Effect of Various Temperatures on Strength of Concrete with Partial Replacement of Cement By Rice Husk Ash And Partial Replacement of Coarse Aggregate By Blast Furnace Slag

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Abstract- *this research aims to investigate the strength of concrete under various temperatures by using partial replacement of cement with Rice Husk Ash and partial replacement of coarse aggregate with Blast Furnace Slag. Concrete does not burn, it cannot be 'set on fire' like other materials in a building and it does not emit any toxic fumes when affected by fires. It will also not produce smoke or drip molten particles, unlike some plastics and metals, so it does not add to the fire load. For this reason concrete is said to have a high degree of fire resistance and in the majority of applications, concrete can be described as virtually 'Fire Proof '.This excellent performance is due in the main to concrete's constitute materials. (I.e. Cement and Aggregate) which when chemically combined with concrete, form a material that is essentially inert and importantly for fire safety design has a relatively poor thermal conductivity. It is this slow rate of heat transfer (conductivity) that enables concrete to act as an effective fire shield not only between adjacent spaces, but also to protect itself from fire damage. The rate of increase of temperature through the cross section of concrete element is relatively slow and so internal zones do not reach the same high temperature as surface exposed to flames. When concrete is exposed to the high temperatures of a fire, a number of physical and chemical changes can take place.*

Keywords- Rice Husk Ash, Blast Furnace Slag, Steel Fibers, Elevated Temperature, Mix Proportion, Partial Replacement

I. INTRODUCTION

Any engineering advancement is for betterment of human life. Shelter is considered as one of the basic needs for human beings. The buildings constructed should give protection from heat, cold, rain, and also from disasters like fire, floods and earthquakes. Fire is considered as one of the disastrous event which causes loss or damage to human life and property. When there is an accidental fire in a structure, the duration of fire will be less but the intensity of heat produced will be more, this heat causes damage to the structures. In addition to accidental fire there are some special structures which are subjected to high temperatures, like take-off areas of jet aircraft, rocket launching pads, nuclear reactors, chimneys, metallurgical or chemical industries, glass, cement industry, coke ovens, storage tanks for hot crude oil and hot water, where the localized areas of concrete are subjected to high temperatures, The material used for construction should be capable of resisting high temperatures and it should also give minimum time for the inmates to escape.

The rapid growth of modern cities inspired much Speculative building and the structures usually were built close to one another because of the disorganized manner in which construction was proceeding. As more and more people congregate closer and closer together in settlements as urbanization increases, risks associated with fire increase. If there, fire will be occur; it is difficult to save life of residents live in such places. Fire in human settlements is caused predominantly accidentally, usually in relation to the use of various fuel types for open-flame cooking, lighting and heating in buildings. Fire-safety education and law and order can be the major factors in reducing the causes of fires.

With the increased incidents of major fires and fire accidents in buildings; assessment, repair and rehabilitation of fire damaged structures has become a topical interest. This specialized field involves expertise in many areas like concrete technology, material science and testing, structural engineering, repair materials and techniques etc. Research and development efforts are being carried out in these related disciplines. 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. The problem is where to start and how to proceed. It is vitally important that we create buildings and structures that protect both people and property as 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

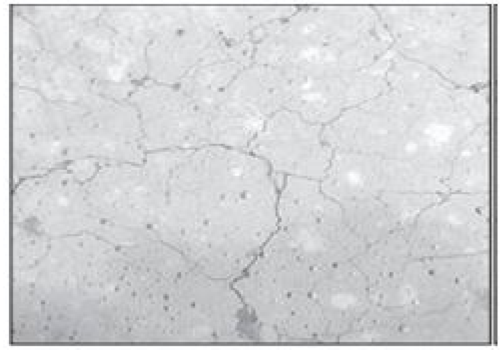
1.1 Structural Fire Protection Measures Must Fulfil Three Aims

1) Personal protection to preserve life and health
2) Protection of property to preserve goods and other belongings both in residential or commercial units that have caught fire, and in neighbouring properties. To this must be added substantial preservation of the building structures;
3) Environmental protection to minimize the adverse effects on the environment through smoke and toxic gases as well as from contaminated water used for extinguishing fires.

