Experimental Study to Improve the Durability of Self Compacting Concrete Using Waste Marble Dust and Fly Ash

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Abstract- Concrete being the most important constituent of construction has gone a mile change in recent years either by replacing its ingredients by some other or by adding some essential ingredients to improve the quality and endurance of concrete. An attempt has been made to replace natural fine aggregate (sand) by brick dust and addition of marble powder to the mix generating a new additive concrete which can more or less results to a self-compacting concrete (SCC). In this experimental work, attempt has been made to substitute natural sand (Fine Aggregate) by a mixture of brick kiln dust and marble powder (0%, 25%, 50%) to produce M30 grade of concrete with adding proper dosage of Super Plasticizer (SP-430) and Viscosity Modifying Admixture (VMA).

I. INTRODUCTION

Self Compacting Concrete (SCC) was first developed in Japan in1988 in order to achieve durable concrete structures by improving quality in theconstruction process. It was also found to offer economic, social andenvironmental benefits over traditional vibrated concrete construction.Research and development work into SCC in Europe began in Sweden in the1990s and now nearly all the countries in Europe conduct some form ofresearch and development into the material. Once the fully compliant SCC issupplied to the point of application then the final operation of casting requiresvery little skill or manpower compared with traditional concrete to produceuniformly dense concrete. Because of vibration being unnecessary, the noise isreduced and the risk of developing problems due to the use of vibratingequipment is reduced. Fewer operations are required, but more time is neededto test the concrete before placing. In addition to the benefits described above,SCC is also able to provide a more consistent and superior finished product forthe client, with less defects. Another advantage is that less skilled labour isrequired in order for it to be placed, finished and made good after casting. Asthe shortage of skilled site labour in construction continues to increase in UKand many other countries, this is an additional advantage for the materialbecause it will become increasingly important.

It is assumed that higher the compressive strength of concrete, better would be its durability. However, this assumption is not always true. A concrete mix satisfying the required strength may not necessarily be durable. Concrete, whether containing natural or artificial aggregates is relatively brittle, and its tensile strength is typically only about one tenths of its compressive strength. Ordinary concrete is therefore normally reinforced with steel reinforcing bars. For many applications, it is becoming increasingly popular to reinforce the concrete with small, randomly distributed fibers. Their main purpose is to increase the energy absorption capacity and toughness of the material. But also, the increase in tensile and flexural strength is often the primary objective. While steel fibers are probably the most widely used fibers for many applications, other types of fibers are more appropriate for special applications. Fiber addition in the concrete brings a better control of its cracking and improves its mechanical properties.

II. LITERATURE REVIEW

Biswadeep Bharali (2015) In this paper experimental studies are carried out to understand the fresh and hardened properties of SelfCompacting Concrete (SSC) in which cement is replaced by Ground Granulated Blast Furnace Slag (GGBS) and Fly Ash (FA) invarious proportions for M30 grade concrete. The proportions in which cement replaced are 30% of GGBS, 20% of both GGBS andFA, 40% of GGBS, 15% of both GGBS and FA, 40% of FA and 30% of FA. The strength behaviour, flexural behaviour and splittensile strength behaviour of SSC are studied. The parameters are tested at different ages in accordance with Bureau of IndianStandards (BIS) for the various proportions in which cement is replaced and also the obtained parameters are compared with normalSSC (100% cement). Super plasticizer GLENIUM B233 a product from BASF is used to maintain workability with constant Water-Binder ratio

Grdic et al. (2010) gave compressive strength results conducted on self-compacting concrete
prepared by replacing coarse aggregates with recycled aggregates in different proportions. For
making of concrete mixture the fractions of 0/4, 4/8 and 8/16 mm of the river aggregate were
used, and the fractions 4/8 and 8/16 of recycled aggregate. They prepared three series of mix
with 0%, 50% and 100% replacement of coarse aggregate with recycled aggregates respectively.Proportions used of recycled aggregates of fraction 4/8 and 8/16 was kept constant to 429 kg/m3in all three mixes. Limestone filler of specific gravity 2.692 g/cm3 was used in proportion 260kg/m3 for all the mixes.

Nanthagopalan et al. (2011): The main objective of their study is to explore the possibility of
using manufactured sand (Msand) in self compacting concrete. In recent years, Msand producedby crushing rock deposits is being identified as a suitable alternative source for river sand inconcrete. In this process, an attempt was made to understand

the influence of paste volume andw/p ratio (water to powder ratio) on the properties of self-compacting concrete (SCC) using Msand.

Reena K and Mallesh M (2014) In the present work a wide range of SCC mix were developed using fly ash as a filler material alongwith Portland cement of 43 grade. To qualify Self-Compacting Concrete mixes Slump flow, V-funnel, L-Box, U-Box tests wereconducted and the fresh properties obtained are checked against the specifications given by EFNARC guidelines. Compressivestrength tests were conducted to know the strength properties of the mixes at the age of 7 and 28 days of curing.

