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A Research on To Study The Characteristic Behaviour of Concrete Using Rice Husk Ash and Sugarcane Bagasse Ash

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ABSTRACT

In the last decades, the use of residue in civil construction, especially in addition concrete, has been subject of many researches due to, besides to reduce the environmental polluters factors, it may lead several improvements of the concrete properties. The world rice harvest is estimated in 600 million tons per year. Considering that 22% of the grain is husk, and 22% A part from this, extraction of natural aggregates This report evaluates how different contents of rice husk ash (RHA) added to concrete may influence its physical and mechanical properties. Samples with dimensions and generation of industrial, agricultural and domestic waste also leads to environment degradation. The use of these waste materials not only helps to reduce the use of natural resources also helps to mitigate the environment pollution. The basic objective of this research is to investigate the effect of Waste Rice Husk (RHA) as partial replacement of fine aggregates and Sugarcane Bagasse ash Ash (SCBA) as partial replacement of cement in concrete. This research work examined the potential use of Sugarcane Bagasse ash Ash (SCBA) as apartial replacement material. SCBA has been partially replaced in the ratio of 0%, 10% ,20% and 30% with and without addition of steel fibre by weight of cement in concrete. M25 Grade of concrete were adopted throughout the study This study primarily deals with the characteristics of concrete, including compressive strength, workability and thermal stability of all concrete mixes at elevated temperature. Twenty five mixes of concrete were prepared at different replacement levels of RHA (0%, 10%, 20%, 30% & 40%) with fine aggregates and SCBA (0%, 5%, 10%, 15% & 20%) with cement. The water/cement ratio in all the mixes was keptat 0.55. The workability of concrete was tested immediately after preparing the concrete whereas the compressive strength of concrete was tested after 28 and 60 days of curing. Based on the test results, a combination of 10% RHA and 10% SCBA is the most significant for high strength and economical concrete. This research also indicates that the contribution of RHA and SCBA doesn't change the thermal properties of concrete.

KEYWORDS: *Waste Rice Husk, Sugarcane bagasse ash ash, Workability, Compressive strength*

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INTRODUCTION

The utilization of concrete ingredients such as cement and aggregates has been enhanced, which ultimately results in the ill effects on the environment. Basically concrete is a composite material obtained by using cement, aggregates and water. Few decades ago, these materials were easily available while nowadays there is an adverse effect of the utilization of these materials The waste materials locally available are efficiently deployed to improve the functioning of the rural-based industries. Civil Engineers are always in search of waste materials that can be used as a blending component in cements to improve its quality and to reduce the cost. Several Apart from getting rid of these materials, their use in construction protects the environment from contamination. Industrial and agricultural wastes are used for the production of low cost building materials. Agro-industrial wastes such as tobacco waste, non-edible oil cake and hyacinth have been used successfully for installing bio-gas plants.

Agricultural Sugarcane Bagasse ash Ash is one of the main by product generated by the sugar industry worldwide. Food and Agriculture Organization (FAO) states that India is the second largest producer of sugarcane after Brazil. Sugarcane bagasse ash is fibrous residue after the extraction of juice from the sugarcane. That fibrous residue material (Bagasse ash) is the major industrial waste from sugar industry. The sugarcane bagasse ash consists of 50% of cellulose, 25% of hemicelluloses and 25% of lignin. Each ton of sugarcane generates approximately 26% of bagasse ash and 0.62% of residue ash. Most of the bagasse ash is used as a fuel in boilers, distilleries and small amount for power generation in sugar factories. After burning of bagasse ash at controlled condition, by product bagasse ash ash can be used as a supplementary replacement material with cement due to high content of silica ($SiO2$) (cordeiroet al 2018). The use of SCBA as supplementary cementitious material (SCM) not only reduces the production of cement which is responsible for high energy consumption and carbon emission, but also can improve the compressive strength of cement based materials like concrete and mortar. The main improvement in compressive strength of concrete with the use of SCBA replaced with cement is due to its physical as well as chemical effects. The physical effect is filler effect, which in turn depends upon the size, shape and texture. In contrast, the chemical effect is due to its pozzolonic nature.

