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Flexural Behaviour of Self Compacting and Self Curing Concrete Beams

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Abstract - **The objective of this study is comparing the flexure behaviour of self compacting concrete beams. This research is proposed to replace the constituent materials by mineral Admixtures and adding chemical admixtures. Also it is proposed to use self curing compound instead of conventional water curing. Many researchers studied about the self compacting concrete only and not for self compacting and self curing concrete, but this study proposed a methodology for self compacting and curing concrete beams. Mechanical properties such as compressive strength, split tensile strength, modulus of concrete have been found out and compared with controlled beams, self compacting concrete beams, self curing concrete beams and admixture beams. Beams in size of 125mm×250mm×1000mm were cast and tested to analyze the behaviour. The ANN modelling has compared the flexural behaviour of beams at various stages such as yield load, ultimate load and deflection.**

Keywords: **ANN, Fly Ash, Self Compacting Concrete, Self Curing Concrete**

I. Introduction

The Self-Compacting Concrete (SCC) is the newest innovating category of high performance concrete, characterized by its ability to spread and self consolidation in the formwork exhibiting any significant separation of constituents. Elimination of vibration for compacting concrete during placing with the use of Self Compacting Concrete leads to substantial advantages related to better homogeneity, enhancement-of working-environment and improvement in the productivity by increasing the speed of construction. Replacement of cementanious material like fly ash has increased the paste content, and hence enhance the fresh and strength properties. Partial replacement of metakaolin with silica fume helped attaining high earlier strength of around 50-70 Mpa of SCC. Contribution of steel fibers in SCC improve the durability properties like permeability, water absorption, abrasion resistance, resistance to marine as well as a sulphate attack. Fibers resists all type of attack with in tolerable limits and the optimum dosage of fibers have promoted the better performance.

In past decades, the effect of self curing concrete possesses improved properties while comparing to identically cured controls. It was found that, initial surface absorption, chloride ingress, carbonation, corrosion potential and freeze and thaw resistance characteristics were comparatively better by air cured self-cure concrete than the air cured control.

This paper presents the experimental work which includes the materials used and the testing procedure adopted comparison of analytical to experimental, discussion on test results.

II. Objectives

1. This study is to evaluate the effectiveness of various percentages of mineral and chemical admixtures in producing self compacting concrete and self curing concrete.

2. Its flowing characteristics depend on the correct proportioning of ingredients and dosage of super plasticizer/viscosity modifying agent.
3. Studies are done in different ways for the development of SCC with different materials.
4. Flexure behaviour of beams and formulate the modelling by using artificial neural network.

III. Materials Used

Table I Materials Used

Cement	Ordinary port land cement of 43 grade confirming to IS-12269 having specific gravity of 3.15
Fine Aggregate	Natural river sand conforming to IS-383, Zone –II having specific gravity of 2.63
Course aggregate	Crushed granite angular aggregate of size 20mm passing conforming to IS-383 having specific gravity 2.73
Mineral admixtures	Lime-stone powder, quarry dust, class c-fly ash and silica fume
Chemical admixtures	Conplast sp-430, viscosity modifying agent,(GELINIUM™ STREAM) and Enfiiq(curing agent)
Water	Ordinary potable water confirming to IS 456

The percentage of all replacement materials has been worked out from the trial and error method. Lime stone powder was replaced by 10%, class c-fly ash is 20%, silica fume 5% with cement and quarry dust was replaced by 20% of fine aggregates. Super plasticizer conplast SP430, high range water reducing admixtures of 0.80 litres/100kg of cementitious material. Viscosity modifying agent (VMA) is a self compacting admixture, no need of external vibration and *enfiiq* was used as self curing admixtures to achieve the self curing effects.

IV. Experimental Work

A. *Fresh Properties*

The slump flow test is the most widely used method for evaluating concrete consistency in the laboratory and at construction sites. The consistency and workability were evaluated using the slump flow, U Box, L-Box, J-Ring, V funnel and fill box tests .The slump flow of SCC concrete was in the range of 650-800 mm, which is an indication of a good deformability. The time to reached 500 mm slump was in the range of 3-5 s, the J Ring was in the range of 3-8mm, the funnel test flow time was in the range of 3-7s, the v funnel test flow after 5 minutes was in the range of 6-12 s, L-box is range in the of 0.8-1.0. The fresh properties of SCC are summarized.

