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STUDY ON THE STRESS-STRAIN BEHAVIOR OF FIBER REINFORCED SELF-COMPACTING CONCRETE WITH & WITHOUT CONFINEMENT

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ABSTRACT

In this paper we tested Self-compacting concrete (SCC) by adding different types of fibers, That development of SCC has made casting of dense reinforcement and mass concrete convenient has minimized noise. With regard to its composition, self-compacting concrete consists of the same components as conventionally vibrated concrete. In this study, the cement content was partially replaced mineral admixture (flyash) that improves the flowing and strengthening characteristics of the concrete. As the concrete is the brittle material, is having the draw-back of very low tensile strength and its ductility is almost nil .the solution for the two problems to some extentis addition of fibers, there is an improvement in the mechanical properties of SCC and this is due to the addition of the fibers andalso confinement in the formof hoops in Self Compacting Concrete.

Keywords:Self-compacting concrete (SCC), Fiber rein forced self compacting concrete, confinement.

I. INTRODUCTION

Concrete is the most common construction material used throughout the world for infrastructure, civil engineering and housing applications, followed by wood, steel and a number of miscellaneous materials. Worldwide, over ten billion tons of concrete are being produced each year (Mehta 2002)(Lafarge.com 2005).

Fresh concrete is an inorganic material consisting of a mixture of particles suspended in water. Particles include hydraulic and inert powders, and fine to coarse aggregates. Hydraulic powders comprise Portland cements and semi-hydraulic mineral admixtures like fly ash and silica fume, which react with the water and solidify into a matrix phase bonding the components together to create a stone-like material. Chemical admixtures may be applied to enhance the control of the workability,hardening process, and air void distribution (Herholdt, Justesen, Christensen &Nielsen 1985)(Neville & Brooks 1990).

The development of Self-Compacting Concrete has been closely related to the development of chemical cement dispersing plasticizers. Today, the “new generation” of super plasticizers, the polycarboxylate ethers (PCE), gives improved workability retention to the cementitious mix. These super plasticizers disperse the cement by steric stabilization, which is more powerful compared to the electrostatic repulsion of older types of plasticisers (Sakai & Daimon 1995) (Collepardi 1998) (Yamada, Takahashi, Hanehara & Matsuhisa 2000) (Flatt 2004a).

The SCC in fresh form addresses any problems associated with the skill of workers, complexity of reinforcement, type and shape of structural section, pump ability, segregation resistance and more particular compaction. The self-compacting concrete, which is rich in fines content, is proved to be more durable.

In this work we proposed novel four element MIMO antennas using octagon split ring resonator metamaterial

Hence in this paper we studied and tested Self-compacting concrete (SCC) by adding different types of fibers,

II. DESIGN PROCESS

The key fresh properties of SCC are the filling ability, passing ability and segregation resistance. These three properties must be satisfied regardless of the sophistication of the mixture design and other considerations such as cost. Among other fresh properties, plastic shrinkage, unit weight and air content are noteworthy.

A.Filling ability

Filling ability is defined as the ability of fresh SCC to flow into and fill the spaces within the formwork under self-weight at unconfined condition (Bartos 2000, EFNARC 2002). It is associated with the formability, self-leveling capacity, and finishing ability of SCC. The filling ability is an essential property of SCC to achieve self-consolidation capacity. This property is crucial for concrete placement with proper casting technique. The filling ability primarily depends on the aggregate content, W/B ratio, binder content and HRWR dosage of concrete (Okamura and Ozawa 1995). A good filling ability can beachieved by limiting the coarse aggregate content and increasing the amount of cementing materials, while adding a proper dosage of HRWR.

B. Passing ability

Passing ability is defined as the ability of fresh SCC to flow through tight openings or spaces confined by steel reinforcing bars (Bartos 2000, EFNARC 2002). Where structures are heavily reinforced, a good passing ability of SCHPC enables it to be placed and consolidated through dense reinforcing bars without any aggregate blockage. The factors affecting the filling ability also influence the passing ability of concrete. In addition, the passing ability depends on the number and spacing of the reinforcing bars. A good passing ability can be achieved by increasing the filling ability of fresh concrete and by limiting the segregation of coarse aggregates.