Rice Husk Ash (RHA)

India is the second largest populated country all over the world. Due to large number of consumers, there is a significant rise in the waste and by-products in various forms from households and industries. This obviously contaminates the natural resources like air, water and soil. In order to eradicate this problem, utilization of many waste products is now well developed, as it changes the unsustainable to sustainable development by two ways. Firstly, waste materials are utilized which otherwise will be the burden on the environment and require too much land in order to dispose them. Secondly, it will help to mitigate the problem of digging of sand. Many of industrial waste such as The waste materials locally available are efficiently deployed to improve the functioning of the rural-based industries. Civil Engineers are always in search of waste materials that can be used as a blending component in cements to improve its quality and to reduce the cost. Several investigations have been carried out to utilize waste material in construction. Apart from getting rid of these materials, their use in construction protects the environment from contamination. Industrial and agricultural wastes are used for the production of low cost building materials. Agro-industrial wastes such as tobacco waste, non-edible oil cake and hyacinth have been used successfully for installing bio-gas plants. Agricultural residues such as bagasse ash, rice husk and rice straw are utilized in the production of light weight clay bricks. Industrial wastes such as blast furnace slag, fertilizer wastes, fly ash, silica fumes and incinerators ash are silica-based materials having pozzolanic properties. These are used for the development of novel low temperature cements and added to portland cement as supplementary cementitious materials with improved properties compared to Portland cement. In addition to the above industrial wastes, the agro wastes such as rice husk ash.

Literature Review

Mehta and Pirtz (2018) have reported that a highly reactive silica ash produced by incineration of rice hulls could be successfully used in mass concrete applications requiring high strength without excessive rise in adiabatic temperature. Due to exceptionally high surface area of the ash, the concrete containing RHA showed only 13mm slump as compared to 95mm slump for control concrete. To provide the same slump as that of control concrete, additional water and corresponding cementitious material would have been needed, hence the strength. Under this condition the difference in heat evaluation could have been substantially reduced. In a concrete mixture when 30% RHA by weight of total cementing material was present, the 7 and 28 days compressive strength were higher and the adiabatic temperature Rise was 18° F (10°C) lower than that of control concrete. It was also shown that mortars made with rice husk ash cement had superior resistance to acidic environments compared even to OPC and other Pozzolans. When the lime

Maheshbhai Prajapati (2016) experimental investigation is doing to study the effect of partial replacement of cement by Rice husk ash with using Steel fiber in concrete. Thus the present research study includes the experimental investigation of concrete by adding Rice Husk Ash with using steel fiber different proportion in M30 grade of concrete. For steel fibers in Geopolymer concrete composites enhanced its mechanical properties. Compressive strength, split tensile strength and flexural strength of steel fiber reinforced Geopolymer concrete composites increases with respect to the increase in the percentage volume fraction from 0.25 to 0.75. Workability of steel fibre reinforced concrete gets reduced as the percentage of steel fibres increases. Rice Husk Ash at 25% decreases the compressive strength and inclusion of polypropylene fibres into concrete mixes increases the compressive strength at 0.5% fibres content as compared to the control mix. For all the cement replacement levels of Rice husk ash; there is gradual increase in compressive strength from 3 days to 7 days. There is significant increase in compressive strength from 7 days to 28 days followed by gradual increase from 28 days to 56 days.

