

An Experimental Investigation of Self Compacting Concrete

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ABSTRACT: Global warming and environment destruction have become the major issue in recent years. Emission of green house gases from industrial process and its adverse impact has changed the climate. Preventing the depletion of natural resources and enhancing the usage of waste materials has become a challenge to the scientist and engineers. Number of studies has been conducted to concern the protection of natural resources and the prevention of environmental pollution. So to reduce the CO₂ emission from cement, the waste materials such as flyash are replaced partially in cement. To prevent the environment from noise and to make the work easy for the workers, self compacting concrete is used in this project. The ingredients used for SCC are 53 grade Ordinary Portland cement, Fine aggregate, Coarse aggregate, Super plasticizer, class-F Flyash from Thermal power plant, Viscosity modifying agent. Cement is replaced by fly ash at 20% by weight of cement. The basic properties of Cement, Flyash, and Coarse aggregate, Fine aggregate are studied. The Mix design is carried out for M30 grade concrete by European method. The Workability tests such as Slump Flow, V-Funnel, L-box, U-box test are carried out for self-compacting concrete. To carried out the mechanical properties such as compressive strength, flexural strength and split tensile. The slab are casted and tested at 7 and 28 days for self-compacting concrete and its impact test results are compared with Conventional M30 grade concrete.

KEYWORDS: SCC, Impact strength, self compacting concrete.

I. INTRODUCTION

There has been a growing interest in the past few decades among the engineering community to understand the response of reinforced concrete structures subjected to extreme loads due to blast and impact. Although these severe transient dynamic loads are rare in occurrence for most structures, and sudden structural failure. Self-compacting concrete (SCC) is considered as a concrete which can be placed and compacted under its own self-weight and no require vibration, and handled without segregation or bleeding. It is used to proper filling and good structural performance of restricted areas and heavily reinforced structural members. In seismic regions, SCC mainly used for highly congested reinforced structures. Recently, this concrete has gained wide use in many countries for different applications and structural configurations.

SCC can also provide a better working environment by eliminating the vibration noise. The super plasticizer addition of concrete mixture the slump value is highly are easily can be achieved. However, for such concrete to remain cohesive during handling operations, special attention has to be paid to mix proportioning. The addition of super plasticizer to avoid segregation, a simple approach consists of increasing the sand content at the cost of the coarse aggregate content by 4% to 5%. But the reduction in aggregate content results in using a high volume of cement which, in turn, leads to a higher temperature rise and an increased cost. The viscosity-modifying admixture is an alternative approach consists of incorporating to enhance stability.

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Self-compaction is often described as the ability of the fresh concrete to flow under its own weight over a long distance without segregation and without the need to use vibrators to achieve proper compaction. The main functional requirements of fresh self-compacting concrete(SCC) have been well documented and discussed by many workers . It is generally recognized that for SCC to perform efficiently, it should have an adequate plastic viscosity together with a low yield stress approaching the behavior of a Newtonian fluid. To achieve these, some of the basic requirements are for mixes to have high powder content and the incorporation of surface-active agents, such as super plasticizers. Inert fillers such as limestone are traditionally used to increase the powder content of SCC mixes. More recently, mineral admixtures have also been considered.

II. MATERIALS AND METHODS

The material used for this experimental work are cement, sand, water, steel fibers, and super plasticizer.

CEMENT

Cement can be defined as material having adhesive and cohesive properties which make it capable of bonding material fragments into a compact mass. Cement is the most important ingredient in concrete. Different brands of cement have been found to possess different strength development characteristics and rheological behaviour due to the variations in the compound composition and fineness. In this experimental study, Ordinary Portland Cement conforming to IS: 8112-1989 was used. The physical and mechanical properties of the cement used are shown in Table.

Table Properties of Cement

| S.No | Name of the test | Value |
|------|----------------------|-----------------|
| 1 | Consistency | 28 % |
| 2 | Initial Setting Time | 1 hr 15 minutes |
| 3 | Fineness modulus | 3 % |
| 4 | Specific gravity | 3.14 |

FINE AGGREGATE

The sand used for experimental program was locally procured and conforming to zone II. The sand was first sieved through 4.75 mm sieve to remove any particles greater than 4.75 mm. The fine aggregates were tested as per Indian Standard Specification IS: 383-1970. The physical and mechanical properties of the sand used are shown in Table 3.1.

