International Journal of Research Publication and Reviews

Journal homepage: www.ijrpr.com ISSN 2582-7421

Sustainable Geopolymer Concrete using Ground Granulated Blast Furnace Slag and Rice Husk Ash: A Review

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ABSTRACT:

Self-compacting concrete (SCC) has low yielding stress, excellent deformability, and a medium viscosity, placement time without using external compaction. SCC is the highest-performing concrete, with excellent strength and durability. However, the proportioning of the mix and the methods for assessing flow qualities are quite different from those used in regular concrete. SCC can flowing under its own wt. and entirely filled without causing vibrations, while also being cohesive enough to handle. It ensures that restricted regions and strongly reinforced structural components are properly filled and operate well structurally.SCC usually requires a large content of binder and chemical admixtures.In beginning 21st century, the construction industries have gain momentum. The big international and national project has increased significantly around the globe. The self compacting Concrete having high strength, workability, durability and less number of labors. For engineers, finding alternative materials with equivalent qualities to cement is critical. One of these materials is RHA, which is utilised as an additive. Mineral admixtures are utilised in the manufacture of SCC to give cost savings and decrease hydration heat. The extent of RHP (15 percent, 20%) or it have bond content are the most important parameters in this study. Fine aggregate is measured using constant parameters, coarse aggregate, water, SP content, w/b proportion. I will the extent of GGBS (5%, 10%, 15%, 20%). The motive behind this see if using rice husk cinder as a supplemental cementitious material alongside GGBS as an expansion material in SCC is feasible by looking at its fresh and hardened properties.

The addition of both greatly altered the fresh characteristics of SCC, according to the test results. The findings were all well inside the code's specified range. RHA and GGBS used as cement substitutes has no significant impact on strength qualities, as strength maintains up to 30% binder replacement, but begins to decline at 40% binder replacement.

Keywords: Concrete, rice husk ash, compressive strengthening, split tensile strengthening, flexural.

INTODUCTION:

SCC, sometimes known as "Self-Consolidating Concrete," has long been regarded as one of the most fundamental advancements in the construction business. SCC is an unique concrete that can sink into the heavily reinforced, significant, and contract zones by its own weight, and can link itself without requiring inward of course outside vibration, while maintaining its solidity without causing segregation and depletion. To communicate an uniform and enduring blend, SCC requests a considerable amount of powder substance that differs from standard vibrated bond. To achieve self-similarity in SCC, the basic method is to limit the coarse total substance and the most extreme size, as well as to employ lower water–powder extents in conjunction with new period super plasticizers. During the transportation and storage of SCC, the extended flowability may cause separation and depletion, which can be avoided by achieving the fundamental consistency, which is typically achieved by increasing the fine total substance; requiring the largest total size; increasing the powder content; or utilising consistency-altering admixtures. Due to the usage of producing admixtures and significant volumes of Portland bond, one of the disadvantages of SCC is its high cost. Mineral included components, such as limestone powder, conventional pozzolans, fly fiery remnants, and slag, are finely fixings before or during blending, and are another option for lowering the cost of SCC.

History of SCC

In 1983,construction industries was more interested around the world, the money, big number of labors and time was spend for important structure, tall building as well as all big project for nation like Nuclear power plant, Tunnel, Dam, Bridge etc. Japan was one of those countries having the capacity to construct the essential structure and the question of the quality of solid for building was a remarkable focus of passion for Japan. Compaction by skilled employees is essential to build strong, solid structures. Two gradual reductions in the no. of persons with knowledge in the country development industry have resulted in a corresponding decrease in the attitude of expansion work. The Answer for all this problems was to create the concrete which can be used on site with less numbers of labors and saving time, cost and as well as concrete with good quality in terms of durability and compressive strength. After Japan start using this concrete, a lot of country across the world has starts using SCC and in this day it is most useful in every important structure because its properties, easily to constructed.

Motive of SCC

The intention being developed of Self-Compacting Concrete was the social issue on durability of solid structure that emerged around 1983 in JapanBecause the number of skilled labourers in Japan's development business has been steadily decreasing, the nature of development work has deteriorated. As a delayed consequence of this reality, one response for the achievement of solid structures free of the way of advancement work was the use of concrete, Its well compacted from edge of a reinforced bars , essentially by technique for its own weight. Self-Compacting Concrete is made up of a variety of fragments from commonly vibrated conventional solids, including bond, totals, water, included components, and admixtures.

