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Partial Replacement of Cement by using Rice Husk Ash and Sugarcane Bagasse Ash

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Abstract: *The concrete is one of the important material in construction industry. For the formation of concrete the cement is basic material. The use of cement as a main binding material in the field of civil engineering construction. But during the manufacturing of cement large amount of formation of CO_2 which causes air pollution. There is many searches for developing alternative of binding material that can be eco-friendly and helps towards waste management. The utilization of waste materials in concrete manufacture provides a satisfactory solution to some of the environmental concerns and problems associated with waste management. Agricultural waste such as rice husk ash, wheat, straw, bagasse ash are used as pozzolanic materials for the development of blended cement. Few studies have been reported on the use of bagasse ash and rice husk ash partial cement replacement material with respect to cement mortar. Usage of sugarcane industry waste such bagasse and its ash needs to be disposed in appropriate way for solid waste management. Rice husk is by product from the rice mill. Rice husk ash and sugarcane ash contain pozzolanic properties. Therefore, the purpose of study was to investigate the strength performance of cement concrete contain sugarcane bagasse ash and rice husk ash as partial replacement of cement. In this project work we have replaced the cement with different percentage i.e.,0% ,10%,15%,20% of both sugarcane bagasse ash and rice husk ash .Compressive strength were examine by casting 24 standard cubes of 150 mm x150 mmx150 mm size and cured for 7days and 28 days . For compressive strength, it was found that the compressive strength of 20% replacement of both rice husk ash and sugarcane bagasse ash gives more strength of 7 days and 28 days as compare to other.Based on experimental finding it was conclude that, the replacement of both rice husk ash and sugarcane bagasse ash by 10 % ,15% gives more compressive strength with compare to conventional concrete but replacement of 20% rice husk ash and 20% sugarcane bagasse ash gives more strength as compare to other result.*

Keywords: bagasse ash

I. INTRODUCTION

1.1 GENERAL

After water concrete is most widely used material in our planet. The estimate of yearly consumption of concrete about 30 billion tones. In the preparation of concrete cement is main ingredient to bind the concrete which is used as binder. The agricultural waste such as rice husk ash and sugarcane bagasse ash are the waste product from industry. Due to this, solid waste management problem arises and hence this rice husk ash and sugarcane bagasse ash get used in partial replacement of cement and developing sustainable environment. Partial replacement of cement by rice husk ash (RHA) and sugarcane bagasse ash (SCBA) is a sustainable approach in the construction industry that aims to reduce the environmental impact of cement production and utilize agricultural by-products effectively. Both RHA and SCBA are considered pozzolanic materials, meaning they possess the ability to react with calcium hydroxide in the presence of water, forming cementitious compounds. This property makes them suitable as cement substitutes or supplementary materials.

1.2 SUGARCANE BAGGASE ASH

Bagasse ash is a waste product from sugar industries which is burnt in the factory. The researches all over world are focussing the on ways of utilizing either industrial or agricultural waste. The burning of sugarcane bagasse gives

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bagasse ash as waste product which contain pozzolanic property that would potentially be used as a cement replacement material.The extent of pozzolanic properties depends on the temperature in which bagasse is burning.When the bagasse is burnt under controlled condition it contain amorphous silica,which has pozzolanic properties. Due to this pozzolanic property it gives good compressible strength and workability.It has been known that the worldwide total production of sugarcane is over 1500 million tones. Sugarcane consist of 30% bagasse whereas sugar recovered is about 10%and bagasse leaves about 8% bagasse ash as a waste, this disposal of bagasse ash will be serious. sugarcane bagasse ash recently tested for cement replacement material.

