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Development on Self-Compacting Concrete using GGBS

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Abstract

Self-Compacting Concrete (SCC) is a special type of concrete which is capable of flowing into the formwork, without segregation, to fill uniformly and completely every corner of it by its own weight without any application of vibration or other energy during placing. SSC has ultrahigh compressive strength. SSC is made to reduce time efficiency and help to minimize the number of labor required because that can flow and compact by itself. Materials required for SSC are cement, fine aggregate, super plasticizer course aggregate, water and admixtures.

Keywords: *Self-Compacting Concrete, Other Energy, Compressive Strength.*

1. Introduction

Self-Compacting Concrete (SCC) is a special type of concrete which is capable of flowing into the formwork, without segregation, to fill uniformly and completely every corner of it by its own weight without any application of vibration or other energy during placing. SSC has ultrahigh compressive strength. SSC is made to reduce time efficiency and help to minimize the number of labor required because that can flow and compact by itself. Materials required for SSC are cement, fine aggregate, super plasticizer course aggregate, water and admixtures. GGBS is a material used in partial replacement of OPC by weight varies from between 30% to 80%. Specific gravity of GGBS is 2.9, Bulk density of GGBS is 1200 Kg/m3, Fineness is 350 m2/Kg. Fine aggregates used in manufacture of concrete is generally natural river sand whose availability in recent is limited due to high cost and scarcity and it is the biggest barrier to the growth of construction industry. Fine aggregates make 20-35% of the volume of concrete mix, which results in the high consumption. About 420 to 520 Kg of fine aggregates are used per cubic meter of concrete. Requirement of fine aggregate is considerably more in self-compacting concrete compare to normal concrete. In this project we are going to replace Ground Granulated Blast Furnace slag (GGBSS) with fine aggregate in self-compacting concrete (SSC) [1].

2. Literature Review

Burak Felekogluet al. (2007) studied the use of SCC with its improving production techniques is increasing every day in concrete production. However, mix design methods and testing procedures are still developing. Mix design criterions are mostly focused on the type and mixture proportions of the constituents. Adjustment of the water/cement ratio and super plasticizer dosage is one of the main key properties in proportioning of SCC mixtures. In this study, five mixtures with different combinations of water/cement ratio and super plasterer dosage levels were investigated. Several tests such as slump flow, v-funnel flow, l- box were carried out to determine optimum parameters for the self-compatibility of mixtures. Compressive strength development, modulus of elasticity and splitting tensile strength of mixtures were also studied [2].

Sofia AraújoLima et al., (2010) studied the Use of Brazilian sugarcane bagasse ash in concrete as sand replacement-The main objective of research is replacement of fine aggregate with sugarcane bagasse ash in concrete. The results indicated that the SBA samples presented physical properties

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similar to those of natural sand. The mortars produced with SBA in place of sand showed better mechanical results [3].

Prashant O et al., (2013) described the work regarding Utilization of Bagasse Ash as a Partial Replacement of Fine Aggregate in Concrete. In this paper, untreated bagasse ash has been partially replaced in the ratio of 0%, 10%, 20%, 30% and 40% by volume of fine aggregate in concrete. The result shows that bagasse ash can be a suitable replacement to fine aggregate [4].

3. Properties of Materials

- Cement
- Fine Aggregate
- Course Aggregate
- Fly ash
- Sugarcane Bagasse Ash
- Super plasticizer

3.1. Cement

Ordinary Portland slag cement of 43 grade is used which is shown in fig 3.1. Laboratory test were conducted on cement and properties were determined as per IS 4031 & IS 269-1967. The specific gravity of cement was determined as 3.13 using pycnometer.

3.2. Fine Aggregate

River sand passing on 2.36 mm and retained on 600 microns was used as fine aggregate which is shown in the Fig 3.2. The specific gravity of fine aggregate was calculated as 2.62 using pycnometer. Sieve analysis was carried out to estimate particle size distribution and fineness modulus is calculated as 2.94.

3.3. Coarse Aggregate

When the size of aggregate is greater than 4.75mm, it is called course aggregate. Crushed angular granite metal of 10 to 12.5 mm size from a local source was used as coarse aggregate as shown in the Fig 3.3. The specific gravity of the collected sample is 2.77 and fineness modulus of coarse aggregate is 3.70.

