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The use of ground-granulated blast furnace slag and rice husk ash as partial cement replacements in SCC

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ABSTRACT

SCC is a kind of self-compacting concrete that does not need external compaction during transportation or placing because of its low yield stress, excellent deformability, and average viscosity. Because of its exceptional strength and longevity, SCC is considered the best High Performance Concrete. However, compared to regular concrete, the mix proportioning and flow property testing procedures are drastically different. Superior cross-compaction concrete (SCC) is able to flow under its own weight, fill the formwork entirely, and not be affected by vibrations. It is also cohesive enough to be handled without bleeding.Binder and chemical admixtures are often used in significant quantities in SCC. The building and construction sectors have been booming since the turn of the century. Worldwide, the scope of major national and multinational projects has grown substantially. The self-compacting concrete is a labor-saving material with excellent strength, workability, and durability. SCC is making great strides in that project, and the demand for cement is skyrocketing. Engineers place a premium on finding substitute materials that exhibit comparable characteristics to cement. Two of these materials, RHA and GGBS, are admixtures. Mineral admixtures have dual purposes in SCC production: lowering the heat of hydration and making the material more cost-effective.The main considerations in this study are the bond content and the amount of rice husk powder (e.g., 15% or 20%). The measured quantities of fine and coarse aggregate, water, SP content, and w/b proportion are constant parameters.

KEY WORDS : RHA- Rice Husk Ash, GGBS – Ground Granulated Blast Furnace Slag, SCC- Self compacting concrete, OPC - Ordinary Portland cement, mm – Millimetre, SP – Superplasticizer.

INTRODUCTION

General 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. 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.

Motive behind Development of SCC

The intention being developed of Self-Compacting Concrete was the social issue on durability of solid structure that emerged around 1983 in Japan. Because of a continuous decrease in the quantity of gifted laborers in the Japan development industry, a comparative diminishment in the nature of development work occurred. 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, which could be compacted into every edge of a reinforced bars , essentially by technique for its own weight. As for its union, ―Self-Compacting Concrete involve a vague fragments from generally vibrated customary solid, which are bond, totals, water, included substances and admixtures. In any case, the high measure of Superplasticiser for abatement of beyond what many would consider possible and for better workability‖, the high powder content as Lubricant for the coarse total, and additionally the utilization of consistency operators to expand the thickness of the concrete.

Global present development of SCC

After Japan in 1983, 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 ,amid the most recent couple of years ,endeavors were made in the labs and in the field to create and utilize SCC.

SRM's – Secondary Raw Materials

Secondary Raw

Materials are finely material divided materials that replace or supplement the use of Portland cement. Their use reduces the cost and improves one or more technical properties of concrete. SCMs also called mineral admixture, contribute to the properties of hardened concrete through hydraulic or pozzolanic activity. In my research, I'm using Rice Husk Ash (RHA) and Ground Granulated Blast Furnace Slag (GBBGS) as Secondary cement materials.

Use of Rice Husk Ash as Filler Material

In this work, Rice Husk Ash was used as a mineral admixture. Rice husk is an agricultural residue obtained from the outer covering of rice grains during milling process. It constitutes 20% of the 500 million tons of paddy produced in the world. Initially rice husk was converted into ash by open heap village burning method at a temperature, ranging from 300°C to 450°C. When the husk was converted to ash by uncontrolled burning below 500°C the ignition was not completed and considerable amount of unburned carbon was found in the resulting ash. Carbon content in excess of 30% was expected to have an adverse effect upon the pozzolanic activity of RHA. The ash produced by controlled burning of the rice husk between 550°C and 700°C incinerating temperature for 1 hr, transforms the silica content of the ash into amorphous phase. The reactivity of amorphous silica is directly proportional to the specific surface area of ash.

The ash so produced is pulverized or ground to required fineness and mixed with cement to produce blended cement. About 600 million tons per year of rice paddy was produced all over the world out of which an estimated 120 million tons in year 2010-2011 was grown in INDIA. Rice husk is the outer covering of the rice grain that is removed as a result of milling process on rice kernel. Huge amounts of RHA obtained after burning of rice husk, probably has no use at all and getting rid of it is also a problem.

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.

In INDIA Ground-granulated impact heater slag (GGBS) is gotten by extinguishing liquid iron slag (a by-result of iron and steel-production) from an impact heater in water or steam, to create a shiny, granular item that is then dried and ground into a fine powder.

Applications of GGBS :

GGBS make durable concrete structures in combination with ordinary portland cement and/or other pozzolanic materials. GGBS has been widely used in Europe, and increasingly in the United States and in Asia (particularly in Japan and Singapore) for its superiority in concrete durability, extending the lifespan of buildings from fifty years to a hundred years.

Two major uses of GGBS are in the production of quality-improved slag cement, namely Portland Blast furnace cement (PBFC) and high-slag blast-furnace cement (HSBFC), with GGBS content ranging typically from 30 to 70%; and in the production of ready-mixed or site-batched durable concrete.

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.

REVIEW OF LITERATURE

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.

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.

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.

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.