Dr. Abhay S. Wayal (2015) presents an overview of the work carried out on the use of RHA as partial replacement of cement in concrete and its effect on workability, compressive strength and chloride permeability of concrete. To produce environment friendly and durable concrete products incorporation of RHA as partial replacement of cement in concrete has gained importance. In the previous studies tests were carried on RHA concrete containing RHA as partial replacement in comparison with control concrete by varying replacement percentage. From the literature review it can be concluded that the workability of the fresh concrete mix decreases as the RHA replacement percentage in concrete increases. The required workability can be attained by good superplasticizer and proper mix design. The partial replacement of cement by RHA improves the compressive strength of hardened concrete whereas; the optimum replacement percentage varies in the studies. The chloride ion penetration of the concrete decreases as RHA percentage increases mainly due to pore refining capacity of RHA. From the above literatures the optimal replacement percentage was found to be ranging from 10% to 20%.

Md. Abdullah Al Mamun (2017) Review of the researcher on physical, mechanical and structural properties of concrete containing RHA as partial replacement of ordinary Portland cement was included in this paper. Simultaneously, concrete specimens were tested with different percentages of RHA as replacement of cement content and with different w/c ratio.

Compressive strength, flexural strength, tensile strength and slump test were carried out to evaluate the appropriateness of using RHA in concrete.

The replacement of cement by RHA in structural concrete represents a good alternative in as economical as strength consideration of concrete, even without any kind of processing and found environmental benefits related to the disposal of waste. Rice husk ash is suitable as additional cementious material, which can be obtained by controlled or natural incineration and used with or without further processing. Reduction of environmental pollutants and economy in concrete construction was possible using RHA as partial replacement of cement. The concrete contains rice husk ash having density within the range for normal weight concrete and, thus, can be used for general purpose application. The compressive strength, flexural strength and tensile strength of concrete specimens with 10% cement replacement with RHA are comparable to the control specimens. Uses of RHA in concrete lower the reduction in strength due to some chemical attack.

Amrita Kumari (2015) Normal consistency and setting time of the pastes containing Portland pozzolana cement and sugarcane bagasse ash at 5%, 10%, 15% & 20% replacement were investigated. The compressive strength of mortars containing Portland pozzolana cement with bagasse ash at 5%, 10%, 15% &20% replacements were also investigated. The result shows that consistency, initial setting time, final setting time increases with increase in percentage of sugarcane bagasse ash where as soundness and compressive strength of mortar decreases with increase in percentage of sugarcane bagasse ash. Normal consistency, initial setting time, final setting time of mix of cement and SBA increases with increase in percentage of SBA. The results of concrete work revealed that, the compressive strength, split tensile strength, flexural strength and density of concrete containing SBA have shown reduction. As the water cement ratio increases, they decreases slightly. Since bagasse ash is a by-product material, its use as a cement replacing material reduces the levels of CO2 emission by the cement industry and also saves a great deal of virgin materials.

Muzammil Ahmed(2017) cement with rice husk ash and fine aggregate with ceramic powder reveals that there is a significant change in the strength properties of concrete such as compressive strength, flexural strength and split tensile strength. These experiments were carried out in various grade of concrete to find out the result. From the above literature reviews optimum percentage of rice husk ash varies from 10% to 30% by weight of cement and ceramic powder varies from 10% to 20% by weight of fine aggregate .Up to these percentage replacement improvement in the strength of concrete has been observed in terms of Compressive Strength, Flexural Strength and Tensile Strength. Previous studies also show that utilization of rice husk ash and ceramic powder as partial replacement in concrete enhances the durability of concrete.

Dr.M.Vijaya Sekhar Reddy(2015) The tests were carried out as per IS: 516-1959 [15]. The 150mm size cubes of various concrete mixtures were cast to test compressive strength. The cubes specimens after de-moulding were stored in curing tanks and on removal of cubes from water the compressive strength were conducted at 7days, 28days. The experimental results show that the maximum compressive strengths for seven and 28 days curing period achieved are 17.93 and 30.57 N/mm2 respectively with 10% replacement of cement by bagasse ash. The results show that the SCBA in blended concrete had significantly higher compressive strength compare to that of the controlled concrete. It reveals that the cement could be advantageously replaced with SCBA up to maximum limit of 10%.

