Performance Evaluation of GGBFS and Rice Husk Ash based on Concrete Blocks

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Abstract: ***GGBFS mixing in Self-Compacting Concrete (SCC). Preceding research gives us information about the optimal use of GGBFS and RHA in mixture of concrete. Huge amount of CO2 is released into the atmosphere while manufacturing of cement which causes atmospheric phenomenon so Rice husk ash proofs to be a green product which is carbon neutral so its replacement of RHA and GGBFS deduct the emission of gases like greenhouse. Rice Husk Ash is material obtained from agricultural waste matter and it is present in excess in rice producing country like India and every one subtropical countries. By using of RHA there is a good impact on properties of OPC. On burning the rice husk under uncontrolled temperature, highly reactive RHA is obtained and ash was used as additional cementing material. This paper gives mainly the knowledge about compressive, tensile, flexural strength gain efficiency of Rice Husk Ash (RHA) and strength concretes imparts initial strengths and also indicate about later strengths of GGBFS. During this paper we are able to conclude that by doing variation in the proportion of GGBFS for assessment of compressive strength. it absolutely was seen that up to 30% replacement of RHA and 45% replacement with GGBFS in the concrete will yield good increase in the strength.***

Keywords: GGBFS, RHA, Compressive Strength, Durability, SCGC (Self Compacting Geopolymer Concrete), SCC (Self Compacting Concrete).

1. Introduction

Every year about trillions of loads of wastes are produced everywhere the planet which causes an imbalance in ecology. The utilization of the rice husk influences the micro properties and its several qualities of concrete yet as microstructure of paste after its hardening. In many developed countries, lots of action on every level like administrative level, personal level is considered scale backs the cause of pollution because of exit from various waste materials. The products contain huge dimensions of inorganic and organic compounds which can be biodegradable and non biodegradable. (Sangeetha, 2016). So by using these waste products from industries an oversized quantity of field is used for other purposes for the disposal of wastes from industries because before this system all waste products are disposed over land. During the assembly of cement in industry about 1 ton of carbonic acid gas is produced each year. So our point of concern is to scale back the assembly of cement production in near future year. With the growing environmental awareness all the pollution and health hazards related to concrete and the cement industry are under continuous surveillance by government organizations and several other NGOs. RHA contains 75-85% from rice industry that of silica quantity. (Arivalagan, 2014). Heat of hydration is very less when GGBFS is used in concrete (Ekolu & Ngwenya, 2014). The optimum content of GGBFS shouldn't cross 25% to help in early-age cracking and therefore the proportion of GGBFS including is 45%, 35%, 25%, 15%. The mechanical property of concrete also gets enhanced from the utilization of RHA. Quite half & above the proportion of GGBFS there's no improvement within the compressive strength of concrete (Sangeetha, 2016). Our study is proscribed to see the effect of various mineral admixtures like RHA (0%, 10%,20%,30%) & GGBFS (45%, 35%, 25%, 15%) on performance based M40 grade of concrete and compare the test results with control mix for 1,3,7,14 & 28 days of curing. Rice husk is an agricultural product more precisely it's waste obtained from the outer layer of rice grains during milling process. (Srinivasa Reddy et al., 2019). It contains 30% of the 600 million plenty of rice produced within the world initially then rice husk was converted into ash by large temperature of about 500 to 600 degree Celsius. RHA is then added to GGBFS based SCC to extend the strength in early 1, 3, 7, 14 and 28 days because GGBFS helps additionally later age strength to low and moderate grade concretes but rate of gain of strength in youth isn't much considerable so within the present work the strength efficiency of RHA and GGBFS in SCC is computed to understand the role of pozzolanic behavior of RHA and GGBFS combination on the performance of SCC. (Mounika, Reddy, et al., 2019). (Patel & Shah, 2018a). A number of the commonly used mineral fillers in asphalt pavement mixes are Ordinary hydraulic cement (OPC), stone dust, slag dust, hydrated oxide and ash. These filler materials don't seem to be readily available at affordable cost. (Mounika, Srinivasa Reddy, et al., 2019). Consequently, research efforts have gone into waste materials within the industry exploring alternative materials at affordable cost. With the growing environmental awareness the health related hazards due to pollution related to concrete and cement industries are under intense surveillance. The mineral fillers utilized in this study are Ordinary Portland cement (OPC) and Rice Husk Ash (RHA). Ordinary cement is basically a calcium silicate cement, which is produced by firing to partial fusion, at a temperature of roughly 1500 degree centigrade (Sangeetha, 2016). Rice husk ash had usually been dumped as solid waste that caused pollution and contamination of the environment, until it absolutely was known to be a useful mineral admixture for concrete. Rice Husk Ash is obtained from the combustion of rice husk. It consists of non-crystalline oxide (SiO2) with high specific expanse and high pozzolanic reactivity. it absolutely was described as super pozzolana. A pozzolana could be a construction material that originally lacks binding properties. However, when such material is exposed to lime hydrate from the hydration of cement, it acquires cementitious property (Sangeetha, 2016).. (B. N. Sangeetha, 2015). The GGBFS may be a combination of lime, silica, and alumina. RHA is formed of highly reactive silica thanks to its high fineness or high extent and non-crystalline structure. to judge the strength efficiency factors for 1, 3, 7, 14 and 28 days of GGBFS and RHA based SCC mixes (Sandhu & Siddique, 2017). To study the role of GGBFS content in various mix design of concrete blocks and percentage is varying from 0% 15%, 25%, 35%, and so on, strength gain is just up to 50 % but after this percentage value is getting decreased and suitable amount of replacement of GGBFS and rice husk has been applied.

