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# Effect and Strength Behaviour of Column in Self Compacting Using Partial Replacement by Mineral Admixture

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**Abstract:** The utilization of supplementary cementation materials is well accepted, since it leads to several possible improvements in the concrete composites, as well as the overall economy. The present paper is an effort to quantify the strength of ground granulated blast furnace slag (GGBS) at various replacement levels and evaluate its efficiencies in concrete. Cement with GGBS replacement has emerged as a major alternative to conventional concrete and has rapidly drawn the concrete industry attention due to its cement savings, energy savings, and cost savings, environmental and socio-economic benefits. The use of fine materials such as crushed rock as a replacement for fine aggregate enhances the property of concrete. Since, concrete is weak in tension hybrid fibers such as asbestos fiber are used to improve the tensile property of the concrete structures. The initial results of experimental programs aimed at producing and evaluating SCC made with GGBFS, crushed rock powder and hybrid fibers are presented and discussed. This research evaluates the strength efficiency factors of hardened concrete, by partially replacing cement by ground granulated blast furnace slag for M30 grade of concrete at a percentage of (20-30%) and fine aggregate by crushed rock powder at varying percentage of (30-40). Asbestos fibers were used to increase the tensile strength of concrete. The mix design of SCC was arrived as per guidelines of European Federations of National Associations Representing for Concrete (EFRNAC). The material properties and hardened properties were found out. The axial loading on column is to be monitored with the optimum percentage.

***Keywords:*** *self-compacting concrete, hardened properties, GGBS, Crushed Rock Powder (CPR), Asbestos fiber*

## 1. Introduction

Self-compacting concrete (SCC) is an innovative concrete that does not require vibration for placing and compaction. It is able to flow under its own weight, completely filling formwork and achieving full compaction, even in the presence of congested reinforcement. The hardened concrete is dense, homogeneous and has the same engineering properties and durability as traditional vibrated concrete.

Self-compacting concrete offers a rapid rate of concrete placement, with faster construction times and ease of flow around congested reinforcement. The Fluidity and segregation resistance of SCC ensures a high level of homogeneity, minimal concrete voids and uniform concrete strength, providing the potential for a superior level of finish and durability to the structure. SCC is often produced with low water-cement ratio providing the potential for high early strength, earlier remolding and faster use of elements and structures. The elimination of vibrating equipment improves the environment on and near construction and precast sites where concrete is being placed, reducing the exposure of workers to noise and vibration.

## 2. Aim and Objective

The primary objective of the work is to experimentally study the effect of the replacement of cement with Fly Ash (FA) and Ground Granulated Blast Furnace Slag (GGBS) for M30 mixtures of concrete to obtain the optimum percentage of replacement of cement in concrete. The main objective is to study the effect of RHA and SF on workability and compressive strength of concrete at the age of 7, 14 and 28 days.

## 3. Experimental study

The aim of the experimental program is to compare the split tensile strength and compression strength of concrete made with partial replacement of ordinary Portland cement with ground granulated blast furnace slag with varying percentage like 5, 10, 15 and 20. Concrete mix for M30 grade was designed. The basic tests cared out on materials used for Mix Design are discussed in this paper.

### 3.1Materials Used

#### *3.1.1 Cement*

Ordinary Portland cement of 43 grades available in local market was used. The preliminary tests on cement were conducted according to IS: 4031-1988 and results are tabulated in TABLE

***Table1:*** *Properties of Cement*

| Properties | Observed values |
|---|---|
| Specific gravity | 3.15 |

| | |
|---|---|
| Fineness | 3 % |
| Initial setting time | 45 min |
| Final setting time | 195 min |

### *3.1.2 Fine aggregate*

River sand passing through IS 4.75 mm sieve confirming to zone III as per IS: 383-1970 was used as fine aggregate. Source of Fine Aggregate from Karur. The properties of fine aggregates determined are given in TABLE 2

***Table 2:*** *Properties of Fine Aggregate*

| Properties | Observed value |
|---|---|
| Specific gravity | 2.6 |
| Fineness modulus | 2.46 |
| Bulk density | 1587 $Kg/m^3$ |
| Percentage of bulking | 35 % |
| Water absorption | 1.21 % |

### *3.1.3 Coarse Aggregate*

The coarse aggregates with a maximum size of 12.5 mm was used .The properties of coarse aggregates determined are given in TABLE 3

***Table 3:*** *Properties of Coarse Aggregate*

| Properties | Observed value |
|---|---|
| Specific gravity | 2.67 |
| Fineness modulus | 6.89 |
| Bulk density | 1534 $Kg/m^3$ |
| Aggregate crushing value | 30.2 |
| Aggregate impact value | 34.1 |
| Maximum size of aggregate | 20 mm |
| Water absorption | .69 |

### *3.1.4 Water*

Water is an important ingredient of concrete as it actually participates in the chemical reaction with cement. Potable water available in the laboratory was used.