C. Segregation resistance

The segregation resistance of SCC refers to its ability to remain uniform during and after placement without any loss of stability due to bleeding, mortar separation and coarse aggregate settlement (EFNARC 2005). In particular, the distribution of aggregates becomes non-uniform if SCC does not possess sufficient segregation resistance. This might affect the properties and durability of concrete. A study has reported that the water absorption and chloride penetration of SCC can be affected under poor segregation resistance (Daczko 2002). A good segregation resistance can be attained in SCC by a proper mixture composition. An increased amount of cementing materials, a small nominal maximum size of aggregate, a limited content of well-graded coarse aggregates, and a low W/B ratio should be used to achieve good segregation resistance (Bonen and Shah 2005). In addition, the segregation resistance of SCC can be improved by using VEA (Okamura and Ozawa 1994).

SLUMP FLOW TEST.

This is simple, rapid test procedure, though two people are needed if the T50 time is to be measured. It can be used on site, though the size of the base plate is somewhat unwieldy and level ground is essential. It is most commonly used test, and gives a good assessment of filling ability. It gives no indication of the ability of the concrete to pass between reinforcement without blocking, but may give some indication of resistance to segregation. It can be argued that the completely free flow, unrestrained by any boundaries, is not representative of what happens in practice in concrete construction, but the test can be profitably be used to assess the consistency of supply of ready-mixed concrete to a site from load to load.

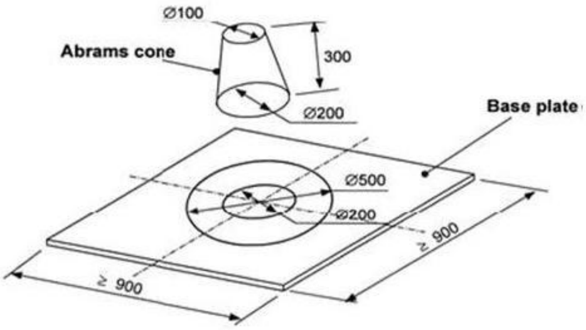

Figure 1 slump flow apparatus

Procedure:

- About 6 liter of concrete is needed to perform the test, sampled normally Moisten the base plate and inside of slump cone.
- Place base plate on level stable ground and the slump cone centrally on the base plate and hold down firmly.
- Fill the cone with the scoop. Do not tamp, simply strike off the concrete level with the top of the cone with trowel.
- Remove any surplus concrete from around the base of the cone.
- Raise the cone vertically and allow the concrete to flow out freely.
- Simultaneously, start the stopwatch and record the time taken for the concrete to reach the 500mm spread circle. (This is T50 time).
- Measure the final diameter of the concrete in two perpendicular directions.
- Calculate the average of the two measured diameters. (This is slump flow in mm).

U BOX TEST METHOD

This is a simple test to conduct, but the equipment may be difficult to construct. It provides a good direct assessment of filling ability-this is literally what the concrete has to do-modified by an unmeasured requirement for passing ability. The 35 mm gap between the sections of reinforcement may be considered too close. The question remains open of what filling height less than 30 cm. is still acceptable

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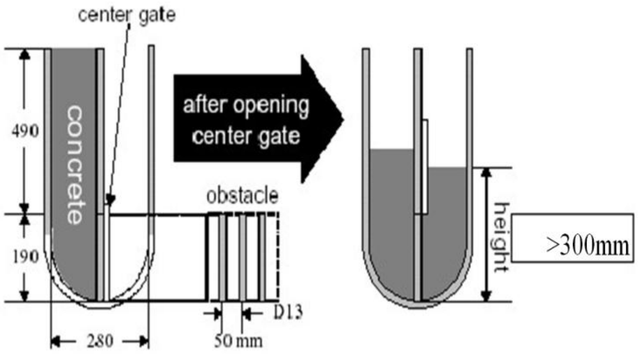

Figure 2 U Box apparatus

– About 20 liter of concrete is needed to perform the test, sampled normally.
– Set the apparatus level on firm ground, ensure that the sliding gate can open freely and then close it.
– Moisten the inside surfaces of the apparatus, remove any surplus water.
– Fill the one compartment of the apparatus with the concrete sample.
– Leave it to stand for 1 minute,
– Lift the sliding gate and allow the concrete to flow out into the other compartment.
– After the concrete has come to rest, measure the height of the concrete in the compartment has been filled, in two places and calculate the mean (H1). Measure also the height in the other compartment (H2). Calculate H1-H2, the filling height.
– The whole test has to perform within 5 minutes.

