

## Self-compacting concrete (SCC) properties resulting from the use of uncrushed coarse aggregate and fly ash (CA)

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### Abstract:

*This exploration paper talks about the adjustment in the usefulness and quality attributes of Self Compacting Concrete (SCC) because of expansion of fly-debris and utilization of un-squashed Coarse Aggregate (CA). Lab based exploratory work was done by getting ready 12 SCC blends among which six blends contained squashed total and other six blends contained un-squashed coarse total. A sum of 550 kg/m<sup>3</sup> cover content and fixed Water-Binder (W/B) proportion as 0.35 were utilized. Two blends were constrained by utilizing Portland Cement (PC) and other ten blends contained PC and Fly Ash (FA). Droop stream time, droop stream distance across and J-ring tallness tests were led to contemplate the new properties of SCC. Besides, compressive quality was determined at 7, 14 and 28 days of restoring. The results demonstrated that the droop stream time, droop stream breadth and J-Ring stature for all the blends are inside the cutoff points indicated by EFNARC rules. The compressive quality of SCCs relies on measurements of fly debris. Compressive quality for SCCs with squashed CA was better than got in the event of un-squashed CA. The most extreme compressive-qualities were seen as 64.58 MPa and 58.05 MPa for SCC with squashed and un-squashed CA individually.*

**Keywords:** Self-Compacting Concrete; SCC; Fly Ash; Un-crushed Coarse Aggregates; Fresh Properties; Compressive Strength.

### I. Introduction

Compaction at narrow places is one of the major problems observed in reinforced concrete construction. However, the SCC is the best option in such situations. SCC is the one that flows through its own weight and hence is very effective in pouring at heavily-reinforced, narrow and deep sections without any vibrational efforts required [1-3]. SCC is the mixture of cement, aggregates, water, admixtures and some mineral additives analogous to the normal concrete. Unlike normal concrete, SCC requires more amount of fillers materials and Super Plasticizers (SP) to give better strength and workability. SCC results in reduction of labour work and also economizes the cost of concreting [4-8]. High quantity of fine-materials such as fly-ash is utilized for acquiring required workability to SCC. This also reduces the issue of segregation and bleeding while transportation and placement of concrete. Many researchers concerned with environmental conservation have criticized the use of cement as a binding material.

Since the demand of cement in concrete production is amplified, it has caused resource depletion, environmental damages and huge amount of carbon-dioxide (CO<sub>2</sub>) emission during cement manufacturing process [9]. This has made serious concern of the practitioners and researchers to bring alternative materials of cement such as fly ash. These types of materials are considered safer for emitting. Thus, investigating symbolic properties of these waste materials open new possibilities for concrete development [10]. Use of such waste material in concrete is also very useful in enhancing the properties of concrete and also enhancing durability values [11-14]. Hence, this study has focused to conduct symbolic work for studying behaviour of fly ash in SCC. Fly ash generated from burnt coal is waste material and available at huge amount worldwide which creates more chances to use it as an alternate for cement concrete works. When the fly ash is inserted in concrete, it forms Calcium Hydrated Silicate Gel due to its reaction with calcium hydroxide during process of hydration at ambient temperature. Research works has highlighted that availability of Fly ash can provide the opportunity of replacing OPC up to 60% of its mass [9].

Several researchers have proposed and tested fly ash as mineral admixture for improving the properties at fresh and hardened state as well as the durability of the SCCs. Phathak and Siddique (2012) investigated of SCC with class F Fly ash by replacing cement with (0%, 30%, 40% and 50%) of fly-ash while temperature variation was considered as 20°C, 100°C, 200°C and 300°C. Test results revealed that compressive strength was in between 21.43 MPa and 40.68 MPa while tensile strength was recorded in between 1.35 MPa (min) and 3.60 MPa (max). The authors concluded that

28 days curing caused increment in compressive as well as tensile strength. Further, it was noted that compressive strength had improvement at the temperature of 200°C to 300°C while tensile strength was slightly reduced when temperature was raised above 20°C [15]. Fernando et al. (2018) developed SCC with reduced amount of cement. They added metakaolin and fly-ash as cementitious materials in SCC for evaluating flow ability and strength characteristics of concrete. From research work, it can be argued that metakaolin and fly ash addition is very usable in manufacturing low strength SCC with required workability and lower use of binder [16].