### *3.1.5 Ground Granulated Blast Furnace Slag*

Ground Granulated Blast Furnace Slag is obtained by quenching molten iron slag from a blast furnace in water or steam, to produce a glassy, granular product that is then dried and ground into a fine powder. GGBS is used to make durable concrete structures in combination with ordinary portland cement and or other pozzolanic materials.

For the project Ground Granulated Blast Furnace Slag was obtained that is commercially available in Coimbatore. The specific gravity of Ground-granulated blast-furnace slag is 2.85.

### *3.1.6 Crushed rock powder (CRP)*

Crushed rock powder consists of finely crushed rock processed by natural or mechanical means, containing minerals and trace elements widely used in organic farming practices. The igneous rock basalt and granite often containing the highest mineral content, whereas limestone, considered inferior in this consideration, is often deficient in the majority of essential macro-compounds, trace elements, and micronutrients.

### *3.1.7 Super plasticizer*

Sulphonated Naphthalene Formaldehyde based super plasticizer was used with the brand name Fosroc Conplast SP430 DSI. Dosage of super plasticizer is 1% of cementations material. The specific gravity of super plasticizer is 1.145. It is a dark brown liquid in color.

## 4.Experimental investigation

In this investigation the hardened properties of self-compacting concrete for various replacement percentages of GGBS and Crushed rock powder are determined.

### *4.1.1 Mix proportions*

Based on the EFNARC guidelines the mix proportions of SCC were prepared for M30 grade.

### *4.1.2 Hardened properties of SCC*

In order to find the mechanical properties Compressive strength tests were conducted at 28 days of cube (150 X 150 X 150 mm) specimens. For each combination, two specimens were tested.

***Fig 1*** *Compressive strength*

The following tables show the compressive strength of SCC:

***Table 4:*** *Compressive strength of SCC with GGBS and CRP*

| S.NO | % of replacement | | Compressive strength | |
|---|---|---|---|---|
| | GGBS | Crushed rock powder (CRP) | 7days ($N/mm^2$) | 28 days ($N/mm^2$) |
| 1 | 5 | 40 | 21.3 | 27.89 |

| | | | | |
|---|---|---|---|---|
| 2 | 10 | 40 | 24.88 | 35.23 |
| 3 | 15 | 40 | 28.12 | 40.87 |
| 4 | 20 | 40 | 27.43 | 38.15 |

The following graph shows the variation in Harden properties

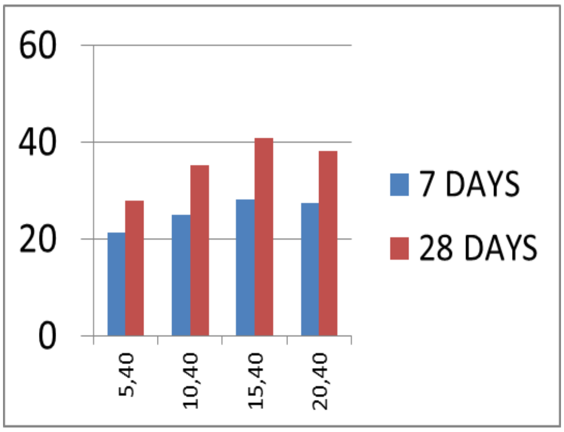


***Fig.2****Chart for compressive strength*

***Fig 3*** *Split tensile strength*

The following table shows the split tensile strength of SCC:

***Table 5:*** *Split tensile strength of SCC with GGBS and CRP*

| S.NO | % of replacement | | Compressive strength | |
|---|---|---|---|---|
| | GGBS | Crushed rock powder (CRP) | 7days ($N/mm^2$) | 28 days ($N/mm^2$) |
| 1 | 5 | 40 | 2.30 | 3.04 |
| 2 | 10 | 40 | 2.52 | 3.25 |
| 3 | 15 | 40 | 2.69 | 3.35 |
| 4 | 20 | 40 | 2.59 | 3.19 |

