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Performance of Self Compacting Concrete using Flyash & Msand - An Experimental Study

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Abstract: **Self Compacting Concrete (SCC) demands large amount of powder content and fines for its cohesiveness and ability to flow without bleeding and segregation. In this investigation, cement and sand are partly replaced by pozzolanic-cementitious material Fly ash (class F) and manufactured sand to produce M30 grade Self Compacting Concrete which minimizes the overall cost of SCC. The trial mix of SCC is designed by the reference of EFNARC specifications and some research papers. The partial replacement percentage of fly ash and manufactured sand varies from 0 to 40%.**

The total number of trial mix proportions is 25, and for each trial mix, fresh concrete properties were studied such as filling ability, passing ability and segregation resistance through slump flow test, T_{50cm} slump flow test, V-funnel test and L-box test. The satisfied trial mixes in fresh state were cast for the study of hardened concrete properties such as compressive strength, split tensile strength and flexural strength. The cube compression tests, flexural tests and split tensile tests were carried out at 3, 7 and 28 days of curing periods. The increase in partial replacement of cement by fly ash improved fresh and hardened concrete property up to the range of 30%. Better results were observed in split tensile and flexural strength up to the mix proportion of 30% of fly ash and 40% of manufactured sand.

Keywords: **SCC, Msand, Flyash, admixtures**

1. INTRODUCTION

Self-compaction concrete (SCC) also referred as "self-consolidated concrete" or "silent concrete" is the one which flows to a virtually uniform level under the influence of gravity without segregation during which it de-aerates and completely fills the form work and the spaces between the reinforcement without any need for induced compaction. SCC demands large amount of powder content and fines for its cohesiveness and ability to flow without bleeding and segregation.

SCC is obtained by limiting the water-cement ratio (w/c), adding an effective plasticizer, increasing sand-aggregate ratio and adding some mineral pozzolanic admixtures such as fly ash, GGBFS, silica fume, stone powder etc. The use of SCC will lead to mass production and improved quality, durability, and reliability of concrete structures as well as eliminate human error.

1.1 Significance of Flyash and Manufactured Sand

In this investigation, fly ash from thermal power plant is being used as partial replacement of cement. The spherical shape and particle size distribution of fly ash improves fluidity of flowable concrete, thereby reduces the demand of mixing water and contributes to long term strength.

Msand which is being used as a substitute for river sand contains high fines content, contributes to the filler content of the SCC. In this investigation, river sand is partially replaced by manufactured sand up to the range of 40%.

2. SCOPE AND OBJECTIVES OF THE PRESENT INVESTIGATION

2.1. SCOPE

- To reduce the exploitation of natural resources and cost reduction
- To improve the ground water potential and avoid sea water intrusion
- To reduce vibration in concrete

2.2. OBJECTIVE

To study the properties of SCC in fresh and hardened state with and without replacement and compare with conventional concrete.

3. EXPERIMENTAL INVESTIGATION ON MATERIALS USED

M53 grade Ordinary Portland (PENNA) cement was chosen confining to the requirements of IS12269-1987. Fly ash (Class F) confining to IS3812:1981is used for the production of SCC. Natural sand was replaced by Msand and from the preliminary investigations, the water absorption of sand, fineness modulus of sand and msand was found to be 1.0%, 2.483 and 2.602 respectively. The preliminary tests on coarse aggregates of size 12.5 mm pertaining to IS 383 – 1970 were conducted, the water absorption, fineness modulus and average specific gravity of coarse aggregate were found to be 0.5%, 6.87 and 2.72 respectively.

3.1 CONCRETE MIX DESIGN

The mix design for normal concrete was carried out for M30 grade as per IS and the mix ratio was arrived as **1: 1.99: 2.35** for a w/c ratio 0.39 and**1: 2.1: 1.85** for SCC**.** The mix proportions were arrived for partial replacement of cement by fly ash and sand by Msand at intervals of about 10%, 20%, 30% and 40%.

