which makes it highly pozzolanic. There is an increasing importance to preserve the environment in the present day world. India, being the highest rice-producing country generated about 20 million tons of RHA annually. Rice husk is a major agricultural waste.Combustion of rice husk yields ash with a silica content above 90%. The use of industrial and biogenic wastes in concrete as supplementary cementing materials is the present vital issue to obtain a sustainable environmental solution, save energy and natural resources. The ash (RHA) is highly porous, lightweight and has a high specific surface area. It has been employed as an additive in many materials, including refractory brick, concrete and lightweight building materials. Their utilization not only improves properties and durability of concrete, but also makes it cost effective and environment-friendly Due to the pozzolanic reactivity, rice husk ash (RHA) is used as supplementary cementing material in mortar and concrete and has demonstrated significant influence in improving the mechanical and durability properties of mortar and concrete. Proper consumption of these RHA contributes in solving environmental pollution and production of cost-effective concrete it canalso play a vital role for the production of sustainable concrete. About self-compacting concrete it is easily placed in thin-walled elements or elements with limited access it results in high-performance concrete its ease of placement can result in cost savings through reduced equipment and labor requirements; and reduced noise and vibration during placement.

The increased flow ability and consolidation of SCC can also improve appearance and enhance the durability of the finished element. Recently the idea of making simultaneous use of different type of fibers with different geometry or material is gaining acceptance. This improves the tensile strength and ductility of the material. When compared to ordinary concrete flexural members, SCC beams exhibited early initial cracking and higher deflection at later stages. Steel fibers as additional reinforcement in beams allows substantial increase in flexural and shear strength and ductility. The hybrid fibers of steel and polypropylene used is stronger and stiffer. It improves first crack stress and ultimate strength. Steel fiber which is more flexible and ductile leads to improved toughness and strain capacity in post cracking zone. Also the onset of cracking is delayed and fiber addition allows multiple cracking with lesser crack widths. Thus my project aims at producing Sustainable, Green, Self Compacting Concrete with better Crack Resistance and Deflection Properties employing the combined advantages of SCC, RHA and HFRC.

2. EXPERIMENTAL INVESTIGATIONS

2.1 MATERIAL PROPERTIES:

The material properties for preparation of concrete are cement, fine aggregate, coarse aggregate, rice husk ash, super plasticizer, hybrid fiber is explained below.

Cement:

Ordinary Portland cement 53 grade cement is used confirming to various specifications as perIS 4031-1998. Results showed that specific gravity is 3.15 and standard consistency is 32.

Fine aggregate:

River sand confirming to IS 4031-1998. Results showed that the specific gravity is 2.6, fineness modulus 3.07 which is confirms to grading zone II.

Coarse aggregate:

Crushed coarse aggregate of 10mm down size is used which is confirming to IS 4031-1998. Results showed that specific gravity 2.7, fineness modulus 7.30.

Super plasticizer:

Master glenium sky 8650 is an admixture of e new generation based on modify polycarboxylic ether. The product has been primarily developed for application in high performance concrete where the highest durability and performance is required. Master glenium sky 8650 is free of chloride and low alkali.

Admixture	Master Glenium SKY 8650
Aspect	Light brown liquid
Relative density	1.07 ± 0.01 at 25°C
Ph	>6
Chloride ion content	< 0.2%
Dosage	0.2 – 1.0 lit/ 100 kg cement

Steel fibre (Novocon-XR):

Steel fibre obtained from jeetmulljaichandlalpvt.ltd Chennai, the shape of fibres are crimpled of length 9mm.

Polypropylene fibre:

ENDURO 600Polypropylene fibers is obtained from jeetmulljaichandlalpvt.ltd Chennai.

Water: potable water is used.

Rice husk ash (hyper-2000) :

Obtained from Kccontechpvt.ltd Chennai, having specific gravity of 2.06. Rice husk ash produced under controlled temperature of below 800 ºC contains 85% to 90% amorphous silica plus about 5% alumina, which makes it highly pozzolanic. The ash (RHA) is highly porous, lightweight and has a high specific surface area. It has been employed asan additive in many materials, including refractory brick, concrete and lightweight building materials.

Composition	%
Fineness passing 45micron	96
Specific gravity	2.06
Bulk density	0.675 g/cc
Silicon dioxide	87.20
Aluminium oxide	0.15
Ferric oxide	0.16
Calcium oxide (CaO)	0.55
Magnesium oxide (MgO)	0.35
Sulphur trioxide	0.24
Carbon (C)	5.91
Loss on Ignition	5.44

2.2 DETAILS OF DESIGNED MIXES

The mix proportions of SCC, rice husk ash are replaced in the cement by the way of increasing the percentage of RHA content (0%, 5%, 10%, 15%, 20%, 25% and 30%).

