

Experimental Study On Effect Of Elevated Temperature On Properties Of Concrete With RHA As Partially Replacement of Cement

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Abstract— This proposed work is an effort underway to investigate the impact of enhanced temperatures on different properties of conventional and concrete with Rice Husk Ash (RHA) as an additive. In the analysis, effect on compressive strength, split tensile strength and flexure strength was investigated. This study presents Effect of partially replacement of cement by using RHA by 10 %, 20% and 30% with addition 1 % of steel fibers. The said samples were heated from 200 °C to 1200°C in the increment of 200°C for 1 hour. The compressive strength, split tensile and flexure strength was executed for heated samples at different temperature at 28 days. At enhanced temperature RHA1 (10% RHA +1% steel fibre) found suitable combination as compared to conventional concrete and other replacement.

Keywords— compressive strength, tensile strength, steel fibres, Rice Husk Ash (RHA)

INTRODUCTION

Any structure can undergo fire accident, but because of this the structure cannot be denied neither abandoned. To make a structure functionally viable after the damage due to fire has become a challenge for the civil engineering community. It is vitally important that we create buildings and structures that protect both people and property in effectively as possible. One of the advantages of concrete over other building materials is its inherent fire-resistive properties. However, concrete structures must still be designed

for fire effects. Structural components must still be able to withstand dead & imposed loads without collapse even though the rise in temperature causes a decrease in the strength & modulus of elasticity for concrete & steel reinforcement.

Fire resistance is measured in terms of structural stability, structural integrity and insulation. Stability refers to the ability to remain standing without collapse. Integrity refers to the ability to remain intact and not move and buckle to create openings through which flames can escape. Insulation relates to the ability to either contain the fire within the building and not to ignite any material outside, or to insulate what is inside the building from being ignited by a fire outside

Blast furnace slag is a non-metallic by-product produced in the process of iron making (pig iron) in a blast furnace and 300kg of Blast furnace slag is generated when 1 ton of pig iron produced. In India, annual productions of pig iron is 70-80 million tons and corresponding blast furnace slag are about 21-24 million tons. Blast furnace slag is mildly alkaline and exhibits a pH in solution in the range of 8 to 10 and does not present a corrosion risk to steel in pilings or to steel embedded in concrete made with blast furnace slag cement or aggregates. The blast furnace slag could be used for the cement raw material, the roadbed material, the mineral admixture for concrete and aggregate for concrete, etc. The property of blast furnace slag is similar to coarser aggregate, the price is cheap and the output is large too, could be regarded as the substitute of the coarser aggregate. But there is no experience about application of blast furnace slag coarse aggregate in concrete and the reports about the research are also few.

EXPERIMENTAL WORK**Material Testing[2]**

Cement - Although all materials that go into concrete mix are essential, cement is very often the most important because it is usually the delicate link in the chain. The function of cement is first of all to bind the sand and stone together and second to fill up the voids in between sand and stone particles to form a compact mass. It constitutes only about 20 percent of the total volume of concrete mix; it is the active portion of binding medium and is the only scientifically controlled ingredient of concrete. Any variation in its quantity affects the compressive strength of the concrete mix. Portland cement referred as (Ordinary Portland Cement) is the most important type of cement and is a fine powder produced by grinding Portland cement clinker. Maintaining the Integrity of the Specifications

Table- 1 Properties of cement

Sr. No	Name of Test	Result		
01	Fineness	1.45 %		
02	normal consistency	35%		
03	Initial setting time	54 min		
04	Final setting time	600 min		
05	Soundness	0.6 cm		
06	compressive strength	3 days	7 days	28 days
		24.7	38.34	52.46

Fine Aggregate - In this experimental program, locally available river sand was used as fine aggregate and conformed to Indian Standard Specifications IS: 383-1970. The sand was sieved through 4.75 mm sieve to remove any particles greater than 4.75 mm and conforming to grading zone II.