B. *Mechanical Properties*

The mechanical properties like compressive strength, flexural strength, split tensile and modulus of elasticity of SCC were obtained from 150 x 150 x 150 mm cubes, 100x 100 x 500 mm prism and 150 x 300 mm cylinders and the results are summarized in Table IV.

The experimental work was done on casting the structural elements of the size of beam specimen 1000mm length, 125mm width, 250mm depth. Two beam of conventional concrete, two beam of admixtures concrete, two beams self compacting concrete, and self curing concrete elements were casted and tested.

1.Compressive Strength of Specimens: Compressive strength tests were carried out on cubes of 150 mm size on a compressive testing machine of 2000 kN capacity as per IS516:1959.

2.Tensile Strength of Specimens: Tensile strength tests were carried out on cubes of 150 mm size on a compressive testing machine of 2000 kN capacity as per IS516:1959.

3.The Modules of Elasticity of Concrete: compression rests were carried out on cylinders of 150mm diameter and 300mm height on a testing machine of 2000 kN capacity as per IS516:1959.

Fig. 1 Specimen in compressive testing machine (cube

TABLE II COMPRESSIVE STRENGTH OF SPECIMEN

Types of specimen	Weight of specimen in kg	Ultimate load in kN	Average Compressive strength N/mm^2
Conventional concrete	8211	733	32.59
Admixture concrete	8156	710	32.90
Self compacting Concrete	8043	841	37.40
Self-curing concrete	7860	766	34.07

Fig. 2 Test setup for tensile strength of concrete cubes

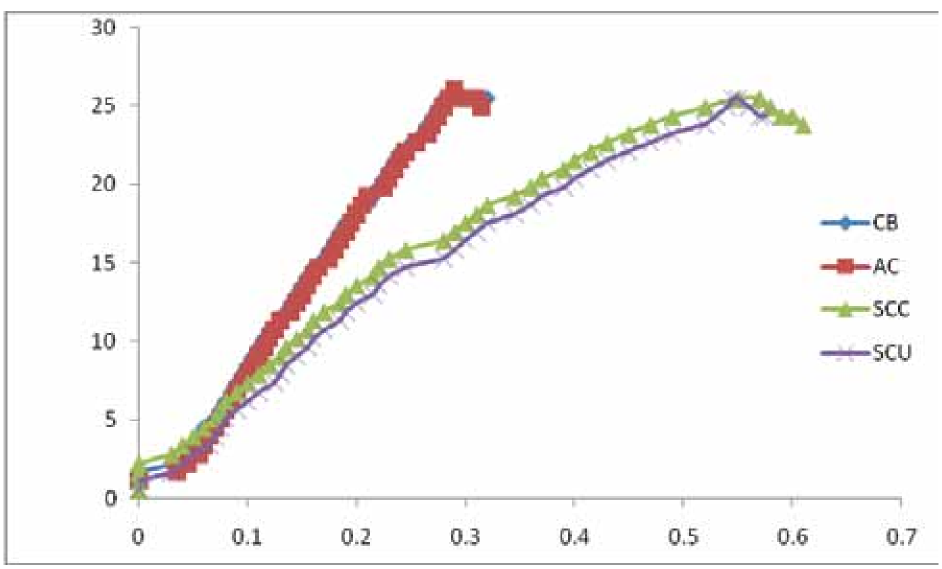
TABLE III TENSILE STRENGTH OF SCC CONCRETE CUBES

types of specimen	Weight of specimen in kg	Ultimate load in kN	Average tensile strength N/mm^2
Conventional concrete	8181	140	6.21
Admixture concrete	8254	145	6.45
Self compacting Concrete	8295	153	6.84
Self-curing concrete	8292	150	6.67

Fig. 3 Test set up for load deflection behaviour under compression

TABLE IV COMPARISON OF EXPERIMENTAL VALUE WITH IS CODE VALUE FOR E FOR CONCRETE

Sl.No.	Type of concrete	Experimental value of E in Mpa	E value as per IS code $5000\sqrt{fck}$
1	Control concrete	21032	28543.82
2	Admixture concrete	21107	28679.26
3	Self compacting concrete	20872	30577.56
4	Self curing concrete	20700	29184.75