With concrete construction all three aims can be achieved. Its non-combustibility and high fire resistance mean that concrete provides comprehensive fire protection for people, property and the environment.

Concrete is composite material that consists mainly of mineral aggregate bound by a matrix of hydrated cement paste. A matrix is highly porous and contains a relatively large amount of free water unless artificially dried. When expose to high temperature, concrete undergoes change in its chemical composition, physical structure and water content. This change occurs primarily in the hardened cement paste in unsealed condition. Such changes are reflected by changes in the physical and mechanical properties of concrete that are associated with temperature increases. Deterioration of concrete at high temperature may appear in two forms:

1) Local damage (cracks) in the material itself.
2) Global damage resulting in the failure of the elements.



Surfacecracking after Structural failure subjected to high temperatures.

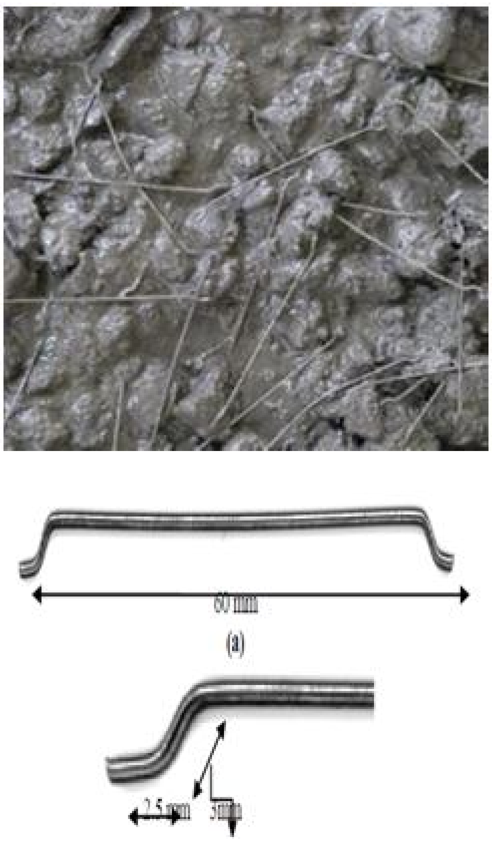
One of the advantages of concrete over other building material (steel, wood…) is its fire resisting properties. It is regarded as fireproof because of its incombustibility and its ability to with stand high temperature without collapse however its property can change dramatically when exposed to high temperature & many problems were experienced with concrete in fire such as deterioration in mechanical properties.

Concrete temperature up to 95º has little effect on strength and other properties of concrete. Above this threshold cement paste undergoes shrinkage (contraction) due to temperature rise which result in overall expansion of concrete and reduction in its strength. This project work will pilot study on effect of fire on conventional concrete and concrete with different additives like rice huskash, steel fibres, plastic fibres, blast furnace slag etc. In some cases the strength of concrete with different additives may be high but strength after fire is less than conventional concrete.

II. MATERIALS

A. STEEL FIBRE

The use of fibres to reinforce concrete materials is a well–known concept. It has been practiced since ancient times, with straw mixed into mud bricks and horsehair included in mortars. However, in our modern day construction practices we have forgotten the ancient practices to control cracks in concrete. Concrete cracking is normal. Portland cement concrete is considered to be a relatively brittle material and is prone to crack in the plastic as well as the hardened stage. Plastic shrinkage occurs when the evaporation of water from the surface of concrete is greater than the rising bleed water. As concrete is very weak in tension in its plastic stage, a volume change causes the surface to crack. As it hardens, the water present in the pores of concrete begins to evaporate. This causes the concrete to shrink due to the volume change, which is restrained by the subgrade and reinforcement. This results in a tensile stress being developed in hardened concrete, again causing the concrete to crack.



