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# Fiber Reinforced Self Compacting High Performance Concrete.

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## ABSTRACT

This paper presents the experimental procedure for the design of self-compacting concrete, in which we proposed the mix design with the globally acceptance result of all tests and the carried out test are slump flow test, V-funnel test, L-box test. The mix design consists of GGBS (as a cement replacement material), super plasticizer and steel fibers. The compressive strength, split tensile strength and flexural strength was checked on the 7-day, 14-day, 28-day and results are indicating that the proposed design mix can produce self-compacting concrete with higher quality. High- performance concretes are made with carefully selected high-quality ingredients and optimized mixture designs; these are batched, mixed, placed, compacted and cured to the highest industry standards. Typically, such concretes will have a low water- cementing materials ratio of 0.20 to 0.45. Plasticizers are usually used to make these concretes fluid and workable. High-performance concrete almost always has a higher strength than normal concrete. However, strength is not always the primary required property. This paper also describes the test performed for the globally acceptance for the characteristics for self-compacting concrete such as slump flow, V-funnel, L-box test. Strength of concrete is determined for the 7-day, 14-day, 28-day are also mentioned. To establish an appropriate mixture proportion for a self-compactingconcrete the performance requirements must be defined taking into account the structural conditions such as shape, dimensions, reinforcement density and construction conditions. The construction conditions include methods of transporting,placing, finishing and curing. The specific requirement of self-compacting concrete is its capacity for self-compaction, without Conventional concrete tends to present a problem with regard to adequate consolidation in thin sections or areas of congested reinforcement, which leads to a large volume of entrapped air voids and compromisesthe strength and durability of the concrete. Self-compacting concrete (SCC) can eliminate the problem, since it was designed to consolidate under its own mass.

## INTRODUCTION

Concrete is a very strong and versatile moldable construction material. It consists of cement, sand and aggregate (e.g., gravel or crushed rock) mixed with water. The cement and water form a paste or gel which coats the sand and aggregate. When the cement has chemically reacted with the water (hydrated), it hardens and binds the whole mix together.The initial hardening reaction usually occurs within a few hours. It takes some weeks for concrete to reach full hardness and strength. Concrete can continue to harden and gain strength over many years.

### Self Compacting Concrete (SCC)

Making concrete structures without vibration has been done in the past. For example, placement of concrete under water is done by the use of tremie without vibration. Mass concrete, and shaft concrete can be successfully placed without vibration. But the above examples of concrete are generally of lower strength and difficult to obtain consistent quality. Modern application of self-compacting concrete (SCC) is focused on high performance, bet- ter and more reliable and uniform quality.
Self-compacting concrete has been described as "the most revolutionary development in concrete construction for several decades". Originally developed in Japan to offset a growing shortage of skilled labor, it has proved to be beneficial from the following points.

- Faster construction

- Reduction in site manpower
- Better surface finish
- Easier placing
- Improved durability
- Greater freedom in design
- Thinner concrete sections
- Reduced noise level
- Safer working environment

**High-performance concrete (HPC)**

High-performance concrete (HPC) exceeds the properties and constructability of normal concrete. Normal and special materials are used to make these specially designed concretethat must meet a combination of performance requirements. Special mixing, placing, and curing practices may be needed to produce and handle high-performance concrete. High- performance concrete characteristics are developed for particular applications and environments; some of the properties that may be required include:

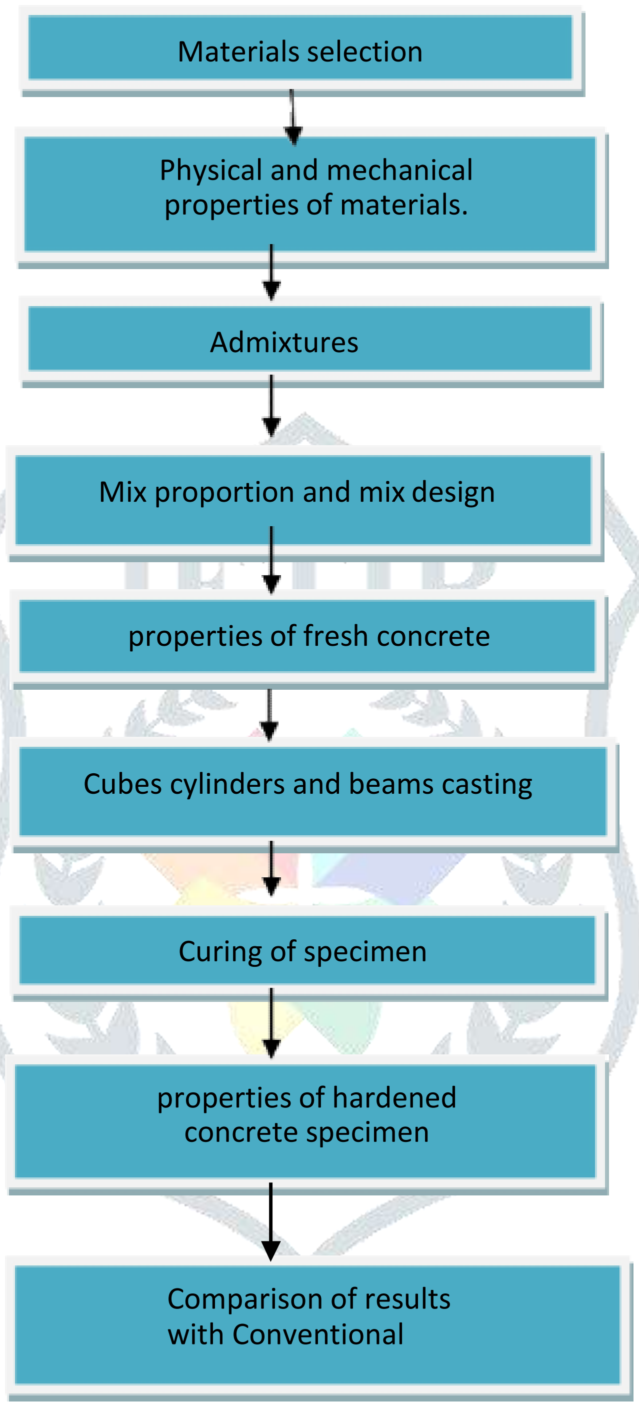
- High strength
- High early strength.
- High modulus of elasticity
- High abrasion resistance
- High durability and long life in severe environments
- Low permeability and diffusion
- Resistance to chemical attack
- High resistance to frost and deicer scaling damage
- Toughness and impact resistance
- Volume stability
- Ease of placement
- Compaction without segregation
- Inhibition of bacterial and mold growth.

## OBJECTIVE

The main objective of the project is to

- To check strength performance of concrete with partial replacement of cement withGGBS.
- To achieve high compressive and tensile strength of concrete as per mix design.
- To check the performance of concrete with steel fiber under tensile stress.
- To produce highly workable and dense concrete
- To achieve full compaction with clean and smooth surface finish.

## METHDOLOGY




## MATERIALS REQUIRED

The materials are used which are locally available and are economical which also fits for their required properties suitable for making high performance concrete. The properties ofthe material are very important is selection of the materials for preparing high performanceconcrete.

**Cement :** Commercially available Portland pozzolana cement (PPC) 53 grade is going to be used. Literally, cement means a binding material. It has the property of settingand hardening when mixed with water to attain strength. The cement may be natural or artificial. Natural cement is manufactured by burning and then crushing natural cement stones, which contain argillaceous and calcareous matter. Artificial cement is manufactured by burning appropriately proportioned mixture of argillaceous and calcareous materials at a very high temperature and then grinding the resulting burnt mixture to a fine powder.

**Coarse aggregate**: The coarse aggregate from a local crushing unit having 12mm normal size well-graded aggregate according to IS was used in this investigation. The coarse aggregate procured from quarry was sieved through 20mm, 16mm, 12.5mm, 10mm and 4.75mm sieves. The material passing through 20 mm IS sieve is to be used in this investigation

.

**Fine Aggregate:** The fine aggregate was obtained from a Nearby river course. The sand obtained was sieved through all the sieves (i.e.4.75mm, 2.36mm, 1.18mm, 600μ, 300μ, 150μ). Sand passing through 4.75mm IS sieve is to be used.

**Super-Plasticizer:** The super plasticizer used in this experiment is Glenium 51.It is manufactured by BASF construction chemical India pvt ltd, Mumbai.

**Viscosity Modifying Agent (V.M.A):** Glenium Stream 2 which is manufactured by BASF construction chemical India pvt.ltd, Mumbai and it is a premier ready-to- use, liquid, organic, viscosity modifying admixture (VMA) specially developed for producing concrete with enhanced viscosity and controlled rheological properties. Concrete containing GLENIUM STREAM 2 admixture exhibits superior stability and controlled bleeding characteristics, thus increasing resistance to segregation and facilitatingplacement.