IV. Test Procedure

Flexure strength tests were carried out on beams of size 125×250×1000mm on loading frame of capacity 500kN. All the beams were tested under centre single point load Condition. The beams are tested as simply supported beam. The beam designed as a under reinforced beam having 3 numbers of 12mm dia bar used as a tension reinforcement and 2 numbers of 10mm dia bar used as a compression reinforcement. Two legged 8mm stirrups used as a shear reinforcement spacing of 170mm c/c. The deflectometer was set the bottom of the beam. Proving ring as placed the beam. While the load was applied from hydraulic jack the deflectometer in the proving ring indicates the load applied on the beam as shown as fig.5.

Table V Test Results

S.No.	Load KN	DEFLECTION in mm			
		Control beam (CB)	Admixture beam (AC)	Self compacting concrete beam(SCC)	Self curing concrete beam(SCU)
1	0	0	0	0	0
2	2.5	0.12	0.129	0.0565	0.129
3	5	0.165	0.185	0.129	0.185
4	7.5	0.315	0.255	0.1795	0.255
5	10	0.47	0.31	0.21	0.31
6	12.5	0.57	0.345	0.29	0.345
7	15	0.64	0.37	0.325	0.37
8	17.5	0.735	0.4	0.36	0.4
9	20	0.805	0.465	0.38	0.465
10	22.5	0.865	0.54	0.435	0.54
11	25	1.035	0.61	0.515	0.61
12	27.5	1.085	0.695	0.565	0.695
13	30	1.145	0.83	0.665	0.83
14	32.5	1.28	0.865	0.79	0.84
15	35	1.39	0.97	0.86	0.89
16	37.5	1.505	1.095	0.99	0.94
17	40	1.63	1.195	1.09	0.98
18	42.5		1.335	1.195	1.025
19	45		1.5	1.325	1.055
20	47.5		1.76	1.495	1.095
21	50			1.65	1.195
22	52.5			1.755	1.335
23	55			1.86	1.5
24	57.5			2.085	1.76
25	60			2.355	
26	62.5			2.45	

Fig. 5 Static load set up for beams

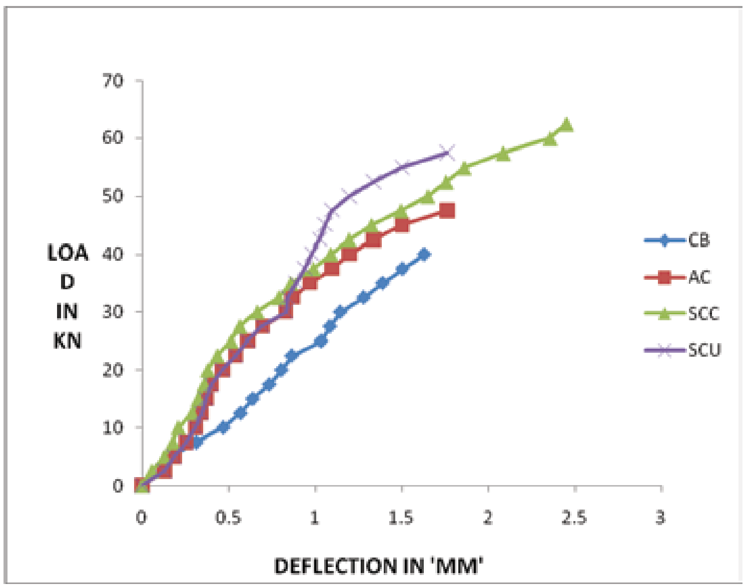


Fig. 6 Load deflection Behaviour for all Beams

Mode of Failure: Figure 7 shows the cracking pattern of self compacting concrete beam (SCC), admixtures beam, self curing concrete beams, and conventional beam subjected to flexural load until failure. During early stages of loading, fine vertical flexural crack appeared around the mid span of beams, as expected. With the increase in load, flexural cracks formed. With further increase in load, the flexural cracks started to propagate diagonally towards the loading point and other new diagonal cracks began to form separately in other locations. In general, SCC beams had slightly lower number of cracks than those other beams.