Fig 1.1: sugarcane bagasse ash (researchgate.com)
(Source :https://www.researchgate.net/figure/Sugar-cane-bagasse-and-sugar-cane-bagasse-ash-9_fig3_335594944)

1.3 RICE HUSK ASH

The construction industry has experienced major innovations in concrete production methods alternative to conventional concrete. Rice husk ash is an agricultural by product of which is obtained from rice mill. This rice husk waste management is big problem of disposal of waste. The rice husk ash is get burned which gives some extra advantages when utilized in cement. It contain high amount of pozzolanic properties due to presence of silica. Hence it can be supplementary cementitious material. The pozzolanic action of rice husk ash depends on amount of silica content and the silica crystallization stage. The partial replacement of cement by rice husk ash in concrete production is an exploratory cost beneficial. In research it has been seen that the world produces about 649.7 million ton of rice every year. For 1000kg of paddy milled about 200 kg of husk is produced and about 40 kg of rice husk ash. rice husk ash is great pozzolanic material which makes concrete good sustainable to the environment. RHA base structural is more economical when it close to areas of rice production due to reduced RHA transportation cost.

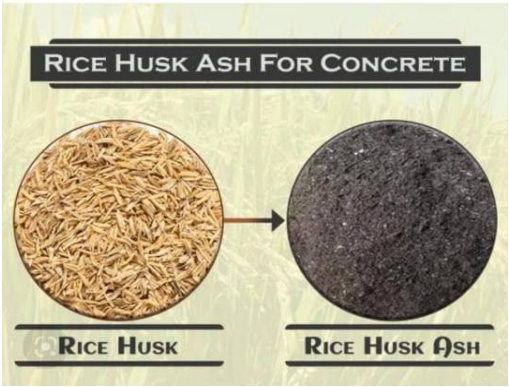

Fig 1.2 Rice husk ash (gharpedia.com)
(Source :https://gharpedia.com/blog/rice-husk-ash-in-concrete-pros-cons/)

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II. LITERTURE REVIEW

Asad A.Khedheyer et al.,(2022)was studied " The impact of using rice husk ash as a replacement material in concrete".In this study, the impact of adding RHA in different ratios such as (0%, 7%, 14%) as replacement to ordinary Portland cement with taking the different w/c ratios (0.3,0.5,0.7) and cured this into the water for period of 10 days 20 days and 30 days.The prepared specimen tested by flexural, compressive, tensile strength test,slump test, rapid chloride ion penetration test for determining the partial replacement of cement by RHA in concrete They conclude that increase in RHA content increase the flexural,compressive and tensile strength values with time and decrease the slump value and the chloride ion penetration rate. Also seen that with increase in w/c ratio,decrease the value of all strength test and increase chloride penetration rate and slump value. Increase in pore structure in concrete decrease its strength and increases the chloride penetration rate. while increase the RHA increase or decrease the strength of concrete depending on RHA used. Waqas Ahmad, Ayaz Ahmad et al., (2021)studied the 'sustainable approach of using sugarcane bagasse ash'. Cement based composites are widely used construction material and cement is main ingredient in it. The use of SCBA in composites is a sustainable approach towards the environment. In this review two approaches have been taken namely, scientometric analysis and through manual review of the use of SCBA in cement based composites. The addition of SCBA in composite is sustainably beneficial to it. The amount of silica in SCBA making it good pozzolanic material and suitable to used as supplementary to the cementitious material in cement based composites.As compared to conventional concrete it need less amount of water when SCBA added in composites and also reduce the solid waste management problems and prevent the environmental pollution. The strength properties of cement based composites improves with addition of SCBA in an optimal amount. If it get further increased get negative effect on strength properties of composites.

Abdul Qatoom Tunji Lawal et al., (2019)studied "The effect of unburnt rice husk on the properties of concrete". rice husk is agricultural by-product which is replacement of cement due to its pozzolanic content present in ash. However no studies conducted to finalize the definite temperature to which rice husk can be heated. This study evaluated by changing the different percentage of rice husk ash with partial replacement of cement (0, 1.5, 2.5, 5, 7.5 & 10 %) to find its workability, water absorption and compressive strength of concrete. The result were compared to a controlled sample and viability on adding the ground rice husk to concrete was verified.By adding of unburnt ground rice husk workability values are different. From this study we can infer that cement can be reduced upto 15 % with unburnt ground rice husk without compromising compressive strength of concrete especially the situations were water absorption is not important. In this study the slump test,water absorption test and compressive strength were studied. The slump values of concrete with varying percentage of ground unburnt rice husk. The result of replacement of cement with ground rice husk in concrete increased its water absorption which is not good for durability of concrete.