Rama Krishna Bolla (2015) The test specimens shall be stored on the site at a place free from vibration, under damp matting, sacks or other similar material for 24 hours + ½ hour from the time of adding the water to the other ingredients. The temperature of the place of storage shall be within the range of 220 to 32 0C. After the period of 24 hours, they shall be marked for later identification, removed from the moulds and, unless required for testing within 24hours, stored in clean water at room temperature and cured for required period as per IS: 516-1969. The cement has been replaced by rice husk ash accordingly in the range of 0%, 5%, 10%, 15%, and 20% by weight of cement for mix. Concrete mixtures were produced, tested and compared in terms of compressive strengths with the Conventional concrete. These tests were carried out to evaluate the mechanical properties for the test results of 7, 28, 60 days for compressive strengths in MgSO4 solution of 1%,3%,5% and also durability aspect rice husk ash concrete for sulphates attack was tested. The specific surface area of RHA is 420 m2/kg greater than 330 m2/kg of cement. The workability of RHA concretes have decreased in compared with ordinary concrete. It is inferred that reduction in workability is due to large surface area of RHA. The compressive strengths of concrete (with 0%, 5%, 10%, 15% and 20%, weight replacement of cement with RHA) cured in Normal water for 7, 28, 60, 90 and 180 days have reached the target mean strength.

P.Jagadesh (2018) A comprehensive review of literature on SCBA properties as pozzolan has been carried out. SEM results shows that SCBA are porous in nature and having irregular shape typical for morphology of fibres. SCBA also retains air bubbles, indicates that they are in molten state, which suggesting that combustion temperature reached in burning process did not produce the melting of volatile matter. So, that spherical shaped particle can be obtained either at high combustion temperature or higher grinding time. The vitreous phase indicates that SCBA are in amorphous state and small quantities of quartz, un-burn carbon and iron oxides are identified with predominance of silica as cristobalite form. To confirm the results from SEM, the presence of cristobalite indicates that 800°C temperature is required for conversion of silica to reactive silica form. The reactivity nature of SCBA is determined by using particle size distribution curve which shows that the mean particle size is helpful for increasing the packing density of concrete. SCBA is classified as N type pozzolan31 based on chemical properties only. Having large amount of silica, SCBA exhibits excellent pozzolanic property. From physical properties it is noted that the size of SCBA are actually obtained from dump yard has approximately 2 to 4 times particle size of OPC but it can be reduced by various techniques. Most of researchers found out that the optimum level of cement replacement is between 10% - 20% of SCBA by various techniques. As whole, SCBA can be used as pozzolan in concrete based on its hardened and durability properties.

Ashish Kumar Singh (2018) Rice husk ash (RHA) is a farming based Pozzolanic material, produced by rice processes in immense amounts. This paper abridges the trial work of cement in which common Portland concrete (OPC) bond were supplanted by Rice husk ash (RHA). Incomplete substitution of OPC concrete was done at 0% to 20% in ventures of 5% and contrasted and 0% substitution Rice husk ash thus great impact on compressive quality. RHA builds the quality and strength of concrete. Strength of self-compacting solid utilizing silica smolder increments up to 20% replacement. The mechanical properties as far as protection from official and footing have been significally enhance with expansion of RHA. Utilization of these materials a domain friendly. Utilization of RHA in solid prompts sparing in materials cost so utilization of RHA is practical approach towards the utilization of bond.

Divyadevi Sundaravadivel (2018) investigates the various process involved in the SCBA. provides a historical point of view on the explanation and use of SCBA as a mineral admixture. 45µm sieve gives the better pozzolanic activity. Burning the material at 600-800ºC and grinding for 120 min gives the 100% pozzolanic activity. It could be concluded 20-30% of SCBA increases the mechanical and durability propertiesThe partial replacement of cement with SCBA reduces environmental problems, green house gases and global warming.

