# EFFECT OF FLY ASH AND BRICK DUST AS A PARTIAL REPLACEMENT OF FINE AGGREGATES ON THE TENSILE STRENGTH OF SELF COMPACTING CONCRETE

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**ABSTRACT**

The main aim of this study is to study the effect of brick dust and fly ash as a partially replacement of fine aggregates in self compacting concrete on the tensile strength of concrete. In this study seven mixes were prepared using different percentage of fly ash and brick dust as a replacement of fine aggregates. Experiments were conducted on the ordinary concrete and self compacting concrete to study the effect of brick dust and fly ash on the tensile strength of concrete.

**Key words :** Brick dust, Fly ash

## 1.0 INTRODUCTION

Self-compacting concrete (SCC) is considered as a concrete which can be placed and compacted under its self weight with little or no vibration effort, and which is at the same time cohesive enough to be handled without segregation or bleeding of fresh concrete. Whilst the use of super plasticizer maintains the fluidity, the fine content provides stability of the mix resulting in resistance against bleeding and segregation. Compared to normally vibrated concrete (NVC), self-compacting concrete (SCC) possesses enhanced qualities and improves productivity and working conditions due to the elimination of compaction. SCC generally has higher powder content than NVC and thus it is necessary to replace some of the cement by additions to achieve an economical and durable concrete. Japan has used self-compacting concrete (SCC) in bridge, building and tunnel construction since the early1990‘s. In the last five years, a number of SCC bridges have been constructed in Europe. In the United States, the application of SCC in highway bridge construction is very limited at this time. However, the U.S. precast concrete industry is beginning to apply the technology to architectural concrete. SCC has high potential for wider structural applications in highway bridge construction. The introduction of "modern" self-leveling concrete or self-compacting concrete (SCC) is associated with the drive towards better quality concrete pursued in Japan around 1983, where the lack of uniform and complete compaction had been identified as the primary factor responsible for poor performance of concrete structures (Dehn et al., 2000). Due to the fact that there were no practical means by which full compaction of concrete on a site was ever to be fully guaranteed, the focus therefore turned onto the elimination of the need to compact, by vibration or any other means. This led to the development of the first practicable SCC by researchers Okamura and Ozawa, around (1986), at the University of Tokyo and the eminent Japanese contractors (e.g. Kajima Co., Maeda Co., Taisei Group Co., etc.) quickly took up the idea. The contractors used their large in-house research and development facilities to develop their own SCC technologies. Each company developed their own mix designs and trained their own staff to act as technicians for testing on sites their SCC mixes. A very important aspect was that each of the large contractors also developed their own testing devices and test methods. In the early 1990's there was only a limited public knowledge about SCC, mainly in the Japanese language. The fundamental and practical know-how was kept secret by the large corporations to maintain commercial advantage. The

SCCs were used under trade names, such as the NVC (Non-vibrated concrete) of Kajima Co., SQC (Super quality concrete) of Maeda Co. or the Bio concrete. Simultaneously with the Japanese developments in the SCC area, research and development continued in mix-design and placing of underwater concrete where new admixtures were producing SCC mixes with performance matching that of the Japanese SCC concrete (e.g. University of Paisley / Scotland, University of Sher Brooke / Canada) (Ferraris, 1999).

As we know that brick dust is a waste which is produced in every place of the world and in India tons of wastes is produced every year. Similarly fly ash is also type of waste. So this study is also an attempt towards the efficient use of the waste brick dust and fly ash.

## 2.0LITERATURE REVIEW

**Felekoglu (2005)** has done research on effect of w/c ratio on the fresh and hardened properties of SCC. According to the author adjustment of w/c ratio and super plasticizer dosage is one of the key properties in proportioning of SCC mixtures. In this research, fine mixtures with different combinations of w/c ratio and super plasticizer dosage levels were investigated.

**Nan Su (2001)** proposed a new mix design method for self-compacting concrete. First, the amount of aggregates required was determined, and the paste of binders was then filled into the voids of aggregates to ensure that the concrete thus obtained has flow ability, self-compacting ability and other desired SCC properties. The amount of aggregates, binders and mixing water, as well as type and dosage of super plasticizer to be used are the major factors influencing the properties of SCC. Slump flow, V-funnel, L-flow, U-box and compressive strength tests were carried out to examine the performance of SCC, and the results indicated that the proposed method could be used to produce successfully SCC of high quality.

**Hajime Okamura (1997)** A new type of concrete, which can be compacted into every corner of a formwork purely by means of its own weight, was proposed by Okamura (1997). In 1986, he started a research project on the flowing ability and workability of this special type of concrete, later called self-compacting concrete. The self-compact ability of this concrete can be largely affected by the characteristics of materials and the mix proportions. In his study, Okamura (1997) has fixed the coarse aggregate content to 50% of the solid volume and the fine aggregate content to 40% of the mortar volume, so that self-compact ability could be achieved easily by adjusting the water to cement ratio and super plasticizer dosage only.

**Dehn (2000)** have focused their research work on the time development of SCC compressive and splitting tensile strength and the bond behavior between the reinforcing bars and the self-compacting concrete compared to normal concrete. In order to ensure a good production of SCC, a mix design should be performed, so that the predefined properties of the fresh and hardened concrete would be reached for sure. All the components should be coordinated so that bleeding and segregation would be prevented. Because of these aspects, their mix design was based on experience from Japan, Netherlands, France, and Sweden. Due to the fact that the load bearing capacity of a reinforced concrete structure is considerably influenced by the bond behavior between the reinforcing bars and the concrete, the following items were taken into account:

- crack width control
- lapped reinforcing bar

For this reason, investigations on the bond behavior between the re-bars and the SCC were necessary, especially considering the time development of the bond strength. These investigations showed, that the main parameters which influence the bond behavior are the surface of the re-bars, the number of load cycles, the mix design, the direction of concreting, as well as the geometry of the (pull-out) test specimens (Figure 2.4). The bond behavior was determined under uniform static loading using pullout specimens having a uniform concrete cover around the reinforcing bar. The bar diameter for the whole test series was 10 mm and the concrete cover around it had a diameter of 10 cm and a length of also 10 cm.

