Strength Behaviour of Concrete With Rha Activated GGBS As Partial Replacement In Cement

G Kishore Kumar[1], J N V N Lakshmi Kumari[2], K Nani[3], U Venkata Ramana[4], D. Uma Maheswari[5]
[1,]Assistant Professor, Dept of Civil Engineering
[2, 3, 4, 5]Dept of Civil Engineering
[1, 2, 3, 4, 5] Kakinada Institute of Technology & Science, Divili, E.G Dist., A.P

Abstract- *Concrete is well known material which has been used in the field of construction mostly. It is the combination of cement, fine aggregate & coarse aggregate. In now a days there is a lot of research work done on the production of concrete in an economical way by using different waste materials produced from various sources like agriculture, industrial, transportation, textile and etc. There are lot of different waste materials (Rice Husk Ash, Flyash, Waste tyre rubber, Geo textiles and many) produced from different fields as mentioned above, based on the properties like type, size, reactive nature, availability of such a waste materials we can use those as a replacement or addition to the conventional materials in concrete.In the present study we are going to use different proportions in the binder and without change in fine and coarse aggregate proportions to find variation in the strength properties of hardened concrete of M40 grade by determine the compressive strength of standard cube size of 150X150X150 mm at different curing periods like 3 Days, 7 Days, 14 Days & 28 Days. Also ease of work doing of fresh concrete by determining the workability with slump. In this work as a binder along with cement, Ground Granulated Blast furnace Slag (GGBS) with 0% & 10% as a replacement to the cement along with Rice Husk Ash (RHA) of 0%, 3% and 6%.*

Keywords- Industrial Waste (Ground Granulated Blast furnace Slag), Agricultural Waste (Rice Husk Ash), Workability, Compressive Strength.

I. INTRODUCTION

Big attention is being focused on the environment and safeguarding of natural resources and recycling of wastes materials. One of the new waste materials used in the concrete industry is industrial wastes. For solving the disposal of large amount of industrial waste material, reuse of such materials in concrete industry is considered as the most feasible application. Those industrial waste materials have some pozzalonic nature which can react with water and act as binders, also recycled plastic can be used as coarse aggregate in concrete. There are many recycling plants across the world, but as plastics are recycled they lose their strength with the number of recycling. So these plastics will end up as earth fill. In this circumstance instead of recycling it repeatedly, if it is utilized to prepare aggregates for concrete, it will be a boom to the construction.

The aim of the project is to increase the compressive strength of concrete by using different industrial waste materials like Rice Husk Ash (RHA) & Ground Granulated Blast furnace Slag (GGBS) as a replacement to the cement.

II. REVIEW OF LITERATURE

Different Industrial Wastes:

1) Flyash:

Fly ash is a byproduct from burning pulverized coal in electric power generating plants. During combustion, mineral impurities in the coal (clay, feldspar, quartz, and shale) fuse in suspension and float out of the combustion chamber with the exhaust gases. As the fused material rises, it cools and solidifies into spherical glassy particles called fly ash. Fly ash is collected from the exhaust gases by electrostatic precipitators or bag filters. The fine powder does resemble Portland cement but it is chemically different. Fly ash chemically reacts with the byproduct calcium hydroxide released by the chemical reaction between cement and water to form additional cementitious products that improve many desirable properties of concrete.

2) GGBS:

Ground-granulated blast-furnace slag (GGBS or GGBFS) is obtained by quenching molten iron slag (a by-product of iron and steel-making) from a blast furnace in water or steam, to produce a glassy, granular product that is then dried and ground into a fine powder. The chemical composition of a slag varies considerably depending on the composition of the raw materials in the iron production process. Silicate and aluminate impurities from the ore and coke are combined in the blast furnace with a flux which lowers the viscosity of the slag. In the case of pig iron production the flux consists mostly of a mixture of limestone and forsterite or in some cases dolomite. In the blast furnace the slag floats on top of the iron and is decanted for separation. Slow cooling of slag melts results in an unreactive crystalline material consisting of an assemblage of Ca-Al-Mg silicates.