Steel fibre added in concrete

B. BLAST FURNACE SLAG

Throughout the world there is an increasing focus on the need to recycle and to more fully utilise co-products of manufacturing processes in an attempt to conserve our finite natural resources. Technical evaluation supported by field experience has shown that co-products such as blast furnace slag have, in many applications, properties suitable to replace or supplement and improve traditional materials used.


Blast furnace slag

Term ‘slag’ used throughout this publication refers specifically to metallurgical slag produced in modern blast furnaces (i.e. blast furnace slag and not basic oxygen steel slag or electric arc furnace slag which are generally referred to as ‘steel furnace slags’).

Although the term ‘recycling’ is referred to when slag is used in any of its applications, strictly speaking slag is not a recycled material. As a co-product in the manufacture of iron, blast furnace slag is considered a recovered resource material. The slag has not been previously used but was formed as part of and during the iron making process. Slag has a controlled chemistry and leaves the blast furnace in a molten form free from foreign matter.

C. RICE HUSK ASH (RHA)

The rice husk was obtained from a rice mill and was burnt in a ferrocement furnace to produce rice husk ash (RHA). For each incineration, the furnace can accommodate rice husk of about 50 to 60 kg. After maintaining the flame underneath the furnace for about one hour, the husk started to burn slowly on its own for about 24 hours. The ash was left to cool inside the furnace for another 24 hours before taken out for grinding using a Los Angeles machine. Figure below shows the placement of the rice husk in the ferrocement furnace, grinding of RHA using the Los Angeles machine, and the final finely ground RHA. Fineness of RHA as that retained on 45 μm sieve was about 18%.

The ferrocement furnace. Rice husk in the wire mesh cage.

ROLE OF RHA

Substantial research has been carried out on the use of amorphous silica in the manufacture of concrete. There are two areas for which RHA is used, in the manufacture of low cost building blocks and in the production of high quality cement.

Pozzolans improve strength because they are smaller than the cement particles, and can pack in between the cement particles and provide a finer pore structure. RHA is an active pozzolan. RHA has two roles in concrete manufacture, as a substitute for Portland cement, reducing the cost of concrete in the production of low cost building blocks, and as an admixture in the production of high strength concrete. The type of RHA suitable for pozzolanic activity is amorphous rather than crystalline.

Ordinary Portland cement (OPC) is expensive and unaffordable to a large portion of the world's population. Since OPC is typically the most expensive constituent of concrete, the replacement of a proportion of it with RHA offers improved concrete affordability, particularly for low-cost housing in developing countries.

The potential for good but inexpensive housing in developing countries is especially great. Studies have been carried out all over the world, such as in Guyana, Kenya and Indonesia on the use of low cost building blocks. Portland cement is not affordable in Kenya and a study showed that replacing 50% of Portland cement with RHA was effective, and the resultant concrete cost 25% less. Using a concrete mix containing 10% cement, 50% aggregate and 40% RHA plus water, an Indonesian company reported that it produced test blocks with an average compressive strength of 12N/mm2. This compares to normal concrete blocks, without RHA, which have an average compressive strength of 4.5 to 7N/mm2 or high strength concrete blocks which have a compressive strength of 10N/mm2. Higher strength concrete with RHA allows lighter weight products to be produced, such as hollow blocks with enhanced thermal insulation properties, which provide lighter walls for steel framed buildings. It also leads to reduced quantities of cement and aggregate.

III. LITERATURE REVIEW

Rafat Siddique , Deepinder Kaur (2011) Normal strength (NSC) and high-performance concretes (HPC) are being used extensively in the construction of structures that might be subjected to elevated temperatures. The behaviour of concrete structures at elevated temperatures is of significant importance in predicting the safety of structures in response to certain accidents or particular service conditions. This paper deals with the mechanical properties of concrete made with ground granulated blast furnace slag (GGBFS) subjected to temperatures up to 350 . For this purpose, normal concrete having compressive strength of 34 MPa was designed using GGBFS as partial replacement of cement. Cylindrical specimens (150 • 300 mm) were made and subjected to temperatures of 100, 200 and 350 . Measurements were taken for mass loss, compressive strength, splitting tensile strength, and modulus of elasticity. This investigation developed some important data on the properties of Concrete exposed to elevated temperatures up to 350 .