III. RESEARCH METHODOLOGY

Setting out objectives
↓
literature review
↓
Selection of project : partial replacement of cement by RHA & SCBA
↓
selection of procedure
↓
Preparation of mix design & casting and testing of cubes
↓
result and discussion : comparative study of result obtain between ordinary concrete & partial replacement of cement by RHA & SCBA
↓
Comparative analysis of compressive strength of concreate having different percentage of RHA & SCBA
↓
Conclusion

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IV. MATERIALS AND METHODS

4.1 MATERIALS :

4.1.1 CEMENT

Cement is a fine powder which mixed with water undergoes chemical reaction allowed to set and harden. The cement is finely pulverized material which itself is not a binder, but develops the binding properties as result of hydration. Ordinary Portland cement 53 grade used. The physical properties of the cement used are listed in table below :

Properties	Values
Cement brand	Vasavadatta
Colour of cement	Gray
Grade of cement	OPC 53
Specific gravity of cement	3.15

Table 1 : Cement properties

4.1.2 FINE AGGREGATE

Locally available crushed sand was used as fine aggregate. It is aggregate of which passes 4.75 mm IS sieve and contain only so much coarser as is permitted by specification. The physical properties of fine aggregate are listed in table below :

properties	Values
Type of fine aggregate	VSI crush sand
Specific gravity	2.66
Water absorption	2.37%

Table 2 : Properties of fine aggregate

4.1.3 COARSE AGGREGATE

It is aggregate most of which is retained on 4.75 mm IS sieve and contains only so much final material as is permitted by specifications, according to size of coarse aggregate described as graded aggregate of its nominal size i.e 40mm, 20mm, 16mm and 12mm. Coarser sand were preferred, as finer sand increases water demand of concrete.

Properties	CA-II	CA-I
Specific gravity	2.91	2.90
Water absorption	0.98%	1.36%

Table 3 : Properties of coarse aggregate

4.1.4 RICE HUSK ASH

Rice husk ash (RHA) is a byproduct obtained from the burning of rice husks, which are the outer protective coverings of rice grains. Rice husks are rich in silica and other minerals, and when burned, they leave behind a residue known as rice husk ash.Due to presence of silica in rice husk ash is contain pozzolanic properties.Utilizing rice husk ash offers environmental advantages. It promotes the sustainable use of agricultural byproducts, reduces waste disposal problems, and decreases the carbon footprint associated with rice husk incineration.

Oxide	RHA (Garrett et al. 2020)
SiO_2	94.3
Al_2O_3	0.77
Fe_2O_3	0.05
CaO	0.66
MgO	0.58

Table 4 : Oxide composition of RHA

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4.1.5 SUGARCANE BAGASSE ASH

The sugarcane bagasse ash is a agricultural waste it is abundant by product of the sugar and ethanol industry the sugarcane bagasse ash is generally is used as land filling which has lead to intensified environmental concern hence the use of SCBA in a commercial is a better solution for sustainable environment.

Oxide	SCBA (Garrett et al. 2020)
SiO_2	71.36
Al_2O_3	11.2
Fe_2O_3	3.79
CaO	6.83
MgO	1.56

Table 5 : Oxide composition of SCBA

4.1.6 WATER

Water is a important ingredient of concrete as it mixed with cement and make concrete hardens since it gives strength to the cement it is important to maintain the quality and quantity of required water, the PH value of water must not be less than 6. The water used for the study was free of acids, organic matter, suspended solids, alkalis and impurities which when present may have adverse effect on strength of concrete.

