Flexural Behaviour Of 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/mm^2 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.

Keywords – Reactive Powder Concrete (RPC), Flexure Beam

1.INTRODUCTION

In this chapter a general introduction about high strength reactive powder concrete is done. The properties of such concrete show a substantial improvement over conventional concrete of low or medium strength. High Strength Reactive Powder Concrete is a concrete which has an extremely low water to cement ratio (i.e. less than 0.26), higher binder content, optimum packing density to eliminate capillary pore and provide an extremely dense matrix. It is a high strength material formulated from a special combination of combination of constituent materials which include Portland cement, silica fume, fine aggregate, high-range water reducer and water. The material has the capability to sustain deformation and resists flexural and tensile forces, even after initial cracking.

2.MATERIALS USED IN RPC

Cement, sand, silica fume, silica powder, steel fibre and water.

2.1 CEMENT

Ordinary Portland Cement (OPC) – The cement used during the experiments is Ordinary Portland Cement of Grade 53 conforming to IS 12269:1987.

2.2 FINE AGGREGATE

Fine aggregate used for RPC should be properly sieved to give minimum void ratio and free from deleterious materials like clay, silt and chloride contamination etc., Here it is used in the range of 1.16mm sieve.

2.3 SILICA FUME

It is in grey powder form micro silica which contains latently reactive silicon dioxide and no chloride or other potentially corrosive substances. It has 94.3% of silicon dioxide.

2.4 SILICA POWDER

The crushed quartz/silica powder used in the experiments is in a form of white powdered quartz flour. The particle size range is 70µm. 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.

2.5 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 UHSC to improve both the compressive and tensile strength because no other fiber will give the required high strength to the concrete.

3.EXPERIMENTAL WORK

Since the high strength reactive powder concrete has no proper mix design and no design code book is preferred, only trail and error method is possible to attain the required strength. The water to binder ratio is less than 0.25 , the dosage of silica fume can reach 25% of the weight of the cement to give better bonding property. Here the silica fume is replaced with cement and silica powder is an additive. RPC has a high dosage of superplasticizers which gives a good flowability to the concrete.

3.1MIX PROPORTIONS FOR RPC

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 vol. of conc.

Super plasticizer -1.0 % to weight of cement

Water/binder ratio - 0.2

3.2 COMPRESSIVE STRENGTH

Compressive test are made at recognized ages of the test specimens. Compression test was carried out on the specimens after 7 days and 28 days of curing. Here cubes of size 100x100x100mm are used. After casting, demoulding and curing under normal water, the cubes are placed in the compression testing machine in such manner that the load is applied to the opposite sides of the cube as cast. The ultimate strength was recorded after the specimen failed to resist any more loads. The values were recorded and compressive strength was calculated. The average of 3 cubes is taken as the compressive strength.

3.3 SPLIT TENSILE STRENGTH

The tensile strength of concrete is one of the basic mechanical properties. The concrete is weak in tension due to its brittle nature and develops cracks when subjected to tensile forces. Thus , it is necessary to determine the load at which the concrete member may crack**.** cylinder of 200mm x 100mm (length x dia) is used for the test. The average of 3 cylinder is taken as the split tensile strength.The values were recorded and split tensile strength was calculated.

3.4 FLEXURAL STRENGTH

The flexural strength is mainly conducted to know the stiffness of the RPC without any reinforcement. For this prism of size 10x10x50 cm is used. After casting and curing it is tested under an flexural testing machine with two point loading system and the load is applied at at distance of L/3. The results are then tabulated.

3.5 BEHAVIOUR OF FLEXURE BEAM WITH REINFORCEMENT

To check the performance of the reactive powder concrete in real structure, a beam with steel reinforcement is casted and tested in the loading frame. The beam is designed as a flexure beam with more spacing in middle than in support and it is made to fail in flexure. The size of the beam is 1.5x0.15x0.18m (LxWxH) and 10mm and 8mm dia bars used as main and stirrup reinforcement respectively. The stirrups are spaced at a distance of 200mm c/c at the middle and 100mm c/c at the support.

