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A Study on the Flexural Behavior of Plain Cement Concrete with Self Compaction Concrete

K. Srinivas[1], Dr. C. Ravi Kumar[2], V. Rajendra Kumar[3]
[1](*Graduate Student, Kallam Haranadareddy institute of technology, GUNTUR-522019*
[2](*Professor, Kallam Haranadhareddy institute of technology, GUNTUR-522019*
[3](*Assistant professor, Kallam Haranadhareddy institute of technology, GUNTUR-522019*

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Abstract: To study the flexural behaviour of plain cement concrete with self-compaction concrete using three point loading. We are using two different types of concrete (Plain Cement Concrete and Self Compaction Concrete). For this we are using M20 grade concrete. We cast cubes and beams of sizes 150x150x150mm and 150x150x700mm respectively.Based on the test results it is concluded that the flexural strength of the self-compaction concrete beams is more than the plain cement concrete beams. And in the combination also the flexural strength is more when the plain cement concrete layer is at the bottom while the self-compaction concrete layer is at top.

I. INTRODUCTION

Reinforced cement concrete beams are effectively used as structural member in various constructions.

Hence both concrete and steel will reaches the stress and corresponding strains due to external subjected loads simultaneously. In this study is on flexural behavior of plain cement concrete with self compaction concrete with three point bending without any reinforcement and the observation is done by destructive methods.

Self compaction concrete is the concrete that is able to flow under its own weight and completely fill the formwork while maintaining homogeneity even in the presence of congested reinforcement. Flexural strength also known as modulus of rupture which is a material property, define as the stress in a material just before it yields in a flexure test. This test most frequently done on a specimen having either a circular or rectangular cross sections until fracture or yielding occurs, the three point bending flexural test provides values for the modulus of elasticity in bending, flexural stress, flexural strain of the material. As comparison of plain cement concrete (PCC) with self compaction concrete (SCC), The SSC has many benefits in terms of production and placement compared to plain cement concrete namely, the elimination of external or internal vibration for compaction, better flowability, workability and pumpability, as well as increased bonding with congested reinforcement. The appearance, mechanical performance and durability of SCC can be considerably better

Than plain cement concrete.SCC used in the precast industry uses the same technology as cast in-situ as SCC, similar benefits can be expressed using SCC in the precast industry. They are

1) Complex congested moulds can be cast with more easy.
2) No noise from vibration equipment gives better working environment.
3) It makes light weight construction elements by SCC.
4) SCC increase in lightweight aggregate content had a detrimental impact on the workability and compressive strength of lightweight self compacting concrete.

II. METHODOLOGY

Experiments were guide on concrete mix design of M20 grade concrete, for this M20 grade concrete the preparation of combination of PCC and SCC involves 50% of PCC moulds and 50% of SCC moulds prepared for casting of cubes and beams. The cast of moulds separately filled with M20 grade concrete of PCC and SCC by individual. The filled moulds kept under sunrise for dry till 2days and unmould the cubes and beams kept in water for curing purpose, then the both cubes and beams of PCC and SCC curing the period of 7days and 28days, finally the beams and cubes removed from water after curing period and testing under UTM for knowing flexural strength of cubes and beams by 1000KN capacity universal testing machine(UTM), note down the results of PCC and SCC cubes and beams results individually to show the flexural behavior of plain cement concrete with self compaction concrete.

III. MATERIALS USED

A. Cement
Ordinary Portland cement conforming to IS 12269-1983 was used for the concrete mix and specific gravity was found to be 3.5.

B. Fine Aggregate
The fine aggregate (sand) used in the work was obtained from a nearby river course. The fine aggregate that falls in zone-II was used. The specific gravity was found to be 2.60.

C. Coarse Aggregate
Crushed coarse aggregate of 4.75mm size passing and 10mm retained proportion and 10mm size sieve passing through 20mm size retaining proportion was used in the mix. Uniform properties were to be adopted for all prisms for entire work. Specific gravity was found to be 2.78.

