

## A Comparative Study of SCC with and without Fibre

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### ABSTRACT

A self-compacting concrete (SCC) is the one that can be placed in the formwork and can go through obstructions by its own weight and without the need of vibration. The primary aim of this study is to increase the strength properties of SCC with the addition of PP fibers and also compare the strength of concrete obtained with and without the use of PP fibers. This experimental study is aimed at producing SCC mix by using the Okumura Method, incorporating Master Glenium sky 8630 as chemical admixture and GGBS and Fly Ash powder as mineral admixtures which are supplementary cementing material. Replacement of mineral admixture by weight of cement was done in percentages, namely 100% cement, 70% cement + 30%GGBS. The test specimens were casted and cured well for 7 and 28 days and the compressive strength, flexural strength and split tensile strengths were investigated.

**Keywords :-** Self compacting concrete, Mix design, Modified nan su method, GGBS, Micro cement, Flow tests, Compressive strength, Flexural strength, Split tensile strength

### I. INTRODUCTION

Modern, present-day Self-Compacting Concrete (SCC) can be classified as an advanced construction material. The SCC, as the name suggests, does not require to be vibrated to achieve full compaction. This offers many benefits and advantages over conventional concrete. These include an improved quality of concrete and reduction of on-site repairs, faster construction times, lower overall costs, facilitation of introduction of automation into concrete construction. An important improvement of health and safety is also achieved through elimination of handling of vibrators and a substantial reduction of environmental noise loading on and around a site. The composition of SCC mixes includes substantial proportions of fine-grained

inorganic materials; this offers possibilities for utilization of dusts, which are currently waste products demanding with no practical applications and which are costly to dispose of. So far a mix design procedure to fix the ratio of all the ingredients in SCC is not standardized.

### II. POTENTIAL BENEFITS OF SCC

- **Use of complex designs and heavy reinforcement:**  
Because SC flows so readily into thin sections & details; it opens the potential for using complex shapes and intricate surfaces. It also ensures no patching of holes after casting or potential damage to pieces during vibration.

- **Construction times:**

Because SCC flows smoothly; it can be poured quickly & eliminates the need to vibrate the concrete into the tight spaces & around densely packed reinforcement. That speeds the entire production process.

- **Improved aesthetics and durability:**

The SCC's ability to remain stable during and after placement maximizes the structural integrity & durability of the concrete. It offers less permeability due to the high consolidation of material, allowing it to resist chemical attack & improve the components durability. Flow ability with higher powder content makes the surface finish look superior and attractive.

### III. APPLICATION OF SCC

After an extremely successful initial application in actual structures in Japan, the application of self-compacting concrete began in the entire world. Presently it is a very eagerly used material both in construction sites and in production of precast members. Extensive testing of physical and mechanical properties of SCC was carried out during the past decade. This was followed by economic analysis which confirmed the rationality of SCC application. Practical application was extended from large infrastructure buildings (bridges, tanks, retaining walls, tunnels, etc.) onto architectural buildings. SCC appears here as a structural material in load-bearing members but at the same time, it also appears frequently as architectural concrete. Architectural concrete was defined by the American Concrete Institute as "concrete which will be permanently exposed to view and which therefore requires special care in selection of the concrete materials, forming, placing and finishing obtaining the desired architectural appearance".

### IV. CONSTITUENT MATERIALS OF SCC:

#### A. Cement

Cement used for SCC should not contain  $C_3A$  content higher than 10% to avoid the problems of poor workability retention (EFNARC, 2002). Selection of the type of cement depends on the overall requirements for concrete, such as strength and durability. The typical content of cement is 350-450  $Kg/m^3$ . More than 500  $Kg/m^3$  cement can be dangerous and increase the shrinkage. Less than 350  $Kg/m^3$  may only be suitable with the inclusion of other fine filler, such as fly ash, pozzolana etc. Ordinary Portland cement 43 Grade (Brand name: RAMCO (43 GRADE)) conforming to the requirements of Grade IS 8112: 2013 was used in this experimental work. The quantity of cement required for the experiments was collected from single source and stored in a nearly airtight container. The tests were conducted on cement to obtain specific gravity, normal consistency, initial setting time and compressive strength.