COMPRESSIVE STRENGTH

Compressive strength of concrete was done by using compressibility testing machine. The compressive strength of concrete is important for strength of structure and field quality control.

A) PREPARATION OF TEST SPECIMEN :

In this study the total number of 36 cubes were prepared. For this test, the test mould is 150mm x 150mm x 150mm cube moulds were used to cast cubes. All the mixes were cast using mix proportion 1:1:2, For mix preparation mechanical mixer used. Mixed concrete is filled in mouldin three layers of 50mm each layer tamped at least 25 - 35 times with tamping rod to remove air voids. After finishing it kept 24hrs for set.

B) DEMOULDING OF CUBES

After proper casting ani finishing the concrete cube set it for 24 hours. After this remove from moulds by using air compressor and placed in water for required period after removal from water and testing is carried out in compressive testing machine.

C) CURING OF SPECIMEN :

After demoulding of specimen it kept submerged in water for curing until the time of testing 3 specimen were tested at 7 days, 28 days of compressive strength respectively. The specimens were tested for the testing of compressive strength by using compression testing machine.

D) TESTING OF SPECIMEN :

Compressive strength test were carried out at specified age on cubes. During testing of cubes in compression testing machine, the cubes are placed in machine in such manner that the load is applied on forces perpendicular to the direction of cast. The top surface of machine is fixed and load is applied on the bottom surface of specimen. The rate of loading on cube is gradual and note down the failure load.

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4.2 PERCENTAGE TABLE :

Cement (Percentage)	SCBA (Percentage)	RHA (Percentage)	Total (Percentage of Cementitious Material)
100 %	-	-	-
80 %	10 %	10 %	20 %
70 %	15 %	15 %	30 %
60 %	20 %	20 %	40 %

Table 7 :Percentage table

4.3 MIX PROPORTION TABLE :

Sr No	Cement Kg/m^3	SCBA Kg/m^3	RHA Kg/m^3	Coarse Aggregate Kg/m^3	Fine Aggregate Kg/m^3	Water litre
1	341	00	00	1140	789	168
2	279	31	31	1090	754	168
3	248	46.5	46.5	1057	732	168
4	217	62	62	1041	720	168

Table 6 :Mix proportion table

V. RESULT

5.1 Result of M25 concrete

mix	Percentage of RHA +SCBA	Compressive strength of 7 days (MPa)	Compressive strength of 28 days (MPa)
A1	0%RHA + 0% SCBA	18	26
A2	10%RHA +10%SCBA	20.4	31.47
A3	15%RHA +15% SCBA	21.38	33.47
A4	20%RHA +20% SCBA	24.31	38.07