Importance of this research

Substitution of the cement as a cementious material is extremely hot topic now on a daily basis thanks to ecological issues so many government bans also are there for environment protection. Some issue during this developing time that of incorporate the quality and therefore the texture of the structural system. Few substitution of cement has dual goodness, because it uses the economic waste products like the RHA, GGBFS and silica fume which requires land and similarly because it hurdles the over use of conventional type of cement so dumping and environment both issued has been ready to solve by using GGBFS (Arivalagan, 2014). By adding some required cementious substance in concrete, CO_2 release can decreased easily.

2. Material used

a) RHA (Rice Husk Ash)

One interesting fact is that India is one of the major rice producing country in world. Nearly 800 million load of rice husk are generated everywhere the globe. Rice husk ash contains nearly 20% by weight of rice husk when burnt in the boilers. the boiler shouldn't show scaling, it's transferred to furnace from cooking purpose when used as fuel (Sadeeq et al., 2014). RHA may be a carbon neutral green product (Srinivasa Reddy et al., 2019). (Srinivasa Reddy et al., 2020). The structure of RHA is very much dependent on temperature, RHA when burnt below 7500 degree centigrade cause amorphous silica and when burn at temperatures greater than 8000 degree Celsius it gives crystalline silica.

Advantages of using Rice husk ash in concrete

Workability of the concrete declines as the elevated quantity of cement by the RHA replacement until any appropriate mixtures are used. Scientists suggest that the low value of water–cement ratio with admixtures to be used of RHA concrete. Few experiments showed that the RHA contain high amount of quantity of silica, which is further increase the sturdiness of concrete if it's employed in proper ratio along cement expansion of RHA containing concrete is lower as compared to normal OPC when exposed to magnesium sulphate solution (Ekolu & Ngwenya, 2014). The resistance to chemical attack also gets increased by using RHA. (Assistant et al., n.d.).

b) Cement

Ordinary hydraulic cement (OPC) is that the most typically used binder material within the manufacturing of concrete because of its immense good adhesive and cohesive properties that helps in its bonding with other materials as we all know that manufacture of OPC is extremely crucial step to realize the desirable properties and ingredients which goes to combine is argillaceous and calcareous compounds. When these compounds get mixed in definite proportion then bogus compound has been formed. The cement is obtainable in 3 varieties of grades, OPC 33,43,53. (Er. Kimmi Garg, 2016) OPC are that typically used cement within the world. This kind of cement is preferred where speedy construction is required with addition of suitable compounds for instances some super plastisiers, water reducers agents has been added, in fact the making of OPC has reduced to a good extent as blended cement like PPC has advantages, like lower pollution, less energy consumption and more economical (Siddika et al., 2018). Hence OPC having more superior over PPC. Here we use OPC 43 as shown in figure 1 and figure 2. Properties are shown in table 1 and table 2.