Global Development of SCC

SCC has started used in construction industries, people across the world have increasing doing research on this type of concrete, scientist, Engineers have performed several tests on SCC, from USA to EUROPE, country like FRANCE,ENGLAND, GERMAN, SWEDEN many paper have been published on SCC, up 2002 it was clear that this type concrete it more important in construction because it have more advantage compare to other type of concrete in terms of durability and workability. In India, efforts have been undertaken in the labs and on the ground to create and apply SCC. In Delhi, some pioneering efforts have been made. Metro strengthens its ties with L&T and MBT. Significant size research facility experiments have been conducted by Nuclear Power Corporation, Gammon India, and Hindustan 3 Construction Company. SERC (Structural Design Exploration Center) Chennai laboratory investigations received SCC in India. The Delhi Metro extension has used SCC on a large scale for vault building, burrow lining, and segment tossing in a number of locations. (Sood and colleagues, 2009) In India, the development of cement with self-compacting capabilities is still in its early stages. Few attempts have been undertaken in the previous few years to evaluate SCC in research facilities and in the field using European Guidelines.

LITERATURE REVIEW:

Adewuyi and ola (2005) - conducted research on binary O.P.C blends with various pozzolanic materials in cement production composites. Supplementary cementious materials have been shown to meet the majority of the requirements for concrete durability.

Ahmadi et al. (2007) studied the compressive strengthof SSC mix containing RHA in comparison to normal mix.Six arrangement of self compacting concrete with normal cement Table 3.13 Mix Design of various SCC mixes.

Aruna D (2015): For tile waste-based concrete, C.A.were substituted with 20mm downsize, tile wastes with 0%, 5%, 10%, 15%, 20%, and 25%, and cement was partially replaced with fly-ash. At a 25% replacement rate, average max. strengthening of roof T.A. is achieved. At 25% roof tile aggregate replacement, a 10-15% drop in strength is found when compared to standard concrete. Roof tile waste concrete has a medium workability. For modest structures, the replacement of tiles with concrete is satisfactory.

B. TOPÇU AND M. CANBAZ (2010): The amount of tile waste generated is sufficient to substitute C.A. in concrete. C.T.W. benefits the environment. Concrete self wt. is lowered by around 4% when tile aggregate is used, making the building more cost effective. When it comes to concrete strength, T.A. substitution has detrimental impact on both compressive and split tensile strength. But this paper studied maximum replacements of tile waste which can be further divided into smaller percentages and can be utilized in concrete with desirable properties.

Batriti Monhun R. Marwein (2016): Broken tiles were used as the ceramic waste. 0 percent, 15 percent, 20 percent, 25 percent, and 30 percent CWC manufactured with these tiles. All concrete mixes are made with M20 grade concrete and a constant water cement ratio of 0.48. At 3, 7, and 28 days, concrete qualities such as workability for fresh concrete, and Strengthening, are measured. The report proposes that waste tile aggregate should be replaced at a rate of 5-30%, and that it is suitable for typical mixes such as M15 and M20.

Ghassan Abood Habeeb, Hilmi Bin Mahmud (2009), Habeeb and Fayyadh (2009)-have investigated the influence of RHA average particle size on properties of concrete They discovered that the strength was equivalent at young ages, but that at the age of 28 days, the sample with finer RHA had better strength than the sample with coarser RHA.

Ghassan Abood Habeeb, Hilmi Bin Mahmud (2010) RHA produced in a Ferrocement furnace were examined. The impact of grinding on particle size and surface area was studied first, followed by an XRD study to confirm the existence of amorphous silica in the ash. When compared with OPC mixtures, increasing RHA fineness increased the strengthening of concrete.

Gritsada Sua-iam, Natt Makul (2013) The characteristics of SCC mixtures including ternary combinations of Type 1 Portland cement (OPC), untreated rice husk ash (RHA), and pulverised fuel ash were examined (FA). The SCC mixes were made using a controlled slump flow with a diameter of 67.5 to 72.5 cm. Physical qualities of self-compacting concrete mixes formed with ternary blends were significantly better than those of SCC combinations comprising simply RHA or FA.

Julia García-González, Desirée Rodríguez-Robles, Andrés Juan-Valdés, Julia Ma Morán-del Pozo and M. Ignacio Guerra-Romero (2014): The study focuses on ceramic waste from Spanish industry. The recycled C.A. met all of the technical standards imposed by current Spanish regulations, and the concrete was designed according to the Spanish concrete code. Ceramic aggregates substitute as C.A. up to 100 percent. The mechanical properties of the concrete were compared to regular concrete using appropriate tests. The ceramic ware aggregate concrete was exhibited a feasible concrete properties as like the normal gravel concrete.