4.RESULT

4.1 COMPRESSIVE STRENGTH

The values of the **cube compressive strength** are listed in the following table.

s.no	7 day (N/mm^2)	28 day (N/mm^2)
1	46	87
2	44	85
3	48	88
Average	**46**	**87**

Table 4.1 Cube compressive strength

4.2 SPLIT TENSILE

The values of the **Split Tensile strength** are listed in the following table.

s.no	7 day (N/mm^2)	28 day (N/mm^2)
1	6.4	9.8
2	6.7	10.2
3	6.3	10.5
Average	**6.5**	**10.2**

Table 4.2 Split Tensile strength

4.3 FLEXURAL STRENGTH

The First crack in the prism appeared in 2100kgf and the ultimate load is 3140 kgf . The stiffness factor is calculated as 7.14 Kg/mm and it can be said that for a deflection of 1mm 7.14 kg of load is taken which is 70 N.

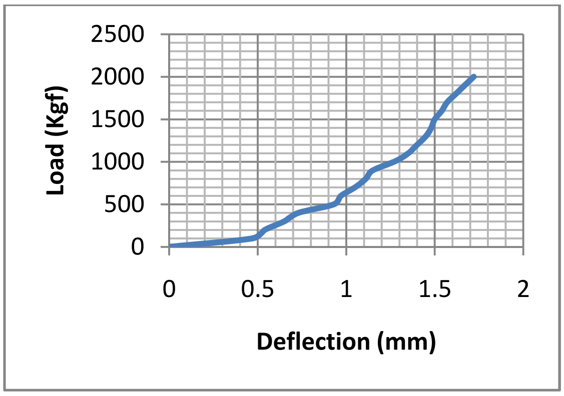

Fig 4.1 Load Deflection of prism

4.4 FLEXURAL BEAM PERFORMANCE

Two beams are tested with simply supported end conditions and the results are tabulated.

SPECIMEN	BEAM B1	BEAM B2
First crack (kN)	35	30
1st yield load (kN)	40	42
2nd yield load (kN)	55	57
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 4.3 Comparative result of 2 beams

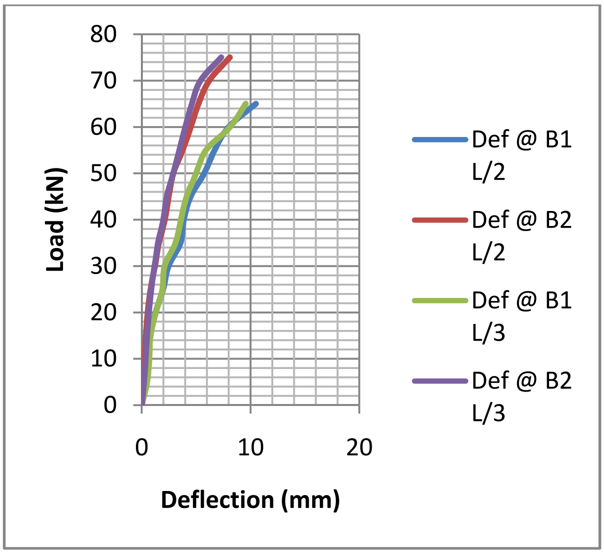

Fig 4.2 Load Deflection of Beam

Fig 4.3 Flexure Beam B1

Fig 4.4 Flexure Beam B2

5.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.

APPLICATIONS OF RPC

I. Reduction in self-weight and a consequent reduction in the foundation cost.
II. The ability to withstand large column loads with reasonable sizes of columns.
III. Reduction in floor thickness and beam height
IV. Elimination of a few footing because of adoption of larger spans.
V. Superior durability and long-term performance. Lower creep and shrinkage
VI. Reduction in member-size, resulting in an increasing in the usable floor space.
VII. Elimination of coarse aggregate.

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