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Partial replacement of cement with rice husk ash and ground granulated blast furnace slag in SSC

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ABSTRACT

Self-compacting concrete (SCC) is concrete which has a very low yield stress, great deformability, and average viscosity (which is able to ensure uniform suspension of solid particles in transportation, placement time without using external compaction). SCC is the most High Performance Concrete with very good strength and durability properties. But, the mix proportioning and testing methods for flow properties are very different from those of the normal concrete. SCC is a type of concrete which has ability to flow under its own weight and completely fill the form work, without vibration effect, and at the same time cohesive enough to be handled without bleeding. It ensures proper filling and good structural performances of restricted areas and heavily reinforced structural members. SCC usually requires a large content of binder and chemical admixtures

The test results revealed that the fresh properties of SCC were significantly influenced by the incorporation of RHA and GGBS. All the results were well within the range Specified by the code. Using of RHA and GGBS as replacement of cement does not affect the strength properties negatively as the strength remains within limits up to 30% of binder material but start decrease when replacement goes up 40% of binder . Overall the hardened properties has seen as enhanced when cement replaced by combination of 15%RHA and 15%GGBS

INTRODUCTION

The improvement of SCC moreover implied as "Self-Consolidating Concrete" has starting late been a standout amongst the most basic progressions in building industry. Self-compacting concrete (SCC) is a novel concrete that can subside into the seriously fortified, significant and contract zones by its own particular weight, and can join itself without requiring inward of course outside vibration, and meanwhile keeping up its solidness without inciting to segregation and depleting. SCC asks for a significant measure of powder substance diverged from routine vibrated bond to convey a homogeneous and durable blend.

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The basic practice to get self-similarity in SCC is to restrict the coarse total substance and the most extreme size and to use bring down water–powder extents together with new period super plasticizers. In the midst of the transportation and situation of SCC the extended flowability may achieve separation and depleting which can be overcome by giving the fundamental consistency, which is for the most part gave by growing the fine total substance; by obliging the greatest total size; by growing the powder content; or by utilizing consistency changing admixtures

One of the obstructions of SCC is its cost, related with the usage of creation admixtures and use of high volumes of Portland bond. One other choice to diminish the cost of SCC is the usage of mineral included substances, for instance, limestone powder, ordinary pozzolans, fly fiery remains and slag, which are finely confined materials added to concrete as discrete fixings either before or amid blending .

Application of Rice Husk Ash

RHA is a carbon neutral green product. Lots of ways are being thought of for disposing them by making commercial use of this RHA. RHA is a good super-pozzolan . This super-pozzolan can be used in a big way to make special concrete mixes. There is a growing demand for fine amorphous silica in the production of special cement and concrete mixes.

Use of Ground Granulated Blast Furnace Slag (GGBS) as filler Material

Impact heater slag is a by-item which got in the fabricate of pig-iron. It is an item delivered by the mix of the gritty constituents of iron-mineral with the limestone flux at high temperature in the impact heater (around 150000c). The liquid slag is quickly extinguished by a hose of water to yield a lustrous granular item called granulated impact heater slag. Hydrated slag's, granulated or palletized, give an indistinguishable hydrates from Portland bond i.e., C-S-H and AF1 stages. As they respond more gradually with water than Portland concrete, they can be enacted by various courses: synthetically in nearness of lime and sulfate activators, physically by pounding or thermally. Slag, which is acquired by pounding the granulated impact heater slag, is exceedingly pozzolanic in nature. Concrete substitution levels of slag can be much higher than that of other pozzolanic materials, for example, Fly fiery debris and silica smolder. By and large, GGBS has higher "CaO" content than different pozzolanas.

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REVIEW OF LITERATURE

Slump Flow Test- Slump flow for all mixes except 10R3.5 (10% RHA and 3.5% super plasticizer) was within the EFNARC range of SCC. Flow increased with increase in quantity of super plasticizer. Proportionally, there was decrease in the flow with increase in the quantity of RHA. The experimental readings achieved in slump flow test were from 595 to 795 mm.

L Box Test – While testing the concrete for passing ability, majority of the mixes passed through the bars very easily and without blockage. Ratio of L BOX increased with the increase in the quantity of super plasticizer. Proportionally, the ratio decreased with the increased quantity of RHA. Experimental readings achieved in L box test were from 0 to 1.

V-Funnel Test- Most of the results of V funnel test remained more towards minimum range or even lesser. This shows more filling ability but less viscous mix. With the increase in quantity of RHA, viscosity of mix started increasing.

Safiuddin *et al.* (2012) studied the fresh concrete properties of self –consolidating concrete (SCC) incorporating rice husk ash (RHA). Air entrained SCC mixtures were produced based on w/b ratios of 0.30-0.40. RHA was used substituting 0-30% of cement by weight.

Filling ability of concrete **-** The filling ability results of all SCC mixes were obtained with respect to slump, slump flow, inverted slump cone flow and orimet flow.

Slump Flow

The droop stream of SCC blends shifted from 665 mm to 770 mm (Table 2.6). The scope of droop stream demonstrates a brilliant filling capacity of SCC. The droop stream was fundamentally expanded by 60 mm within the sight of 30.0% RHA.