Table-2 Properties of Fine Aggregate

Sr. No	Name of Test	Result
01	Specific gravity	2.50
02	Fineness Modulus	2.51

Coarse Aggregate- The normal maximum size is gradually 10-20 mm; however particle sizes up to 40 mm or more have been used in Self Compacting Concrete. Gap graded aggregates are frequently better than those continuously graded, which might expensive grader internal friction and give reduced flow. Regarding the characteristics of different types of aggregate, crushed aggregates tend to improve the strength because of interlocking of angular particles, while rounded aggregates improved the flow because of lower internal friction. Locally available coarse aggregate having the maximum size of 20 mm was used in this work. The

aggregates were washed to remove dust and dirt and were dried to surface dry condition. The aggregates were tested as per IS: 383-1970.

Table-3 Properties of Coarse Aggregate

Sr.N	Name of Test	Result
01	Specific gravity	2.76
02	Fineness Modulus	7.24

RHA- is a good super-pozzolans Silpozz can be used in a big way to make special concrete mixes. There is a growing demand for fine amorphous silica in the production of special cement and concrete mixes, high performance concrete, high strength, low permeability concrete, for use in bridges, marine environments, nuclear power plants etc. This market is currently filled by silica fume or micro silica, being imported from Norway, China and also from Burma. Due to limited supply of silica fumes in India and the demand being high the price of silica fume has risen to as much as US\$ 500/ton in India.

Table-4 Properties of RHA

Physical Properties	Values
Specific gravity	2.05
Fineness	8.3
Nitrogen absorption, m ² /g	20.6
Water requirement, %	104
Pozzolanic activity index, %	99
Chemical Properties	
Silicon dioxide (SiO ₂)	90.7
Aluminium oxide (Al ₂ O ₃)	0.4
Ferric oxide (Fe ₂ O ₃)	0.4
Calcium oxide (CaO)	0.4
Magnesium oxide (MgO)	0.5
Sodium oxide (Na ₂ O)	0.1
Potassium oxide (K ₂ O)	2.2
Equivalent alkali (Na ₂ O+0.658K ₂ O)	1.5
Phosphorous oxide (P ₂ O ₅)	0.4
Titanium oxide (TiO ₂)	0.03
Sulphur trioxide (SO ₃)	0.1
Loss of ignition	4.8

Steel Fibre (Hooked ends)

Table-5 Properties of steel Fibres

PROPERTIES	STEEL FIBRE
Density(kg/m ³)	7840
Tensile Strength (MPa)	1100
Length(mm)	60

Diameter(mm)	1
Steel fibre addition (%)	1
Aspect ratio	60

Mix Design[3]

Table-6 Mix Design

S.N	Mix proportion for 1 m ³ of Concrete	M25 grade
1	Mass of cement in kg /m ³	413 kg /m ³
2	Mass of water in kg /m ³	185 kg / m ³
3	Mass of fine aggregate in kg /m ³	682 kg / m ³
4	Mass of coarse aggregate in kg /m ³	1022.39 kg / m ³
5	Water cement ratio	0.45

Ratio found as 1:1.65:2.47

Test on fresh concrete [4]

Table-7 Test on fresh concrete

Type of concrete	Coarse aggregate replaced	Slump(mm)	Compaction factor test
Conventional	0%	80	0.86
RHA1	10%	75	0.80
RHA2	20%	65	0.71
RHA3	30%	55	0.69

RESULTS AND DISCUSSION

Compressive strength of concrete –

Table- 8 Compressive strength of concrete

Temperature	Normal Concrete	RHA 1	RHA 2	RHA 3
Room temp.	29.41	32.5	33.8	31.02
200	27.32	30.88	31.6	28.82
400	24.1	29.2	30.12	27.34
600	21.69	25.18	26.25	23.47
800	17.41	16.58	21.8	19.02
1000	7.6	6.78	7.2	4.42
1200	0	0	0	0

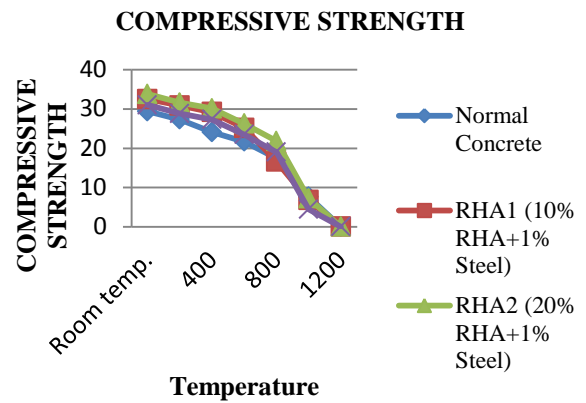


Fig 1. Compressive strength

Discussion –

- As the temperature increases compressive strength of concrete gets reduced for all combinations.
- RHA2(20% RHA+1% steel fiber) gives higher compressive strength as compare to other combinations and conventional concrete.

