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## Study on Self Compacting Concrete with Partial Replacement of Crushed Concrete as Fine Aggregate

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**ABSTRACT:** Self-Compacting Concrete" has recently been one of the most important developments in the building industry. It is a kind of concrete that can flow through and fill gaps of reinforcement and corners of moulds without any need of vibration and compaction during the pouring process. SCC is made of cement, fine aggregate, coarse aggregate, mineral admixture, super plasticizer and Viscosity Modifying Agent(VMA). In this paper the potential for usage of Recycled Fine Aggregate (RFA) obtained from crushed concrete for making of self-compacting concrete is done. Fine aggregate is partially replaced with RFA by 20%, 25%, 30% and 35%. The fresh concrete properties of SCC are investigated by slump flow, J ring flow, T50, V-funnel, Orimet and L-box test.

**KEYWORDS-** Self compacting concrete, Crushed concrete, fresh properties, compressive strength

### I. INTRODUCTION

Self-compacting concrete, also referred to as self-consolidating concrete can flow and consolidate under its own self weight and de-aerated almost completely while flowing in the formwork. It is cohesive enough to fill the spaces of almost any size and shape without segregation or bleeding. This makes self-compacting concrete particularly useful wherever placing such as in heavily reinforced concrete members or in complicated formworks. It has been used in Japan for the construction of bridge girders, towers and piers, culverts and building structures. The amount of aggregates, binders and mixing water, as well as type and dosage of super plasticizer (SP) to be used are the major factors influencing the properties of SCC. Nowadays Precast concrete plants are using self-compacting concrete in manufacturing, where it eliminates the need for vibrating machines and their associated noise. Self-compacting concrete can save labour, eliminate consolidation noise and lead to innovative construction methods. Since self-compatibility is largely affected by the characteristics of materials and the mix proportions, it becomes necessary to evolve a procedure for mix design of SCC. One of the limitations of SCC is that there is no established mix design procedure yet. The EFNARC Specification defines specific requirements for the SCC material, its composition and its application. The Annexes also include a wealth of useful advice to designers, concrete manufacturers, contractors, specifying authorities and testing organizations.

### II. LITERATURE REVIEW

A new mix design method for self- compacting concrete (SCC) is proposed. First, the amount of aggregates required is determined, and the paste of binders is then filled into the voids of aggregates to ensure that the concrete thus obtained flow ability, self-compacting ability and other desired SCC properties. Slump flow, V-funnel, L-flow, U- box and compressive strength tests were carried out to examine the performance of SCC, and the results indicate that the proposed method could produce successfully SCC of high quality[1]. A comparison between mechanical properties of

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self-compacting concrete and the corresponding properties of normal concrete is carried out by considering mechanical properties, such as strength, elastic modulus, creep and shrinkage[2]. Five mixtures of different combinations of water/cement ratio and super plasticizer dosage levels were investigated. Five different mixtures with the same cement dosage were produced by reducing the free water content and at the same time increasing the super plasticizer dosage in order to obtain a slump-flow value in the range of 65-80 cm. Optimum water/cement ratio for producing SCC is in the range of 0.6-0.37 by volume [3].

Different SCC mixes were produced with RCA substituting 0%, 30%, 50%, 70%, and 100% NCA by weight. The water to cement ratio and high range water reducer dosage were kept the same for all concretes. The test results revealed that the filling ability and passing ability of SCC were improved for 30% and 50% RCA which also possessed adequate segregation resistance. The overall test results suggest that RCA can be used to produce SCC substituting up to 50% NCA without affecting the key fresh properties of concrete [4]. Based on the results obtained from compressive strength, split tensile strength, modulus of elasticity and abrasion resistance test, it is reasonable to assume that the use of fine recycled concrete aggregates does not jeopardize the mechanical properties of concrete, for replacement ratios up to 30% [5]. The fine aggregate in concrete was replaced with 0%, 25%, 50% and 100% Crushed Concrete (CC). Generally, there is strength reduction of 15-30% for concrete containing CC. [6]. Three types of concrete mixtures were made by the recycled aggregated was 0%, 50% and 100%. The obtained results indicate that the properties of these concretes have only a slight difference, and that the recycled coarse aggregate can successfully be used for making of self-compacting concrete partially [7]. Fly ash is replaced by equal amount of cement as 10%, 20%, 30% and 40% where SCC is achieved in standard testing values [10].