#### B. Coarse Aggregates:

The maximum size and grading of the aggregates depends on the particular application. Maximum size of aggregate is usually limited to 20 mm. The coarse aggregate content in SCC is kept either equal to or less than that of the fine aggregate content. Better results were also obtained with smaller aggregate diameter.

According to Okamura (1977), if the coarse aggregate content in a SCC mixture exceeds a certain limit, blockage would occur independently of the viscosity of the mortar. Super plasticizer and water content are then determined to ensure desired self compacting characteristics. The aggregate packing factor determines the aggregate content, and influences the strength, flow ability and self-compacting ability (Su et al., 2001). The moisture content of aggregates should be closely monitored and must be taken into account in order to produce SCC of constant quality (EFNARC, 2005). The granite jelly of 12.5mm passing

is used. The sieve analysis of coarse aggregates conforms to the specifications of IS 383: 1970 for graded aggregates and specific gravity.

### C. Fine Aggregates :

Locally obtained natural river sand is used as the fine aggregate in the concrete mixes. The physical characteristics and sieve analysis results are presented in tables below. The sieve analysis result indicates that the sand confirms to zone-II as per IS: 383-1970 Fineness modulus (FM = Sum of cumulative % of wt. retained / 100) FM = 294/100 = 2.94.

### D. MasterGlenium Sky 8630:

MasterGlenium SKY 8630 is an admixture of a new generation based on modified polycarboxylic ether. The product has been primarily developed for applications in high performance concrete where the highest durability and performance is required. MasterGlenium SKY 8630 is free of chloride & low alkali. It is compatible with all types of cements.

**GGBS:** Slag is a by-product of the iron industry, generally used to replace Portland cement in the range of 15% to 30% of the total cementitious conventional concrete mixtures. Ground granulated blast furnace slag from JSW, used as cement replacement material.

## V. WORK PLAN

The research work has been conducted in the following phases.

- The first phase included a comprehensive literature survey and data collection in the following areas:
  1. Basic requirements of SCC
  2. Properties of fresh SCC
  3. Test procedures of SCC
  4. Mix design procedure for SCC
- The second phase involves the quantity calculation of required materials and procurement of the same.
- In the third phase, the mix design of a suitable SCC has been carried out in an exploratory manner. A series of trials has been conducted to

develop a suitable mix design using local aggregates. Number of trial mixes prepared using w/p ratio and FA/CA ratio keeping constant and varying super plasticizer dosages.

- In the fourth phase, specimens were casted and cured for 7 & 28 days
- The fifth phase, involved the analysis of experimental data.

## VI. TESTS ON MATERIALS:

Table 1: Cement

Sl. No	Properties	Test Results
1	Normal Consistency (in %)	32
2	Specific Gravity	3.14

Table 2: Coarse Aggregate & Fine Aggregate

Sl N	Physical properties	Fine aggregate	Coarse aggregate
1	Size	4.75mm	12.5mm
1	Specific gravity	2.62	2.60
2	Fineness modulus	2.69	6.6
3	Loose Bulk density(kg/m <sup>3</sup> )	1456.78	1346.60
4	Rodded Bulk density(kg/m <sup>3</sup> )	1642.89	1498.2

## VII. TESTS ON CONCRETE:

### Properties of concrete:

The properties of concrete is two types, they are fresh and hardened concrete properties. The performance of concrete properties are mainly depends upon the mix design, shape and strength of aggregates. Water-cement ratio is a main factor of fresh concrete property. It also affects the durability of concrete. The strength and life time of the structure is mainly depending on properties of concrete only.

## Fresh Properties Of Concrete:

### A. Slump test :

The slump flow is used to assess the horizontal free flow of SCC in the absence of obstructions. It was first developed in Japan for use in assessment of underwater concrete. The test method is based on the test method for determining the slump. The diameter of the concrete circle is a measure for the filling ability of the concrete.