Kartini, K., Nurul Nazierah According to the study, a 10% half substitution of cement with RHA be most effective in achieving the desired strength; however, for durability index performance, a higher substitution up to 50% obtained, resulting in lower charge passed and lower water absorption, improving the concrete's durability. This demonstrates that the large amount of silica in RHA has an impact on the HSC's strength and durability.

Lee et al (2005)-in their study concluded that some of the waste product like rice husk which having Fly ash, silica fume, volcanic ash, and maize cob ashence have pozzolanic qualities and are used in blended cement to provide good strength properties to concrete.

Maurice E. Ephraim RHA Sp. gravity was 1.55, while RHA density was found to be 2.043, 1.912, and 1.932 kg/m3 at 10%, 20%, and 25% replacement percentages, respectively. With a slump value 100mm, RHA will be workable. The addition of RHA to concrete increased water demand while also improving strength. At same substitution % as above, the compressive strengthening at 28th days were determined to be 38.4, 36.5, and 33N/mm2.

Md Daniyal and Shakeel Ahmad(2015): C.W.C.T. were employed as substitution as C.A. in concrete at 10%, 20%, 30%, 40%, and 50% substitution rates. According to the study, using C.T.A. improves its qualities, with an improvement in both compression and flexural strength.

Mehta and Pirth(2000) - R.H.A used to lower temperature in higher strengthening mass concrete was researched, and it was discovered that R.H.A is particularly effective in reducing temperature in mass concrete when compared to OPC concrete. R.H.A is made by burning rice husk at very higher temperature.

N.Naveen Prasad (2016): As a substitute for coarse and fine aggregates, crushed discarded tiles and Granite powder were employed. Without changing the mix design, 10%, 20%, 30%, and 40% of waste broken tiles were substituted for coarse aggregates, while 10%, 20%, 30%, and 40% of granite powder were substituted for fine aggregates. The M25 concrete grade was created to prepare the traditional mix. Varied mixed were created by substitution as C.A. and F.A. with crushed tiles and granite powder at different percentages without modifying the mix design. Experimental investigation is carried out. The workability of concrete improved as the proportion of granite powder rose, and the compressive strengthening about highest at 30% coarse aggregate substitution.

Parminder Singh and Dr. Rakesh Kumar Singla (2015): Research done on industrial waste ceramic tiles. A partial substitute for C.A. investigated. Concrete in three different grades prepared. Although the results don't match the conventional, and strengthening property, it is recommended that ceramic tile aggregate be used in concrete. Finally, it was determined that using about 20% ceramic tile in M20 grade concrete is preferable.

Pratik et al. (2013) studied the fresh concrete properties. Four distinct mixes were created, each including a percentage of GGBBS and a mix of (SP+VMA) admixtures. The results of the L box test and the Slump flow test.

Premalal (2002) - compared mechanical properties of R.H.P. and concluded that the burning process affects the chemical composition of R.H.A. It produced by burning ash b/w 6000- 7000c for 2 hours containing 90-95% sio2 1-3%k20and 5% burn carbon and R.H.A with cements improves workability and stability reduces heat evolution, thermal cracking and plastic shrinkage.

Rafat Siddique, Geert de Schutter and Albert Noumowec (2008) The findings of an experimental examination into properties of concrete mixtures in which fine aggregate (normal sand) was partially substituted with waste foundry sand were presented. By weight, fine aggregate was substituted with 3 various % of WFS: 10%, 20%, and 30%. The qualities of fresh concrete were investigated. Strengthening and E were measured at 28th , 56th , 91th , and 365th days. WFS boosted the strengthening properties of plain concrete by a small amount when used as half substitution for sand, indicating that it can be used to manufacture concrete and construction materials.

S. I. Khassaf The acquired results revealed a considerable decrease in workability in new concrete as the quantity of RHA in the concrete grew, an increment in compressive and splitting tensile strengthening as the RHA percentage was increased to 20%. The highest rise was around 10.5 percent and 11 percent, respectively. When RHA was increased to 30 percent, the drop in strengthening was around 17 percent and 10.5 percent, respectively. The drying shrinkage test revealed that it dropped as the RHA percent increased, with the highest decreased by 30% RHA being roughly 28% of typical shrinkage after 90 days.

S.P. Gautam On average, replacing fine aggregate with 20% glass waste results in a 13.64 percent improvement in strengthening at 7th days, but only 2.18 percent at 28 days. At 7 days, strengthening increased by around 11.32 percent, however at 28 days, compressive strength decreases somewhat at 30 and 40 percent replacement levels.