Alaa A. Bashandy (2013) In this investigation, the effects of elevated temperatures of 200, 300, 500°C for 2 and 4 hours on the main mechanical properties of economical type of reactive powder concrete (RPC) are studied. The main variables in this study are cement content and steel fibres content in reactive powder concrete samples as well as elevated temperature and heating time. Compressive strength and tensile strength of RPC are obtained after exposure to elevated temperatures. It is found that, RPC can be used at elevated temperature up to 300°C for heating times up to 4 hours taking into consideration the loss of strength. Also, using steel fibres enhance the residual strength of high cement content RPC samples.

B G Buddhdev1, Dr. H R Varia (2014) Concrete is the most-used man-made product in the world. Concrete is widely used for making many types of structural components for different civil engineering applications. In this modern era, cement concrete pavements are in demand as compared to bituminous pavements in highway projects. Due to limitation of quality natural resources for making concrete, the waste utilization in production of concrete especially for pavements are major concern in advances of civil engineering. Blast furnace slag is one of the wastes produced from steel processing plants around the globe. Rajkot (Gujarat) is well known for its small scale industries for long time and one of the fastest developing cities of India is hub of steel and allied industries. Rajkot itself produces blast furnace slag of amount 2500T/month from its 2000 steel processing units. This enormous quantity of blast furnace slag is generally dumped in unscientific manner create environmental issues and little is used for landfill purpose without any technical input. It is interesting to know whether Blast Furnace Slag (BFS) can be utilized as a fine aggregates (i.e. as a sand) to produce concrete mainly for pavements or not. In this paper, the comprehensive experimental programme is taken up to study the feasibility of this BFS used as a fine aggregate in pavement concrete. In this regard the chemical and physical properties of the BFS are observed in this study. These properties depend upon the raw materials used and methods of processing at plants. Based on results of experimentation, variations in chemical and physical properties are studied and checked the suitability of utilizing this BFS for pavement concrete. The results indicate that BFS can be utilized as a fine aggregate in pavement concrete.

P. Jyotsna Devi, Dr. K. Srinivasa Rao (2014) The present study aims at investigating the performance of steel fibre reinforced concrete at high temperatures. It also aims at comparing the flexural and split tensile strengths of normal (M30) and high strength concrete (M60) when mixed with 1% volume fractions of steel fibres. To study flexural strengths prisms of size 100x100x500mm were casted and to study splitting tensile strength cylinders of 150mm diameter and 300mm length were casted. The samples are cured for 7, 28 and 91 days. After specified period of curing, the specimens were air dried and then exposed to 100, 200, 300, 400 and 500oC (apart from 27oC), for duration of one hour and then allowed to cool. The prisms are tested in Universal Testing machine for flexure and cylinders are tested for split in compression testing machine. The use of fibres in high strength concrete is of good advantage than using in normal Strength concrete. By adding steel fibres fracture resistance of concrete can be increased.