3) Silica Fume:

Silica fume is a byproduct of producing silicon metal or ferrosilicon alloys. One of the most beneficial uses for silica fume is in concrete. Because of its chemical and physical properties, it is a very reactive pozzolan. Concrete containing silica fume can have very high strength and can be very durable. Silica fume is available from suppliers of concrete admixtures and, when specified, is simply added during concrete production. Placing, finishing, and curing silica-fume concrete require special attention on the part of the concrete contractor. Silicon metal and alloys are produced in electric furnaces as shown in this photo. The raw materials are quartz, coal, and woodchips. The smoke that results from furnace operation is collected and sold as silica fume, rather than being landfilled. Perhaps the most important use of this material is as a mineral admixture in concrete.

RHA:

Rice milling industry generates a lot of rice husk during milling of paddy which comes from the fields. This rice husk is mostly used as a fuel in the boilers for processing of paddy. Rice husk is also used as a fuel for power generation. Rice husk ash (RHA) is about 25% by weight of rice husk when burnt in boilers. It is estimated that about 70 million tons of RHA is produced annually worldwide. This RHA is a great environment threat causing damage to the land and the surrounding area in which it is dumped. During milling of paddy about 78 % of weight is received as rice , broken rice and bran .Rest 22 % of the weight of paddy is received as husk . This husk is used as fuel in the rice mills to generate steam for the parboiling process. This husk contains about 75 % organic volatile matter and the balance 25 % of the weight of this husk is converted into ash during the firing process, is known as rice husk ash (RHA). This RHA in turn contains around 85 % - 90 % amorphous silica. RHA is a carbon neutral green product.

Quarry Dust:

Quarry dust is a byproduct of the crushing process which is a concentrated material to use as aggregates for concreting purpose, especially as fine aggregates. In quarrying activities, the rock has been crushed into various sizes; during the process the dust generated is called quarry dust and it is formed as waste. So it becomes as a useless material and also results in air pollution. Therefore, quarry dust should be used in construction works, which will reduce the cost of construction and the construction material would be saved and the natural resources can be used properly. Most of the developing countries are under pressure to replace fine aggregate in concrete by an alternate material also to some extent or totally without compromising the quality of concrete. Quarry dust has been used for different activities in the construction industry, such as building materials, road development materials, aggregates, bricks, and tiles.

Studies on Concrete with Industrial Waste:

The use of industrial solid waste to concrete production is environmentally friendly because it contributes to reducing the consumption of natural resources, the pollution concrete production generates and the power it consumes. The results pointed out that there is a potential for the use of copper slag as a supplementary cementing material to concrete production. The concrete batches with copper slag addition presented greater mechanical and durability performance. (Ashington Almeida Moura et al.)

Industrial waste fired clay materials, which are good pozzolans, can be used in place of cement in the manufacture of precast concrete products. All trials and measurements were taken on an industrial ceramic product subsequently used in a second industrial process to manufacture concrete tiles, which were found to meet market standards (M. I. Sánchez De Rojas et al). The microstructural studies revealed the existence of pozzalonic reaction products and an incomplete cement reaction, as in the control specimens, due to the processing conditions. This effect caused an increase in flexural strength after 28 days.

Fly ash, a waste generated by thermal power plants is as such a big environmental concern. The investigation reported in this paper is carried out to study the utilization of fly ash in cement concrete as a partial replacement of cement as well as an additive so as to provide an environmentally consistent way of its disposal and reuse (Dr S L Pati et al.). This work is a case study for Deep Nagar thermal power plant of Jalgaon District in MS. The cement in concrete matrix is replaced from 5% to 25% by step in steps of 5%. It is observed that replacement of cement in any proportion lowers the compressive strength of concrete as well as delays its hardening. This provides an environmental friendly method of Deep Nagar fly ash disposal.