The variation for specimen details are tabulated and explained below.

Table 1: Details of specimen

Specimen	Replacement of RHA
T1	5%
T2	10%
T3	15%
T4	20%
T5	25%
T6	30%

Table 2: Trial mix proportion

Mix	Cement Kg/m^3	Rice husk ash Kg/m^3	F.A Kg/m^3	C.A Kg/m^3	Water lt/m^3	SP Kg/m^3
T1	522.5	27.5	785	735	290.9	3.85
T2	495	55	785	735	290.9	4.5
T3	467..5	82.5	785	735	290.9	4.95
T4	440	110	785	735	290.9	5.5
T5	412.5	137.5	785	735	290.9	6.05
T6	385	165	785	735	290.9	6.6

Steel fiber (g)	600	600	600	600	600	600
Pp fiber (g)	10.12	10.12	10.12	10.12	10.12	10.12

3. EXPERIMENTAL PROCEDURES:

3.1 Mix design:

Mix proportion for SCC is obtained and the ratio is 1:1.427:1.33 with water cement ratio of 0.45. Indian standard method is used for study of mix design. The design involves in the calculation of amount of cement, fine aggregate, coarse aggregate and other related parameters dependent on the properties of constituent material.

3.2 Batching, mixing and casting:

Batching, mixing and casting operations were done carefully. The mixture of concrete was prepared by hand mixing on a water tight platform. The coarse and fine aggregate were weighed first and cement added with needed quantity of rice husk ash. After that steel and polypropylene were added and mixed thoroughly. During mixing fiber is added by sprinkling for proper mix. The moulds were filled with concrete. The top surfaces of the specimen was leveled and finished. After 24 hours the specimen were demoulded and transferred to curing tank. They were allowed to cure for 7 & 28 days. The entire specimens were tested in laboratory.

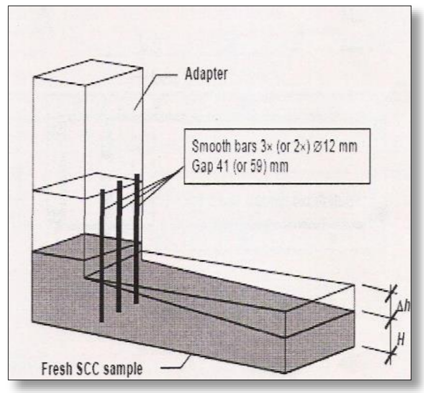
3.2.a Replacement of RHA

3.2.b Addition of hybrid fiber

3.3 Tests carried out for SCC:

3.3.1 L-box test:

Set the apparatus level on firm ground, ensure that the sliding gate can open freely and then close it. Moisten the inside surfaces of the apparatus, remove any surplus water. Fill the vertical section of the apparatus with the concrete sample. Leave it to stand for 1 minute. Lift the sliding gate and allow the concrete to flow out into the horizontal section. Simultaneously start the stop watch and record the time taken for the concrete to reach the 200 and 400mm marks. When the concrete stops flowing, the distance H1 and H2 are measured. Calculate H1/H2, the blocking ratio. The whole test has to be performed within 5minutes.

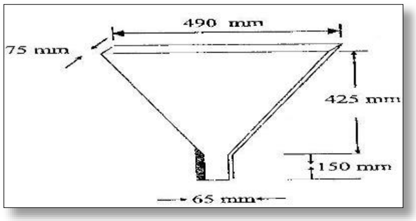


3.3.1. a L-box apparatus

3.3.2. b Diagrammatic representation of L-box test

3.3.2 V-funnel test:

Moisten the inside surface of the funnel. Keep the trap door open to allow any surplus water to drain. Close the trap door and place a bucket underneath. Fill the apparatus completely with concrete without compacting or tamping; simply strike of the concrete on the top with the trowel. Open within 10sec after filling the trap door and allow the concrete to flow out under gravity. Start the stop watch when the trap door is opened, and record the time for the discharge to complete. The whole test has to be performed within 5 minutes.

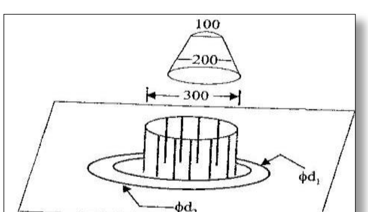


3.3.3.a V-funnel apparatus

3.3.3.b Diagrammatic representation of V-funnel test

3.3.3 J-ring test:

Moisten the base plate inside of slump cone, place base-plate on level stable ground. Place the j-ring centrally on the base plate and the slump-cone centrally inside it and hold down firmly. Fill the cone with the top of the cone with the trowel. Remove any surplus concrete from around the base of the cone . Raise the cone vertically and allow the concrete in perpendicular directions. Calculate the average of the two measured diameter (In mm).measure the difference in between the concrete just inside the bars and that just outside the bars. Calculate the average of distance at four locations (In mm).