**Ground granulated blast -furnace slag:** GGBS is obtained by quenching molten iron slag from a blast furnace in water or stream, to produce a glassy, granular product that is then dried and ground into fine powder. It can be used as filler and helps toreduce the total voids content in self-compacting concrete.

**Steel fiber- Steel:** fiber mixed into the concrete can provide an alternative to theprovision of conventional steel bars or welded fabric in some applications. The concept hasbeen in existence for many years and it has been used in a limited range of applications: among the first major uses was the patching of bomb craters in runways during World War II. However, it was during the 1970s that commercial use of this material began to gather momentum, particularly in Europe, Japan and the USA.

## PRELIMINARY INVESTIGATIONS

**Properties of Cement**

| | |
|---|---|
| Manufacturer | Ultratech cement |
| Specific gravity | 3.15 |
| Fineness | 5% |
| Standard consistency | 25% |
| Initial setting time | 35 min |

**Table 1: properties of cement**

**Properties of fine aggregates**

- Specific gravity of Fine aggregate= 2.65
- Fineness modulus of fine aggregates= 2.41
- Water absorption of Coarse aggregates= 1%

| Sieve size (mm) | Mass retained (g) | Cumulative mass retained (g) | Cumulative % mass retained | Cumulative % finer |
|---|---|---|---|---|
| 4.75 | 0 | 0 | 0 | 100 |
| 2.36 | 12 | 12 | 1.2 | 98.8 |
| 1.18 | 124 | 136 | 13.6 | 86.4 |
| 0.60 | 323 | 459 | 45.9 | 54.1 |
| 0.30 | 357 | 816 | 81.6 | 18.4 |
| 0.15 | 173 | 989 | 98.89 | 1.1 |
| Fineness modulus:2.41 | | | | |

**Table 2: fineness modulus of fine aggregate.**

**Properties of coarse aggregates**

- Specific gravity of Coarse aggregate = 2.8
- Fineness modulus of Coarse aggregates= 6.62
- Water absorption of Coarse aggregates= 0.5%

| Sieve size(mm) | Mass retained (g) | Cumulative mass retained (g) | % mass retained | Cumulative % mass retained |
|---|---|---|---|---|
| 40 | 0 | 0 | 0 | 0 |
| 20 | 39 | 39 | 1.3 | 1.3 |
| 10 | 1779 | 1818 | 59.3 | 60.6 |
| 4.75 | 1183 | 3001 | 39.4 | 100 |
| 2.36 | 0 | 3001 | 0 | 100 |
| 1.18 | 0 | 3001 | 0 | 100 |
| 0.60 | 0 | 3001 | 0 | 100 |
| 0.30 | 0 | 3001 | 0 | 100 |
| 0.15 | 0 | 3001 | 0 | 100 |
| Fineness modulus:6.62 | | | | |

**Table 3: Sieve analysis of coarse aggregates**

**Properties of Mineral and Chemical Admixtures.**

- Specific gravity of GGBS = 3
- Specific gravity of Super plasticizer = 1
- Specific gravity of VMA = 1.1

**MIX PROPORTIONS**

Based on the mix design mix proportions for different mixes are tabulated below.

| Mix | Water (ltrs) | Cement (kg) | GGBS (kg) | FA (kg) | CA (kg) | Fibers (kg) | VMA +superplasticizer |
|---|---|---|---|---|---|---|---|
| **M1** | 135 | 540 | - | 540 | 1344 | - | 21.6 |
| **M2** | 135 | 351 | 189 | 540 | 1344 | 5.4 (1%) | 21.6 |
| **M3** | 135 | 297 | 243 | 540 | 1344 | 8.1 (1.5%) | 21.6 |
| **M4** | 135 | 243 | 297 | 540 | 1344 | 10.8 (2%) | 21.6 |

**Table 4: mix proportions**

## TESTS ON FRESH CONCRETE:

**Slump flow test at t50:**

It is based on the traditional slump test, is utilized to determine the flow ability and flow rate of SCC.