Mucteba Uysal and Kemalettin Yilmaz (2011) studied the benefits ofusing Limestone Powder (LP), Basalt Powder (BP) and Marble Powder (MP)as partial replacement of Portland cement to develop the self-compactingconcrete. Furthermore, LP, BP and MP were used directly without anyadditional processing in the production of Self Compacting Concrete (SCC).The water to binder ratio was maintained at 0.33 for all mixtures. Theexamined properties include workability, air content, compressive strength,ultrasonic pulse velocity, static and dynamic elastic moduli. Workability of thefresh concrete was determined by using both the slump- flow test and the Lboxtest. The results proved that it is possible to successfully utilize waste LP,BP and MP as mineral admixtures in producing SCC. It was reported that the employment of waste mineral admixtures improved the economical feasibilityof SCC production.

Biswadeep Bharali (2015) In this paper experimental studies are carried out to understand the fresh and hardened properties of SelfCompacting Concrete (SSC) in which cement is replaced by Ground Granulated Blast Furnace Slag (GGBS) and Fly Ash (FA) invarious proportions for M30 grade concrete. The proportions in which cement replaced are 30% of GGBS, 20% of both GGBS andFA, 40% of GGBS, 15% of both GGBS and FA, 40% of FA and 30% of FA. The strength behaviour, flexural behaviour and splittensile strength behaviour of SSC are studied. The parameters are tested at different ages in accordance with Bureau of IndianStandards (BIS) for the various proportions in which cement is replaced and also the obtained parameters are compared with normalSSC (100% cement). Super plasticizer GLENIUM B233 a product from BASF is used to maintain workability with constant Water-Binder ratio.

III. CHEMICAL ADMIXTURES

An admixture is a 'material added in small quantities during themixing progress to modify the properties of the mixture'. There are manyadmixtures that have been reported as used in SCC, but essential chemicaladmixtures are superplasticisers (high range water reducers, HRWR) to providethe necessary workability and viscosity modifying agents (VMAs) to providevery good homogeneity and to reduce the tendency to segregation (EFNARC,2002).

IV. SCC APPLICATIONS

Following its success in Japan with more than 400,000 m3 of annualproduction for bridges and buildings, other parts of the world have embracedSCC. At over 828 meters (2,716.5 ft) and 166 stories, Burj Khalifa (2010) inDubai holds the record of the tallest building and free standingstructure in the world with the largest number of stories. Self compactingconcrete is playing a greater role in high-rise construction to overcome theproblem of congested reinforcement and ease of placement. The groundwaterin which the Burj Dubai substructure is constructed is particularly severe, withchloride concentrations of up to 4.5%, and sulfate of up to 0.6%. The chlorideand sulfate concentrations found in the groundwater are even higher than theconcentrations in seawater. Accordingly, the primary consideration indesigning the piles and raft foundation was durability. The concrete mix for thepiles which are 1.5 m in diameter and 43 m long with design capacity of 3000tonnes each was a 60 MPa mix based on a triple blend with 25% fly ash, 7% silica fume, and water to cement ratio of 0.32. A viscosity modifying admixture was used to obtain a slump flow of 675 +/- 75 mm to limit the possibility of defects during construction

V. EXPERIMENTAL PROGRAM

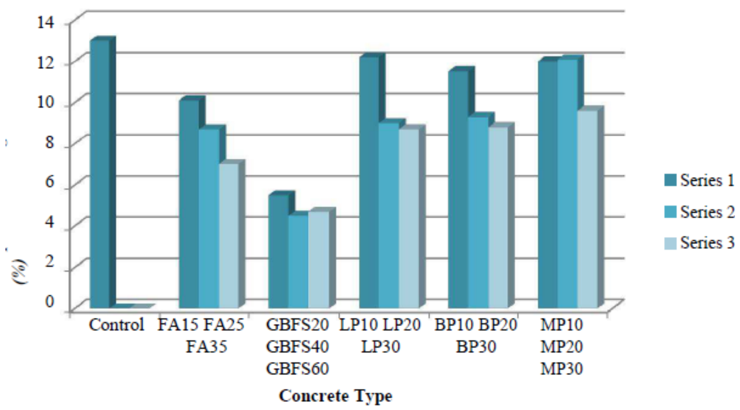

Fig.1: Compressive strength loss of SCC mixtures subjected to sulphate attack in 10% magnesium sulphate solution

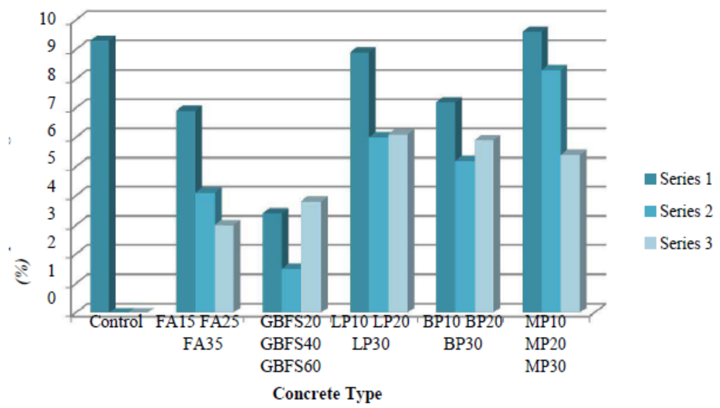

Fig.2: Compressive strength loss of SCC mixtures subjected to sulphate attack in 10% sodium sulphate solution.