Orimet Test

The orimet stream time of SCC blend differed from 4.8 sec to 11.5 sec (Table 3.9). The greatest worthy farthest point for orimet stream time is 9 sec (EFNARC, 2002). The blends having more esteem are more thick than other cement.

Sua-iam *et al.* (2013) Arranged a few blends were readied containing different fine total substitution sums. RHA were utilized to supplant the stream sand at levels of 0.0%, 10.0%, 20.0%, 40.0%, 60.0%, 80.0% or 100.0% by volume. The SCC blends were distinguished utilizing the structures RHAx as a part of which x is the volume rates of stream sand supplanted by RHA.

SlumpFlow test - All of the blends showed agreeable normal droop streams of 70 ± 2.5 cm

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measurement which means that great workability. The droop stream time expanded with expanding RHA content. The droop stream time expanded shifted in the scope of 6-15 sec, 8-20 sec and 6-16 sec for SCC blends containing RHA.

V-Funnel test- Acceptable flow times were obtained for mixtures RHA10 and RHA20. The RHA particles absorbed water, resulting in a highly viscous mix and reducing bleeding.

J-Ring test- There was either no blocking or minimal apparent blocking in samples containing RHA. A small degree of blocking was evident in the control and in mixtures containing 10%, 20%, or 40% RHA. Extreme blocking was observed in samples containing more than 60% RHA.

Pratik et al. (2013) studied the fresh concrete properties. Four different mixes were prepared, with every mixes there is % of GGBBS, and admixtures combination of (SP+VMA). The results for Slump flow test and L box test are showing in following table.

SlumpFlow-The slump stream of SCC blends shifted from 690 mm to 720 mm (Table 2.10). The scope of droop stream shows not astounding filling capacity of SCC. The droop stream was fundamentally expanded by 20 mm within the sight of 20% GGBBS..

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 Two diverse substitution rates of bond by RHA, 10%, and 20% with blend have no RHA and two distinctive water/cementicious material proportions (0.40 and 0.35), were utilized for both of self compacting and normal solid examples. The blend extents as indicated by w/b proportion received and are accounted for in Table 3.13 and 3.14.

Table 3.13 Mix Design of various SCC mixes (Ahmadi *et al.,* 2007)

Table 3.17 The Hardened Properties of the Control Mix (NM), Binary Mix (BM), Ternary Mixes (TM) and Quaternary Mixes (QM) (Nor atan *et al.*, 2011)

Mix	Label	Age (Days)	Compressive Strength
NM	CM	7 14 28 60 90	36.5 37.6 37.8 45.4 44.7
BM	C/RRHA	7 14 28 60 90	22.7 29.6 39.8 41.9 42.5
TM1	C1/LP/RRHA	7 14 28 60 90	20.7 29.4 30.9 38.5 42.4
TM2	C1/FA/RRHA	7 14 28 60 90	24.3 32.3 38.9 42.7 43.4
TM3	C1/SF/RRHA	7 14 28 60 90	9.45 38.3 21.2 23.6 22.7
QM1	C2/LP/FA/RRHA	7 14 28 60 90	10.7 13.6 20.7 21.4 23.8
QM3	C2/FA/SF/RRHA	7 14 28 60 90	19.8 25.4 32.3 38.3 36.3

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Compressive Strength It may be noted from *Table 3.18* and also Fig 3.3 that the 28-days Compressive strength for GGBS based SCC of M25 grade is 26.23 MPa, Which is about 4.92% more than the design strength. From the test results for 7 days, 14 days and 28 days compressive strength of the SF based SCC, it may be noted that the results are not very satisfactory. This could be due to increase in the SF content which is about 50.19% of total powder content, whereas the maximum content of SF in the conventional concrete is restricted to 8% (Assem A.A.H et al. 2012). The Compressive strength of SF based SCC after 7 days, 14 days and 28 days are 9.20 MPa, 11.77 MPa and 18.32 MPa respectively. Whereas the Compressive strength of GGBS based SCC after 7 days, 14 days and 28 days are 21.44 MPa, 23.81 MPa and 26.23 MPa, which clearly indicates that the GGBS based SCC gives better strength than SF based SCC.

OBJECTIVE OF THE STUDY

The construction project are increasing significantly around the globe, the solutions for Workability, durability and high tensile strength are needed in order to fill the dreams every engineer to build concrete structure of high strength, resistance to chemical attack, resistance to earthquake etc. One solution of type of concrete is SCC which need more amount of binder compare to normal concrete. In big project where millions tons of concrete are needed (e.g the Burj Khalifa), the cost of cement can be higher, when RHA and GGBS are used, the cost of binder material will decrease, enhancement of fresh properties and hardened properties. Of course there is benefit for environment as we know CO2is released during the production of cement. So the main objective of the research is:

- To partially replacement of cement by RHA and GGBS
- To get better physical and mechanical properties by making use of these alternate materials.
- To make SCC economical by using RHA and GGBS.
- To find out the most suitable % for the replacement of cement
- To use RHA and GGBS in Construction in big project
- To reduce the content of cement by making use RHA and GGBS

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