D. Water
For mix proportions the portable water was used in the concrete mix with pH range is 6.5 to 8.5.

E. Moulds
Moulds sizes used for casting cubes is 150*150*150 mm, the beam casting the mould size is 150*150*700mm.

F. Silica Fume
Silica fume also referred to as micro silica or condensed silica fume, it is another material to used as achieve high strength and dense concrete. It is a product obtain from reduction of high purity quartz with coal in an electric furnace in the manufacturing of silicon or ferrosilicon alloy.

G. Super Plasticizer
Super plasticizer is chemical compound used to increase the workability, without using any additional water. The super plasticizer used in the present work is the commercial available brand, Cera hyper plasticizer.

H. Mix Designs
Table 1 Design mix proportions for plain cement concrete as per IS 10262-2009.

GRADE	RATIOS	CEMENT KG/M^3	F.A KG/M^3	C.A KG/M^3	WATER %
M20	1:2.17:3.54	338	735	1199	186

Table 2 Design mix proportions for self compaction concrete as per IS 10262-2009.

GRADE	RATIOS	CEMENT KG/M^3	F.A KG/M^3	C.A KG/M^3	WATER %	SP 1%	SILICA-FUME 15%
M20	1:2.35: 2.35	382.5	901	901	202.5	3.8 L/M^3	57.37 KG/M^3

I. Mix Design Casting Procedure
The preparation of combination of plain cement concrete (PCC) and self compaction concrete (SCC) to cast cubes and beams individually as per given quantities and ratios in table 1&2 as per mix design IS 10262-2009.

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IV. RESULTS AND DISCUSSION

A. *Caluculation*

The following expression used to calculating modulus of rupture.--

Modulus of Rupture (M.R) = $\frac{3PL}{2BD^2}$

Where, MR= modulus of rupture, P= ultimate applied load indicated by testing machine, L= span length of specimen, B= average width of the specimen at the fracture, D= average depth of the specimen at the fracture.

B. *Experimental Setup*

Figure 1 Experimental set up PCC beam and its crack formation

Figure 2 Experimental setup of SCC beam and its crack formation.

Figure 3 Experimental setup of combination of both PCC & SCC beam and its crack formation (SCC layer above).

Figure 4 Experimental setup of combination of both PCC & SCC beam and its crack formation (PCC layer above).

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C. Test Reults

Table 3 compressive strength of different type of concrete.

specimen	S.NO	PCC	SCC
		28days	28days
cubes	1	24.7	24.88
	2	27.82	27.87
	3	23.15	28.86
Average(N/mm^2)		25.24	27.18

Graph 1 shows the compressive strength of PCC & SCC cubes.

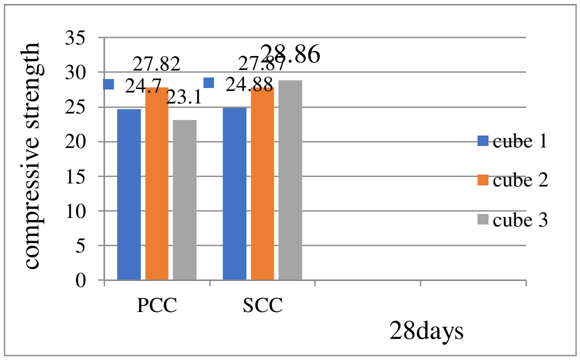


Table 4 compressive strength of combination of different concretes.

SPECIMEN	S.NO	PCC&SCC	PCC LAYER
		28days	
CUBES	1	25.91	PCC UP LAYER
	2	30.11	
Average(N/mm^2)		28.01	
CUBES	1	23.85	PCC DOWN LAYER
	2	27.41	
Average(N/mm^2)		25.63	

Graph 2 showing the compressive strength of combination of both PCC & SCC cubes.