Khaled Mohammed Nassar , Prof. Samir Shihada(2011) Fire has become one of the greatest threats to buildings. Concrete is a primary construction material and its properties of concrete to high temperatures have gained a great deal of attention. Concrete structures when subjected to fire presented in general good behaviour. The low thermal conductivity of the concrete associated to its great capacity of thermal insulation of the steel bars is the responsible for this good behaviour. However, there is a fundamental problem caused by high temperatures that is the separation of concrete masses from the body of the concrete element "spalling phenomenon ". Spalling of concrete leads to a decrease in the cross section area of the concrete column and thereby decrease the resistances to axial loads, as well as the reinforcement steel bars become exposed directly to high temperatures. With the increase of incidents caused by major fires in buildings; research and Developmental efforts are being carried out in this area and other related disciplines. This research is to investigate the behaviour of the reinforced concrete columns at high temperatures. Several samples of reinforced concrete columns with Polypropylene (PP) fibres were used. Three mixes of concrete are prepared using different contents of Polypropylene ;(0.0 kg/m³, 0.5 kg/m³ and 0.75 kg/m³). Reinforced concrete columns dimensions are (100 mm x100 mm x300 mm). The samples are heated for 2, 4 and 6 hours at 400 C°, 600 C° and 800°C and tested for compressive strength. Also, the behaviour of reinforcement steel bars at high temperatures is investigated. Reinforcement steel bars are embedded into the concrete samples with 2 cm and 3 cm concrete covers, after heating at 800°C for 6 hours. The reinforcement steel bars are then extracted and tested for yield stress and maximum elongation ratio. The analysis of results obtained from the experimental program showed that, the best amount of PP to be used is 0.75 kg/m³, where the residual compressive strength is 20% higher than of that when no PP fibres are used at 400 C for 6 hours. Moreover, a 3 cm of concrete cover is in useful improving fire resistance for concrete structures and providing a good protection for the reinforcement steel bars, where it is 5 % higher than the column samples with 2 cm concrete cover at 6 hours and 600 C°.

Rahul Subhash Patil (2014) The present work is aimed to study the effect of elevated temperature ranging from 200oC to 600oC on the compressive strength on M20 grade concrete with percentage of polypropylene fibre (0.22%) & steel fibre (0.5%) by volume of concrete. Tests were conducted on 150mm side cube concrete specimens. The specimens were heated to different temperatures of 200oC, 400oC, and 600oC for 6 hour durations. After the heat treatment the specimens were cooled by wet and dry cooling condition and then they were tested for compressive. The results were analysed and presented with comparison of compressive strength of specimens with & without fibres for different cooling conditions. The concrete containing fibre exhibited better performance than without fibre for high temperature. Strength loss was more significant on specimens cooled in water.

Rajesh Kumar, Amiya K. Samanta and D. K. Singha Roy(2014) At present in India, about 960 million metric tons of solid waste is being generated annually as by products during industrial, mining, municipal, agricultural and other processes. Advances in solid waste management resulted in alternative construction materials as a substitute to traditional materials like bricks, blocks, tiles, aggregates, ceramics, cement, lime, soil, timber and paint. To safeguard the environment, efforts are being made for recycling different wastes and to utilize them in value added applications. The cement industries have been making significant progress in reducing carbon dioxide (CO2) emissions through improvements in process technology and enhancements in process efficiency, but further improvements are limited because CO2 production is inherent to the basic process of calcinations of limestone. In the past two decades, various investigations have been conducted on industrial wastes like fly ash, blast furnace slag, Silica fume, rice husks and other industrial waste materials to act as cement replacements .This paper consist of a review extensively conducted on publications related to utilization of waste materials as cement replacement with an intention to develop a process so as to produce an eco-friendly concrete having similar or higher strength and thus simultaneously providing a remedy to environmental hazards resulting from waste material disposal.

K.G. Hiraskar and Chetan Patil (2013) The Iron industries produce a huge quantity of blast furnace slag as by–product, which is a non–biodegradable waste material from that only a small percentage of it is used by cement industries to manufacture cement. In the present investigation Blast Furnace Slag from local industries has been utilised to find its suitability as a coarse aggregate in concrete making. Replacing all or some portion of natural aggregates with slag would lead to considerable environmental benefits. The results indicate that the unit weight of Blast Furnace Slag aggregate concrete is lower than that of the conventional concrete with stone chips. The experimental result show that replacing some percentage of natural aggregates by slag aggregates causes negligible degradation in strength. The compressive strength of Blast Furnace Slag aggregate concrete is found to be higher than that of conventional concrete at the age of 90 days. It has also reduced water absorption and porosity beyond 28 days in comparison to that of conventional concrete with stone chips used as coarse aggregate.