Table 1: Few physical properties of OPC

Possessions	Experimental result	Necessity of IS 1489-1991
S.Gravity	3.10	3.0-3.20
Fineness of cement	365	300
Standard consistency	31%	24-36%
IST	22	30
FST	330	600

Figure 1: Cement sample used in Laboratory

Figure 2: Ordinary Portland Cement (OPC43)

Table 2: Classification of Chemical Proportion of OPC and RHA

Chemical Compounds	Proportion in OPC (%)	Proportion in RHA (%)
Fe_2O_3	0.14	1.65
CaO	67.05	33.42
MgO	O.06	10.12
SiO_2	26.20	35.15
Al_2O_3	6.02	15.61
Na_2O	-	0.50
MnO	-	0.23
Cl	-	0.03

c) Ground Granulated Blast Furnace Slag (GGBFS)

When the molten iron slag is fed in predicament, a glass like product are obtained, GGBFS has been utilized in housing industry from such a lot of years back as replacement of ordinary cement then it's dry and convert into powder. it's called GGBFS (Gupta et al., 2022). Finally when it's added to the cement it helps in increases lifetime from 60 to 90 years, so it gives greater durability of product obtained. Setting time is additionally prolonged. Hence it is a risk factor when work the positioning should be done in fast manner. GGBFS is getting by heating molten iron slag from a furnace in water or steam, to provide a glass like substance. Granulated furnace slag has been used as stuff for cement production and as an aggregate and building material and granulated slag has also been used as sand blasting shot materials. Slump value are shown in table 3

Table 3: Value of slump having on varying GGBFS

Types of Concrete	Value of slump
15% GGBFS	45mm
25% GGBFS	65mm
35%GGBFS	75mm
45%GGBFS	60mm

Reference- (Arivalagan, 2014)

d) Colour

Looks dull white in colour. Especially when replacements are done at greater than 50%. Asthethic appearance using GGBFS in bridge retaining structures are more pleasing. For producing coloured concrete, the pigment demand are often less with GGBFS and therefore it is brighter in colour (Gupta et al., 2022).

e) Coarse aggregates

It is generally obtained by performing blast in the quarries or by breaking them by hand or by crushers. When stone are being crushed using machine it's obtained of assorted size but when it's crushed with hand it's obtained in same sizes, so to produce graded aggregates to be used in high-class concrete, they must mixed in specific fixed proportion (B. N. Sangeetha, 2015). Values of coarse aggregate are shown in table1along with figure of sand used in figure3. Properties shown in table 4.

Figure 3: Aggregate used in preparation of blocks

Table 4: Consequences prevail of coarse aggregate

S. Number	Course Aggregate Test	Value	Acceptable limit as per IS:2386
1.	S.G test	2.76	2.75 to 2.85
2.	Sieve analysis test	-	satisfactory
3.	Water absorption	1.25%	not more than 1.5%
4.	Impact value	23%	not more than 30%
5.	Crushing value	26%	not more than 30%

f) Sand

Sand is residual material of granular type which consists of the finely crushed rock and the mineral particles. The composition of the sand is of varying range but it's defined on the premise of its size, sie of sand is between clay and gravel. Normally ennore sand is employed in construction, that's a soil containing over 85 percent sand-sized particles by mass (Siddika et al., 2018). The composition of the sand varies, reckoning on the parent rock because it is residual and windblown sand and climate conditions, but the foremost common constituent of sand is silica (silicon dioxide) usually within the kind of quartz and lots of other minor materials are available in sand.

g) Water

Water could be a important ingredient in making of concrete because it participates very actively within the reaction with the cement. Since it would help in offer the all types of strength by making gel of bogus compounds therefore the both the amount and quality of the water is required to be taken carefully. The water mustn't contain any undesirable substances in excessive proportion. IS code norms also say that the water pH mustn't be but 6 is suitable and also the water is free from organic touch on stop several reaction in concrete. Impurities would affect the setting time of the cement. The washing soda may cause quick setting time; the bi- carbonates may either accelerate or retard the setting. The upper concentration of those salts quite permissible will reduce the concrete strength very considerably. Drinking water is avoided in mixing concrete.