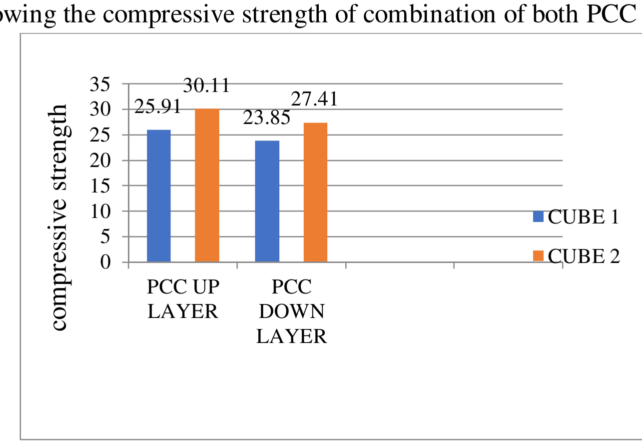
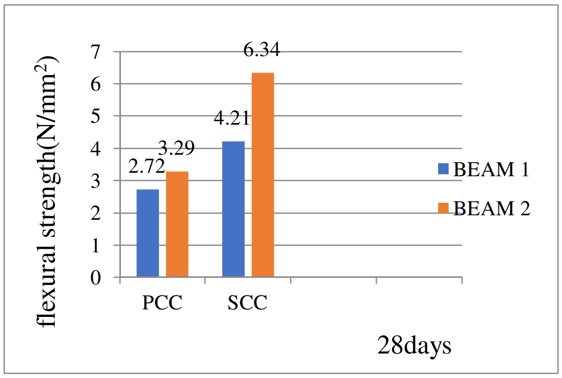


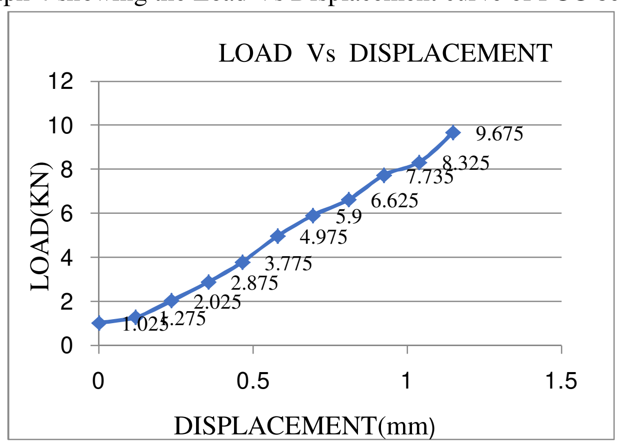
Table 5 flexural strength of different types of concrete.

SPECIMEN	SI.NO	PCC	SCC
		28days	
BEAMS	1	2.72	4.21
	2	3.29	6.34

Graph 3 showing the flexural strength of PCC & SCC beams.



Graph 4 showing the Load Vs Displacement curve of PCC beam.



Graph 5 showing the Load Vs Displacement curve of a SCC beam.