### B. V-Funnel Test And V-Funnel At T<sub>5</sub> Minutes:

The test was developed in Japan and used by Ozawa Et Al . The equipment consists of a V-shaped funnel, shown in figure 3.4 An alternative type of V-funnel, the O funnel, with a circular section is also used in Japan. The described V-funnel test is used to determine the filling ability ( flow ability of the concrete with a maximum aggregate size of 20mm. The funnel is filled with about 12 liters of concrete and the time taken for it to flow through the apparatus measured. After this the funnel can be refilled with concrete and left for 5 minutes to settle. If the concrete shows segregation then the flow time will increase significantly.

### C. L- Box Test:

This test, based on a Japanese design for underwater concrete, has been described by Peterson . The test assesses the flow of concrete, and also the extent to which it is subjected to blocking by reinforcements. The apparatus is as shown in figure. The apparatus consists of a rectangular section box in the shape of an “L”, with a vertical and horizontal section, separated by a movable gate, in front of which vertical lengths of reinforcement bars are fitted. The vertical section is filled with concrete, and then the gate is lifted to let the concrete flow into the horizontal section. When the flow has stopped, the height of the concrete at the end of the horizontal section is expressed as a

proportion of that remaining in the vertical section. It indicates the slope of the concrete when at rest. This is an indication of the passing ability, or the degree to which the passage of concrete through the bars is restricted.

### D. U-Box Test:

The test is used to measure the filling ability of self- compacting concrete. The apparatus consists of a U-shaped Box and is divided by a middle wall into two compartments, as shown in fig.3.7 An opening with a slide gate is fitted between the two sections. Reinforcing bars with nominal diameters of 13 mm are installed at the gate with centre to centre spacing of 50 mm. This creates clear spacing of 35 mm between the bars. The left hand section is filled with about 20 liters of concrete then the gate lifted and concrete flows upwards into the other section. The height of the concrete in both sections is measured.

## Hardened Properties Of Scc:

### A. Compressive Strength Test:

The compression strength of concrete i.e., ultimate strength of concrete is defined as the load which causes failure of the specimen divided by the area of the cross section in uniaxial compression, under a given rate of loading. The steel cube moulds were coated with mould oil on their inner surfaces and were placed on Plate. Concrete was poured in to the moulds. The top surface was finished using trowel. After 48 hours concrete cubes were demoulded and the specimens were kept for curing under water. The test results are tabulated.

### B. Splitting Tensile Strength Of Concrete:

The bearing surfaces of the testing machine and of the loading strips shall be wiped clean. The test specimen shall be placed in the centering jig with packing strip and pieces are loaded carefully positioning along the top and bottom of the plane offloading of the specimen. The jig shall then be placed in the machine so that the specimen is located centrally. For cylindrical specimen it shall

be ensured that the upper plate is parallel with the lower plate

### VIII. RESULT AND DISSCUSSION

Table 6: Fresh concrete tests for without fiber:

MIX	Mix-1	Mix-2	EFNARC (2005)
Slump flow(mm)	660	659	650-800
V-funnel (sec)	12	11	6-12
L-box (H <sub>1</sub> /H <sub>2</sub> mm)	0.85	0.89	0.8-1.0
U-box (H <sub>1</sub> -H <sub>2</sub> mm)	26	23	0-30

Table 7: Fresh concrete tests for with fibre

MIX	Mix-1	Mix-2	EFNARC (2005)
Slump flow(mm)	665	662	650-800
V-funnel (sec)	10	8.5	6-12
L-box (H <sub>1</sub> /H <sub>2</sub> )mm)	0.87	0.93	0.8-1.0
U-box (H <sub>1</sub> -H <sub>2</sub> mm)	22	19	0-30

Table 8: Compressive strength of m30 concrete:

CURING IN DAYS	MIX PROPORTION	COMPRESSIVE STRENGTH (N/mm <sup>2</sup> )	
		WOF	WF
28 DAYS	MIX 1	29.7	31
	MIX2	23.6	30.6

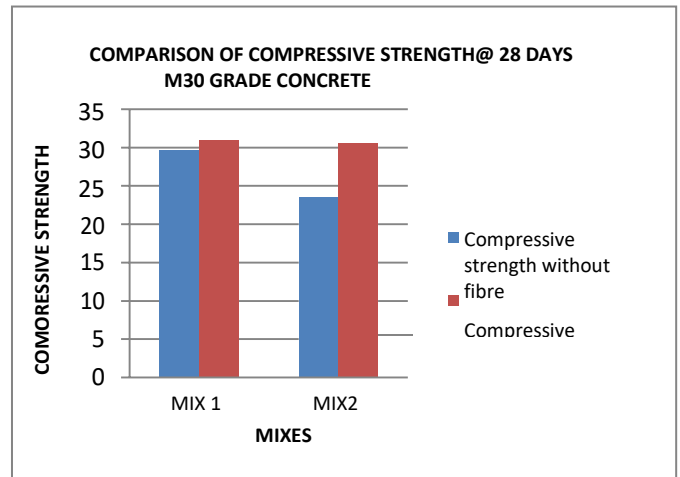
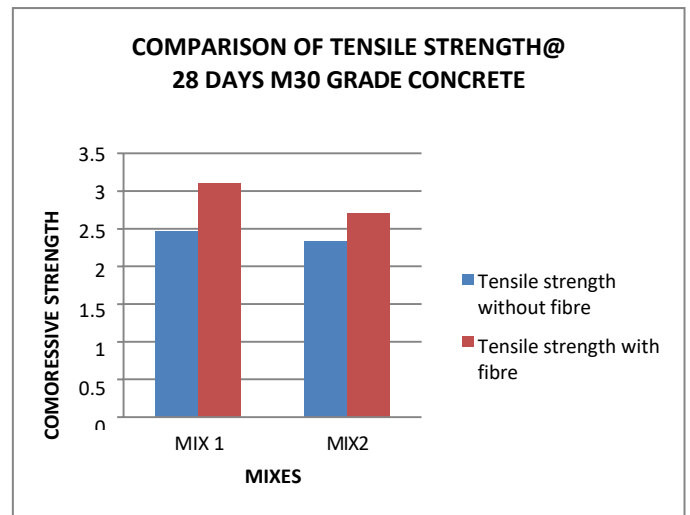


Table 9: Split tensile strength of m30 concrete

CURING IN DAYS	MIX PROPORTION	SPLIT TENSILE STRENGTH (N/mm <sup>2</sup> )	
		WOF	WF
28 DAYS	MIX 1	2.47	3.1
	MIX2	2.33	2.7



## IX. CONCLUSION

This Based on experimental study the following conclusion can be drawn

- A mix design based on Nan su method can be successfully employed for achieving SCC.
- All the mix proportion developed satisfies the requirement of SCC specified by EFNARC.
- In this study it has been found that with the increase in super plasticizer dosage the workability increases, hence the required slump value fulfils the criteria of EFNARC.
- Higher paste content not only makes the mix cohesive but also increases the compressive strength and at the same time it is well suited for achieving good flowability when crushed angular aggregates are used.
- It is advantageous to mix the super plasticizers and water before hand and mix the constituents for a time period of six minutes to achieve better absorption on cement particles and to provide good results for the fresh property tests of concrete.
- The compressive strength of all the specimen increases for concrete with fibre when compared to concrete without fibre..
- The split tensile strength of all the specimen increases for concrete with fibre when compared to concrete without fibre.
- Specimen containing PP fibres shows great percentage of increase in compressive strength, flexural and split tensile strength.
- Similarly based on the experimental results, it can be concluded that SCC with addition of fibers will reduce the shrinkage and increase the cohesiveness of the mix and also helps to increase the strength of the concrete.

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