4. EXPERIMENTAL INVESTIGATION

4.1 COMPRESSIVE STRENGTH

The compression strength test for standard cubes of size 150 mm × 150 mm × 150 mm for 3, 7 and 28 days were done and obtained as 34.18 N/mm^2 at 28 days for 20FA-20MS, which is 5% higher than the strength of mix 0FA-0MS. The figures 1and 2 show the strength increment with the increase in the percentage of fly ash and age of concrete. Also it shows that strength increment with increase of manufactured sand up to the range of 40% and figure 6 shows the decrease in strength of concrete for 40% partial replacement of cement by Fly Ash.

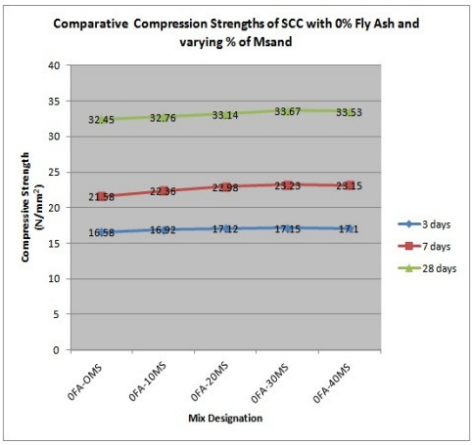

Fig.1 0% FA and varying % of Msand

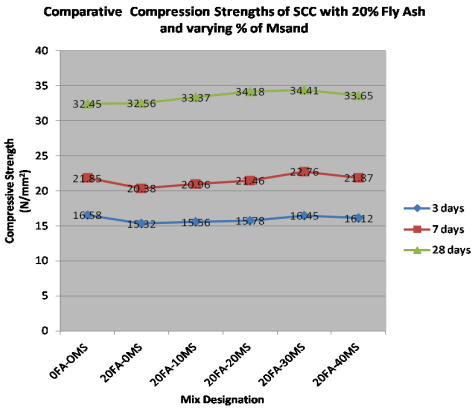

Fig. 2 20% FA and varying % of Msand

4.2 SPLIT TENSILE STRENGTH

The split tensile tests were carried out at 7 and 28 days for standard cylinders of diameter 150 mm and height 300 mm. The split tensile strength increases with the increase of fly ash and Msand upto the range of 30% and 40% respectively. These test results are plotted as line charts given below.