Table 8 : Result of M25 concrete

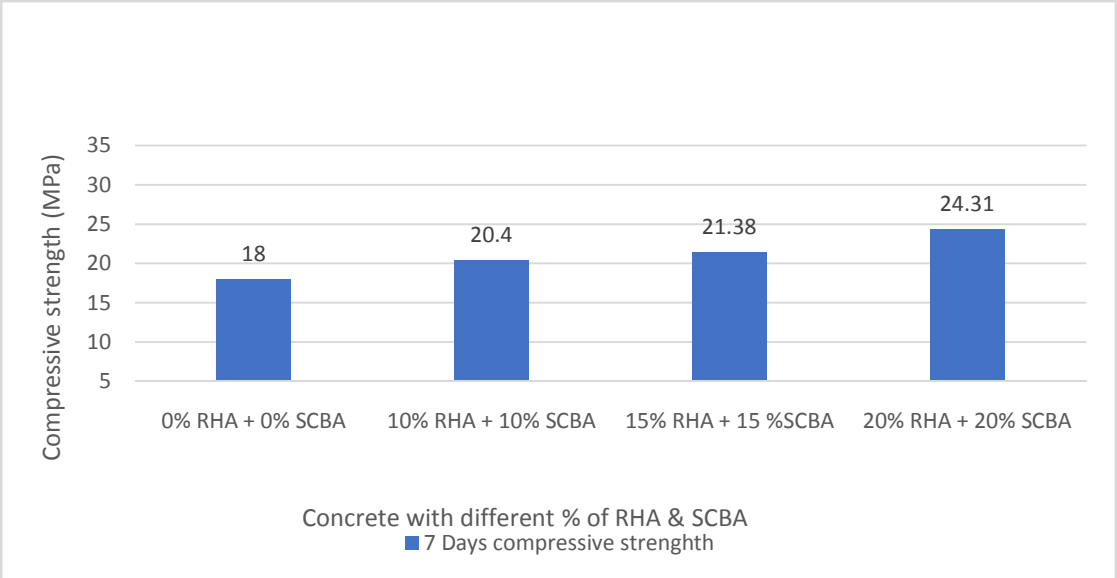

Fig 6.1 : 7 days compressive strength

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Most of the properties of concrete are directly related to its compressive strength. In present study, the compressive strength improvement were found with partial replacement of cement with both RHA and SCBA. The specimens were properly molded and cured. the specimens were loaded at a control rate in the compression testing machine. Fig 6.1 shows the for 7days replacement compressive strength for different percentage of RHA and SCBA by replacing OPC. After 7days of curing, the compressive strength increases as percentage of RHA and SCBA increases. Both RHA and SCBA contain pozzolanic materials in it and it give positive performance and good strength as compare to conventional concrete. The specimen with 10% RHA +10% SCBA of supplementary cementitious material in concrete had compressive strength 20.4 MPa. The specimen with 15%RHA+15% SCBA had compressive strength of 21.38 MPa while specimen with 20% RHA + 20%SCBA had 7day compressive strength 24.31 MPa .The 20% RHA+20% SCBA of supplementary cement substitute material gave good strength with compare to the other.