L BOX TEST METHOD

This is widely is used test, suitable for laboratory, and perhaps site use. It assesses filling and passing ability of SCC, and serious lack of stability (segregation) can be detected visually. Segregation may also be detected by subsequently sawing and inspecting sections of the concrete in the horizontal section. Unfortunately there is no agreement on materials, dimensions, or reinforcing bar arrangement, so it is difficult to compare test results. There is no evidence of what effect the wall of the apparatus and the consequent 'wall effect' might have on concrete flow, but this arrangement does, to some extent, replicate what happens to concrete on site when it is confined within formwork. Two operators are required if times are measured, and a degree of operator error is inevitable.

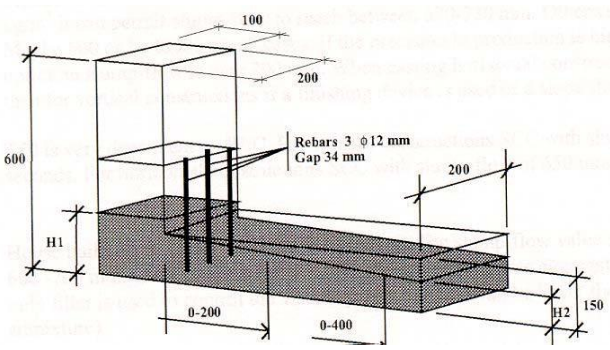

Figure 3 L Box apparatus

– About 14 liter of concrete is needed to perform the test, sampled normally.

- Set the apparatus level on firm ground, ensure that the sliding gate can open freely and close it.
- Moisten the inside surfaces of the apparatus, remove any surplus water
- Fill the vertical section of the apparatus with the concrete sample.
- Leave it to stand for 1 minute.
- Lift the sliding gate and allow the concrete to flow out into the horizontal section.
- Simultaneously, start the stopwatch and record the times taken for the concrete to reach the 200 and 400 mm marks.
- When the concrete stops flowing, the distance “H1” and “H2” are measured. Calculate H2/H1, the Blocking Ratio.
- The whole test has to be performed within 5 minutes.

V FUNNEL TEST AND V FUNNEL TEST AT T5 MINUTES

Though the test is designed to measure flow ability, the result is affected by concrete properties other than flow. The inverted cone shape will cause any liability of the concrete to block to be reflected in the result – if, for example there is too much coarse aggregate. High flow time can also be associated with low deformability due to high paste viscosity, and with high inter-particle friction.

While the apparatus is simple, the effect of the angle of the funnel and the wall effect on the flow of concrete are not clear.

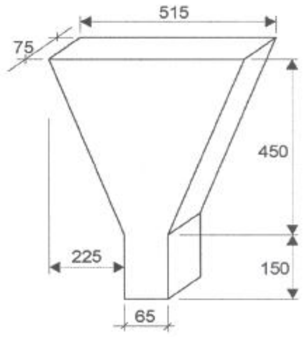

Figure 4 V Funnel test apparatus

All the different method and there properties are summarized are in table1.

Table 1. List of methods for workable properties of SCC:

S. No	METHOD	PROPERTY
1	Slump flow by Abrams cone	Filling ability
2	T_{50} Slump flow	Filling ability
3	J-Ring	Passing ability
4	V-Funnel	Filling ability
5	V-Funnel at T5 minutes	Segregation resistance
6	L-Box test	Passing ability

7	U-Box test	Passing ability
8	Fill Box	Passing ability
9	GTM Screen Stability Test	Segregation resistance
10	Orimet	Filling ability

III. RESULTS AND DISCUSSION

Figure 4:Split Tensile Test On cylinders

Figure 5: Axial Compressive test on Cylinders

The compressive strength values for the cubes are given in figure 7, 8, and 9. As per the given methods we can observe that the compressive strength of the cubes is satisfying the characteristic compressive strengths.