Milind V. Mohod (2012) Cement concrete is the most extensively used construction material in the world. The reason for its extensive use is that it provides good workability and can be moulded to any shape. Ordinary cement concrete possesses a very low tensile strength, limited ductility and little resistance to cracking. Internal micro cracks, leading to brittle failure of concrete. In this modern age, civil engineering constructions have their own structural and durability requirements, every structure has its own intended purpose and hence to meet this purpose, modification in traditional cement concrete has become mandatory. It has been found that different type of fibres added in specific percentage to concrete improves the mechanical properties, durability and serviceability of the structure. It is now established that one of the important properties of Steel Fibre Reinforced Concrete (SFRC) is its superior resistance to cracking and crack propagation. In this paper effect of fibres on the strength of concrete for M 30 grade have been studied by varying the percentage of fibres in concrete. Fibre content were varied by 0.25%, 0.50%, 0.75%, 1%, 1.5% and 2% by volume of cement. Cubes of size 150mmX150mmX150mm to check the compressive strength and beams of size 500mmX100mmX100mm for checking flexural strength were casted. All the specimens were cured for the period of 3, 7 and 28 days before crushing. The results of fibre reinforced concrete for 3days, 7days and 28days curing with varied percentage of fibre were studied and it has been found that there is significant strength improvement in steel fibre reinforced concrete. The optimum fibre content while studying the compressive strength of cube is found to be 1% and 0.75% for flexural strength of the beam. Also, it has been observed that with the increase in fibre content up to the optimum value increases the strength of concrete. Slump cone test was adopted to measure the workability of concrete. The Slump cone test results revealed that workability gets reduced with the increase in fibre content.

Osama M. Ghazi (2013) This study presents the benefit gained from using steel fibre reinforcement on concrete mixture. The effect of fire on compressive strength is investigated. Two different tests, one of them is the non-destructive test which is the ultrasonic pulse velocity (UPV) test and the other is the destructive compression test, are carried out using (10cm) cubes. Forty-eight cubes (half of them are with steel fibre reinforcement of fibre/concrete ratio of (0.01) by volume and the remaining cubes are without fibre reinforcement) are heated to temperature levels of (100,200,300,400,500,600 and 700°C). Then after that specimens are air cooled and (UPV) test is done, the specimens are destructively tested. The results indicated that the addition of steel fibre increases the compressive strength at all tested heating levels with a maximum percentage increase of (56.9%) at a temperature level of (500°C), in spite of that they have the same behaviour but the residual compressive strength decreases with the addition of steel fibre for the tested heating levels lower than (400°C) and increases for the heating levels above this degree.

Dongsheng Shi (2011) In their experimental study the potential use of blast furnace slag fine aggregate was produced by 3 different steel factory in high strength concrete and mechanical properties of high strength concrete were studied. The concrete using blast furnace slag aggregate is admitted the increase of compressive strength as well as in case of river sand the water cement ratio is reduced and the compressive strength attain 100 N/mm2. The strength of concrete using blast furnace slag fine aggregate is lower than the strength of concrete using natural river sand as fine aggregate and the strength of concrete using mixture fine aggregate is middle of strength used river sand and strength used blast furnace slag fine aggregate. The crushing value of blast furnace slag fine aggrgte is bigger than the natural river sand and it could influence the strength of high strength concrete using blast furnace slag fine aggregate.