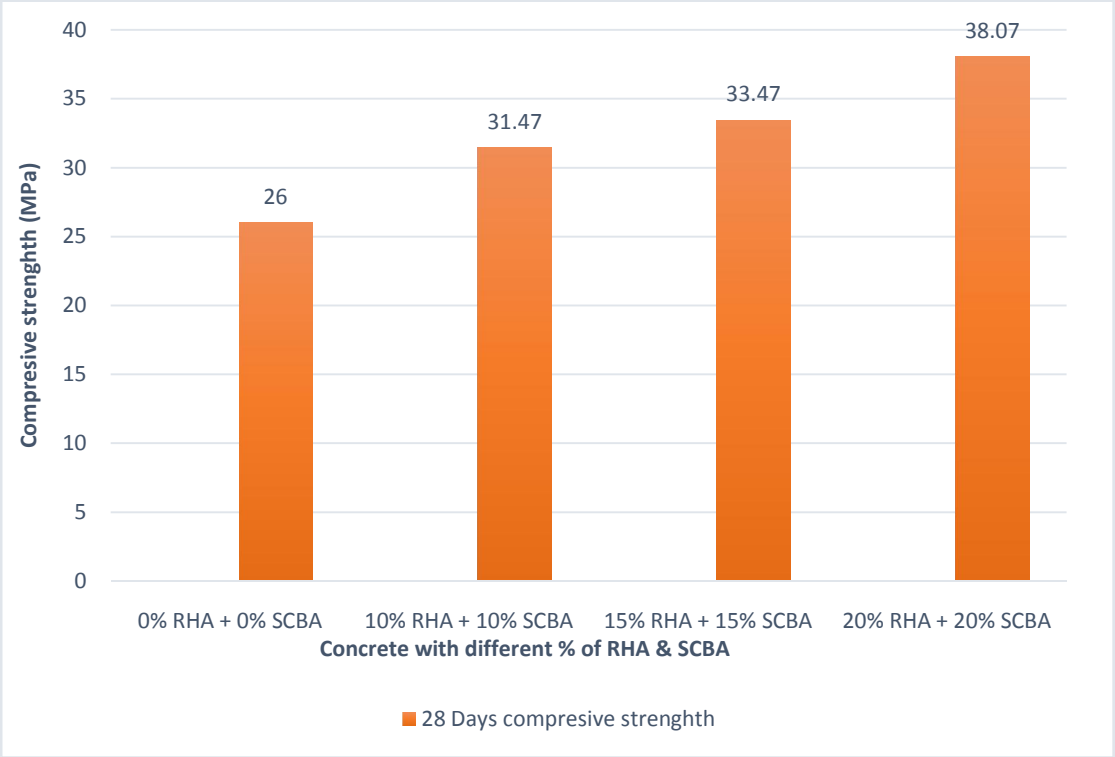

Fig 6.2 : 28 days compressive strength

Compressive strength is the capacity of concrete cubes to withstand compressive loads or the resistance of material to breaking under gradual loading. The test involves applying a compressing axial load to molded cubes which kept for curing of 28 days. The compressive strength is calculated by dividing the highest possible load attained throughout the test by the cross section area of sample. The above fig 6.2shows the concrete with different percentage of RHA and SCBA as OPC replacement material. The specimen with partial replacement of OPC by 10% RHA+10%SCBA had 28 days compressive strength of 31.47 MPa. The specimen with partial replacement of OPC by 15% RHA +15% SCBA had 28 days compressive strength of 33.47 MPa while 20% RHA+20% SCBA had 28 days compressive strength of 38.07 MPa. The 20% RHA+20%SCBA as a partial replacement to the cement gave good compressive with compare to other percentage of concrete and conventional concrete. As percentage of RHA and SCBA increases the compressive strength of concrete also increases.

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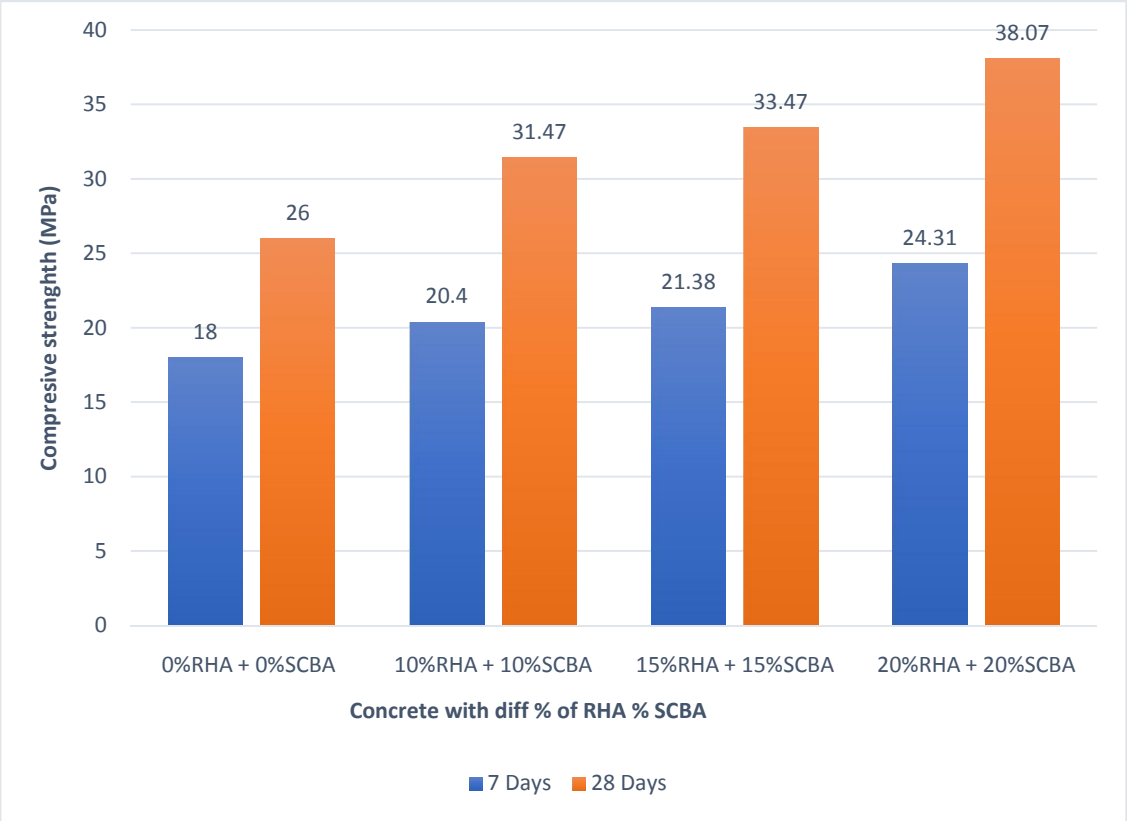

