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Effect of Steel Fibre in Non-Conventional Self Compacting Concrete

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Abstract: ***In this study self-Compacting-Concrete containing steel fiber offer improvements on strength parameters of self-compacting concrete for M-30 grade of concrete using steel fiber. The main objective of this project has to find the effect of steel fiber on fresh and harden properties of Non-conventional self-compacting concrete. The use of fibers extends its potentialities since fibers arrest cracks and retard their propagation. In this investigation Mix proportion of concrete was 1:1.67:1.31 and maintaining water-cement ratio of 0.6 in order to find harden properties of steel fiber reinforced concrete (SFRC) containing fibers of 1%, by volume of cement. The flexural and split tensile strength of becomes higher compared with the conventional concrete. The non-conventional SCC with demolished aggregate is less costly than the conventional concrete.***

Keywords : conventional concrete, demolished aggregate, segregation, self compacting concrete, steel fiber.

I. INTRODUCTION

SCC is concrete with enhanced fresh properties that allow pouring without external compaction. Its advantages also are extended to good segregation resistance, higher homogeneity, lower permeability, which among others, lead to a product with higher durability SCC consists basically of the same constituents as a normally vibrated concrete. The purpose of fibers arrest cracks and retard their propagation. Steel fibers improving the mechanical properties of SCC so that it can be applied in beam column joints. For all concepts, high-efficient water reducing and dispersing super plasticizer is used. Superplasticizers aim at increasing the dispersing effect and furthermore decreasing the friction between the particles. There has been an intense development of superplasticizers during the last decades making SCC feasible.

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II. MATERIAL PROPERTIES

Materials used for the study are Cement, coarse Aggregate, M-Sand, GGBS, Steel Fiber, Super Plasticizer and Water.

A. *Cement*

Portland Pozzolana cement grade 43confirming to IS: 12269-1987 was used for the study. The specific gravity is 2.85.

B. Coarse Aggregate

A demolished aggregate with a size of 12.5 mm was used with a specific gravity of 2.8 and water absorption of 2.59.

C. M-Sand

A manufacture sand confirming to the grading zone –II as per IS 383/1970 was used with a specific gravity of 2.68 and a water absorption of 0.9.

D. Steel Fiber

Straight Steel Fibers type with a diameter of 0.75 mm having a length 30mm and 1% addition was used for the experiment

III. EXPERIMENTAL INVESTIGATIONS

A. Fresh Concrete

To characterize the flow and the deformability properties of SCC mixtures, the standardized slump-flow, U- Box, L- Box and V-funnel tests were performed. Concrete mixture fresh properties are summarized below.

B. Slump Flow

The slump flow diameters of self-compacting steel fiber concretes mixture were 600 mm, which were determined as the average of two measured diameter of flowed concrete. As shown in Fig. 1, were produced in the study; however, the slump flow diameter of plain self-compacting concrete was 765 mm. According to EFNARC, the acceptable limit of diameters falls in the range of 650-800 mm. Test results indicated that the producing self-compacting concrete with plastic waste as fine aggregate and according to EFNARC (Table 4), can be categorized as SF1, which is appropriate for unreinforced or slightly reinforced concrete structures that are cast from the top with free displacement from the delivery point, casting by a pump injection system, sections that are small enough to prevent long horizontal flow. It can be noticed that the addition of steel fibers decreased the slump-flow diameter, less values were recorded when more fibers are added to the concrete.

Fig.1.Slump flow

C. L-box Test

The L-box height ratio by means of H2/H1 ratio was determined to specify the passing ability of the produced SCC. The L-Box test to BS EN 12350-10 is used to employ the passing ability of self-compacting concrete to flow through tight obstructions without segregation or blocking. For perfect fluid behavior of self-compact concretes, L-box height ratio value is from 0.8 to 1.0 According to EFNARC table 5 all mixtures satisfy the EFNARC limitation for the given L-box height ratio. The L-box height ratio value for the produced non-conventional SCC and conventional SCC was 0.93 and 0.925 respectively.