Tensile strength of concrete –

Table- 9 Tensile strength of concrete

Temperature	Normal Concrete	RHA 1	RHA 2	RHA 3
Room temp.	2.16	2.8	3.1	2.45
200	2.07	2.6	2.74	2.09
400	1.68	2.34	2.43	1.78
600	1.33	1.8	2.2	1.55
800	1.23	1.69	1.8	1.15
1000	0.73	0.8	0.97	0.32
1200	0	0	0	0

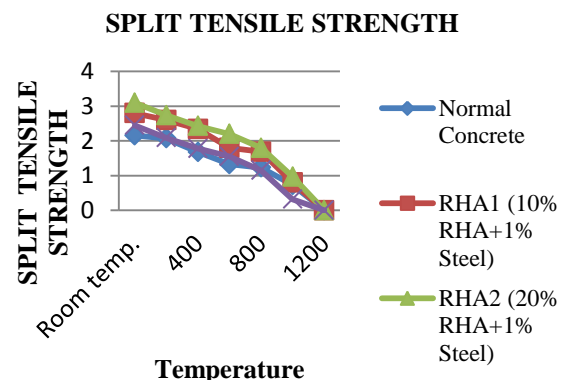


Fig 2 Tensile strength

Discussion –

- As the temperature increases compressive strength of concrete gets reduced for all combinations.
- RHA2(20% RHA+1% steel fiber) gives higher compressive strength as compare to other combinations and conventional concrete.

Flexural strength

Table- 10- Flexural strength

Temperature	Normal Concrete	RHA 1	RHA 2	RHA 3
Room temp.	1.1	2.28	2.4	1.42
200	1.03	2.04	2.16	1.18
400	0.86	1.45	1.59	0.61
600	0.55	1.11	1.24	0.26
800	0.49	0.46	0.64	0.3
1000	0.26	0.32	0.4	0.24
1200	0	0	0	0

FLEXURAL STRENGTH

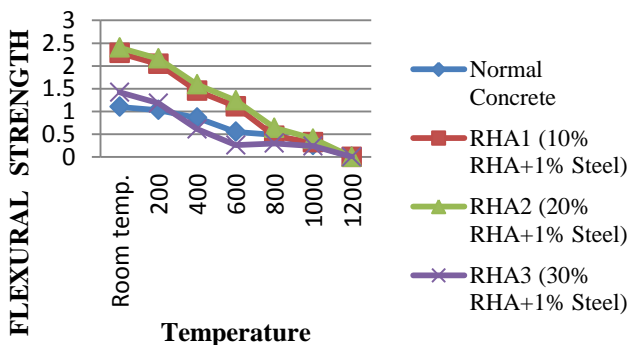


Fig 3 Flexural strength

Discussion –

- As the temperature increases compressive strength of concrete gets reduced for all combinations.
- RHA2(20% RHA+1% steel fiber) gives higher compressive strength as compare to other combinations and conventional concrete.

CONCLUSIONS

Based on experimental work carried out in this particular study, the Following conclusions have been drawn out,

- After enhanced temperatures test and analysis it was found that with the increasing temperature the compressive strength, tensile strength and flexural strength of concrete gets reduced.
- As temperature and exposure time increases the effect of fire on concrete increases.
- Effect of fire can be observed on the surface of concrete in the form of deep cracks.
- Between 400-600°C temperature Strength loss starts.
- Above 600°C temperature concrete is not functioning at its full structural Capacity.
- At 1000°C temperature hair cracks developed on specimen.
- At 1200°C temperature concrete will not functional to its strength.
- At enhanced temperature RHA2(20% RHA+1% steel fiber) found suitable combination.

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