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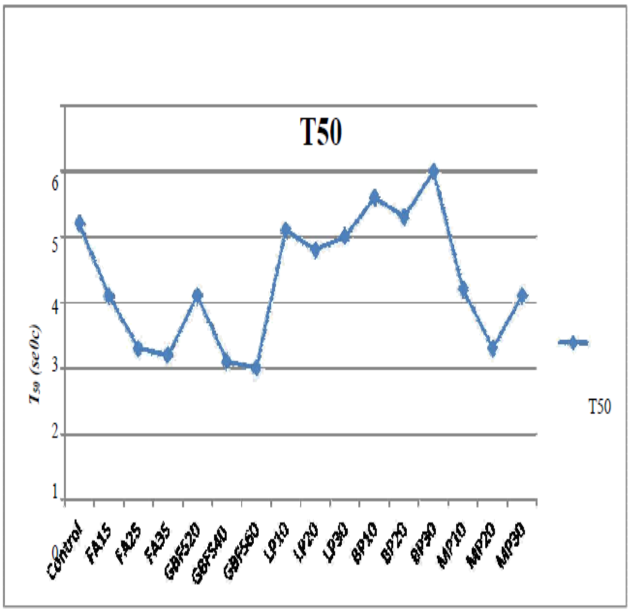

Fig.3: T50 time of SCC mixes.

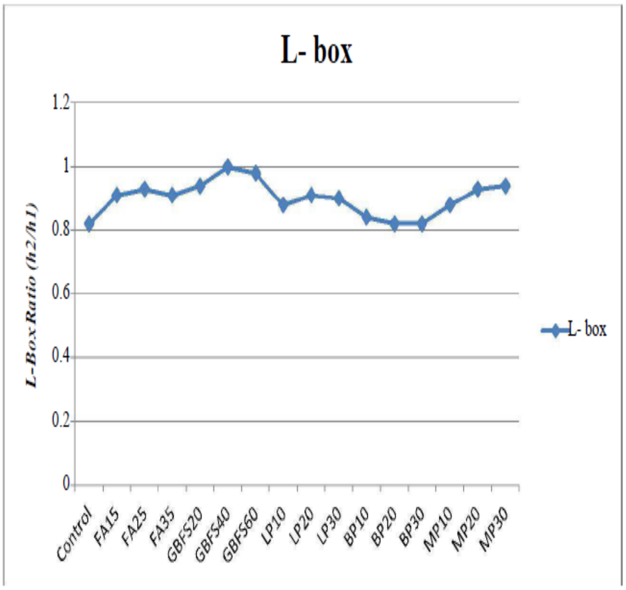

Fig.4: L-box ratio of SCC mixtures

In terms of slump flow, all SCC mixtures exhibited satisfactory slump flows in the range of 690–750 mm, which is an indication of a good deformability. The slump flow time for the concrete toreach diameter of 50 cm (T50) for all the mixtures was less than 5 s and all SCC mixturesshowed flow time values in the range of 2–5 s. Both the slump-flow values and the T50 times arein good agreement to that of the values given by European guidelines for range of applications.

L-box test (time taken to reach 400 mm distance (T400), time taken to reach 800 mm distance

(T800) and the ratio of heights at the two edges of L-box) represents the filling and passing abilityof SCC. In L-box test blocking ratio (h2/h1) must be between 0.8 and 1.0. All the mixtures ofSCC have remained in target range which is as per EFNARC standards.

VI. CONCLUSION

All concrete mixes using brick dust and marble powder fulfilled the performance criteria for fresh and hardened SCC. Good hardened properties were achieved for the concretes with 25% marble powder which can be considered as the optimum content for high compressive strength. The hardened properties of the SCCs were improved at 28 days due t o greater hydration of cement Brick dust and marble powder can be efficiently used to produce good quality self-compacting concrete with satisfactory slump and setting times. Under certain conditions, replacement of fine aggregate by brick dust and marble powder appears to increase the strength of self-compacting concrete. In this study an effort has been made to evaluate the usefulness of brick kiln dust and marble powder both of which are waste material to produce cost effective self-compacting concrete.

VII. REFERENCES

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