Safiuddin et al. (2012) Self-consolidating concrete (SCC) using rice husk ash was investigated for its fresh concrete qualities (RHA). w/b ratios of 0.30-0.40 were used to make air entrained SCC mixes. RHA was utilised to replace 0-30% of the cement by weight.

Sathawane Strengthening increased by 30.15 percent when compared to targeted strength and decreases by 8.73 percent when compared to 28th days, flexural strengthening increased by 4.57 percent when compared to 28th days, and split tensile strengthening decreases by 9.58 percent when compared to 28th days, according to the study. Partially replacing FA and RHA decreases environmental consequences and generates cost-effective and environmentally friendly concrete.

Sua-iam et al. (2013) A number of mixes were prepared, each with a different fine total substitution sum. By volume, RHA was used to replace stream sand at values of 0.0 percent, 10.0 percent, 20.0 percent, 40.0 percent, 60.0 percent, 80.0 percent, and 100.0 percent. The SCC blends were identified using the RHAx structures, where x represents the vol. rates of stream sand replaced by RHA.

T. Phani Madhavi Fly ash as a cement replacement material and glass aggregate as a fine aggregate ingredient in concrete were proposed. F.A. replaced (10 percent, 20%, 30%) with sheet glass aggregate, while cement was half substitution (10 percent, 20%, 30%) with fly ash. With the substitution of 10% cement by fly ash and 20% fine aggregate by glass aggregate, the highest strengthening achieved by 28^{th} days was 43.73 N/mm2, which was the most cost-effective and optimal mix.

Yogesh Aggarwal, Paratibha Aggarwal, Rafat Siddique, El-Hadj Kadri and Rachid Bennacer (2010) discussed the design of concrete mixes with up to 40% waste foundry sand as half substitution F.A.. Different mechanical qualities are assessed (compressive strength, and split tensile strength). The concrete's durability in terms of chloride penetration and carbonation is also assessed. Test results show that industrial by-products can make concrete that is strong and long-lasting enough to replace regular concrete. At 28, 90, and 365 days, compressive and split-tensile strength were measured. The strengthening was compared to 0, which was a mix without foundry sand. As a result, the use of foundry sand as half substitution of fine particles in concrete appears to be effective.

EXPERIMENTAL INVESTIGAITON

The motive of this investigate and compare the qualities of SCC formed when cement is replaced with a mixture of RHA and GGBS. In this work, research base on experiments conduct in labor, the paper which has already published and reading material from books.

Material Used

Cement It having binding property that hardens and sets in construction and can bond other materials. The most common varieties of cement are used in masonry mortar and concrete structure, Mixture of cement and aggregate that forms a strong building material.

Test on Cement:

Fineness Test

Wt. of cement=300g

Wt. of passing cement=292g

Wt. retained =4.5g<10% of 300

Hence accepted

Consistency test

Wt. of cement=300g

Table 3.1 Reading for consistency

% of water	Wt. of water	Initial reading	Final reading
25	75 g	38mm	35mm
28.5	85 g	38mm	17mm
29	87 g	38mm	10mm
29.5	89 g	38mm	8mm

Cement consistency =30%

Initial and Final setting time

Wt. of Cement=300g

Wt. of water=0.85×0.3×300=76.5g

Initial setting Time=38min

Final setting Time=2h 47min=167min

Soundness of Cement

Initial distance=1 cm

Weight of cement=100g

Weight of added=0.78×0.3×100=23.4g

After 24hrs d1=1.6 and d2=1.4

After 3hrs boiling D1=1.8 and D2=1.7

Soundness= ((D1-d1) + (D2-D2))/2=0.25cm=2.5 mm<10mm

.Hence accepted

Specific Gravity Test

Weight of cement=50g

W1= Wt of empty flask =108

W2=Wt of flask + cement =159

W3= Wt of flask +cement +diesel=395g

W4=Wt of flask + diesel =358g

S.G = (W2-W1)/((W2-W1)-(W3-W4))×0.92=3.1

3.2.2 Test on coarse aggregate

Sieve analysis of course aggregate

Weight of sample tested=3.454Kg

Table 3.2 Observation for coarse aggregate test

IS sieve size in mm	WT. of CA retained	% wt. retained	Cumulative percentage of total wt. retained	% passing	Desirable value according to Is 383
20	61	1.73	1.73	98.27	85-100
16	1438	42.63	43.36	55.64	0
12.5	1405	40.64	85	15	0
10	467	12.54	97.54	2.46	0-20
4.75	84	2.46	100	0	0-5
Pan	0	0	0	0	0

Water absorption of CA

The WA of CA used is 0.48%

Sp. gravity of C.A.