The following graph shows the variation in Harden properties

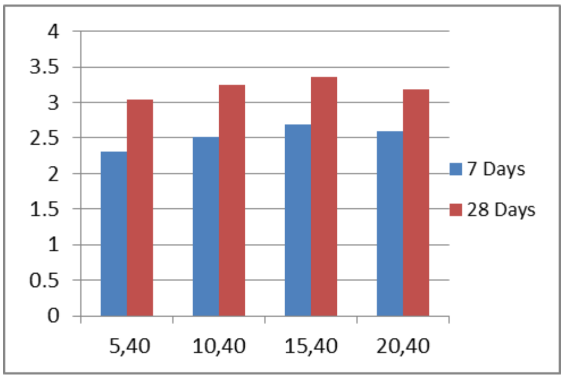


***Fig 4*** *chart for split tensile strength*

## 6. Crack pattern and failure mode

The experimental work consists of testing of 2 short columns. All short columns were casted of size 1m height with 200mm diameter. The axial load capacity of column specimens and details of the specimen were arrived based on the procedure given in IS456-2000.All the columns failed in compression either by crushing of the concrete core, together with the buckling of the longitudinal reinforcement.

***Fig 5****Load frame test*

The following table shows the axial load for nominal an and optimum mix

***Table 6****: Axial load for nominal concrete and SCC*

| S.NO. | Nominal mix | | Optimum mix | |
|---|---|---|---|---|
| | Load (kn) | Deflection (mm) | Load (kn) | Deflection (mm) |
| 1. | 0 | 0 | 0 | 0 |
| 2. | 25 | 0.18 | 25 | 0.14 |
| 3. | 50 | 0.29 | 50 | 0.21 |
| 4. | 75 | 0.54 | 75 | 0.46 |
| 5. | 100 | 0.73 | 100 | 0.65 |
| 6. | 125 | 1.18 | 125 | 0.98 |
| 7. | 150 | 1.27 | 150 | 1.10 |

| | | | | |
|---|---|---|---|---|
| 8. | 175 | 1.53 | 175 | 1.15 |
| 9 | 200 | 1.72 | 200 | 1.26 |
| 10 | 225 | 1.87 | 225 | 1.45 |
| 11 | 250 | 1.96 | 250 | 1.78 |
| 12 | 300 | 2.01 | 300 | 1.89 |
| 13 | 350 | 2.99 | 350 | 2.10 |
| 14 | 400 | 3.25 | 400 | 2.75 |
| 15 | 450 | 3.58 | 450 | 2.94 |
| 16 | 500 | 3.71 | 500 | 3.10 |
| 17 | 550 | 3.82 | 550 | 3.25 |

The following graph shows the variation in deflection for nominal and optimum mix

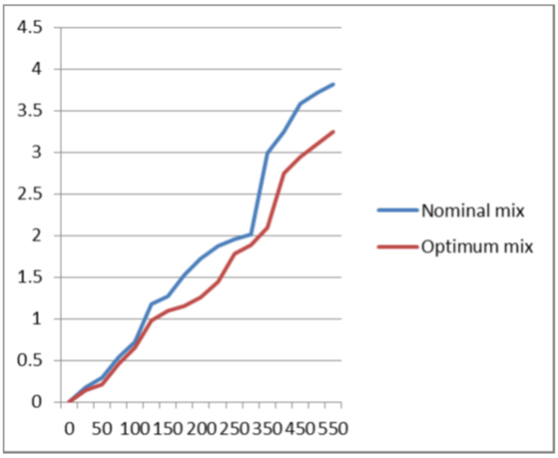


***Fig6** chart for deflection*

## 7. Conclusion

The following conclusions have been derived from the above study:

- Self-compacting concrete which uses aggregates of size 12.5 mm can even fill up congested reinforced areas such as beam column joints.
- Replacement of concrete with admixtures such as ground granulated blast-furnace slag (GGBS) and CRP will retain the original strength of concrete.
- When the replacement of cement with ground granulated blast-furnace slag (GGBS) is kept within 20% it gives good results.
- The use of crushed rock powder as a percentage replacement for sand is environment friendly.
- The mix design for self-compacting concrete with M30 grade has been calculated keeping the replacement percentages of ground granulated blast-furnace slag (GGBS) 15% and CRP as 40%.
- Deflection and control of cracks are minimized while comparing to nominal mix
- It has been found out that when the replacement percentage of CRP is increased the compressive strength also increased, but when the replacement percentage of GGBS is increased more than 15% the compressive strength reduces. So the optimum replacement percentage is found out to be a combination of 15% replacement of cement with GGBS and 40% replacement of fine aggregate with CRP.
- The main aspect followed in this project is to reduce the waste disposal and save the earth from environmental hazards.

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