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To Study the Properties of Self-Compacting Concrete Using Recycled Aggregate and Glass Fiber

[1]Ravi Shanker Yadav, [2] Juned Ahmad

[1]Post-Graduate Student, Department of Civil Engineering, Integral University, Lucknow, U.P., India
[2]Assistant Professor, Civil Engineering, Integral University, Lucknow, U.P., India

Abstract: **This paper investigates the study of workability and durability characteristics of Self-Compacting Concrete (SCC) with Viscosity Modifying Admixture (VMA), and containing fly ash. The mix design for SCC was arrived as per the Guidelines of European Federation of National Associations Representing for Concrete (EFNARC). In this investigation, SCC was made by usual ingredients such as cement, fine aggregate, coarse aggregate, water, mineral admixture fly ash and demolished concrete at various replacement levels (5%, 10%, 15%, and 20%). To enhance the property of SCC made with the use of demolish concrete and fly ash, glass fiber has been added to the mix. Glass fiber in various % (i.e. 0.15%, 0.20% 0.30%, of Wt. of cement) has been added in the mix which contain demolish concrete and gave highest strength i.e. (10% demolish concrete).**

Keywords: **Self-compacting concrete, Fly ash, Mineral admixture, recycled aggregate, glass fiber.**

1. INTRODUCTION

Self-compacting concrete (SCC), requiring no consolidation work at site or concrete plants, has been developed in Japan to improve the durability and uniformity of concrete in 1988 (Okamura and Ouchi, 1999). The mix composition is chosen to satisfy all performance criteria for the concrete in both the fresh and hardened states. There is no standard method for SCC mix design, and many academic institutions as well as admixture, ready-mixed, precast and contracting companies have developed their own mix proportioning methods. As per EFNARC Guidelines for SCC mix design, one of the most important differences between SCC and conventional concrete is the incorporation of a mineral admixture. Thus, many studies on the effects of mineral admixtures on the properties of SCC have been conducted. These studies show the advantage of demolished concrete usage in SCC. Therefore, the durability of concrete is also increased (Assie et al., 2007). Industrial byproducts or waste materials such as limestone powder, fly ash and granulated blast furnace slag are generally used as mineral admixtures in SCC (Felekoglu et al., 2006; Unal et al., 2006). Thereby, the workability of SCC is improved and the used amount of by-products or waste materials can be increased. Besides the economical benefits, such uses of byproducts or waste materials in concrete reduce environmental pollution (Bosiljkov, 2003). Fly ash is an industrial by-product, generated from the combustion of coal in the thermal power plants. The increasing scarcity of raw materials and the urgent need to protect the environment against pollution has accentuated the significance of developing new building materials based on industrial waste generated from coal fired thermal power stations creating unmanageable disposal problems due to their potential to pollute the environment. Fly ash, when used as a mineral admixture in concrete, improves its strength and durability characteristics. Fly ash can be used either as an admixture or as a partial replacement of cement. It can also be used as a partial replacement of fine aggregates, as a total replacement of fine aggregates and as supplementary addition to achieve different properties of concrete. Viscosity Modifying Admixtures

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(VMA) make the concrete more tolerant to variations in the water content of the mix, so that plastic viscosity is maintained and segregation is prevented (EFNARC, 2005).

2. MATERIALS USED AND PROCEDURE

The sieve analysis of the coarse aggregate and fine aggregate are given in Table. In the dissertation demolished concrete has been used of size between 10mm and 12mm. The water absorption of the demolish concrete was found to be 3.5%. The specific gravity of fine and coarse aggregate was 2.62. A glass fiber has been used in the project to enhance the properties of SCC made with demolish concrete and fly ash. Ordinary Portland Cement of 43 grade was used in all mixes with a specific gravity of 3.15. 40% fly ash by mass of cementitious material as cement replacement was used. A poly-carboxylic-ether (PCE) super plasticizer was added in all mix, the PCE used was in the liquid form with specific gravity of 1.20. To enhance the stability of SCC a viscosity modifying agent (VMA) has been used.

Demolish concrete with different percentage say (5%, 10%, 15% and 20%) was used as partial replacement of coarse aggregate in the work.

Aggregate, demolish concrete, sand, cement and fly ash were mixed first for 1min, and then super plasticizer, VMA & polypropylene fiber that was mixed in water was added. Then all materials were mixed for 2 to 4 min. Several design procedure based on scientific theories or empirical experience have been proposed for the normal S.C.C. in general these procedures fall into the following three categories: 1) combination of super plasticizer and high content of mineral powders.2) combination of super-plasticizer and VMA with or without deforming agent, and 3) a combination of super plasticizer, mineral power and VMA. Here to achieve the SCC mix design, among the three mentioned basic criteria suggested to produce normal SCC, a combination of super plasticizer and VMA type was chosen and it was found that it is working well for a concrete to be self-compacting.

The main requirement of fresh SCC is a high rate of workability caused by high flow and mobility with sufficient cohesion and resistance to segregation during transportation and placement. The significant requirement is also resistance to blocking during concrete work of densely reinforced components and prolonged time of workability. Concrete design to fulfill such requirement completely fill the forms and moulds of complex, densely reinforced component by its own weight and at the same time, compact itself uniformly within as much as 90 min after mixing. The benefit of this technology is certainly also the fact that the SCC technologies considerably utilize waste materials, e.g fly ash, blast furnace slags, demolish concrete (as in this case).