It is observed that the compressive strength of the Plain SCC, GFRSCC and SFRSCC is in increasing order. The compressive strength of Plain SCC, GFRSCC and SFRSCC are 37.91., 38.51., and 39.20 respectively.

Figure 6: Cylinder specimen after testing

The ultimate strength of the cylinders is found to be in the increasing order of the percentages of the steel in them. Also it is observed that the cylinder compressive strength is improved with the addition of the glass fibres and steel fibres. The compressive strengths obtained for different cylinders with and without confinement are shown in the figure 7, 8 and 9. Hence by using fibers in self-compacting concrete the strength will be more than ordinary Portland cement concrete.

The compressive strength of self-compacting concrete is more when we added different types of fibers respectively and it is more when we added steel fibers.

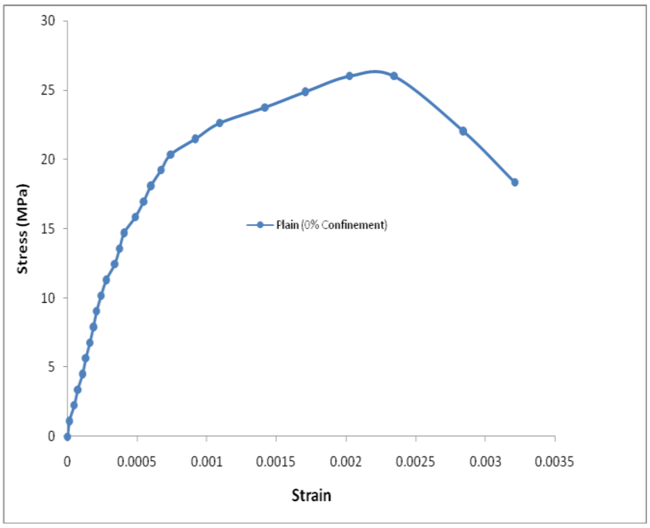

Fig: 7Stress-Strain behavior of SCC without confinement

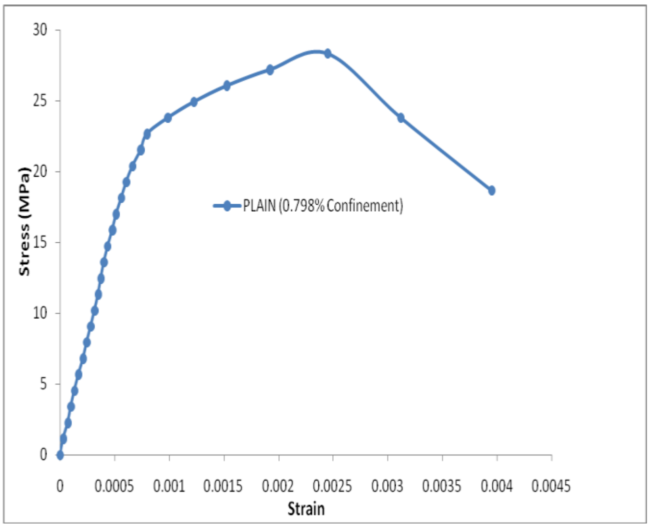

Fig: 8 Stress-Strain behavior of SCC with 0.798% confinement

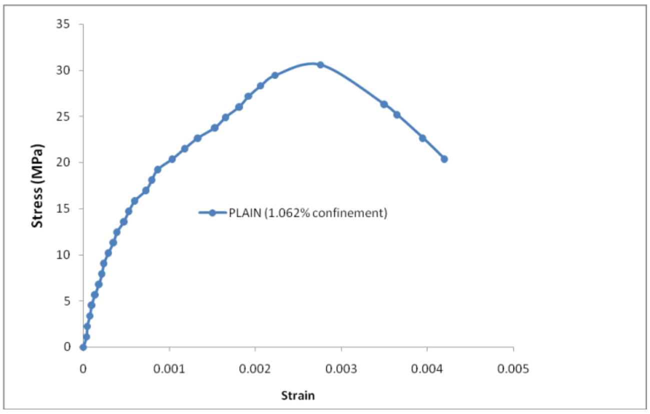

Fig: 9 Stress-Strain behavior of SCC with 1.062% Confinement

IV. CONCLUSION

1. There is marginal increase in compressive strength of self-compacting concrete with addition of glass fiber and steel fiber to SCC from 20.63 $^{N}/mm^{2}$ to 25.63$^{N}/mm^{2}$ to 29.21 $^{N}/mm^{2}$ respectively.
2. By increasing the volume of confinement reinforcement percentage the cylindrical compressive strength increased from 29.524 Mpa to 45.27/Mpa and strain at peak stress is also increased from 0.00243 to 0.00385 respectively.
3. By adding fibers to self-compacted concrete and compressive strength increases from 20.63 to 25.66 for glass fiber reinforced self-compacted concrete and 29.21 $^{N}/mm^{2}$ for steel fiber reinforced self-compacting concrete respectively
4. The ductility factor increases with the increase in the confinement

REFERENCES

[1] **M Chandrasekhar, M.V.SeshagiriRao and M. Janard9hana** "Studies on stress-strain behavior of SFRSCC and GFRSCC under axial compression" International Journal of Earth Sciences and Engineering ISSN 0974-5904, Volume 04, No 06 SPL, October 2011, pp. 855-858

[2] A ravichandran, K. Suguna and P.N.Ragunath "Strength Modeling of High Strength Concrete with Hybrid Fibre (combination of steel and polyolefin fibres reinforcement)" American journal of Applied Sciences: 219-223,2009 ISSN 1546-9239.