Fly ash utilization in concrete as partial replacement of cement is gaining importance day by day. Technological improvements in thermal power plant operations as well as collection systems of fly ash improved the quality of fly ash. To study the use of fly ash in concrete, cement is replaced partially by fly ash in concrete. In this experimental work concrete mix prepared with replacement of flies ash by 0%, 25%, 50%, 75% and 100%. Effect of fly ash on workability, setting time, compressive strength and water content are studied. To study the impact of partial replacement of cement by fly ash on the properties of concrete, experiments were conducted on different concrete mixes (Khushal Chandra Kesharwani et al).

III. METHODOLOGY

Materials Used and Their Properties:

Cement:

A 53 Grade Ordinary Portland Cement (OPC), (IS: 12269-1987) was bought from Market.

Table 3.1: Properties of Cement

S.No	Name of Property		Value
1	Sp. Gravity Value		3
2	Fineness		3.60%
3	Normal Consistency		32%
4	Setting Time	Initial	38
		Final	360
5	Compressive Strength	3 Days	35.8
		7 Days	52.7
		28 Days	56.7

Fine Aggregate:

The Fine Aggregate i.e. Sand has been brought from the Godavari River from Rajahmundry.

Table 3.2: Properties of Fine Aggregate

S.No	Name of Property	Value
1	Sp. Gravity Value	2.62
2	Fineness Modulus	2.71
3	Bulking of Sand	0.9

Coarse Aggregate:

For the present study, the coarse aggregate has been brought from Prathipadu Village.

Table 3.3: Properties of Coarse Aggregate

S.No	Name of Property	Value
1	Sp. Gravity Value	2.7
2	Bulking of Sand	1.2

Ground Granulated Blast Furnace Slag (GGBS):

For the present study the GGBS was brought from the Visakhapatnam Steel Plant by using wet bags.

Rice Husk Ash (RHA):

Locally available Rice Husk Ash was brought from nearby brick industry at Virava Village, East Godavari District.

Table 3.4: Chemicals Present in GGBS

S.No.	Chemical	Composition
1	CaO	30-50%
2	SiO_2	28-38%
3	Al_2O_3	8-24%
4	MgO	1-18%
5	MnO	0.68%
6	TiO_2	0.58%
7	K_2O	0.37%
8	N_2O	0.27%

List of Laboratory Tests:

- Specific Gravity,
- Fineness of Cement,
- Normal Consistency of Cement,
- Setting time of Cement,
- Compressive Strength of Cement,
- Bulking of Sand,
- Waster Absorption of Coarse Aggregate,
- Sieve analysis for aggregates,
- Workability for fresh concrete,

Different variables Studied*:*

S.No.	Material	Variables Studied
1.	GGBS	0% & 10%
2.	RHA	0%, 3% & 6%.

Mix Proportion*:*

By using Indian Standard method of Mix-Design done the mix design for grade of concrete. IS Code used for the design is IS: 10262-2009.

Grade	(f_m) Mpa	W/C	(C) (Kg/m³)	F.A (Kg/m³)	C.A (Kg/m³)	Proportion
M40	48	0.365	493	416	1287	1:0.8:2.6

IV. RESULTS & DISCUSSION

Effect of Rice Husk Ash (RHA) & Ground Granulated Blast furnace Slag (GGBS) on workability:

Table 4.1, Fig 4.0 shows the variation of workability test (Slump cone Test) on fresh concrete with various percentages of Rice Husk Ash (RHA) and 10% of Ground Granulated Blast furnace Slag (GGBS) as a replacement to the cement. From fig 4.1 we can observe that the slump was getting decrease with increase in GGBS content from 0% to 10% also slump decrease with increase in % RHA from 0% to 6%. Compared to conventional concrete slump decreased by 31.25% at 0% RHA & 30% GGBS as a replacement to the cement.