A research work conducted by Dinesh et al. (2017) showed comparison of effect of silica-fume and fly-ash as cementitious materials. The study revealed that silica fume exhibited positive results in increasing the concrete properties as compared to fly ash [17]. Jalal et al. (2015) studied the rheological characteristics of SCC when cement was partially replaced by silica nano, SF and fly ash. Experiments showed that fly ash is helpful in improving the rheological properties when compared with the other materials. However, when SF and silica nano particle are mixed together as cementitious material, they revealed considerable effect on both the mechanical and rheological characteristics [18]. Considering the need of sustainability, it is more advisable to utilize waste materials as new construction materials. This will exert positive impact on environment as well social values. Hence, this study is aimed to use fly ash as cementitious material to reduce the quantum of OPC. Also un-crushed coarse aggregates obtained from sieving of hill sand are used as coarse aggregate. For this purpose, total 12 concrete mixes were designed. Out of them six mixes for crushed and six for un-crushed CA with respect to the inclusion of fly ash. Fly ash has partially replaced (by weight), the cement at the levels of 0% to 20% with 4% increment. This article is structured systematically to study the behavior of fly ash in SCC. It is stated with introduction following the material and methodology used for conducted the research work. Finding of the current work are presented and the article is ended up with conclusion of the research work.

The results of the average compressive strength profile of SCCs using crushed and un-crushed coarse aggregates at different curing ages respectively. It is observed that the compressive strength is improved by raising the dosage of fly ash up to 8%. The average increase was observed 6.7% and 4% at 28 days curing for SCC manufactured by using crushed and un-crushed aggregates respectively. While for more replacement levels of fly ash, the compressive strength is slightly decreased for both the concretes at all curing ages. Similar study was conducted by Jalal et al. (2015) by adding 10% fly ash where compressive strength measured at 28 day was recorded as 37.3 MPa [18]. Comparing the results of current study as in Table 2 with the work of Jalal et al. (2015), it can concluded that the compressive strength with 8% fly ash at 28 days obtained is approximately 18% higher than that achieved by Jalal et al. (2015). Figures 8, 9 and 10 shows the graphical comparison of compressive strength of proposed concrete by using crushed and un-crushed coarse aggregates for 7, 14 and 28 days curing respectively. From these figures it may be observed that SCCs manufactured with crushed CA exhibited the higher compressive strength than concretes with un-crushed CA in the respective group of mixes having the same replacement levels of fly ash and curing ages.

## **II. Conclusions**

From the obtained results subsequent conclusion are drawn:

- Fresh properties of SCC depend upon mix proportions and these can be adjusted with the appropriate dosage of SP;
- The optimum dosage of SP used to maintain the required specified values of slump flow diameter between 70 to 80 cm is 2%;
- An identical trend was observed in slump flow time and J-Ring height for all the mixes were found to be within the limits specified for EFNARC;
- It was observed that the values of fresh properties are remarkably increased while using un-crushed CA;
- Compressive strength of SCCs depends upon the dosage of cement replacement levels of fly ash;
- The 28 days compressive strength of SCC with crushed and un-crushed CA increases by raising the percentage of fly ash to 8% instead of 6.7% and 4% of their respective controlled mix;
- The strength properties were improved when SCC was manufactured with crushed CA. The maximum compressive strength at 28 days was recorded 64.58 MPa at 8% replacement level of fly ash.

## **III. Conflicts of Interest**

The authors declare no conflict of interest.

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