Table Properties of Fine aggregate

| S.No | Name of the test | Value |
|------|------------------|--------------------------|
| 1 | Specific Gravity | 2.60 |
| 2 | Fineness modulus | 2.70 |
| 3 | Water absorption | 2.5 % |
| 4 | Bulk Density | 1487.6 kg/m ³ |

Angular shape aggregate which passes through 20 mm sieve and retain on 10mm are used as coarse aggregate in this project work. The specific gravity of coarse aggregate was 2.64 and fineness modulus of 7 was found out 12.5mm.

COARSE AGGREGATE

Aggregates typically constitute 70–80 wt-% of concrete; hence, aggregate types and sizes play an essential role in modifying the concrete properties. The maximum size of aggregate is generally limited to 20mm . Aggregate of size 10

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mm is desirable for structures having congested reinforcement. Well graded cubical or rounded aggregate are desirable. Aggregates should be of uniform quality with respect to shape and grading. The maximum 15 mm size was selected to reduce difficulties of producing, mixing and placing concretes and to prevent segregation of aggregates in fresh concretes. In my work aggregate of size 12.5 and down has been used. The physical and mechanical properties of the coarse aggregate used are shown in Table3.2.

Table Properties of Coarse aggregates

| S.No | Name of the test | Value |
|------|-------------------|---------------------------|
| 1 | Specific Gravity | 2.7 |
| 2 | Water absorption | 0.65% |
| 3 | Bulk density | 1652.89 kg/m ³ |
| 4. | Crushing strength | 22.12% |
| 5. | Impact strength | 19.18% |
| 6 | Flakiness index | 99.85% |
| 7. | Elongation index | 99.65% |

FLYASH

Flyash consists of fine, powdery particles that are predominantly spherical in shape, either solid or hollow, and most glassy in nature. Class F Fly ash as per IS 3812-2000 is used. The chemical and physical properties of fly ash are given below

TableChemical Properties of Fly Ash

| S. No. | Constituents | Percentage by weight |
|--------|--|----------------------|
| 1. | Silica (SiO ₂) | 59.62 |
| 2. | Iron Oxide (Fe ₂ O ₃) | 6.61 |
| 3. | Alumina (Al ₂ O ₃) | 26.43 |
| 4. | Calcium Oxide (CaO) | 1.2 |
| 5. | Magnesium Oxide (MgO) | 0.76 |
| 6. | Total Sulphur (SO ₃) | 0.07 |
| 7. | Sodium Oxide (Na ₂ O) | 0.58 |
| 8. | Potassium Oxide (K ₂ O) | 1.26 |

SUPERPLASTICIZERS

A number of studies have been conducted on the use of different types of super plasticizers with or without viscosity modifying agents in self-compacting concrete. These studies seem to indicate those that super plasticizers that work on the principle of 'steric hindrance' require a lower dosage compared to those based on 'electrostatic repulsion'. Stated in other words, acrylic copolymers (AC) and polycarboxylate ethers (PCE) are effective at lower dosages compared to sulfonated condensates of melamine (SMF) or naphthalene (SNF) formaldehyde. At present, SNF-based admixture is priced lower (in India) than that based on AC and PCE. In our project, we use Glenium 8233, a polycarboxylateether based super plasticizers.Gleniumsky 8233 is an admixture of a new generation based on modified polycarboxylicether. The produce has been primarily developed for applications in high performance concrete where the highest durability

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and performance is required. GLENIUM sky 8233 is free of chloride and low alkali. It is compatible with all types of cements.