Objective of the work

The aim of this study is to formulate ternary concrete and find out the effect of supplementary cementing material i.e., Rice husk ash and SCBA on strength parameter of ternary concrete.

The aim is achieved with the help of following various objectives.

To design concrete mix by replacing cement with various proportions of SCBA and Rice husk.

To determine the following strength parameters of various concrete specimens-

i) Slump Test
ii) Compacting Factor Test
iii) Vee Bee Consistometer Test
iv) Flow Table Test

To compare results of various mix designs and determine optimum mix design that can be used economically.

Materials and Methodology

In this study, rubber is used as the partial replacement of coarse aggregate by different amount of percentage. Cement

- ✓ Fine aggregate
- ✓ Coarse aggregate
- ✓ SCBA
- ✓ Rice husk
- ✓ Water

Result

In this study, rubber is used as the partial replacement of coarse aggregate by different amount of percentage. Several test methods will be used to complete this project, these are:

- ✓ Compressive strength
- ✓ Workability Test
- ✓ Flexural strength Tests
- ✓ Split Tensile Test

Workability of concrete

In fresh condition, workability characteristics for high quality concrete should be acceptable (90-100mm slump height). The desired strength of concrete can be obtained if fresh concrete has adequate slump value.

Mix	SCBA (%)	RHA (%)	Slump(mm)
M1	0	0	108
M2	5		104
M3	10		100
M4	15		92
M5	20		87
M6	0	10	11
M7	5		103
M8	10		101
M9	15		92
M10	20		89
M11	0	20	115
M12	5		116
M13	10		108
M14	15		99
M15	20		95
M16	0	30	125
M17	5		116
M18	10		113
M19	15		103
M20	20		101
M21	0	40	130
M22	5		130
M23	10		120
M24	15		118
M25	20		115

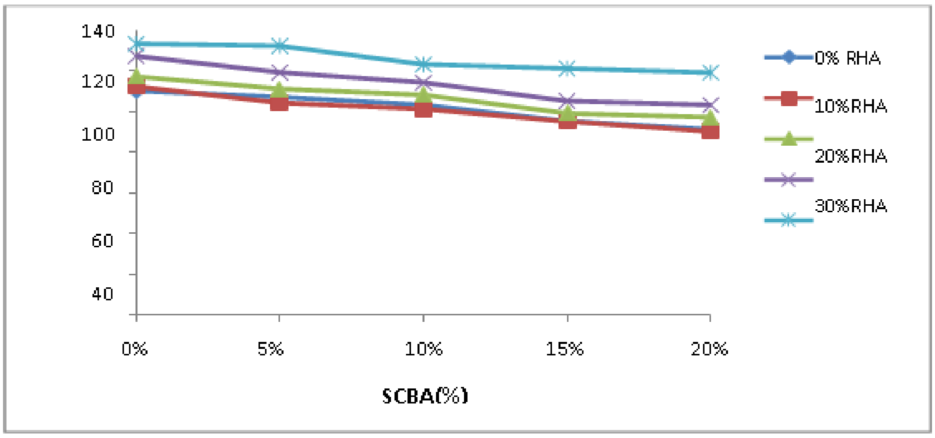


Figure:-Slump values of concrete with different replacement levels of SCBA and RHA