### III. MATERIALS

Typical materials used for SCC are coarse aggregate, fine aggregate, cement, mineral admixture (fly ash) and chemical admixtures (super plasticizer, viscosity modifying agents).

#### CEMENT

Ordinary Portland cement of 53 grade from the local market (L&T ULTRATECH) is used and tested for physical and chemical properties as per IS 4031-1988 and found to be conforming to various specifications as per IS: 12269- 1987. Table 1 shows the physical properties of cement. Fly ash is used as a mineral admixture (powder content) and collected from "Thermal Power Station" at Mettur. This fly ash is based on Class C type.

**Table 1 Physical properties of OPC 53 grade**

S. No.	Characteristics	Values obtained	Standard value
1	Normal consistency	32%	26-33%
2	Initial setting time (minutes)	48	Not less than 30
3	Final setting time(minutes)	440	Not greater than 600
4	Fineness (%)	3.5%	<10%
5	Specific gravity	3.15	3.15

#### FINE AGGREGATE

The Specific Gravity, Fineness Modulus and Water absorption is 2.61, 3.46 & 10.6% respectively.

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## CRUSHED CONCRETE

The concrete is collected from a site of 20 year old residential building near Salem, which was crushed using a small jaw crusher. By sieving, the fractions between 0.075mm and 4.75 mm were used. The specific gravity and water absorption was 2.56 & 1.2%

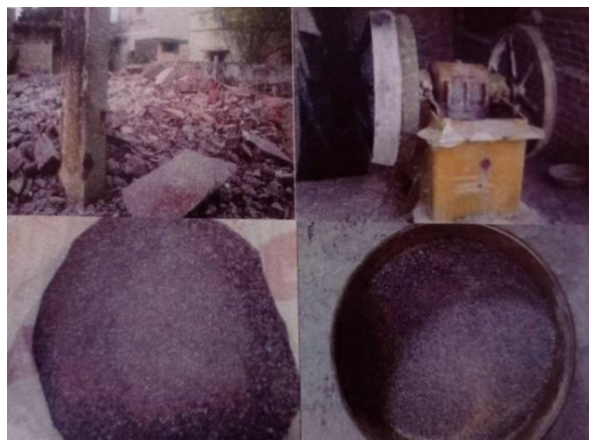


Fig. 1 Process of Crushing Concrete

## COARSE AGGREGATE

Granite stone aggregate of maximum size 16mm and retained on 10 mm sieve as per IS: 383-1970 was used for experimental purposes. The coarse aggregate is taken nearly 60% of 12.5mm size and the remaining 40% of 10mm size. Fineness modulus & specific gravity was 2.5 & 2.704.

## SUPER PLASTICIZER AND VISCOSITY MODIFYING AGENT

Glenium B233 is used as water reducing admixture which is based on modified polycarboxylic ether type [8]. GLENIUM STREAM 2 is used as Viscosity-Modifying Admixture (VMA).

## IV. EXPERIMENTAL INVESTIGATION

Based on EFNARC specification and guidelines, filling ability, Passing ability and Segregation resistance of SCC was carried out. Totally 5 trials were performed, the table 2 shows the workability values for 5<sup>th</sup> trial mix, which satisfies the all fresh concrete properties.

