Experimental Study on Fibre Reinforced High Strength Reactive Powder Concrete

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Abstract— This study shows the experimental study on high strength reactive powder concrete using available materials specifically silica fume, silica powder and ordinary Portland cement. The curing cycles are employed only under normal water curing. The maximum cube compressive strength obtained in 28 day is 87 N/mm2 using steel fibres. In Further, split tensile test and flexure testing is also conducted and the results are tabulated. The reactive powder concrete is then used in flexure beam, the ultimate load obtained was 90 kN followed by maximum deflection is 9.3mm and stiffness is 8.7 kN/mm which is effective for the structural purposes.
Key words: Microcontroller, Filter, Embedded System

I. INTRODUCTION

In this chapter a general introduction about reactive powder concrete is discussed. Many new types of concrete such as High Strength Concrete (HSC), High Performance Concrete (HPC), Self Compacting Concrete (SCC), Ultra High Performance Concrete (UHPC) and Ultra-High Strength Concrete (UHSC) are being constantly developed to improve the mechanical properties and durability. The properties of such concrete show a substantial improvement over conventional concrete of low or medium strength.

A. WORKS DONE

1) Study of various journal papers regarding ultra high strength reactive powder concrete
2) Selection of materials used in RPC
3) To study the various mix proportion and composition of RPC
4) Experimental work carried out to achieve the required cube compressive strength.
5) Experimental work carried out to achieve other mechanical properties like split tensile and flexural strength.
6) The obtained test results are tabulated for 7 day and 28 day strength.
7) The stiffness factor for the flexural strength of the prism is calculated.
8) High Strength Reactive powder concrete is applied on a flexural member like beam with reinforcement to analyse the performance and testing has been carried out to obtain the result.
9) The result is tabulated and required values like yield load, deflection, ultimate load and stiffeness factors are obtained.

B. MATERIALS USED IN HSC

- Cement
- Silica Fume
- Silica Powder
- Fine sand
- Super Plasticizer
- Steel Fiber
- Water

II. PROPERTIES OF CEMENT

Chemical Component	% content (OPC)
CaO	63
SiO_2	20
Al_2O_3	6
Fe_2O_3	3
MgO	1.5
Alkalies (K_2O, Na_2O)	1
SO_3	2

Table 1: Chemical composition of cement

A. Silica Fume

Silica fume is a very fine non-crystalline SiO_2, is a byproduct of producing silicon metal or ferrosilicon alloys. It is made at a temperature of approximately 2000°C. It acts as an excellent pore-filling material. It can be used in proportions of 5-10% of cement content in a mix.

Fig. 1: Silica Fume

B. SILICA POWDER

The crushed quartz/silica powder used in the experiments is in a form of white powdered quartz flour. The particle size ranges from 10 to 90µm. Quartz powder act as effective filler material at normal water curing. The content of silicon dioxide is 99.9% and it as some traces of ferrous oxide and aluminium oxide.

Fig. 2: Silica Powder

C. STEEL FIBRE

The fibre used here is a hooked end steel fibre with an aspect ratio of 77 which has a length of 35mm and a diameter of 0.45mm. Mostly steel fibres are used in HSC to improve both the compressive and tensile strength because no other fiber will give the required high strength to the concrete.

Fig. 3: Steel Fibre

Properties	Results obtained
Type	Sulfonated naphthalene formaldehyde Condensate
Specific gravity	1.22 to 1.225 at 30°
Chloride content	Nil as per BIS:456 and BS:5075
Recommended dosage	0.6 to 1.5 liters per 100 kg of cement
Approximate additional air entrainment	1% at normal dosage
Compatibility	All type of cement except high alumina cement
Solid content	40%
Workability	Produce high workable flowing concrete mix without segregation and requires no compaction
Cohesion	Minimizing segregation and improving surface finish
Compressive strength	Early strength up to 40 to 50%

Table 2: Properties of SIKA VISCOCRETE

III. MIX PROPORTIONS

Cement	-850kg/m^3
Silica fume	-200kg/m^3 (replacement- 25% of cement)
Silica powder	-200kg/m^3
Sand	- 950kg/m^3
Steel fibre	-1.5% of total volume. of concrete
Super plasticizer	-1.0 % to weight of cement
Water/binder ratio	- 0.2