Atul Dubey(2012) In their study the Ordinary Portland Cement (OPC) is one of the main ingredients used for the production of concrete. Unfortunately, production of cement involves emission of large amounts of carbon-dioxide gas into the atmosphere, a major contributor for greenhouse effect and the global warming, hence it is inevitable either to search for another material or partially replace it by some other material. The search for any such material, which can be used as an alternative or as a supplementary for cement should lead to global sustainable development and lowest possible environmental impact. Concrete property can be maintained with advanced mineral admixtures such as blast furnace slag powder as partial replacement of cement 5 to 30%. Compressive strength of blast furnace slag concrete with different dosage of slag was studied as a partial replacement of cement and it has been observed that, the optimum replacement of Ground Granulated Blast Furnace Slag Powder to cement without changing much the compressive strength is 15%.

IV. TESTING OF MATERIALS

1. Rice Husk Ash(RHA) :

a. Chemical test :

Sr. No.	TEST	RESULT
1.	SiO2	92.76%
2.	Na2O	0.41%
3.	K2O	0.22%
4.	Fe2O3	0.74%
5.	Al2O3	0.79%

b. Physical test :

Sr. No.	TEST	RESULT
1.	Moisture	0.94%
2.	Density	711 Kg/m3
3.	Specific Surface	15 M2/gm

2. Blast furnace slag (BSF) :

a. Chemical Test :

Sr. No.	TEST	RESULT
1.	CaO	39.2%
2.	SiO2	40%
3.	Al2O3	13.5%
4.	MgO	3.6%
5.	Fe2O3	1.8%
6.	MnO	0.63%
7.	S	1%
8.	P2O5	0.21%
9.	Cr2O3	0.06%

b. Physical test :

Sr. No.	TEST	RESULT
1.	Specific Gravity	2.86
2.	Flakiness Index	41.16
3.	Elongation Index	46.05
4.	Bulk Density(kg/m3)	1717

V. TEST RESULTS

In order to study the effect on fresh concrete properties at elevated temperatures when Rice husk ash added to cement and blast furnace slag added into coarse aggregate as replacement in different prorportions as follows :

Sr. no	Combination	Temperature °C
C1	5%RHA + 20% BFS	200°C,400°C, 600°C, 800°C,1000°C,1200 °C
C2	5%RHA + 40% BFS	
C3	5%RHA + 60%BFS	
C4	10%RHA + 20%BFS	
C5	10%RHA + 40% BFS	
C6	10%RHA + 60% BFS	
C7	15%RHA + 20%BFS	
C8	15%RHA + 40% BFS	
C9	15%RHA + 60% BFS	

After experimental performance, the parameters such as Compressive strength, Split tensile strength, Flexural strength and comparisons between various mixes are represented as follows:

Temp	Normal	C1	C2	C3	C4	C5	C6	C7	C8	C9
Room Temp	29.4	25.4	35	36	38.8	40.2	35.1	20.3	28	28.8
200°C	27.3	24.5	33.7	34.9	37.5	39.2	33.8	19.6	26.9	27.9
400°C	24.1	19.6	28.8	29.7	32.3	34.1	28.8	15.7	23	23.7
600°C	21.7	18.8	21.4	25.7	28.8	31.4	28.3	15	17.1	20.6
800°C	17.4	14.3	14.4	14.4	23.1	26.2	15.3	11.5	11.5	11.5
1000°C	7.6	7.21	7.62	7.32	10.3	12.5	7.58	5.77	6.1	5.86
1200°C	0	0	0	0	0	0	0	0	0	0

Table 1. Compressive Strength in N/mm² (28 days)

Temp	Normal	C1	C2	C3	C4	C5	C6	C7	C8	C9
Room Temp	3.01	3.54	4.1	3.69	3.94	4.56	3.98	2.83	3.28	2.95
200°C	2.38	2.78	3.42	2.97	3.21	3.89	3.25	2.22	2.74	2.38
400°C	2.08	2.65	3.04	2.96	2.78	3.61	2.96	2.12	2.43	2.37
600°C	1.48	2.25	2.49	2.24	2.25	2.98	2.35	1.8	1.99	1.79
800°C	1.37	1.78	2.42	1.98	2.23	2.78	2.31	1.42	1.94	1.58
1000°C	0.74	1.65	1.79	1.84	1.75	2.21	1.69	1.32	1.43	1.47
1200°C	0	0	0	0	0	0	0	0	0	0