3.3.4.a J-ring apparatus

3.3.4. b J-ring test

3.4 Compressive strength test:

The compressive strength of concrete is one of the most important properties of concrete. For compressive strength test the cube specimens of dimensions 150×150×150 mm were casted for M30 grade of self-compacting concrete. After curing these cubes were tested on compression testing machine. The failure load was noted. In each category three cubes were tested and their average value is reported. The compressive strength was calculated as follows,

Compressive strength (MPa) = Failure load / cross sectional area.

4. PRELIMINARY INVESTIGATIONS FOR SCC

The effect of hybrid fibers on the properties of SCC was studied by adding varying percentage of hybrid fiber totally 1% by volume of concrete 0.9 mm diameter steel fibers with aspect ratio 30 to the designed mixes. The variation in workability due to hybrid fiber addition on M30 mix was tabulated in table 3. The flow ability properties decreased and the hardened properties such as cube compressive strength, strength and increased with addition of fibers. Since the primary objective of fiber addition was improvement in tensile behavior, optimum performance was observed for SCC with 0.75% of steel fiber addition and 0.25% polypropylene addition. The macro fiber addition showed similar improvement for M30 mix.

Table 3 workability test results for M30 grade SCC mix.

Trial mix	Slump flow(mm)	T50 sec	V funnel (sec)	V funnel @ T5min	L box	J ring (mm)
T1	540	8	25	80sec	0.4	18
T2	560	6	20	60sec	0.5	15
T3	585	7	18	50sec	0.5	12.5
T4	650	4	10	12sec	0.7	9
T5	680	2	8	10sec	0.9	8
T6	685	3	10	10sec	0.85	8

5. TEST RESULTS AND DISCUSSION

The compressive strength results for the specimen is tabulated and test images are included as follows.

5.1 a Testing of specimen

5.2.b Failure of specimen

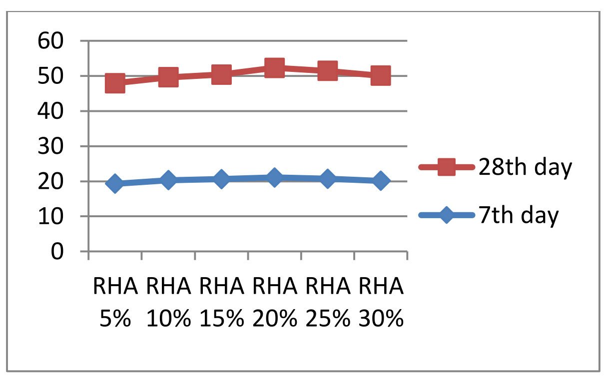
Table 4: 7th day compressive strength

Mix	Compressive load (KN)			Compressive strength(N/mm)			Average (N/mm)
T1	443	441	454	19.7	19.6	20.2	19.8
T2	455	455	465	20	20.2	20.7	20.3
T3	462	479	458	20.5	21.2	20.4	20.6
T4	480	479	464	21.3	21.2	20.6	21.03
T5	472	468	459	20.9	20.8	20.4	20.7
T6	463	454	443	20.6	20.2	19.7	20.1

Table 5: Compressive strength results for 28th day

Mix	Compressive load (KN)			Compressive strength(N/mm)			Average (N/mm)
T1	646	638	652	28.7	28.3	28.9	28.63
T2	660	664	659	29.3	29.5	29.2	29.3
T3	684	678	690	29.9	29.8	29.6	29.76
T4	696	704	712	30.9	31.2	31.6	31.23
T5	691	697	689	30.7	30.9	30.6	30.7
T6	682	676	678	30.3	30.03	29.6	29.96

5.2 GRAPHICAL REPRESENTATION OF 7TH AND 28TH DAY COMPRESSIVE STRENGTH RESULT



DISCUSSION:

Flow of concrete was easily achieved due to the presence of rice husk ash. It's shown that SCC can be made with increasing powder content without increasing the water cement ratio. And also addition of hybrid fiber reduces the crack pattern and also increases the failure load. Depending on different RHA and hybrid fiber composition the strength varies normally at days of compressive strength.

6. CONCLUSION

- Due to the presence of RHA there is an increase in water content by 0.5%.
- By partially replacing RHA is increasing the ultimate strength by 5 to 20 percent. Further addition of rice husk ash is decreasing the strength.
- The addition of fiber reduces the generation of first crack and increases the failure load.

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