Table Physical and chemical properties of Gleniumsky 8233

| S.No | Name of the test | Properties |
|------|---------------------|--------------|
| 1 | Form | Liquid |
| 2 | Colour | Light brown |
| 3 | Boiling point | > 100°C |
| 4 | Specific gravity | ≈ 1.2 |
| 5 | Viscosity | ≈ 50-150 cps |
| 6 | pH | 6 – 9 |
| 7 | Solubility in water | Soluble |

VISCOSITY MODIFYING AGENTS

The conventional method of improving the stability of flowing SCC is to increase the fines content by using a large amount of filler, reactive or inert. Of late, however, attempts are being made to reduce the fines content (and paste content) to the levels of normal concrete (in doing so, reducing the potential for creep and shrinkage) and use viscosity modifying agents (VMAs) to improve the stability. Current research shows that SCC produced with low powder content and VMA had similar fresh concrete properties as SCC with high powder contents produced without VMA. VMAs have been in use for a long time. They were mainly used for underwater concreting in the past, but are now also used in self-compacting concrete. Most VMAs have polysaccharides as active ingredient; however, some starches could also be appropriate for control of viscosity in SCC. The sequence of addition of VMA and super plasticizer into the concrete mixture is important. If VMA is added before the super plasticizer, it swells in water and it becomes difficult to produce flowing concrete. To avoid this problem, VMA should be added after the super plasticizer has come into contact with the cement particles. Another method of addition is to disperse the super plasticizer in mixing water and then add VMA to the mixture. In this project, we use Matrix-2 an viscosity-modifying agent.

Table 3.7 Properties of VMA

| Aspect | Light brown liquid |
|----------------------|--------------------|
| Relative density | 1.09±0.01 at 25°C |
| PH | < 0.6 |
| Chloride ion content | < 0.2% |

WATER

Water is the most important and least expensive ingredient of concrete. It acts as lubricant for fine and coarse aggregate and acts chemically with cement to form binding paste. The quantity water should be sufficient for hydration and suitable for workability. Normal potable water is used for mixing of concrete.

IV. FRESH CONCRETE PROPERTIES

TESTS ON FRESH CONCRETE

1. Slump flow & T₅₀ test
2. V-funnel test & V-funnel at T₅ minutes
3. L- box test

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4. U-box test

Table Workability test results for SCC

| S.No | Workability Test Methods | Minimum | Maximum | SCC |
|------|---|---------|---------|------|
| 1 | Slump flow (mm) | 600 | 800 | 700 |
| 2 | T ₅₀ cm Slump flow(sec) | 2 | 5 | 2 |
| 3 | V – funnel test (sec) | 6 | 12 | 7 |
| 4 | V – funnel test at T ₅ min (sec) | 0 | +3 | 5 |
| 5 | U – box test (sec) | 0 | 30 | 25 |
| 6 | L-box test(H2/H1) | 0.8 | 1 | 0.89 |

IV.SIMULATION & RESULTS

TESTS ON HARDENED CONCRETE

Various tests are carried out on hardened concrete to find its mechanical properties such as Compressive strength, Split tensile strength and Flexural beam test. The test result of conventional concrete is compared with self-compacting concrete for its strength and durability.

RESULTS ON COMPRESSIVE STRENGTH

The load failure on concrete in compressive strength at 7days and 28days in both conventional concrete and self-compacting concrete values are show in table.

Table Compressive strength on concrete

| S.No | Type of Concrete | Compressive strength (N/mm ²) | | | | |
|------|---|---|---------------------------------|---------------------------------|---------------------------------|------------------------------|
| | | Age of curing | Specimen 1 (N/mm ²) | Specimen 2 (N/mm ²) | Specimen 3 (N/mm ²) | Average (N/mm ²) |
| 1 | Conventional concrete 1:1.7:2.2 | 7 days | 21.4 | 19.47 | 20.3 | 20.39 |
| | | 28 days | 30.3 | 29.2 | 29.9 | 29.8 |
| 2 | Self-Compacting concrete 1:2.02:1.15 | 7 days | 22.2 | 24 | 23.4 | 23.2 |
| | | 28 days | 31.6 | 30.8 | 30.5 | 30.9 |

The comparison of compressive strength of conventional concrete and self compacting concrete for 7 and 28 days are show in the below graph in fig.The compressive strength on concrete for 7days and 28days in both conventional concrete and self-compacting concrete values are show in table