Table 2. Split Tensile Strength in N/mm² (28 days)

Temp	Normal	C1	C2	C3	C4	C5	C6	C7	C8	C9
Room Temp	1.62	1.92	2.59	1.98	2.15	3.01	2.25	1.54	2.07	1.58
200°C	1.51	1.85	2.45	1.89	2.14	2.89	2.21	1.48	1.96	1.51
400°C	1.23	1.56	2.18	1.62	1.87	2.74	1.98	1.25	1.74	1.3
600°C	0.9	1.25	1.87	1.32	1.58	2.47	1.64	1	1.5	1.06
800°C	0.28	0.59	1.16	0.64	0.97	2.05	1.02	0.47	0.93	0.51
1000°C	0.18	0.45	1.06	0.51	0.89	1.84	0.98	0.36	0.85	0.41
1200°C	0	0	0	0	0	0	0	0	0	0

Table 3. Flexural Strength in N/mm² (28 days)

VI. GRAPHICAL REPRESENTATION

The results of Compressive strength test, Split tensile strength test, Flexural strength test are arranged graphically for comparisons between various mixes are represented as follows:

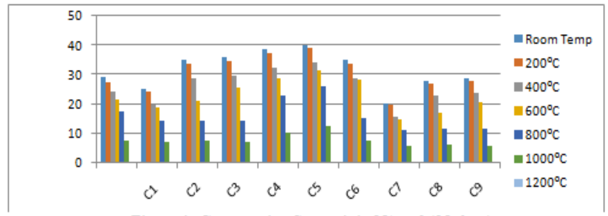


Figure 1. Compressive Strength in N/mm² (28 days)

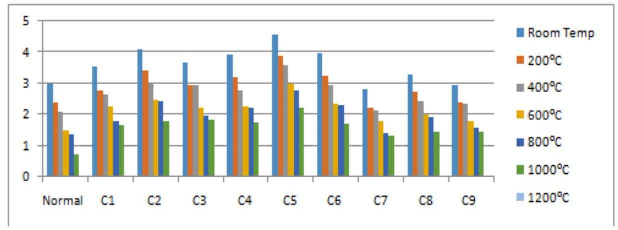


Figure 2. Split Tensile Strength in N/mm² (28 days)

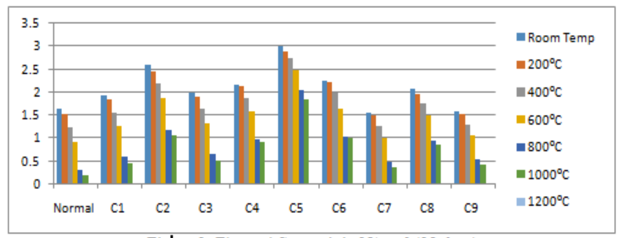


Figure 3. Flexural Strength in N/mm² (28 days)

VII. CONCLUSION

Based on the limited experimental work carried out in this particular study, the following conclusions may be drawn out,

1. After elevated temperatures test and analysis it was found that with the increasing temperature the compressive strength, tensile strength and flexural strength of concrete gets reduced.
2. As temperature and exposure time increases the effect of fire on concrete increases.
3. Effect of fire can be observed on the surface of concrete in the form of deep cracks.
4. Between 400-600°C temperature Strength loss starts.
5. Above 6000C temperature concrete is not functioning at its full structural Capacity.
6. At elevated temperature the concrete becomes more & more brittle and the loss of strength is more than 30%.
7. At 600°C temperature whitish color and at 800°C temperature dark brown color appears on the surface of cubes.
8. At 1000°C temperature hair cracks developed on specimen.
9. At 1200°C temperature blast furnace slag in concrete started to melt, so it gives negligible strength.
10. At elevated temperature C5 (10% RHA + 40% BFS) found to be suitable combination.

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