Effect of Rice Husk Ash (RHA) & Ground Granulated Blast furnace Slag (GGBS) on Compressive Strength:

Table 4.2& 4.3 shows the variation of compressive strength on hardened concrete with various percentages of Rice Husk Ash (RHA) and 10% Ground Granulated Blast furnace Slag (GGBS) as a replacement to the cement. Fig 4.1 to 4.6 shows the compressive strength at different variables of proposed industrial waste materials as a replacement to the cement. The above mentioned figures show the strength at different curing periods there we can observe that from the figures the strength was increase with increase in curing period. The strength observed to be increase with increase in % RHA as a replacement to the cement at all curing periods with no GGBS content which shown in the figures 4.1, 4.2 & 4.3.

Table 4.1 Slump Results for Fresh Concrete

S.No.	% GGBS	Slump in mm at Different % RHA		
		0% RHA	3% RHA	6% RHA
1	0	48	45	40
2	10	43	39	33

Table 4.2 Compressive Strength at 0% GGBS

S.No.	Curing Period	0% RHA	3% RHA	6% RHA
1	7	33.2	34.5	35.3
2	14	42	42.8	44.2
3	28	50.8	51.1	53.2

Table 4.3 Compressive Strength at 10% GGBS

S.No.	Curing Period	0% RHA	3% RHA	6% RHA
1	7	29.5	30.4	32.1
2	14	43.4	44.3	45.7
3	28	52.1	52.6	54.8

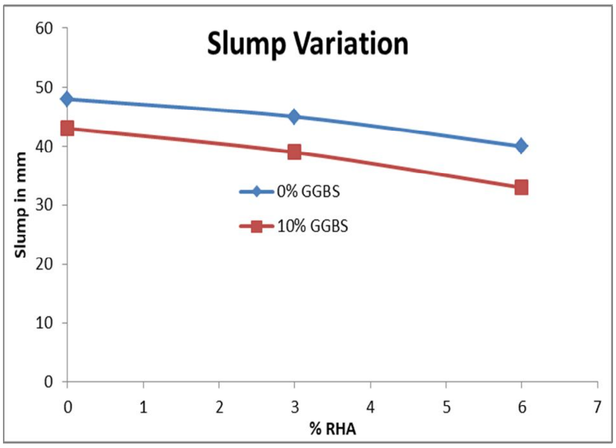

Fig 4.0: Shows the Slump variation for fresh concrete

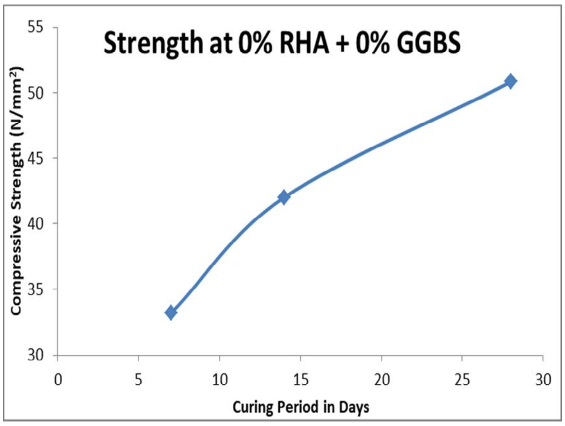

Fig 4.1: Shows the Compressive Strength with 0% RHA + 0% GGBS at different curing periods.

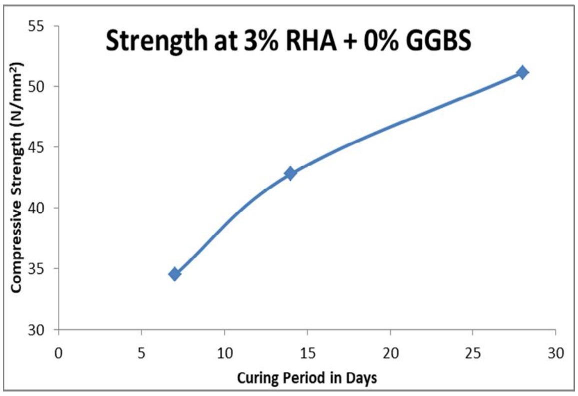

Fig 4.2: Shows the Compressive Strength with 3% RHA + 0% GGBS at different curing periods.