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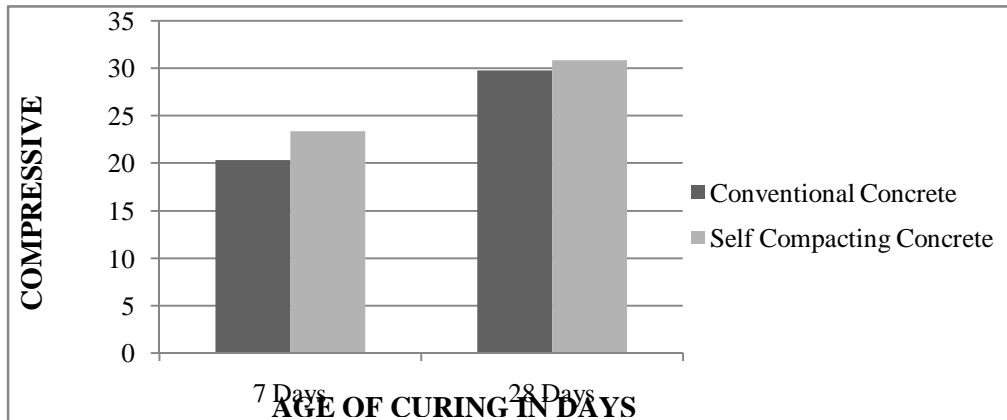


Fig compressive strength compared between CC and SCC

RESULTS ON SPLIT TENSILE STRENGTH

The load failure on concrete in split tensile strength at 7days and 28days in both conventional concrete and self-compacting concrete values are show in tableThe split tensile strength on concrete for 7days and 28days in both conventional concrete and self-compacting concrete values are show in table

TableSplit tensile strength on concrete

| S.No | Type of Concrete | Split tensile strength (N/mm ²) | | | | |
|------|---|---|---------------------------------|---------------------------------|---------------------------------|------------------------------|
| | | Age of curing | Specimen 1 (N/mm ²) | Specimen 2 (N/mm ²) | Specimen 3 (N/mm ²) | Average (N/mm ²) |
| 1 | Conventional concrete 1:1.7:2.2 | 7 days | 1.83 | 1.89 | 1.81 | 1.84 |
| | | 28 days | 2.29 | 2.31 | 2.3 | 2.3 |
| 2 | Self-Compacting concrete 1:2.02:1.15 | 7 days | 2 | 2.1 | 2.11 | 2.07 |
| | | 28 days | 2.5 | 2.49 | 2.58 | 2.52 |

The comparison of split tensile strength of conventional concrete and self compacting concrete for 7 and 28 days are show in the below graph in fig

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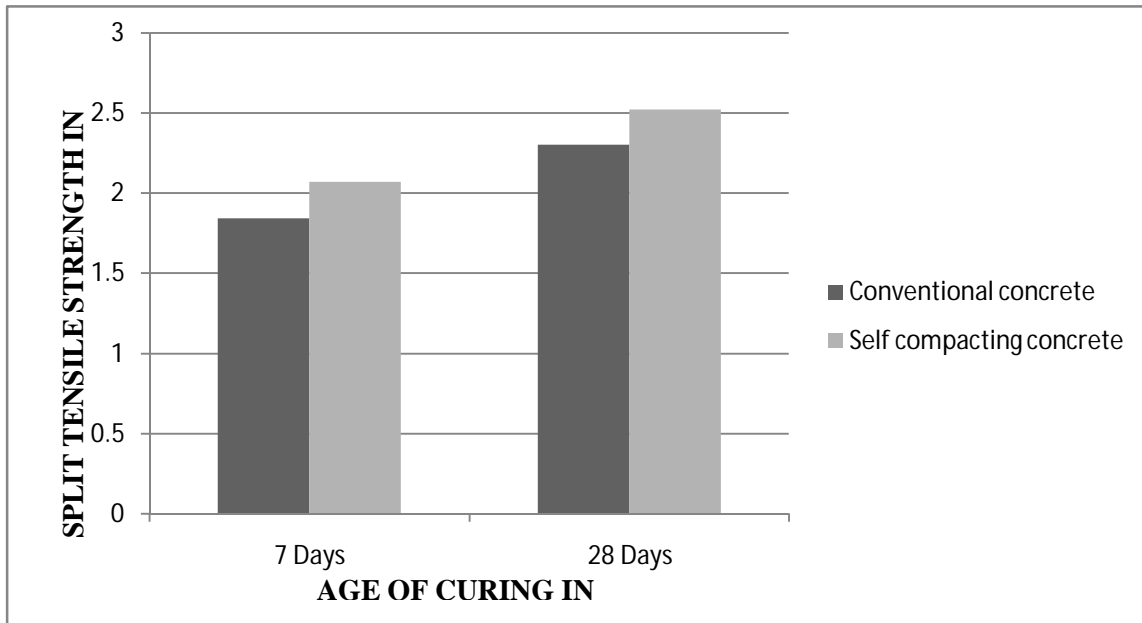