D. U – Box Test

The U Box test method was performed to measure the filing ability of self-compacting concrete. The U Box difference by a means of h2-h1 ratio was determined to specify the passing ability of the produced SCC mix. The U Box value for the non-conventional mix was found to be 20 mm while the U Box value for the conventional self-compacting concrete becomes 17 mm. according to EFNARC the limitation for the given u box test value ranges from 0 to 30 mm. based on the reference EFNARC the produced mix satisfies the limitation range. Street steel fiber with a length of 30-50 mm has found to be not recommended for passing ability characteristics but according to (Yaseen Patel, 2017) a street fiber with a diameter of 50 mm doesn’t affect the strength of the SCC mix.

E. V-funnel Test

The findings of the V-funnel time test results were in the range of 12.56 seconds for the non-conventional mix and 10.57 seconds for the conventional one. The V-funnel flow time of the produced mix value is higher than what is recommended in the EFNARC, which is from 6 to 12 seconds. According to the EFNARC conformity criteria for SCC the produced mix can be categorized in to class of VF2 (Viscosity classes expressed by V-Funnel time). Has no socio-economic class limit however with increasing flow time it's a lot of probably to exhibit thixotropic effects, which can be useful in limiting the formwork pressure or rising segregation resistance

IV. RESULTS AND DISCUSSION

A. Compressive Strength

The result of compression and splitting tensile test performed on both conventional concrete and SCC cube and a cylindrical specimen is presented in below. Each reported result as presented the table was obtained as the average value of three tested specimens. The compressive strength was tested according to IS 516/1995. A cube specimen of 15cm diameter and 15cm height was made, and tested at 7 days, 14 day and 28 days. Figure.2 shows the results of compressive strength for both normal concrete and SCC for all the mixes fall within the acceptable allowance limit for the target compressive strength of 30 N/mm^2 for this study. The non-conventional SCC gets 30N/mm^2 compressive strength at 14 days and the concrete specimen does not show any additional increase at 28 days. The reason behind this might be the full replacement of coarse by demolished one according to Panda et al (2017).

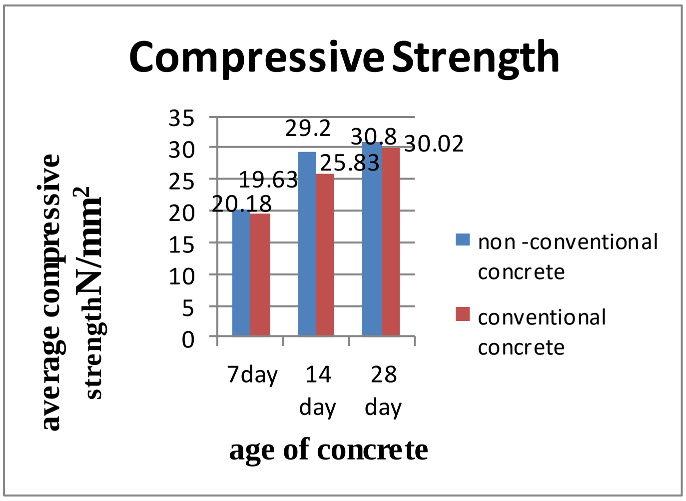

Fig 2 Compressive Strength result

B. Splitting Tensile Strength

Three-cylinder specimens each of the mix were tested to determine the split tensile strength after 7day, 14day and 28 days using a Compression Testing Machine. The tests were conducted as per standard specifications.

The split tensile strength of the SCC was found to be 8.7% higher than the normal/ conventional concrete. With this increased split, tensile strength means the produced mix is highly homogeneous than the conventional concrete. The increased tensile strength because of the addition of steel fiber was also described by (Yaseen Patel, 2017). Average splitting tensile strength result of the produced mix is shown in the fig.3 below.