IV. EXPERIMENTAL WORK

Fig. 4: Finished Concrete cubes

Fig. 5: Finished cylinder specimens

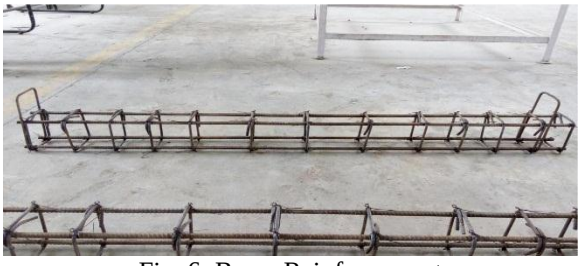

Fig. 6: Beam Reinforcement

V. RESULT

S.No	7 day (N/mm2)	28 day (N/mm2)
1	46	87
2	44	85
3	48	88
Average	46	87

Table 3: Test results for compressive strength of cube

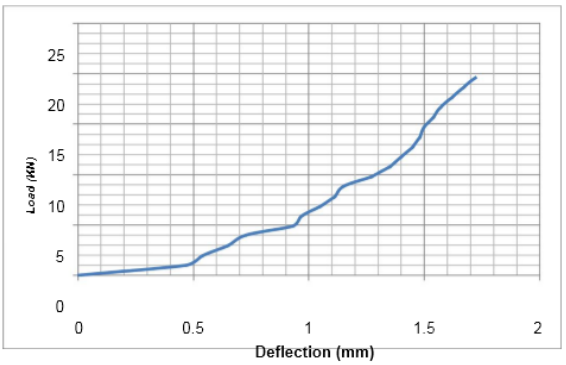

Figure 7 Load deflection graph for prism

Specimen	Beam b1	Beam b2
First crack (kN)	35	30
yield point (kN)	40	42
Ultimate load (kN)	73	90
Avg. Ult. Load (kN)	82	
Deflection (mm)	10.5	8.1
Stiffness (kN/mm)	8.33	9.09
Average Stiffness	8.7	
Mode of failure	Flexure	Flexure

Table 4 Comparative result

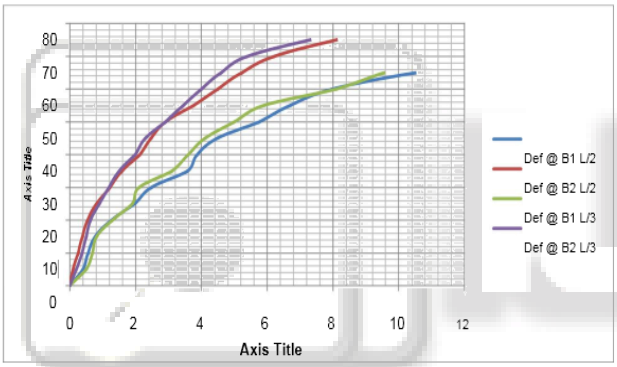

Figure 8 Overall comparison of load deflection graph

Figure 9 Flexure Crack

VI. CONCLUSION

In this study, experimental work on high strength reactive powder concrete with steel fibres are carried out and several trails were conducted to obtain the required compressive strength, split tensile strength and flexural strength. Various trail mixes were carried out and the final mix composition are listed here. Based on that proportions the achieved compressive strength is 87 N/mm^2 and split tensile strength is 12 N/mm^2. The Average ultimate load of the beam is 82 kN which is more than 1.5 times of the safe load estimated as 40kN. The failure mode of the beam is flexure since the spacing provided is more in the middle than the support and there is no crack in the shear portion. The maximum deflection obtained is 10.5mm which is less than maximum deflection of simply supported beam and hence the beam is effective for structural purposes. In addition to this, further work can be carried out in the area for improvising the mechanical properties by altering the composition of the materials and also to analyse structural member like column, slab and frames.

REFERENCES

[1] P. Richard and M. Cheyrezy, "Composition of reactive powder concretes," Cement and Concrete Research, vol. 25, no. 7, pp. 1501–1511, 1995.
[2] S. H. Liu, P. Y. Yan, J. W. Feng, "Research and application of RPC in the bridge engineering,"Highway, vol. 58, no. 3, pp. 149–154, 2009
[3] M. Cheyrezy, "Microstructural analysis of RPC (Reactive Powder Concrete),"Cement and Concrete Research, vol. 25, no. 7, pp. 1491–1500, 1995.
[4] Beglarigale and H. Yazici, "Pull-out behavior of steel fiber embedded in flowable RPC and ordinary mortar," Construction and Building Materials, vol. 75, pp. 255–265, 2015.
[5] L. Huynh, S. Foster, H. Valipour, "High strength and reactive powder concrete columns subjected to impact: experimental investigation," Construction and Building Materials, vol.78, no. 3, pp. 153–171, 2015.
[6] R. Pierre, "Reactive powder concrete: a new ultra-high strength cementitious material," in Proceedings of the 4th International Symposium on Utilization or High Strength/High Performance Concrete, pp. 1343–1349, Paris, France, May 1996.
[7] V. Matte and M. Moranville, "Durability of reactive powder composites: influence of silica fume on the leaching properties of very low water/binder pastes," Cement and Concrete Composites, vol. 21, no. 1, pp. 1–9, 1999.
[8] H. M Al –Hassani, W. I Khalil, L. S Danha, "Mechanical properties of Reactive powder concrete with various steel fibres and silicafume contents", Acta Technica Corviniensis, pp.47-58, 2014.