3. PROPERTIES AND DISCUSSIONS OF FRESH SCC

A concrete mix can only be classified as self-complication if it has the following characteristics.

- Filling ability
- Passing ability
- Segregation resistance

Immediately after the mixing, the value of J-ring, V-funnel and V-funnel at T5min test were determine for finding out passing ability, filling ability and Segregation resistance respectively, for SCC by the following method.

J-ring test:

The J-ring test is used to determine the passing ability of the SCC. The equipment consists of a rectangular section (30mm*25mm), open steel ring, drilled vertically with holes to accept threaded section of reinforcement bar. These section of bar can be of different diameter spaced at different interval, in accordance with normal reinforcement consideration. The diameter of the ring of vertical bars is 300mm, and the height 100mm. After the test, the difference in height between the concrete inside and the just outside the j-ring is measured. This is an indication of passing ability, or the degree to which the passage of concrete through the bars is restricted.

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J-Ring Test **V-funnel and V-funnel at T5min Test**

Figure 1

V-funnel test:

The v-funnel test is used to determine the deformability through restricted area. The version selected for evaluation in this study had a rectangular crossing tapering to a bottom opening of 65mm*75mm. The funnel was fitted with a trap door. The test result is given as a flow time. The v-funnel selected can deal with mixes containing aggregate of size not exceeding 20mm. A sample of fresh concrete of between 12 to 15 liter in volume is required. Acceptable value range from 8-12 sec. The test was carried out for SCC.

V-funnel test at T 5min.:

In this test the funnel can be filled with concrete and left for 5 minutes to settle. If concrete shows segregation then the flow time will increase significantly. For V- funnel flow time at T 5 min. + 3 second is allowed.

Table 1 =Result of properties of fresh SCC

S.NO	Type Of Mix	J-Ring	V-Funnel	V-Funnel-T5min
1	Type 1	3.5mm	8.5 sec	9 sec
2	Type 2(10%)D.C	4mm	9 sec	10.50 sec
3	Type 3 (0.15%)G.F	4.5mm	9.8 sec	13.5 sec
4	0.20% G.F	5.7mm	10.40sec	13.20sec
5	0.30% G.F	6.3mm	11.70sec	13.64sec

4. EXPERIMENTAL TEST AND DISCUSSION OF HARDENED SCC

Casting and curing of test specimen after casting, the molded specimens were left on the casting room at room temperature for 48h. They were than demolded and cured in water for 28 days. The specimens of dimension (15*15*15cm) were used for compressive strength (cube) and specimen of dimension (10*10*50cm) was used for flexural strength (beam).

In this dissertation work 3 type of casting has been done to study the properties of SCC. Type 1-Nominal casting for SCC of M25 grade. Type 2-Casting of SCC with the partial replacement of coarse aggregate with demolish concrete in various percentage say (5%, 10%, 15% & 20%) in the nominal mix. Type 3- Casting of SCC with the addition of glass fiber in various percentage say (0.15%, 0.20% & 0.30% by wt of cement) to the mix which gave highest strength while using demolish concrete.

Compressive Strength Test and Results:

For three type of studied, the total number of 24 concrete cube specimens of (15*15*15cm) was caste and tested at 28 days. The result for average value of three specimens, were calculated and is shown in the table below.

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Table: 2. Compressive strength for type 1 mix

S.NO	Compressive Strength(MPa)
1	37.52

Table: 3. compressive strength for type 2 mix

S.NO	Demolished concrete%	Compressive Strength(MPa)
1	5%	28.17
2	10%	30.37
3	15%	25.32
4	20%	24.85

Table: 4. Compressive strength for type 3 mix

S.NO	% of glass Fiber	Compressive Strength(MPa)
1	0.15	32.50
2	0.20	35.07
3	0.30	33.47

Flexural Strength Test and Results:

For three type of studied, the total number of 24 concrete beam specimens of (10*10*50cm) was casted and tested at 28 days. The result for average value of three specimens, were calculated and is shown in the table below.

Table:5. Flexural strength for type 1

S.NO	Flexural Strength(MPa)
1	8.47

Table 6. Flexural strength for type 2

S.NO	Demolished concrete%	Flexural Strength(MPa)
1	5%	5.04
2	10%	6.20
3	15%	4.12
4	20%	1.98

Table 7. Flexural strength for type 3

S.NO	% of glass Fiber	Flexural Strength(MPa
1	0.154	6.34
2	0.20	7.15
3	0.30	5.08

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5. CONCLUSION

The following important result can be summarized by the investigation carried out on the different mix of SCC tests:

1. The SCC made with 40% of fly ash as the cement replacement gave satisfactory result after the 28 days of testing. Compressive strength for M25 grade of SCC was found to be 35.07MPa and modulas of rapture as 7.15.

2.On the base of above result, on the same mix T.C.A was partially replaced by demolish concrete in different percentages (5%,10%,15% &20%) it was found that best result for compressive strength and modulus of rupture was for 10% demolish concrete i.e 37.52 MPa and 8.47 repectively.

3. On the above mix glass fiber was added in various percentages to enhance the properties of SCC and it was found that no considerable change in compressive strength was found but the modulus of rupture was found to increase for 0.20%. But with further increase in the % of polypropylene modulus of rupture was found to decrease. Hence 0.20% of wt of cement of glass fiber should be added for best result for SCC.

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