Fig 6.3 : compressive strength of concrete cube

Totally 24 cubes were casted and tested. The test was conducted on cubical specimen of 150mm x150mm x 150mmat age of 7 days and 28 days of curing age. The concrete cubes were cast with different percentage of rice husk ash and sugarcane bagasse ash. Fig 6.3 shows the both 7 days and 28 days of compressive strength of concrete by partial replacement of cement with several percentage. The 20%RHA +20% SCBA by partial replacement of cement had good compressive strength of 7 days and 28 days with compare to other percentage of concrete having different percentage. The use of SCBA and RHA with partial replacement of cement showed that as percentage of RHA and SCBA increase in concrete the compressive strength is increases. Hence from above fig 6.3 we can conclude that RHA and SCBA are good cement substitute and they gave good strength to concrete, make concrete more durable and sustainable environment.

VI. RESULT AND DISCUSSION

This study has been considered two agro-industrial waste to recycle in concrete production. 0% 10% 15% 20% both RHA & SCBA are get replaced by cement in concrete to make concrete sustainable and to find the compressive strength of concrete .

This mixture of concrete including several proportions of both SCBA and RHA as partial replacement of cement for determining the compressive strength of concrete at 7 days & 28 days curing age at presented in fig 6.1, fig 6.2, fig6. 3 and shown in table 8 .

As shown in fig 6.1 which gives the compressive strength of concrete at 7 days .The best 7 days compressive strength for M25 concrete was 24.31 MPa by partial replacement of cement using 20% RHA and 20% SCBA .The lowest compressive strength for 7days of concrete by 0% replacement of RHA and SCBA

The fig 6.2 and 6.3 shows the compressive strength of concrete by using different percentage of RHA and SCBA .The best 28 days compressive strength for M25 concrete was 38.07 MPa by partial replacement of cement with using 20% RHA &20% SCBA as shown in fig 6.2 and table 8. The lowest compressive strength for 28 days of concrete was 26.5 MPa by 0% replacement of pure OPC cement concrete.

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From above result the partial replacement of RHA and SCBA both individual by 20% gives good strength as compared to all percentage of RHA and SCBA in concrete.

As the percentage of RHA and SCBA are increases the compressive strength of concrete is increases as compare to conventional concrete. Hence the compressive strength is increases by using RHA and SCBA which gives good result of strength and making use of this agricultural waste RHA and SCBA make concrete more sustainable to environment.

VII. CONCLUSION

Hence compressive strength of concrete using different percentage of RHA and SCBA such as 0%, 10%, 15%, 20% was determined .

From all the results as mention in table 8 , fig 6.1, fig 6.2 ,fig6.3 it can conclude that as the percentage of RHA and SCBA increases the compressive strength of concrete also increases . By using this waste in concrete as substitution of cement gives reasonable result ,reduce solid waste management problem and make environment sustainable.

It can conclude that by using 20% RHA and 20% SCBA i.e 40% replacement of cement gives maximum compressive strength as compared to other percentage

The partial replacement of cement by RHA and SCBA gives good compressive strength and durability as compared to conventional concrete.

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