Nor atan *et al*. (2011) -researches the compressive quality of self compacting concrete consolidating crude rice husk slag, exclusively and in blend with different sorts of mineral added substances, as incomplete bond substitution.

Saifuddin *et al.* (2010) concentrated the compressive quality of self solidifying superior cement (SCHPC). The solid blends were outlined in view of w/b proportions of .30, .35, .40, and .50, utilizing RHA % to 31% of bond by weight. An aggregate air substance of 6% was received for air entrained SCHPC's and 2 % for non air entrained SCHPC'S. Blends were named according to C (w/b proportion), R (substitution rate), An (air entrained).

Pai et al. (2014) The concrete is tested for the hardened properties like compressive strength, split tensile and flexural strengths each for 7 days, 14 days and 28days.

METHEDOLOGY

The aim of this experiments work conducted is to study and compare the properties of SCC made when cement is replaced by combination 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. The experiments has been be held in my School labor (Lovely Professional University, School of Civil Engineering) and outside, several experiments has been conducted by myself with help of knowledge of my Supervisor .

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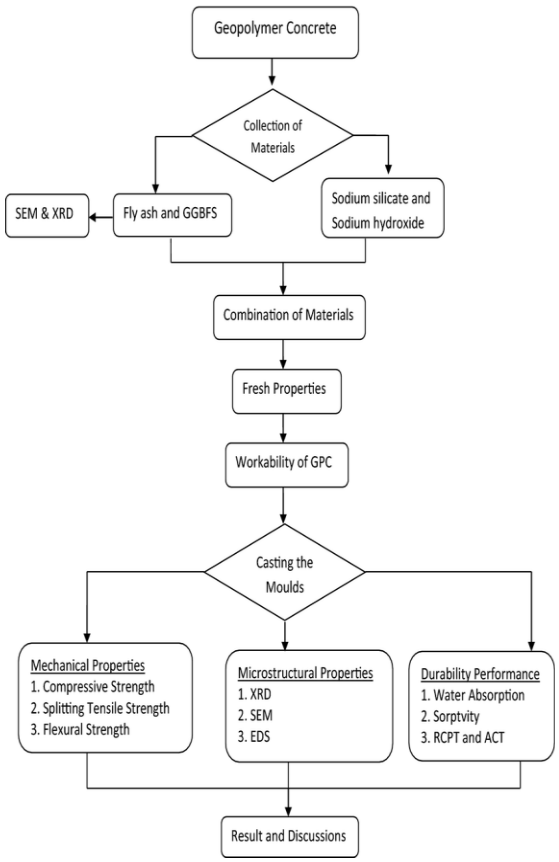


TEST METHODS

SlumpTest :

The slump flow test is done to assess the horizontal flow of concrete in the absence of obstructions. It is a most commonly used test and give good assessment of filling ability. It can be used at site. The test also indicates the resistance to segregation. The usual slump cone having base diameter of 200 mm, top diameter 100 mm and height 300 mm is used.

V-funnel test:

The V-funnel test is used to determine the filling ability (flow ability) of concrete with maximum size of aggregate 20 mm size. The funnel is filled about 12 liters of concrete. Find time taken for it to flow down.

L-box test:

The test assesses the flow of concrete and also the extent to which the concrete is subjected to blocking by reinforcement (passing ability). Interpretation: If the concrete flows as freely as water, at rest it will be horizontal. There for H2/H1 will be equal to 1. Therefore nearest the values, the blocking ration is unity, the better the flow of concrete.

U-Box test:

The test is used to measure the filling ability of SCC. The apparatus consist of a vessel that is divided by middle wall into two compartments. Interpretation: If concrete flows as freely as water, at rest it will be horizontal so H1-H2 will be equal to zero. Therefore nearest the test value, the filling height, is to be zero, the better the flow and passing ability of concrete. The acceptable value of filling height is 30mm maximum.

HARDENED CONCRETE PROPERTIES

Compressive strength :

After doing all fresh properties test, casting and curing done as it has discussed. In this work compressive strength is tested on basis of 7 days, 28 days and 56 days of curing. The cube which is used for specimens is 150 mm x 150 mm x 150 mm size. The test was done by using digital recording CTM, the rate of load is 5.1 KN/Sec and maximum load before specimen got failure was recorded and by knowing load we can calculate corresponding compressive strength.

Calculation of strengthFormula:

strength=P/A Where p is applied load and A cross sectional area of specimen Cube Note: strength in PMa, P in KN and A mm2 Partial Replacement of Cement with Combination of Rice Husk Ash and Ground Granulated Blast Furnace Slag in SCC. Formula:

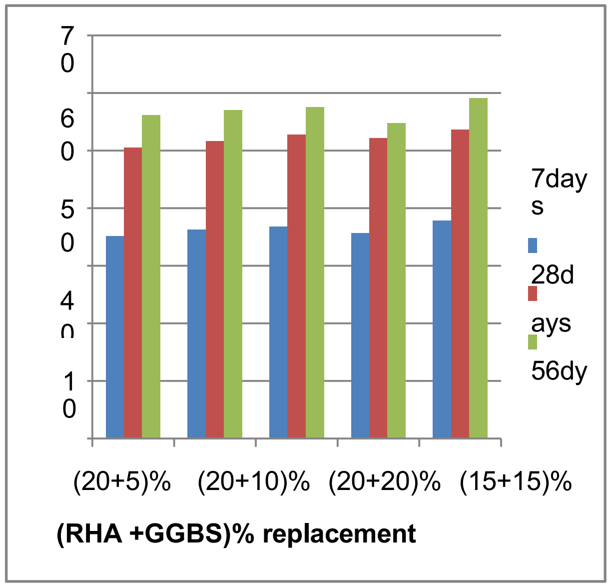
T= 2P/Πld

where T = Split Tensile Strength in MPa

P = Applied load,

L= Length of Concrete cylinder sample in mm.

D= Diameter of Concrete cylinder sample in mm.



CALCULATION OF FLEXURAL STRENGTH:

Flexural strength After doing all fresh properties test, casting and curing done as it has discussed. In this work flexural strength is tested on basis of 7 days, 28 days and 56 days of curing. The beam which is used for specimens is 100 mm x 100 mm x 500 mm size. The test was done

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by using digital recording CTM, the rate of load is 0.9 KN/Sec and maximum load before specimen got failure was recorded and by knowing load we can calculate corresponding flexural strength.

Formula:

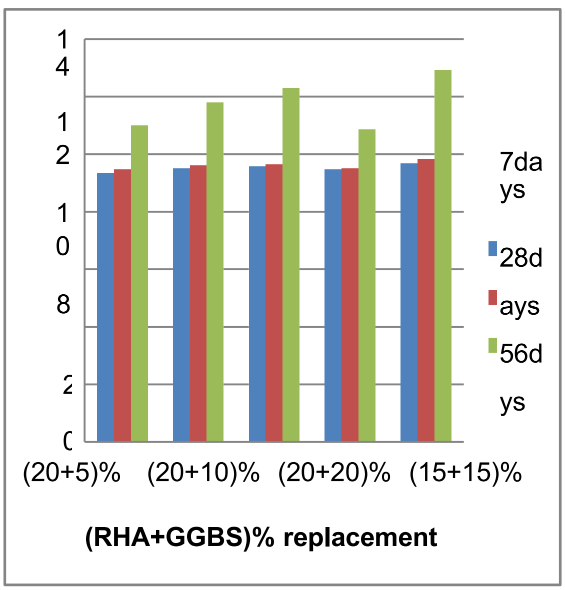
fb=PL/bd2

Where fb =flexural strength in MPa

L = Effective span of the specimen in mm

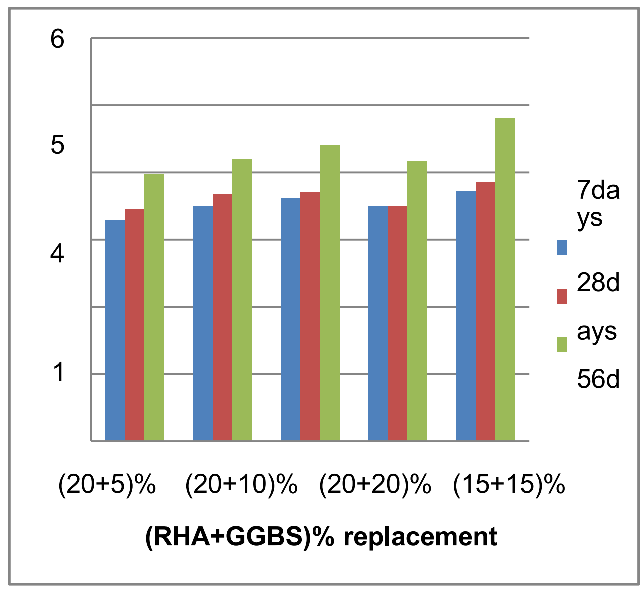
b = Width of the specimen in mm

d = Depth of the specimen in mm



SPLIT TENSILE STRENGTH:

The split tensile strength of all the mixes was determined at the ages 7 days, 28 days and 56 days when additional percentages of RHA along with GGBS in concrete mix. The split tensile strength results of individual concrete mix are also shown graphically. The maximum values of split tensile strength of concrete is when combination of 15%RHA and 15%GGBS are used as replacement while minimum values is when combination of 20%RHA and 20%GGBS are used as replacement of cement.



CONCLUSION

- The SCC mixes containing RHA and GGBS as powder mat their fresh properties as per EFNARC guidelines, have satisfied the norms laid down by EFNARC.
- The combination of RHA and

GGBS based SCC has good Compressive strength.

- Split tensile strength and flexural Strength when compared to SCC without replacement or when cement is replaced by those admixtures separately.
- The good results for all hardened properties tested in this work comes when cement replaced by 15%RHA and 15%GGBS.
- when replacement goes up 20%RHA and 20%GGBS of binder, all results for hardened properties start decrease.
- The construction project are increasing significantly around the globe, the solutions for workability, durability and high tensile strength are needed.

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