Figure 4.7 shows that the compressive strength of concrete at 7 days curing period for all considered different industrial waste variables. From the figure we can observe that the strength was increase with increase in % RHA for both 0% GGBS & 10% GGBS contents as a replacement to the cement. Also we can say that the compressive strength was low for

10% GGBS compared to 0% GGBS at any mix proportion of % RHA with cement at the curing period of 7 days.

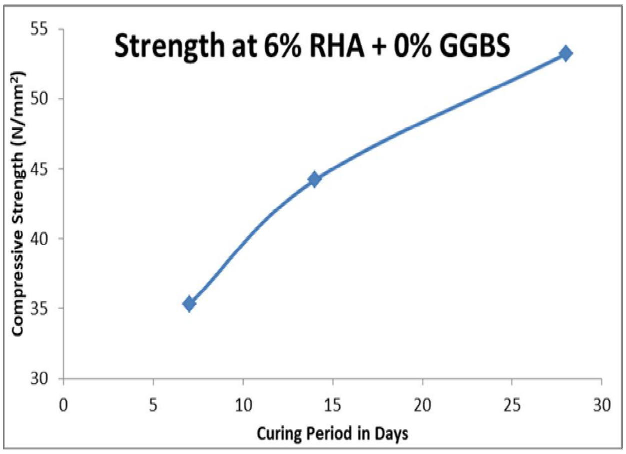

Fig 4.3: Shows the Compressive Strength with 6% RHA + 0% GGBS at different curing periods.

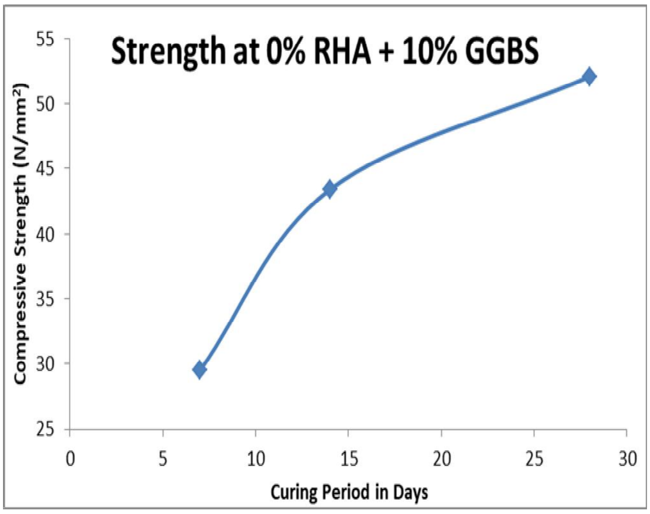

Fig 4.4: Shows the Compressive Strength with 0% RHA + 10% GGBS at different curing periods.

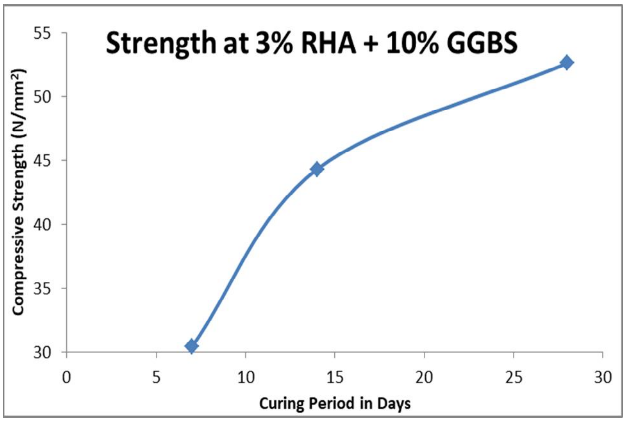

Fig 4.5: Shows the Compressive Strength with 3% RHA + 10% GGBS at different curing periods.