Compressive strength of concrete

The compressive strength of all the mixes was determine the ages of 14,28 and 60 days for the various replacement levels of SCBA with cement and RHA with fine aggregates. The values of average compressive strength and percentage loss for different replacement levels of SCBA (0%, 5%, 10%, 15%, 20%) and RHA (0%, 10%, 20%, 30% and 40%) attend of different curing periods (14days,28days & 60days) are given in Table 4.19 and Table 4.20 respectively. The effect of both waste materials on compressive strength at curing ages of 14, 28 and 60 days. It is quite obvious from the data that there was a gradual increase in compressive strength as the percentage of SCBA is increased up to 15%. After 15%, the value of compressive strength suddenly falls down at all curing periods. The highest percentage gain was observed at 10% SCBA replacement level, it was about 4.6, 6.1 and 5.9 at 14, 28 and 60 days curing respectively. Nevertheless, the replacement of 15% of SCBA still improves the compressive strength of concrete as compared to the control concrete but for much better results, the 10% of SCBA seems to be the optimum. This improvement is basically due to physical as well as chemical effect of SCBA. The chemical effect is mainly due to the reaction between the reactive silica and calcium hydroxide whereas the physical effect relates to the finer particle of SCBA. In contrast, there was a loss in strength of concrete due to replacement of fine aggregates with RHA. The substitution of RHA produced relatively low strength concrete compared to control mix. This decline may be due to the decrease in adhesive strength between the surface of the RHA aggregates and the cement paste as well as the increase in fineness modulus (FM) of the fine aggregates and the decrease in compacting factor in accordance with the increase in the mixing ratio of the RHA. At the curing age of 28 days, there was about 0.6%, 2.5%, 5.9% and 8.1% loss in compressive strength of concrete.

Table: Test results for average compressive strength of concrete

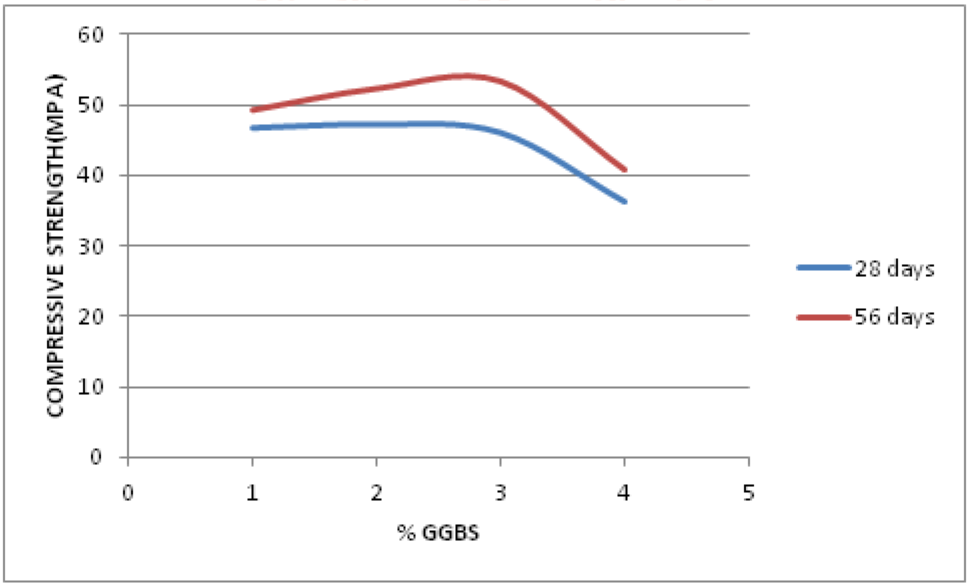
Mix	SCBA (%)	RHA (%)	Average compressive strength (N/mm2) of concrete for different curing days			
			7 days	Mean Value	28 days	Mean Value
S1	0	0	22.01	22.37	27.35	27,11
S2	5		22.63		27.41	
S3	10		23.06		28.01	
S4	15		22.33		26.86	
S5	20		21.84		25.93	
S6	0	10	21.87	22.44	26.10	26.69
S7	5		22.51		27.17	
S8	10		22.92		27.79	
S9	15		23.21		26.65	
S10	20		21.71		25.74	
S11	0	20	21.43	22.00	26.55	26.71
S12	5		22.05		27.59	
S13	10		23.53		27.19	
S14	15		21.73		27.11	
S15	20		21.29		25.11	
S16	0	30	21.65	21.80	24.79	25.95
S17	5		21.25		26.83	
S18	10		22.68		27.21	
S19	15		21.99		25.28	
S20	20		21.46		25.68	
S21	0	40	20.14	20.91	23.80	24.55
S22	5		20.79		25.84	
S23	10		22.23		25.50	
S24	15		20.44		24.27	
S25	20		20.96		23.36	

Flexural Strength (F.S.)