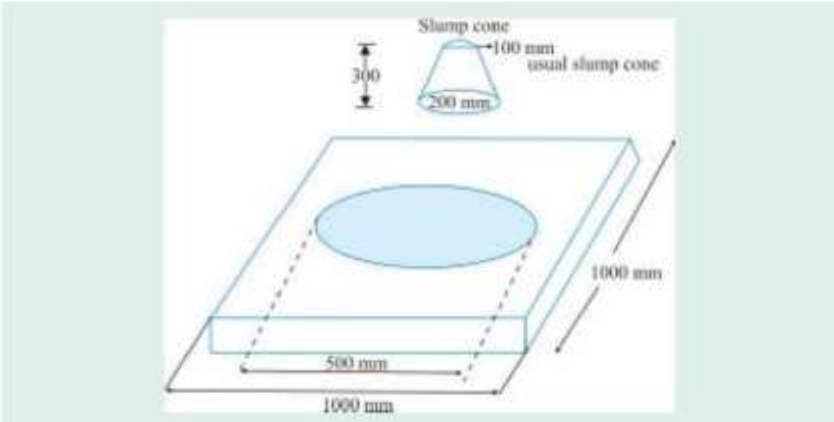
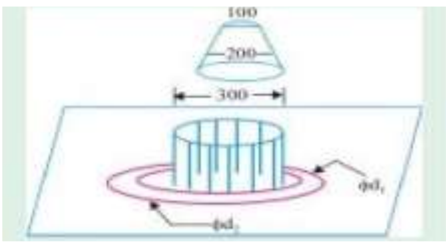



Fig-1. slump flow test

**J ring test**

The J ring test, in combination with the slump flow test, are used together to determine the passing ability of SCC. Passing ability of SCC is defined as the abilityof concrete to flow under its own weight to completely fill all spaces within the Formwork.



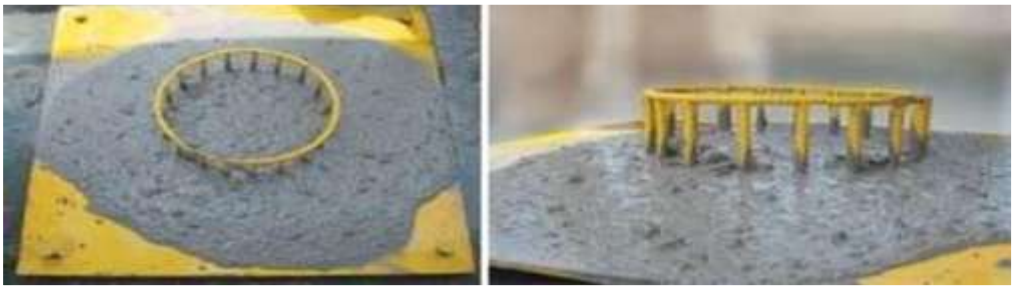



Fig 2. j ring test

**L-box testing method:**

The L-box test to BS EN 12350-10 is used to assess the passing ability of self- compacting concrete to flow through tight obstructions without segregation or blocking.

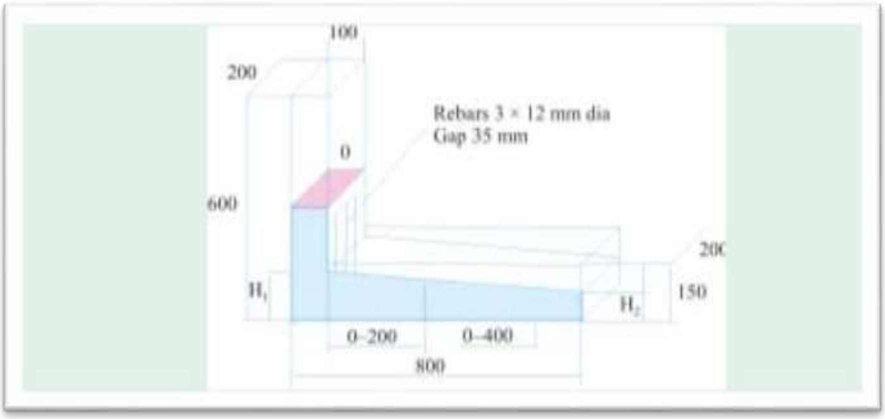



Fig 3. L- box test

**V-funnel test:**

The UTC-0540 V Funnel apparatus is used to evaluate the flow time of freshly mixed self compacting concrete. The test is not suitable when the maximum size ofthe aggregate exceeds 22.4mm. The test set consists of a stainless steel funnel placed vertically