Figure 4.8 shows that the compressive strength of concrete at 14 days curing period for all considered different industrial waste variables. From the figure we can observe that the strength was increase with increase in % RHA for both 0% GGBS & 10% GGBS contents as a replacement to the cement. Also we can say that the compressive strength was high for 10% GGBS compared to 0% GGBS at any mix proportion of % RHA with cement at the curing period of 7 days.

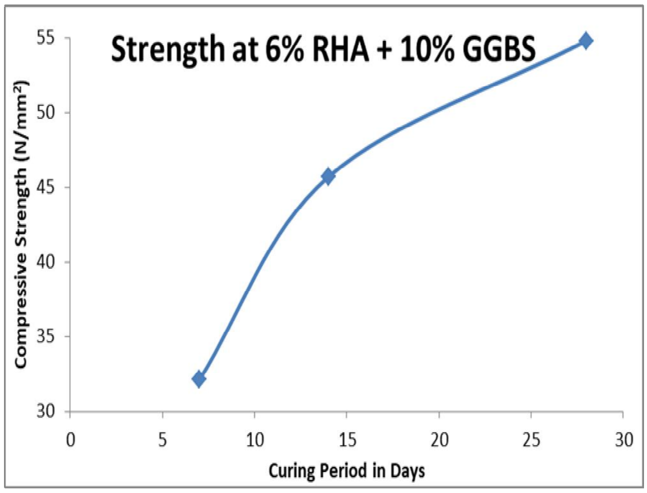

Fig 4.6: Shows the Compressive Strength with 6% RHA + 10% GGBS at different curing periods.

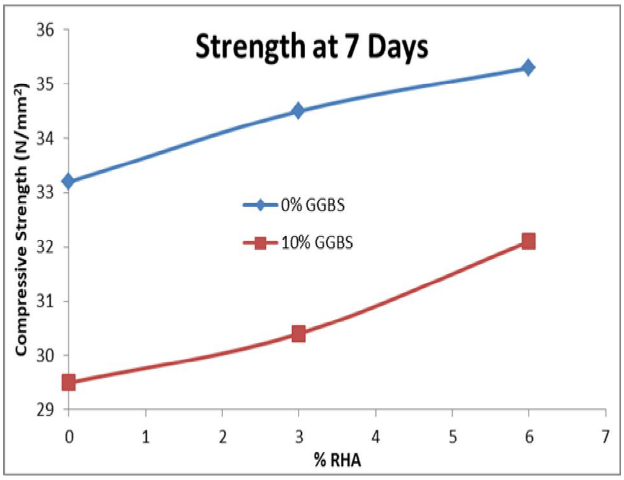

Fig 4.7: Shows the Variation of Compressive Strength with different % of RHA & GGBS at 7 Days of Curing.

Figure 4.9 shows that the compressive strength of concrete at 28 days curing period for all considered different industrial waste variables. From the figure we can observe that the strength was increase with increase in % RHA for both 0% GGBS & 10% GGBS contents as a replacement to the cement. Also we can say that the compressive strength was high for 10% GGBS compared to 0% GGBS at any mix proportion of % RHA with cement at the curing period of 7 days.

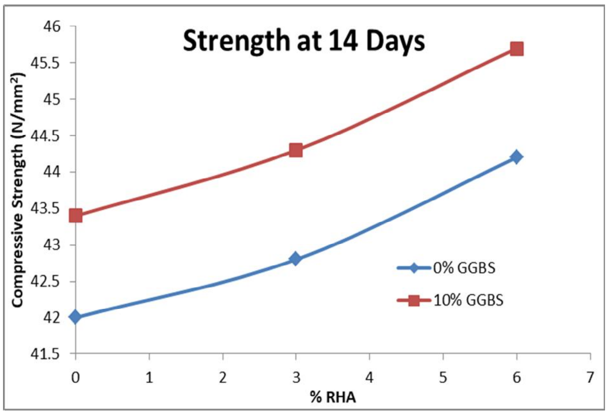

Fig 4.8: Shows the Variation of Compressive Strength with different % of RHA & GGBS at 14 Days of Curing.