W/C = 0.30	Avg Load (KN)	F.S. (MPa)	F.S.(kg/cm2)
Controlled 0% SCBA	35.3475	6.284	62.84
10% SCBA	34.0575	6.055	60.55
20% SCBA	32.0775	5.703	57.03
30% SCBA	29.67	5.275	52.75
10% RHA (FR01)	27.6525	4.916	49.16
20%RHA (FR02)	22.2275	3.952	39.52
30%RHA (FR03)	19.6075	3.486	34.86

Compressive strength Test

Mix No.	MIX Code	Compressive Strength	
		28 days	56 days
1	CEM100	46.82	49.21
2	GGBS20	47.32	52.23
3	GGBS40	46.14	53.25
4	GGBS60	36.21	40.85
5	GGBS20MK10	49.52	54.65
6	GGBS20MK15	54.32	61.02
7	GGBS20MK20	53.21	59.56
8	GGBS40MK10	52.88	58.81
9	GGBS40MK15	56.21	63.24
10	GGBS40MK20	51.24	57.51
11	GGBS60MK10	37.20	40.25
12	GGBS60MK15	34.21	37.25
13	GGBS60MK20	30.54	32.89
14	GGBS20SF10	48.84	54.18
15	GGBS20SF15	52.36	58.74
16	GGBS20SF20	52.04	57.89
17	GGBS40SF10	49.21	55.54
18	GGBS40SF15	54.20	62.21
19	GGBS40SF20	48.20	52.74
20	GGBS60SF10	36.22	40.14
21	GGBS60SF15	33.09	36.12
22	GGBS60SF20	26.87	30.31



Graph Influence of varying GGBS content on compressive strength

Conclusion

In the present study, the workability characteristics, strength characteristics and thermal stability of concrete containing SCBA and RHA are investigated. In experimental work twenty five concrete mixes were prepared each with 0.55 water/cement ratio by replacing the cement with SCBA from 0% to 20% and fine aggregates with RHA from 0% to 40%. In order to determine the effect of replacement of SCBA and RHA on compressive strength, 225 cubes of 15 cm X 15 cm X 15 cm in size were prepared by varying percentage of SCBA and RHA. The effect of elevated temperature on compressive strength was also investigated by same number of 10 cm X 10 cm X 10 cm sized cubes. Apart from this, results were statically analyzed by analysis of variance method. From the whole experimental study, it can be concluded that:

i) The workability of concrete decreases with the increase in percentage of SCBA content. On the other hand there is hike in slump value i.e increase in workability as replacement of RHA increases.
ii) The slump values decreased from 110 mm to 91 mm with increase in percentage of SCBA from 0% to 20%. However, as the percentage of RHA is increased from 0% to 40% workability starts increasing from 110 mm to 133 mm.
iii) The compressive strength of concrete increases as SCBA content increases for all curing ages. The maximum improvement in compressive strength is observed at 10% of SCBA but beyond 10% replacement of SCBA strength starts decreasing. There is a significant reduction in compressive strength at 20% replacement of SCBA.
iv) The replacement of RHA with fine aggregates decreases the compressive strength of concrete for all curing ages. As the percentage of RHA increases there is a continuous loss in strength at every replacement level.
v) The combination of 10% SCBA and 20% RHA give better results without any loss in strength for all curing age. For instance, the value of compressive strength at 28 days is about 28.19.
vi) In order to make higher strength concrete compared to reference mix, the combination of 10% SCBA and 10% RHA is the most significant for higher strength and acceptable workability with 5.7 % decrease in cost.

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