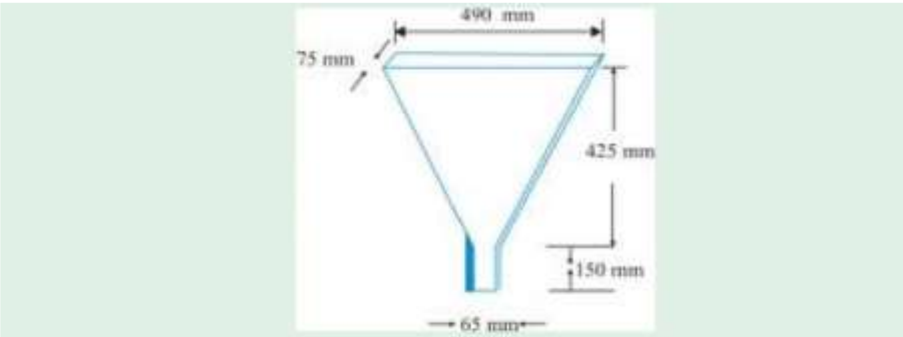



Fig 4.V-funnel test

**<u>TESTS ON HARDENED PROPERTIES OF CONCRETE:</u>**

**Compressive Strength Test: -** The compressive strength of concrete is one of the most important and successful and useful properties of concrete. The concrete making properties of various ingredients of mix are usually measured in terms of compressive strength.

**Split tensile strength: -** The split tensile strength is the indirect way of finding the tensile strength of the concrete by subjecting the concrete cylinders to a compressive force.

**Durability Test: -** In this test specimens are subjected to 5% solution for H2SO4 for 28 days. In this Investigation, the weight loss and strength loss of concrete is compared with the concrete specimens cured under water.

## RESULTS AND DISCUSSION

### TEST ON FRESH CONCRETE

SLUMP FLOW TEST

| MIX | FLOW TIME ($T_{500}$) | DIAMETER (mm) |
|---|---|---|
| M1 | 2s | 750 |
| M2 | 2.5s | 700 |
| M3 | 3s | 680 |
| M4 | 4s | 650 |

**Table 5. slump flow test**

**L-BOX TEST**

| MIX | FLOW TIME |
|---|---|
| M1 | 1 |
| M2 | 0.9 |
| M3 | 0.8 |
| M4 | 0.8 |

**Table 6. L-Box test**

**V-FUNNEL TEST**

| MIX | H1/H2 RATIO |
|---|---|
| M1 | 2s |
| M2 | 2.5s |
| M3 | 3s |
| M4 | 4s |

**Table 7. V-Funnel test**

## TEST ON HARDENED CONCRETE

### COMPRESSIVE STRENGTH TEST

| MIX | 7 DAYS | 14 DAYS | 28 DAYS |
|---|---|---|---|
| **M1** | 38KN/m$^2$ | 58KN/m$^2$ | 70KN/m$^2$ |
| **M2** | 40KN/m2 | 62KN/m$^2$ | 71.5KN/m$^2$ |
| **M3** | 44KN/m2 | 64KN/m$^2$ | 74KN/m$^2$ |
| **M4** | 41KN/m$^2$ | 61KN/m$^2$ | 70KN/m$^2$ |

**Table 8. Compressive strength of cubes**

### SPLIT TENSILE STRENGHT

| MIX | 7 DAYS | 14 DAYS | 28 DAYS |
|---|---|---|---|
| **M1** | 2.1 KN/m$^2$ | 3.73 KN/m$^2$ | 4.3 KN/m$^2$ |
| **M2** | 2.25 KN/m2 | 3.9 KN/m$^2$ | 4.9 KN/m$^2$ |
| **M3** | 2.5 KN/m2 | 4.1 KN/m$^2$ | 5.3 KN/m$^2$ |
| **M4** | 2.9 KN/m$^2$ | 4.3 KN/m$^2$ | 5.9 KN/m$^2$ |