Discussion: The yield load and yield deflection for self compacting concrete beams was increased by 50% and 35% when compared with control beams. The ultimate load and ultimate deflection for self compacting concrete beams was increased by 36% and 32.65% when compared with the control beams. The ultimate load for admixture concrete beams and self curing concrete beams was increased by 27.27% and 30.43% when compared with control beams. The ultimate deflection for admixture concrete beams and self curing concrete beams was increased by 14.5 % and 7.82 % when compared with control beams.

Fig. 7 Failure of All Specimens

The deflection ductility for self compacting concrete beams was increased by 44% when compared with control beams. Whereas deflection ductility for admixture. Concrete beams and self curing concrete beams were increased by 20.51% and 40.60% when compared with control beams. Based on the experimental results it was found that self compacting concrete beams shows better results.

V. Analtical Work

An artificial neural network is an artificial intelligence technique. It is a simulation of human brain–like architecture. An artificial neural network is a massively distributed processor made up of interconnection of simple processing elements i.e. neurons outputs are connected, through weights, to all other neurons including themselves. Artificial neural networks are simply a class of mathematical algorithms, since a network can be regarded essentially as a graphic notation for a large class of algorithm. These are synthetic network that emulate the biological neural networks found in living organisms. Artificial Neural Networks can also be defined a s physical cellular network that are able to acquire, store and utilize the experiential knowledge that has been related to network capabilities and performance.