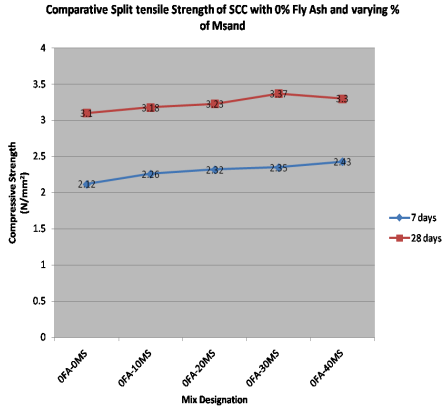

Fig. 3 0% FA & varying % of Msand

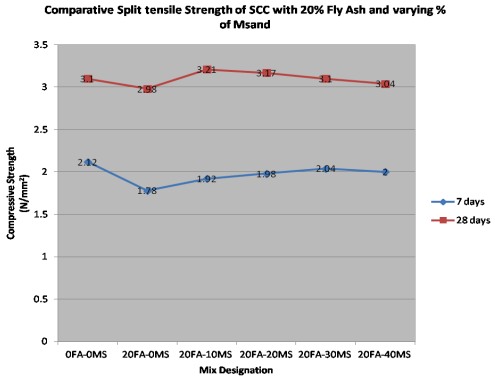

Fig.4 30% FA &varying % of Msand

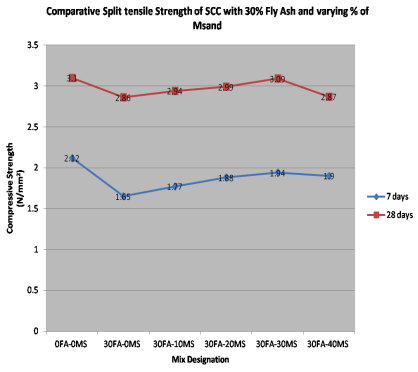

Fig. 5 40% FA &varying % of Msand

4.3. FLEXURAL STRENGTH

For measuring the flexural strength, prisms of size 100 mm x 100 mm x 500 mm were cast and tested at 7 and 28 days by means of central point loading. The figure 6 and 7 shown below shows the variation of flexural strength for replacement of 30% of fly ash and Msand. The mix proportions give satisfactory results as compared with zero replacement.

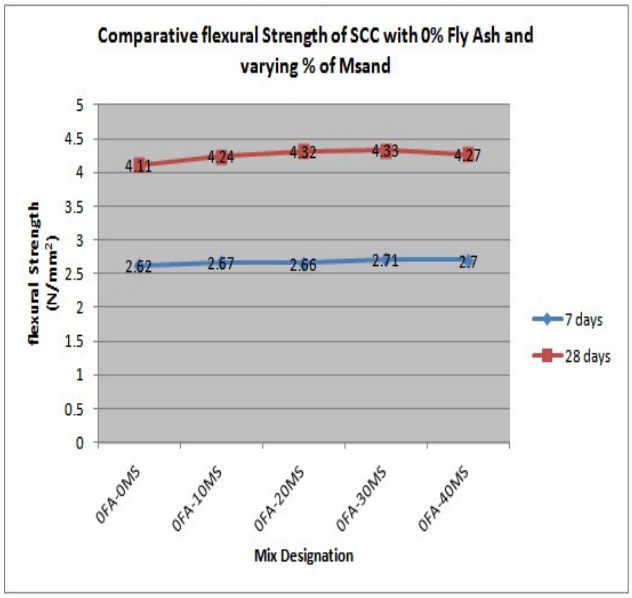

Fig. 6 0% FA and varying % of Msand

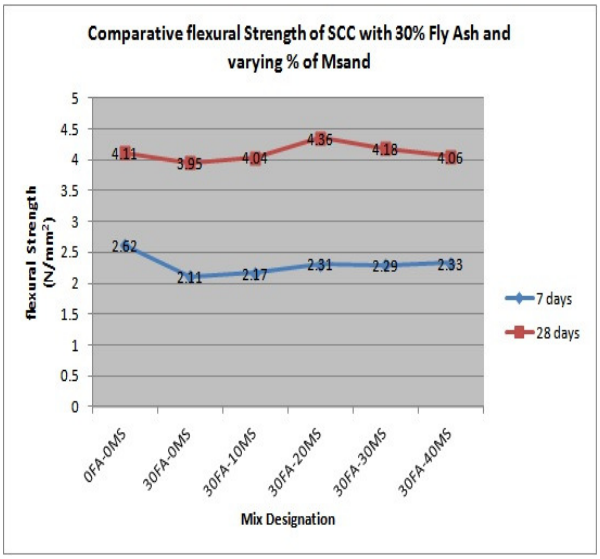

Fig. 7 30% FA and varying % of Msand

5. CONCLUSIONS

Manufactured sand was investigated as a partial replacement of fine aggregate. The following conclusions were made based on the experimental investigation conducted.

- Mix design for M30 grade powder type SCC is successfully arrived without addition of viscosity modifying agent.
- This investigation proves that fly ash and manufactured sand improves fresh (rheology) concrete properties.
- Optimum water requirement for producing SCC ranges between 192 litres/m^3 to 200 litres/m^3 and optimum super plasticizer (GleniumB233) dosage has been fixed as 1% of cementitious material.
- Increase in the partial replacement of cement by fly ash improves fresh and hardened concrete property up to the range of 30%, whereas more than 30% fly ash gives only lower strength.
- Increase in the partial replacement of natural river sand by manufactured sand more than 40% creates segregation problem.
- Split tensile strength and flexural strength also considerably gives better result upto the mix proportion of 30FA-40MS.

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