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STUDY OF PROPERTIES OF SCC CONTAINING MICRO AND NANO SILICA

Jaydeep V Shah[1], Ashutosh D Patel[2]

[1]*Post graduate student in Structural Engineering, Sankalchand Patel University, Visnagar*
[2]*Assistant Professor in Structural Engineering, Sankalchand Patel University, Visnagar*

Abstract - *Self Compacting Concrete (SCC) is considered to be the most successful innovation in construction industry. Over a very short period of time SCC has progressed from the initial concepts of desired functions to routine use in competitive construction markets. It is a special type to concrete with different compositions as compared to normal concrete i.e. there are more amounts of fine aggregates as compared to coarse aggregates which are vice-versa in normal concrete. SCC deforms under its own weight and fills each and every nook and corner even in the congested reinforcement without any need of vibration, tamping etc. Addition of various minerals admixtures as partial cement replacement was found to improve the performance of SCC. The workability and durability of self compacting concrete get enhanced by using industrial by-products such as fly ash, GGBFS (ground granulated blast furnace slag), risk husk, silica fume and limestone powder etc. In production of cement, CO2 gas is emitted which lead to the environment pollution which can be prevented by replacing cement with other industrial by products.*

Current study investigates the effect of incorporating Micro silica and Nano silica by partially replacing cement in the self compacting concrete mix on its mechanical and durability properties. Replacement of micro silica varies from 0% to 10% at an increment of 2.5% and after analyzing the various composite mixes with micro silica to achieve maximum strength in 28 days, the optimum percentage micro silica (giving optimum strength) is fixed. Thereafter, composite mixes with optimum % of micro silica and varying % of nano silica from 0.25% to 1% (increasing @ 0.25%) are casted and analyzed for various mechanical and durability properties. This study also examines the combined effect of micro silica and nano silica on the mechanical and durability properties of the mixes produced when compared with the control mix (mix without micro and nano- silica) and to work out the optimum percentage of replacement of micro silica and nano silica in SCC mixes.

Fresh concrete tests such as slump flow, T500mm time, V-funnel, L-box, U-box and J-ring were conducted to confirm parameters to lie under the category of SCC as suggested by EFNARC standard. Various other tests i.e. compressive strength, UPV, rebound hammer, water absorption, chloride resistance, and sulphate resistance were conducted to achieve objective of research.

Key Words: **Nano SiO_2, Micro silica, Fly ash, Compressive strength, Spilt tensile strength, Durability**

1. INTRODUCTION

The utilization of Self compacting concrete increases day by day due to its advanced performance. Now a day's structure designs are becoming complex to follow the trend of modern era, which cannot be achieved in the absence of SCC. However, the high material cost still prevents the wide spread use of SCC in construction industry i.e. commercial and residential construction. Chemical admixtures play an important role in SCC as it provides the better workability at same water content. In other words, it decreases the water demand or water binder ratio and prevents the SCC mix from segregation or bleeding. With increase in knowledge and experience, an improving track record has increased confidence in the market, leading to the development of production plants and equipment specifically adapted to SCC. The SCC has more scope if its cost is reduced, which is only possible by replacing cement with other industrial by products because cement is main component which contributes to its high cost. Some of these are nano silica , micro silica, fly ash. We also use various method for improved concrete physical & chemical properties use for nano technology.

1.1 Experiment Specimen

In experimental program, the effect of micro silica and nano silica on self compacting concrete mix when partially replaced with cement is observed. Total nine mixes (CM, MS1, MS2, MS3, MS4, MNS1, MNS2, MNS3, and MNS4) were prepared. Control mix (CM) is a reference mix in which no replacement was carried out with powder. Four mixes (MS1-MS4) were casted by replacing cement with micro silica 0-10% at an increment of 2.5% and after analyzing the various composite mixes with micro silica to achieve maximum strength at 28 days, the optimum percentage micro silica (giving optimum strength) is obtained. Thereafter, composite mixes with optimum percentage of micro silica and varying percentage of nano silica from .25% to 1% (increasing @ .25%) is casted (MSN1-MSN4) and analyzed for various mechanical and durability properties.