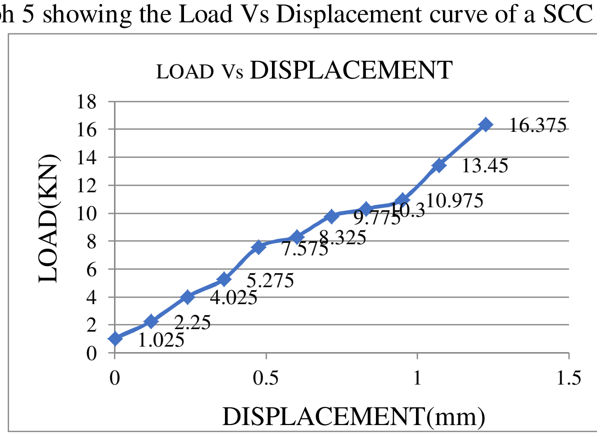


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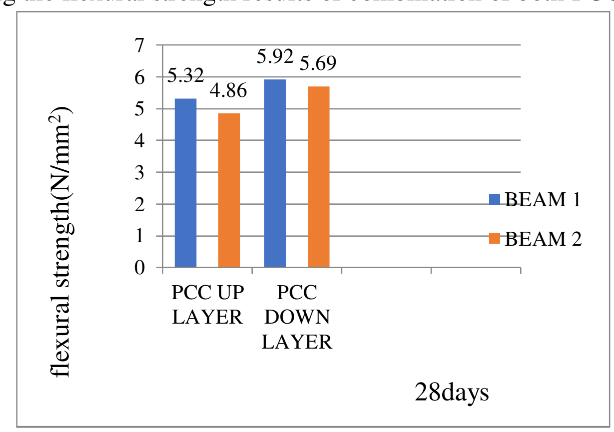
Table 6 flexural strength of combination of different concretes.

SPECIMEN	S.NO	PCC&SCC	PCC LAYER
		28days	
BEAMS	1	5.32	PCC UP LAYER
	2	4.86	
Average(N/mm^2)		5.09	
BEAMS	1	5.92	PCC DOWN LAYER
	2	5.69	
Average(N/mm^2)		5.80	

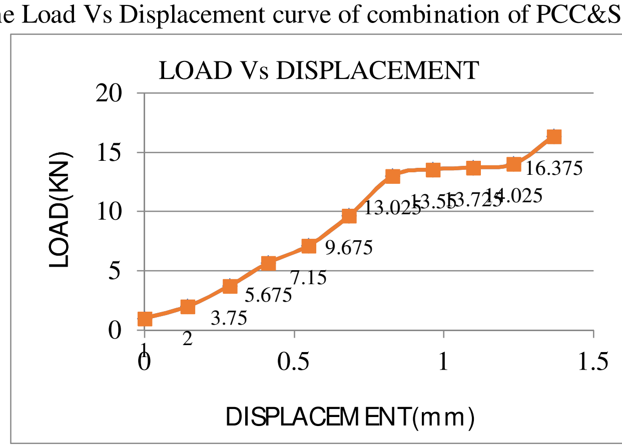
Graph 6 showing the flexural strength results of combination of both PCC & SCC Beams.



Flexural Strength for three point loading, $\sigma = \frac{3PL}{2BD^2}$

Flexural Strain, $\varepsilon = \frac{6\delta D}{L^2}$;Flexural modulus, $E = \frac{L^3 m}{4BD}$ (m = the gradient (slope) of the initial straight line portion of the load deflection curve (P/δ).).

Graph 7 showing the Load Vs Displacement curve of combination of PCC&SCC beams (up layer).



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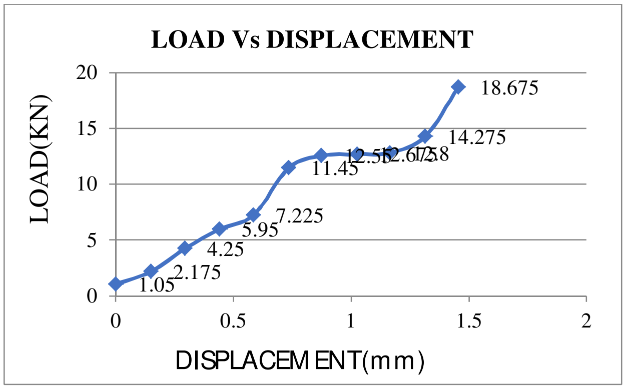
Graph 8 showing the Load Vs Displacement curve of combination of PCC&SCC beams (down layer).



V. CONCLUSION

The following conclusion drawn from the results:

1) The compressive strength of the PCC cubes is quite more than the compressive strength of the SCC cubes.
2) The combination of both concrete PCC&SCC the compressive strength is more when PCC layer is at top.
3) The flexural strength of SCC beams is more than the flexural strength of PCC beams.
4) The combination of both concrete PCC&SCC the flexural strength is more when the PCC layer is at the bottom i.e. the SCC layer is at top.
5) From this conclusion that the SCC beams when made fully or partially are rich in flexural strength when the loading surface is SCC layer. The more flexural strength is due to usage of silica fume as 15% replacement of cement material.