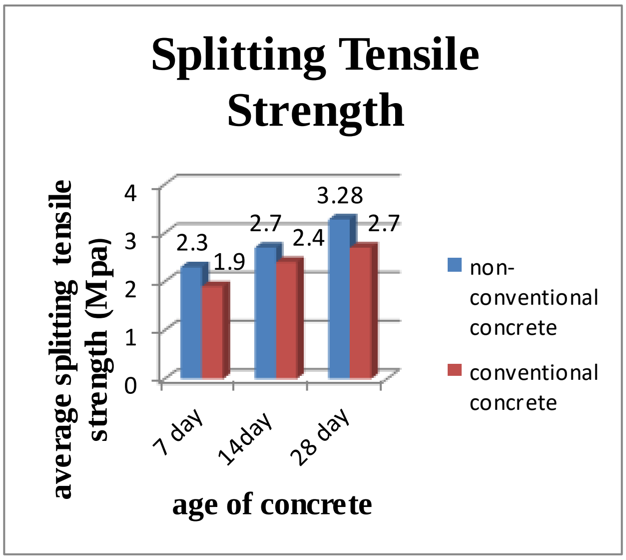

Fig 3 Split Tensile strength result

C. Flexural Strength Test

Prisms of size (100 x100x500mm) were cast and tested for determining Flexural Strength at 7, 14 and 28 days. The modulus of rapture of the produced SCC and normal concrete is 5.36 and 4.5 N/mm^2 respectively. The increase in modulus of rupture of the SCC may be due to the addition of self-compacting concrete. The average modulus of rapture of the control mix and non-conventional mix is presented in fig 4 below.

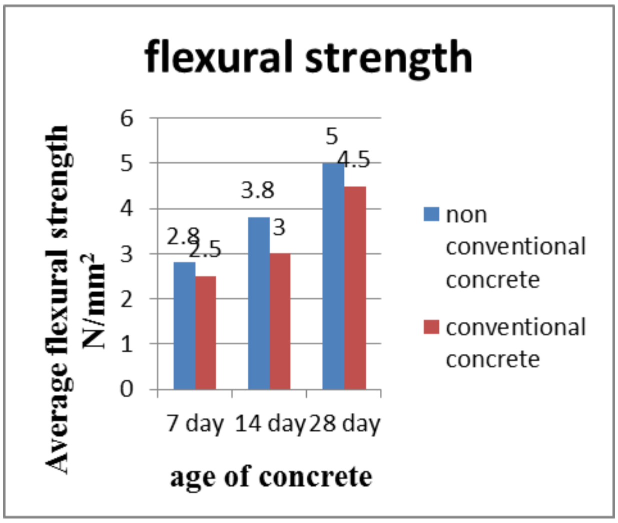

Fig 4 Flexural Strength result

D. Rebound Hammer

In this project the Rebound Hammer test was conducted for a convenient and rapid indication of the compressive strength of the concrete, to assess the uniformity of the concrete, to assess the standard of the concrete supported the quality specifications, to relate one concrete part with alternative in terms of quality. The rebound hammer test was conducted on a prism beam and during the testing time, the length of the beam was dividing into 5 equal points with a distance of 10cm and the average result becomes 28N/mm^2. The average rebound hammer result becomes 34.5N/mm^2 which explain the quality of concrete is good.

E. Ultrasonic Pulse Velocity

The test was used to check the quality of concrete. In this test, the strength and quality of concrete were assessed by measuring the velocity of an ultrasonic pulse passing through a prism concrete specimen formation. In this project the Ultrasonic test was used to know The homogeneity of a material, The presence of voids, cracks or other internal imperfections or defects, Changes in the concrete which may occur with time (i.e. due to the cement hydration) or harm from hearth, frost or chemical attack, The strength or modulus of a material, the quality of the concrete in regard to specified standard needs. The test was conducted in three different transmission methods such as direct, indirect and semi-direct. Ultrasonic pulse velocity detection was performed on a prism beam according to IS 13311-1 (1992) result becomes 4.9. An ultrasonic instrument was used to transmit ultrasonic pulse waves to the prism specimen, and the signals were returned to the pulse wave receiver.

V. CONCLUSION AND RECOMMENDATION

A. Conclusion

The following conclusions are drawn from the experimental work on the effect of steel fiber on SCC.

1. The length of the steel fiber affects the flowability and pass ability property of the mix
2. The 7 and 28 days flexural strength of self-compacting concrete with street steel fibers is higher than the conventional concrete.
3. The split tensile strength of the SCC was found to be 8.7% higher than the normal/ conventional concrete.
4. Fully replacement of demolished aggregate affects the 28-day compressive strength of SCC with steel fiber.
5. The cost of the non-conventional mix with demolished aggregate is lesser than the cost of the conventional mix

B. Recommendation

1. The demolished aggregate should be recycled so that the compressive strength will not be affected when the age of the concrete increases.
2. The length of steel fiber should be less than 30 cm.

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