3. Methodology

To know more about the properties of concrete with RHA and GGBFS various tests were conducted on specimens with 0%, 10%, 20% and 30% RHA replacement with cement. Rate analysis was also performed to test whether it's economical to interchange it with cement. The target strength of SCGC was fixed at worth of 30 MPa. the entire of six mixes were prepared as shown in figure 4, two control mixes (RHA and the GGBFS) as a only binder without RHA and remaining four mixes were prepared with varying proportions of RHA (Patel & Shah, 2018b). GGBFS were replaced with RHA at the odds of 10%, 20% and 30% by mass. The entire binder was fixed at the density of 630 kg/m^3. For all the 6 mixes, 0.25 ratios is taken for water binder. The additional water of the 20% and super plasticizer about 5.5% dosage by mass of binder were wont to satisfy the characteristics of concrete. Physical properties are shown below in table1 and there are some chemical properties of this sample like proportion of SiO_2, K_2O etc. physical properties are shown in table 5.

Figure 4: Sample Cube Preparation

Figure 5: Sample Cube Preparation

Table 5: Physical properties of various sample

Sample (%)	Specific gravity (g/cm3)	Mean particle size (mm)	Specific surface area (m2/g)
Fly ash	2.27	16	4.2
GGBFS	2.65	13	5.0
RH Aash	2.05	12.4	22.4

(Reference -https://doi.org/10.1016/j.conbuildmat.2018.03.166)

Compressive Strength Test Procedure

Test were performed according to IS: 516 on cube specimens of size 150 mm employing a 2500-kN on CTM, ends of sample were packed before and after the test is over. Cap mustn't fail before failure of concrete. Bearing surfaces should be clean. The axis of cube specimen were aligned properly. Put load gently at a rate of 140 kg/ cm^2 /min until the specimen gets fail. higher value of load is calculated for strength calculation (Patel & Shah, 2018b). A primary investigation on the optimization of cement in concretes with varying w/c ratios and RHA contents were performed in laboratory. The RHA obtained from fire condition of natural occurring phase and used after 10 minutes of grinding. The mechanical property is compared as reference to OPC. Testing is shown in figure 6.

Figure 6: Compressive Test of Blocks through Digital Testing of Compressive Machine

4. Result and Discussion

Specimen were casted of dimension 150 mm each side as shown in figure 2. Three samples of cubes with dimensions of 150 were made for each mixture. After the casting is over, the specimens were keep for 24 hours at room temperature, and put in water. The specimens were put in water for 1, 3, 7, 14 and 28 days, then tested for compressive strength test. Within 24 hours, the mould is removed and the sample is put in the water for curing. The top surface of the samples must be flat and smooth. (Er. Kimmi Garg, 2016). This work is done by location of the concrete paste, then share it evenly over the whole surface of the sample. These samples are checked by CTM after 1 days, 3 days,7 days, 14 days, and curing or 28 days curing. Load is applied gradually at a rate of 140 kg/cm2 for 1.5 minute, until the samples got fractured. When load is split by the specimen expanse then the strength of the concrete is calculated. Test result of compressive strength is shown in table 6.

Table 6: Compressive Strength Test Result

Days	GGBFS=45 RHA=0 (in percent)	GGBFS=35 RHA=10 (in percent)	GGBFS=25 RHA=20 (in percent)	GGBFS=15 RHA=30 (in percent)
1	8.6	8.67	8.45	8.16
3	21.48	21.68	21.12	20.40
7	34.90	35.23	34.32	33.15
14	48.33	48.78	47.52	45.9
28	53.7	54.2	52.8	51

5. Conclusion

1) Replacement level of RHA within and up to 30% is usually preferred.
2) More elimination of RHA won't result in longer increase in strength.
3) Crystalline silica having less strength as compare to amorphous silica.
4) GGBFS replacement up to 45 %, because higher elimination will decrease the strength. RHA and GGBFS, these both give good properties of hinderance to elevated temperatures.
5) Uses of GGBFS reduce the release of density and it offers good hinderance to the sulphate attack therefore the concrete are often utilized for elevated temperature use because it shows good resistance to sulphate, it are often utilized in marine water structures.

6. Recommendations for Future Research

we need to compare strength of two or more different kinds of cements containing pozzolonas, which effect the workability of concrete by addition og GGBFS and RHA, then vary the concentration of sulphate solution for study of tensile strength and flexural strength of concrete (Mounika, Reddy, et al., 2019).

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