Table 2 workability properties of SCC

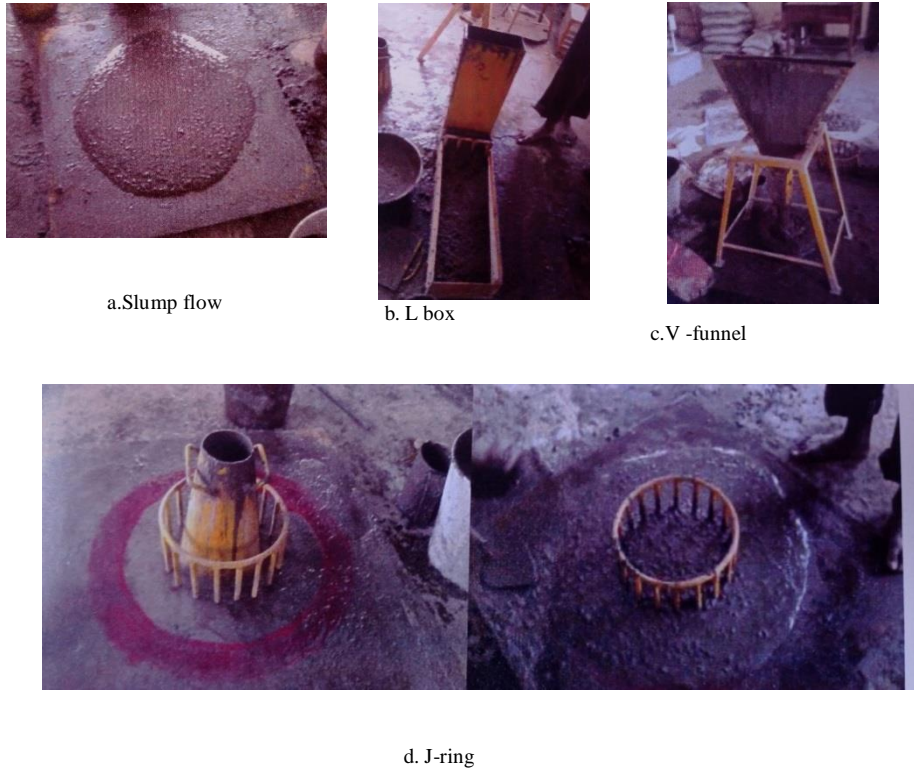
Test	Values
Slump flow(mm)	691
Slump flow (T50) sec	3.0
V-funnel To (sec)	9
V-funnel T5 (sec)	11
L box (H2/H1)	0.81
Orimet (sec)	4
J-ring(mm)	8

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**Fig. 2 Fresh property tests**

## PROPERTIES OF HARDENED CONCRETE

Totally 6 cubes and 6 cylinders are cast for trial mix, which satisfy the hardened concrete properties of SCC. Table 3 shows strength properties of concrete.

**Table 3 Properties of Hardened Concrete**

Mix	Compressive strength N/mm <sup>2</sup>		Tensile strength N/mm <sup>2</sup>	
	7 days	28 days	7 days	28 days
Final mix	27.446	43.46	3.976	4.89

## V. RESULTS AND DISCUSSION

The mix design is prepared for the SCC of M35 grade concrete. In this mix ratio of cement to the fly ash is adjusted by 0.3.0.35.0.4.0.45 and 0.5. The fresh concrete properties of trial are tested by slump flow, J ring flow, T50, V-funnel, Orimet and L-box test. The fresh concrete properties of above trial mixes is compared with EFNARC specification It can be concluded that addition of fly ash in mix increases filling and passing ability of concrete, whereas super plasticizer imparts workability to concrete improving segregation resistance of concrete[9]. Addition of fly ash in mix results in reduction of super plasticizer for a similar workability. Trial 5 mix is satisfied all the fresh concrete properties. The final mix proportion is Cement= 305kg/m<sup>3</sup>, Fly ash=153kg/m<sup>3</sup>, Fine aggregate =921kg/m<sup>3</sup> Coarse aggregate =711kg/m<sup>3</sup>, S.P dosage =1.7%, VMA =0.45%. The hardened properties of final mix are found by Compression Testing Machine with standard specimen. Totally 6cubes and 6cylinder are cast. Average Compressive strength and tensile strength of hardened control SCC at 28 days is 43.46 N/mm<sup>2</sup> and 4.89N/mm<sup>2</sup>.

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## VI. CONCLUSION

Based on the study of making self-compacting concrete and preparing the material of Recycled Fine Aggregate (crushed concrete), RFA has more water absorption and less density compare to natural sand due to its porosity and it can be suited for SCC

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