[3] **T.Jiang J.G. Teng Analysis "**oriented stress strain models for fibre Reinforced polymer (FRP) confined concrete."

[4] **M.L.V Prasad, P.Rathishkumar and Toshiyuki oshima**"International journal of mechanics and solids (2009)" Volume 4, Number 1, pp 25-37.

[5] **RavindraGettu"** Application of Self Compacting Concrete: Recent experience and challenges that remain" Proceedings of International Conference on Advances in Concrete & Construction, ICACC-2008,7-9 feb., 2008, Hyderabad, pp 58-71.

[6] **SrinivasaRao.P, SeshadriSekhar.J**. "Strength properties of Glass Fiber SCC". Indian Concrete Journal, Vol.88, February 2008 pp: 61-65.

[7] **T. Suresh Babu, M.V.SeshagiriRao and Rama Seshu** "Mechanical properties and stress strain behavior of self-compacting concrete with and without glass fibres" Asian Journal of Civil Engineering VOL.9, NO.5(2008) pg 457-472

[8] **NRD Murthy, RamaSeshu D, Rao MVS. "**constitutive behavior of Fly ash Concretes with steel fibres in ordinary grade, IE (Institute of Engineers) Journal" Vol,88(2007) 41-46

[9] **Marwan N. Youssef, Maria Q. Feng and Ayman S. "**Stress –strain model for concrete confined by FRP composites" Engineering Volume 38, Issues 5-6, July-September 2007, pp 614-628

[10] Naveen Kumar C. Jagadish V and Ranganath R.V." Self-Compacting Concrete with Fly Ash and Metakaolin", The Indian Concrete Journal, April 2006, pp33-39.

[11] **G. Wu, Z.T. Lü and Z.S. Wu "**Strength and ductility of concrete cylinders confined with FRP composites" Construction and Building Materials Volume 20, Issue 3, April 2006, pages 134-148.

[12] **The European Gudelines for Self Compact Concrete Specification,** Production and Use Feb 2002 and May 2005.

[13] **Okamura, H. and Ouchi, M., (2003).** "Self-compacting concrete", Journal of Advanced Concrete Technology, Vol. 1, No. 1, April, pp. 5-15.

[14] **RavindraGettu Hannah Collie, CamiloBernad,TomasGareria and Clotilde Robin "**Use of High Strength Self Compact in prefabricated Architectural Elements", International Conference On Recent Trends In Concrete Technology And Structures INCONTEST 2003 Coimbatore,10-12 Sep.,2003,pp 355-363.

[15] **N.Bouzoubaa M .Lachemi "**Self Compacting concrete incorporating high volumes of class F fly ash Cement" and Concrete Research Volume 31, March 2001, Pages 413-420