Fig Spilt tensile strength compared between CC and SCC

RESULTS ON FLEXURAL STRENGTH

The load failure on concrete in flexural strength at 7days and 28days in both conventional concrete and self-compacting concrete values are show in table. The Flexural strength on concrete for 7days and 28days in both conventional concrete and self-compacting concrete values are show in table.

Table Flexural strength on concrete

| S.No | Type of Concrete | Flexural strength (N/mm ²) | | | | |
|------|---|--|---------------------------------|---------------------------------|---------------------------------|------------------------------|
| | | Age of curing | Specimen 1 (N/mm ²) | Specimen 2 (N/mm ²) | Specimen 3 (N/mm ²) | Average (N/mm ²) |
| 1 | Conventional concrete 1:1.7:2.2 | 7 days | 3.81 | 3.9 | 3.72 | 3.81 |
| | | 28 days | 7.01 | 6.92 | 6.83 | 6.92 |
| 2 | Self-Compacting concrete 1:2.02:1.15 | 7 days | 4.1 | 4.23 | 4.17 | 4.15 |
| | | 28 days | 7.43 | 7.52 | 7.59 | 7.51 |

The comparison of flexural strength of conventional concrete and self compacting concrete for 7 and 28 days are show in the below graph in fig.

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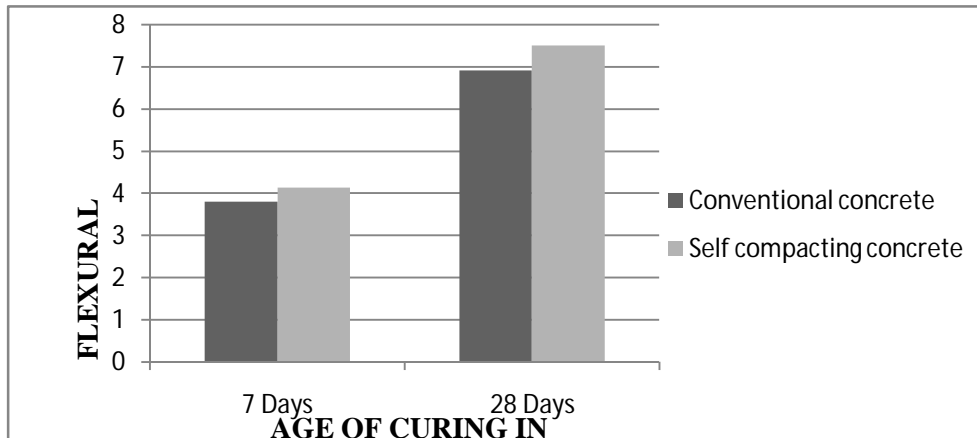


Fig Flexural strength compared between CC and SCC

v CONCLUSION

- The basic properties of materials were tested and results tabulated .The Self Compacting Concrete mix proportions are determined by using various trial and error method of SCC. In this project the used two admixtures such as super plasticizers and viscosity modifying agent. The Self compacting concrete is achieved by Cement, Fly ash, Coarse aggregate, Fine aggregate, super plasticizer, viscosity modifying agent and water. The flyashare replaced in cement at 20%.
- The fresh concrete test are conducted and to find out the workability. The fresh concrete tests like L box, V funnel, U box and slump flow tests were conducted and results tabulated.The prepared cube, cylinder and beam. And the mechanical properties are find out, such as compressive strength, spilt tensile strength and flexural strength on both conventional concrete and self compacting concrete at 7 and 28days.The test result are compared by using chart.
- The slab was prepared by using weld mesh in slab. The impact strength will be carried out both conventional concrete and Self compacting concrete at 7 and 28 days. And also to compare the conventional concrete and Self compacting concrete by using chart.
- In this my project the test results showed that the compressive strength, the split tensile and the flexural strength was good for self compacting concrete when compare to conventional concrete.

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