3.4. Fly Ash

Fly ash is pozzolanic, which means it's a siliceous or siliceous- and-aluminous material that reacts with calcium hydroxide to form a cement shown in fig 3.4. The specific gravity and fineness surface area is 2.2 and 78.6 kg/m2.

3.5. Sugarcane Bagasse Ash

The GGBS used for this Project was taken from a Iron factory near Madurai district and it is shown in the Fig 3.5. It is not possible to measure the temperature in the furnace while taking the GGBS because the measuring instrument was not long enough to go through the furnace. Even though it was not possible to measure the temperature. Most furnace have a temperature above that is required for complete combustion which is around 800 ˚C.But it was suggested that at a temperature around 650˚C the crystallization of minerals occurs. This reduces the pozzolanic activity of the GGBS and the specific gravity of 2.9.

3.6. Super Plasticizer

AUROMIX 200 is an admixture of a new generation based on modified polycarboxylate ether. The product has been primarily developed for applications in high performance concrete where the highest durability and performance is required. AUROMIX 200 is free of chloride & low alkali. It is compatible with all types of cements. Optimum dosage of AUROMIX 200 should be determined with trial mixes, as a guide, a dosage range of 500 ml to 1500 ml per 100 kg of cementations material is normally recommended.

4. Types of Tests

- Specific Gravity of Cement
- Fineness Test of Cement
- Consistency Test of Cement
- Compressive Strength Test
- Flexural Strength Test

4.1. Specific Gravity of Cement

The pycnometer should first be dried carefully and weighed [W1]. About 500grams of cement is taken in the pycnometer. It is weighed along with its contents [W2]. Then the pycnometer is completely filled with water, wiped of outside, and weighed again [W3]. The pycnometer is then emptied and filled with water and weighed [W4] [5].

4.2. Fineness Test of Cement

Fineness modulus of cement is done by taking a sample of cement of 100 grams and it is sieved in 90 micron and then the residue's weight is measured [6].

4.3. Consistency Test of Cement

It is determined by the apparatus called Vicat's

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needle. It is the consistency at which the Vicat plunger G of 10 mm diameter and 50 mm length will penetrate 33-35 mm within 3 to 5 minutes of mixing. The test procedure is to carry out at least three trial experiments by mixing the cement with distilled water varying from about 24 to 27 percent of the weight of cement [7].

4.4. Compressive Strength Test

The concrete cubes were cast and cured for 7 days and 28 days and their compressive strength were estimated using CTM by taking the average value of 3 trials. The compressive test is calculated by the load acting on the specimen to the cross sectional area.it is shown in Table 1 and Figure 1 [8, 9].

Figure 1 **Compression Testing Machine**

Table 1 **Results on Compressive Strength**

S. No	Mix Proportions (%)	Compressive strength (N/mm^2) 7 Days	Compressive strength (N/mm^2) 28 Days
1	SC	15.32	23.84
2	S5	10.59	24.52
3	S10	16.56	21.7
4	S15	18.25	24.68
5	S20	16.27	26.64
6	S25	18.05	24.14

4.5. Flexural Strength Test (as in Table 2)

Table 2 **Results on Flexural Strength**

S. No	Mix Proportions (%)	Flexural strength (N/mm^2) 7 Days	Flexural strength (N/mm^2) 28 Days
1	SC	4.7	4.9
2	S5	2.4	2.5
3	S10	1.56	2.05
4	S15	2.54	3.0
5	S20	3.07	3.82
6	S25	1.5	3.12

Conclusion

This project was aimed for Experimental investigation on self-compacting concrete using partial replacement of GGBS with Cement on the fresh and mechanical characteristics of SCC.

- Fine aggregate is replaced with GGBS about 5% ,10% ,15% ,20% 25% and its compared with conventional SCC.
- EDAX test result shows that the GGBS contains more silica content as in the case of natural river sand, so it is decided to use the GGBS in the replacement of Cement.
- The fresh property test didn't show much difference when compared to conventional mix and is within the limits as per EFNARC guidelines
- The partial replacement of GGBS with FA gives the better compressive strength in 20% replacement compared to conventional mix.
- The partial replacement of GGBS with FA gives the better Tensile strength in 20% replacement when compared to conventional mix.
- The partial replacement of GGBS with FA is not giving better flexural strength when compared to conventional mix.
- From this test results we have concluded that 20% is the optimum percentage for the replacement because it gives the better strength results even though there is decrease in flexural strength.

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