The sp. gravity of C.A. used is 2.56

Testing of fine aggregate

Water absorption of F.A.

The water absorption of F.A. being used is 1.2%

Sp. gravity of F.A.

The sp. gravity of F.A. being used is 2.74

Sieve analysis of fine aggregate

Table 3.3 Observation for F.A. Sieving

Sieve size	Weight of fine aggregate retained (gm)	Percentage retained	Cumulative percentage retained	Percentage passing	Permissible percentage according to Is 383
10	0.0	0.0	0.0	100	100
4.75	0.0	0.0	0.0	100	90-100
2.36	0.0	0.0	0.0	100	75-100
1.18	764	76.4	76.4	23.6	55-90
600	160	16	92.4	7.6	35-59
300	24	2.4	94.8	5.2	8-30
150	50	5	99.8	0.2	0-10
Pan	2	0.2	100	0	

The fine aggregate being used is of Zone 2.

Water

For mixing and curing purpose water used.

Alternate materials

Rice Husk Ash

RHA is produced by incinerating the husk of rice paddy.RHA used, was from

Rudhiana cement plant.

Table 3.4: Physical properties of RHA

Property	Result
Specific gravity	2.74
Consistency	28%
Colour	Black

Ground Granulated Blast Furnace Slag (GGBS)

GGBS is a non-metallic powder made up of calcium silicates and aluminates, among other things. The molten slag is quickly chilled in water, resulting in a glassy sand-like substance. The GGBS comes from ASTRAA CHEMICALS, and its physical parameters are as follows

Table 3.5: Physical properties of GGBS

Property	Result	
Specific gravity	3.02	
Consistency	32.5%	
Colour	Dull white	

Superplasticizer

Is a chemical substance that is used to increase workability without adding more water. The SP utilised in this work is Fosroc Chemicals (India) Pvt.ltd's Auramix 400.

3.3 Mix Design/proportioning

It can be classified as Self-compacting if it has the following characteristics

 Filling ability

 Passing ability

 Segregation resistance

To achieve that, one the most aspect which should be done careful is mix design. EFNARC provide the guidelines for development of SCC.

However, assuming a broad supply from ready-mixed concrete facilities, they have presented a simple mix-proportioning technique. The C.A. and F.A. contents are predetermined, allowing for simple self-compactability by adjusting the wate and plasticizer dosage.

In this work try and error mix was used to find desirable value for fresh properties and hardened properties. The purpose was to design SCC-mix of high strength M45 grade. The design begins with 450 kg/m3 cement, a water cement ratio of 0.4, and a binder content of 1% SP. Table shows the good outcome values that have been used. For fresh properties are in acceptable limited from EFNARC and are discussed in next point.

Table 3.6 : Mix Design

Mix	Cement	C.A.	F.A.	W/B	SP	RHA	GGBS
SCC 0%	530	750	916	0.41	1%	0	0
SCC(20%RHA+5%GGBS)	397.5	750	916	0.41	1%	106	26.5
SCC(20%RHA+10%GGBS)	371	750	916	0.41	1%	106	53
SCC(20%RHA+20%GGBS)	318	750	916	0.41	1%	106	106
SCC(15%RHA+15%GGBS)	371	750	916	0.41	1%	79.5	79.5

The specimens were casted from every mix proportion Table 4, for testing (Hardened) Compressive strength, Flexure and Split tensile strengthening respectively, result are shown and discussed in next point.

Research Methodology

The main characteristics of SCC are the properties in the fresh state. The ability to flowing under its own wt. without vibrating, to flowing through badly blocked reinforcement under its own wt. and to maintain homogeneity without segregation are all factors considered in the mix design. IS 456:2000 specifies a degree of workability, whereas SCC is more workable.

- Passing ability
- Filling ability
- Segregation resistance
- Four tests done for this project to ensure that the design mix could be utilised to generate specimens for testing toughened characteristics.
- Testing freshen concrete
- Slump test
- V-Funnel test
- L-Box test
- U-Box test

Following the completion of fresh property tests, similar specimen used for casting, with cubes, beams, and cylinders serving as specimens for hardened property testing.

SUMMARY:

This study used experimental research to look at the compressive strength, split tensile strength, and flexural strength of concrete with various levels of cement substitution using a RHA and GGBS combination. RHA and GGBS were used to partially replace cement at four different levels of replacement. After 7 days, 28 days, and 56 days of concrete curing, tests were conducted. The results were compared when no cement was replaced, demonstrating that the admixture used in this study may be trusted and used in construction

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