## 3.0 RESEARCH SCOPE

The effect of use of brick dust and fly ash as a partial replacement of fine aggregate in concrete on tensile strength, of self-compacting concrete.

## 4.0 RESEARCH OBJECTIVES

The main objectives set for this research were to compare the tensile strength of self-compacting and normal concrete specimens and. The criteria used were based on 7days, 28-day and 56 days tensile and of conventional and self-compacting concrete for seven Fly ash & Brick dust ratios as a replacement to fine aggregate.

Attempts have also been made to enhance the tensile strength of self compacting concrete by the use of fly ash and brick dust as a partial replacement of fine aggregates in self compacting concrete.

## 5.0. EXPERIMENTAL PROGRAM

### 5.1. Mix Proportions

**Table 5.1.1: Mix Proportions of SCC**

| Mix design | Normal mix | Mix 1 | Mix 2 | Mix 3 | Mix 4 | Mix 5 | Mix 6 |
|---|---|---|---|---|---|---|---|
| Cement (Kg/$m^3$) | 440 | 440 | 440 | 440 | 440 | 440 | 440 |
| Fly ash | 00 | 53 | 85 | 107 | 128 | 160 | 214 |
| Brick Dust | 00 | 53 | 85 | 107 | 128 | 160 | 214 |
| Coarse Aggregate | 720 | 720 | 720 | 720 | 720 | 720 | 720 |
| Fine Aggregate | 1067 | 961 | 897 | 854 | 811 | 747 | 639 |
| Super Plasticizer | 1.25% | 1.25% | 1.25% | 1.25% | 1.25% | 1.25% | 1.25% |
| Water/Cement | 0.40 | 0.40 | 0.40 | 0.40 | 0.40 | 0.40 | 0.40 |

### 5.2 TENSILE STRENGTH

Due to the usage of mineral and chemical admixtures in the concrete mixtures, an increase in the tensile strength of the self-compacting concrete could be observed, compared to the strength of conventional concrete. Table 5.2 presents the splitting tensile strengths for normal and self-compacting concrete specimens, as they were tested after being cured for 7 days, 28 days and 56 days. In addition, It can be seen from chart 5.2 that the strengths of SCC after 7 days are comparable to those obtained after 28 days for NC. This was possible because of the use of Fly ash & Brick dust as fine aggregate replacement, which usually tend to increase the early strength of concrete.

**Figure shows Tensile Strength Testing Machines**

**Table 5.2 Tensile Strength Properties**

| MIX | Tensile Strength (N/mm$^2$) | | Average Tensile strength (N/mm$^2$) | | | |
|---|---|---|---|---|---|---|
| | 7 days | 28 days | 56 days | 7 days | 28 days | 56 days |
| Normal mix | 2.74 | 3.45 | 4.21 | 2.72 | 3.45 | 4.19 |
| | 2.45 | 3.67 | 4.15 | | | |
| | 2.98 | 3.23 | 4.23 | | | |
| Mix 1 | 2.88 | 3.67 | 4.44 | 3.00 | 3.77 | 4.38 |
| | 3.10 | 3.76 | 4.49 | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| | 3.02 | 3.88 | 4.23 | | | |
| Mix 2 | 3.31 | 3.89 | 4.56 | 3.22 | 3.85 | 4.68 |
| | 3.21 | 3.69 | 4.78 | | | |
| | 3.15 | 3.97 | 4.71 | | | |
| Mix 3 | 3.56 | 4.11 | 4.89 | 3.59 | 4.25 | 4.95 |
| | 3.78 | 4.21 | 4.95 | | | |
| | 3.43 | 4.45 | 5.01 | | | |
| Mix 4 | 3.87 | 4.62 | 5.23 | 3.92 | 4.61 | 5.37 |
| | 3.92 | 4.78 | 5.34 | | | |
| | 3.97 | 4.45 | 5.55 | | | |
| Mix 5 | 4.0 | 4.8 | 5.3 | 4.08 | 4.96 | 5.51 |
| | 4.1 | 4.9 | 5.6 | | | |
| | 4.15 | 5.2 | 5.65 | | | |
| Mix 6 | 4.2 | 5.28 | 5.65 | 4.3 | 5.33 | 5.7 |
| | 4.25 | 5.30 | 5.70 | | | |
| | 4.30 | 5.40 | 5.80 | | | |

## CONCLUSIONS

The split tensile strengths of SCC after 7 days are comparable to those obtained after 28 days for NC. This was possible because of the use of Fly ash & Brick dust as fine aggregate replacement, which usually tend to increase the early strength of concrete. Also, because of the special admixtures used, SCC has achieved a density between 2400 and 2500 kg/m3, which was greater than that of normal concrete, 2370-2321 kg/m3. Self-compacting concrete can be obtained in such a way, by adding chemical and mineral admixtures, so that it's splitting tensile are higher than those of normal vibrated concrete.

The strength was increased at later ages also but not so quickly because the pozzolanic reaction of the fly ash is faster at early ages and the brick dust acts as a filler also along with pozzolanic activity against the fine aggregate which acts as a filler product only.

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