The specimen production processor used in the study was finalized after several preliminary experiments. The prepared mixture of poured into the moulds of 150 mm x 150 mm x 150 mm and no vibrations were provided due to SCC mix and specimen were left for hardening. After 24 hours the specimen was demoulded and the concrete cube from it was placed in curing tank containing water with temperature of 20oC until testing were

performed. For each mix at each interval three cubes were casted and tested for the compressive strength, rebound hammer, UPV, water absorption, and weight loss due to sulphate attack, strength loss due to sulphate attack, weight loss due to chloride attack and strength loss due to chloride attack.

2. LITERATURE REVIEW

2.1 Review of selected Literature

1) **Jalal et al. (2015)** examined the influence of micro silica and nano silica on fresh properties of SCC. The binder content (cement + fly ash) 400kg/m3 and 500 kg/m3 was partially replaced with different proportions of micro silica and nano silica shown in table 2.1. The fresh property parameters (Slump flow, T500mm, V-funnel) were obtained and it was observed that slump flow diameter decreases with increase in amount of micro and nano silica, and it was found to maximum decrease from 750 mm to 640 mm and from 840 mm to 740 mm in binder content of 400kg/m3 and 500 kg/m3, respectively.

2) **Berra et al. (2012)** studied the effect of nano silica on fresh properties of self compacting concrete. The addition of nano silica to cementatious mixes resulted in a mark able reduction of the mix workability, due to instantaneous interactions between the nano silica sol. and the liquid phase of the cementatious mixes (mainly dissolved alkalis), with formation of gels characterized by high water retention capacities which increased the demand of water.

3) **Siddique (2011)** studied the fresh properties of self compacting concrete by replacing binder content (cement) with class F fly ash. Various tests like Slump flow, U-box, L-box, V-funnel and J-ring were performed on five mixes of SCC. In different mixes cement was replaced by class F fly ash in different proportions, 15%-35% at an increment of 5%. A polycarboxylic ether based superplasticizer complying to ASTM C 494 type F was used. T50cm time for all mixes was less than 4.5 seconds. All other properties were also found acceptable as per EFNARC standard

4) **Maghsoudi and Arabpour (2009)** studied the fresh properties of SCC mixes produced using cement containing micro silica, nano silica and combination of both micro and nano silica. 43 grade OPC was used to prepare the concrete mix and four mixes were prepared such as mix SM (10 % micro silica replacement with cement), mix SN (0.5% nano silica replacement with cement) and mix SMN (includes replacement of both 10% micro silica and 0.5% of nano silica with cement). Water cement ratio was fixed as 0.42 and the super plasticizer was added to enhance the workability of SCC.

5) **Zulfu et al. (2008)** confirmed that slump flow diameter decreased with increase in amount of micro silica and fly ash content for SCC. T50cm time increases gradually when cement replaced with 25%-40% fly ash whereas exact inverse result was obtained by replacing cement with micro silica 5% -20%.

3. CONCLUSIONS

The conclusions which can be drawn from the research work carried out to evaluate various properties of SCC containing micro silica and nano silica and fly ash on the basis of experimental investigation are as follows.

Incorporation of micro silica (2.5%-10%) and nano silica (.25%-1%) in SCC mix were found to satisfy the norms that are required to attain the self compacting concrete category. The fresh properties were found within limits as suggested by EFNARC standard.

1.) Slump flow diameter decreased and T500mm (slump flow time) increased with increase in amount of micro silica and nano silica in SCC mix.

2.) Incorporation of micro and nano silica caused increase in V-funnel time and J-Ring step height from 8 seconds to 10.3 seconds and 2.1 mm to 5.3 mm, respectively.

3.) L-box's blocking ratio value gradually decreased from 0.97 to 0.82 with increase in percentage of micro and nano silica.

4.) The optimum percentage of replacement of cement with micro silica in SCC was found 5% which increased the compressive strength by 18.6% as compared to control mix at the age of 28 days. Replacement more than 5% resulted in loss in compressive strength.

5.) Optimum percentage of micro silica 5% and 0.75% of nano silica replacement of cement leads to maximum compressive strength.

Water absorption percentage decreased with increase in amount of micro silica up to 5% replacement of cement with micro silica, further replacement with micro silica caused increase in water absorption. Incorporation of varying percentage of nano silica (.25%-1%) plus 5% micro silica lead to gradual loss in water absorption.

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