From the above discussion we can say that the compressive strength of conventional concrete with different waste materials will improve the strength of concrete. Here the considered industrial waste materials have shown prominent effect on strength of concrete when those are used as a replacement to the cement.

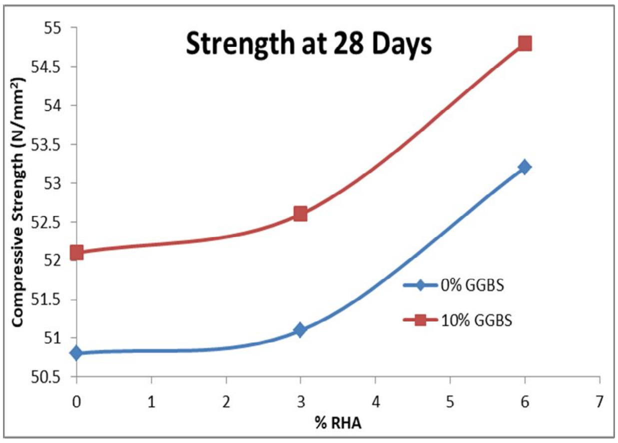

Fig 4.9: Shows the Variation of Compressive Strength with different % of RHA & GGBS at 28 Days of Curing.

V. CONCLUSIONS

The following conclusions are made based on the laboratory experiments carried out in this investigation.

- Workability is decreased with increase in both Rice Husk Ash (RHA) & Ground Granulated Blast furnace slag (GGBS) as a replacement to the cement.
- The slump value was decreased by 31.25% at 84% Cement + 6% RHA + 10% GGBS compared with conventional concrete.
- Compressive strength of M40 grade concrete was decreased for 7 days of curing with increase in GGBS content.
- For 14 days and 28 days curing periods the compressive strength was observed to be increase for GGBS.
- The strength of concrete with considered industrial waste materials was increased when compared with conventional concrete.
- The % increase in compressive strength of concrete increase with increase in GGBS at 28 Days of curing.
- The compressive strength of concrete with replacing cement by 6% RHA + 10% GGBS was increased by 7% when compared to the conventional concrete.
- The effect of 6% RHA alone is more in improving the strength of concrete at 28 days curing period than, the effect of 10% GGBS alone.
- From the above conclusions we can say that usage of proposed industrial waste materials in concrete as a replacement to the cement will give us a better strength improved concrete along with a solution for disposal of such an industrial waste.

REFERENCES

[1] Ashington Almeida Moura, Jardel Pereira Gonçalves, Mônica Batista Leite Lima; Copper slag waste as a supplementary cementing material to concrete;Journal of Materials Science; April 2007.

[2] M. I. Sánchez De Rojas, F. P. Marín, M. Frías, J. Rivera; Properties and Performances of Concrete Tiles Containing Waste Fired Clay Materials; Journel of American Ceramic Society; 06 September 2007.

[3] Dr S L Pati, J N Kale, S Suman; FLY ASH CONCRETE: A TECHNICAL ANALYSIS FOR COMPRESSIVE STRENGTH; International Journal of Advanced Engineering Research and Studies; E-ISSN2249–8974.

[4] Khushal Chandra Kesharwani, Amit Kumar Biswas, Anesh Chaurasiya, Ahsan Rabbani; Experimental Study on Use of Fly Ash in Concrete; International Research Journal of Engineering and Technology (IRJET); Volume: 04 Issue: 09; Sep -2017.