**Table 9. Split tensile strength of cylinders**

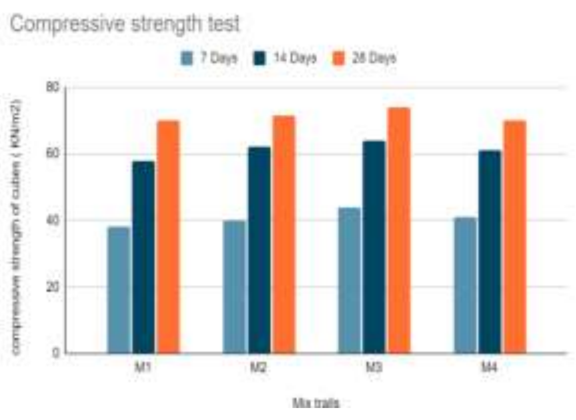
### FLEXURAL STRENGHT

| MIX | 7 DAYS | 14 DAYS | 28 DAYS |
|---|---|---|---|
| **M1** | 9.9 KN-m | 11 KN-m | 12 KN-m |
| **M2** | 9.9 KN-m | 12.7 KN-m | 13.25 KN-m |
| **M3** | 10.05 KN-m | 13.18 KN-m | 13.78 KN-m |
| **M4** | 10.3 KN-m | 13.5 KN-m | 14.05 KN-m |

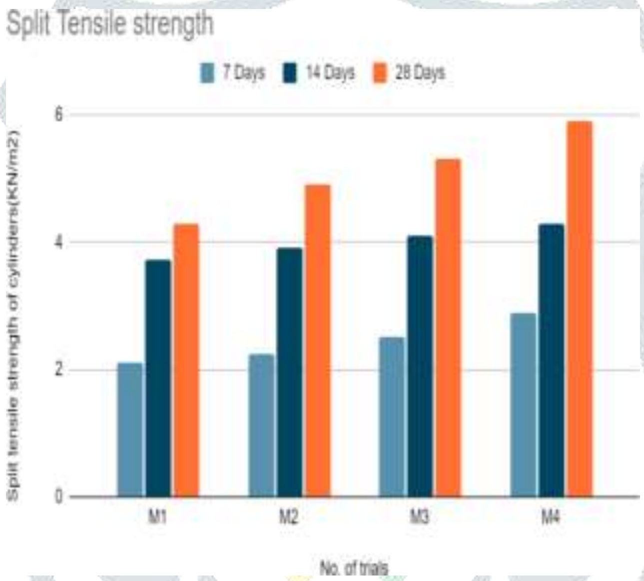
**Table 10.Flexural strength of beams**

**GRAPHICAL REPRESENTATION :**

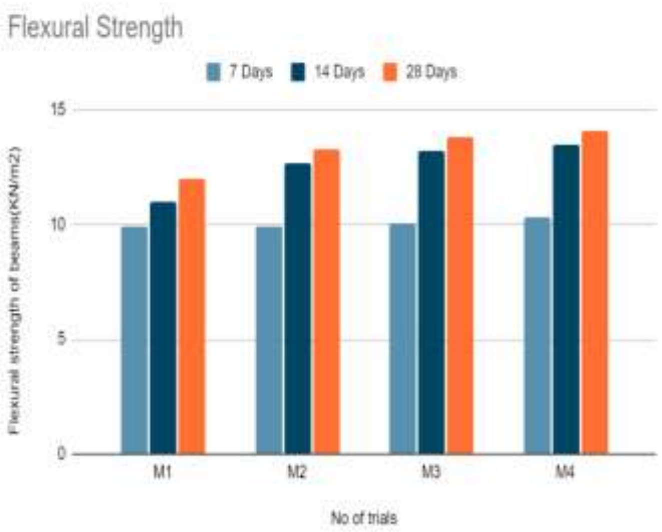
**Compressive strength test**




**Split tensile strength test**




# Flexural Strength



## CONCLUSION

1.The above experimental program leads to emphasize the effects of steel fibre and GGBS on properties of fresh and hardened steel fiber reinforced high performanceconcrete. It is observed from the results that the presence of steel fiber increases theoverall performance of the high performance concrete.

2. The enhancement in engineering properties has clearly shown in all the above mentioned experiments. Basically the superiority of the self-compacting concrete mainly lies in the strength and durability characteristics of the high performance concrete mixture.

3. The Optimum compressive strength of the designed concrete is achieved at mix M3 with 45% of cement is replaced with GGBS.
4. It is evident from the results, that tensile and flexural strengths increase with increase in dosage of fibers
5. But it is also seen that increase in dosage of fibers slightly effects the fresh properties of HPSCC.
6. In the present study it can be concluded that among M1 M2 M3 M4 mixes M3 can give satisfactory results in all engineering properties of concrete (fresh and hardened), with a replacement of 45% of cement with GGBS and using steel fibersat dosage of 1.5% by weight of cementations materials.
7. The specimens were found to be well compacted showing no signs of honeycombing, with smooth and clean surface finish.

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