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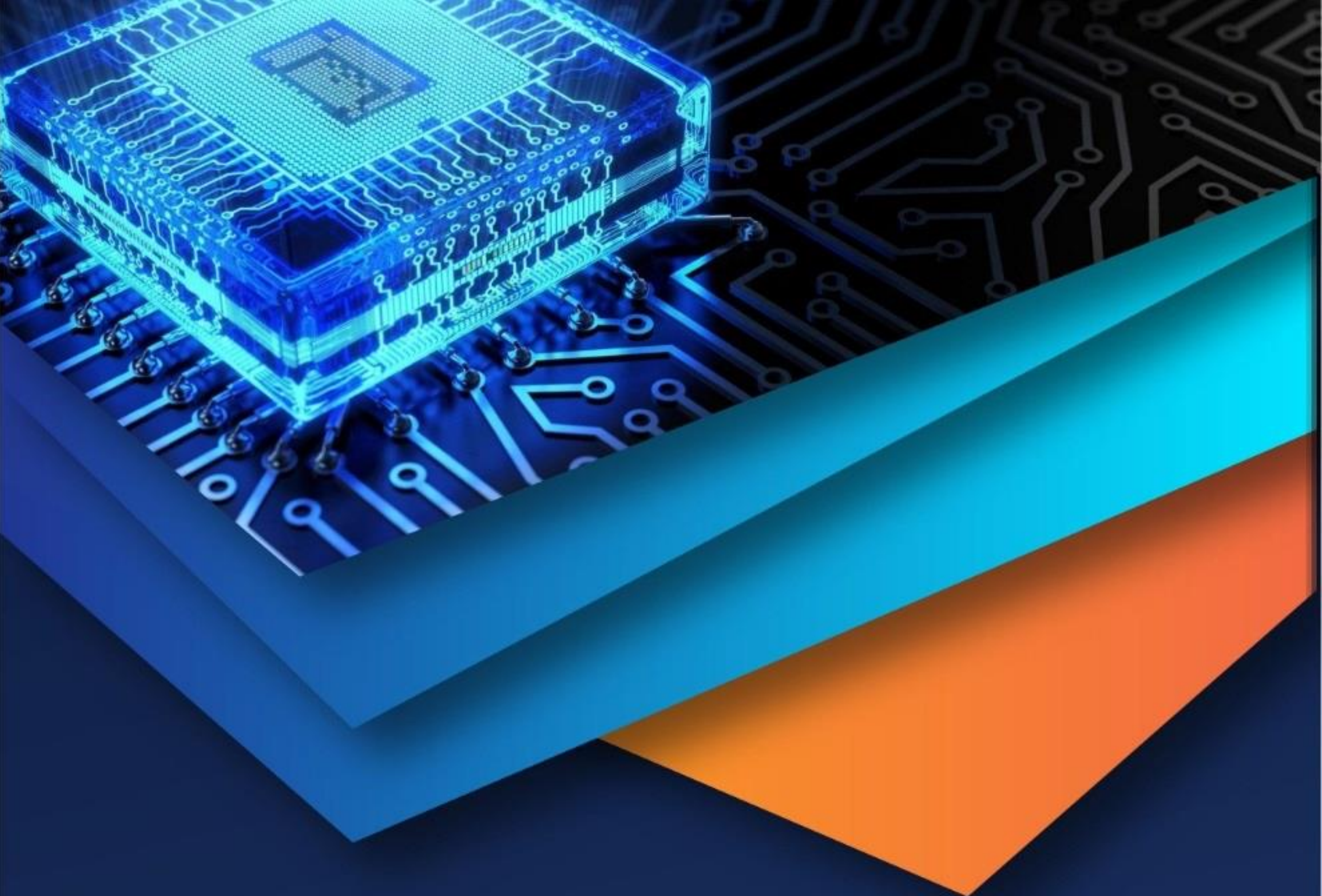

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