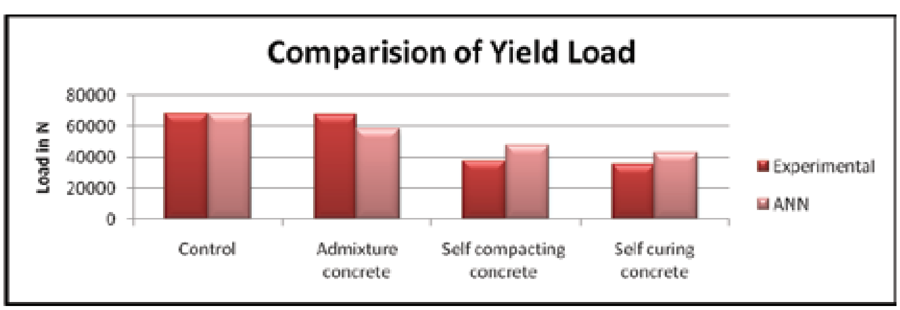


Fig. 8 Comparision of Yield Load

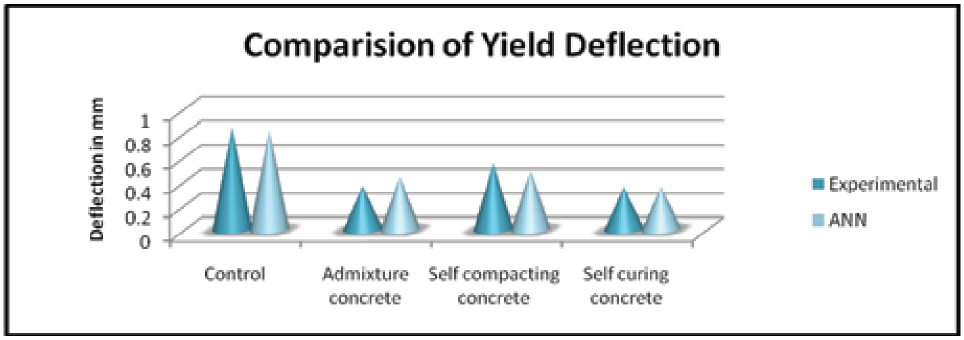


Fig.9 Comparision of Yield Deflection

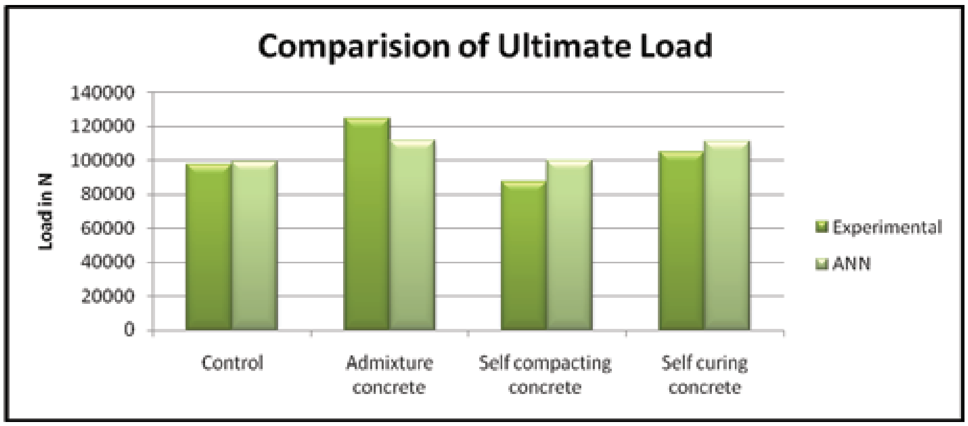


Fig.10 Comparision of Ultimate Load

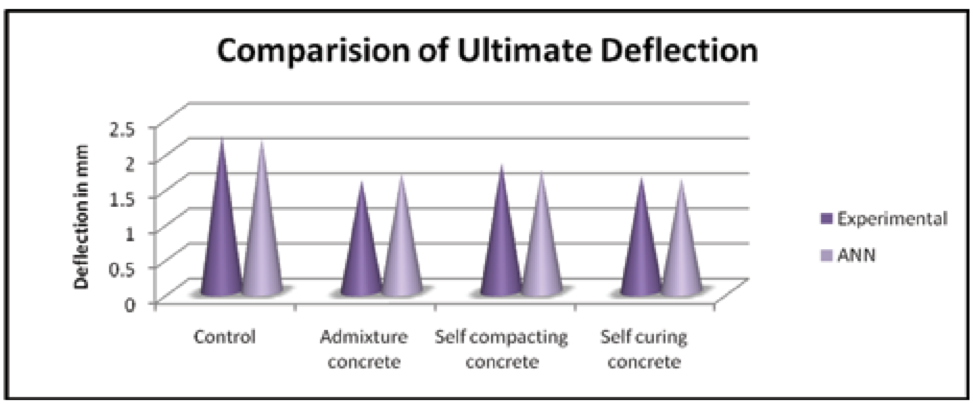


Fig.11 Comparision of Ultimate Deflection

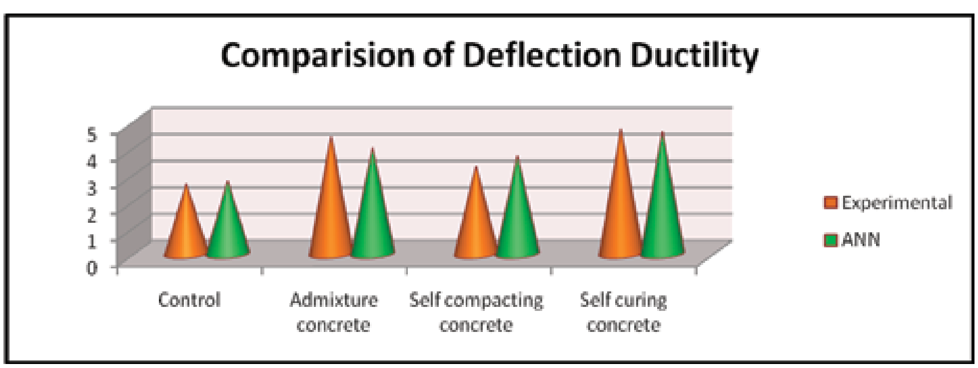


Fig.12 Comparision of Deflection Ductility

VI. CONCLUSION

SCC was designed and 12mixes with various replacements of constituent materials and addition of mineral and chemical admixtures were cast and tested. The self compatibility properties were tested in the fresh state and satisfied the SCC criteria. The experimental results were compared with predicted values through ANN.

For the hardened properties the SCC were derived.

1. Compressive strength of self compacting concrete was increased 12.86% with comparing conventional concrete.
2. Tensile strength of self compacting concrete was increased 9.82 % with comparing conventional concrete.
3. Compressive strength of self curing concrete and admixture was increased 8.9% and 12.03% with comparing conventional concrete.
4. Flexural capacity of self compacting concrete beams show better results.
5. The ultimate load and ultimate deflection for self compacting concrete beam was increased 36% and 32.65% when compared control beams.
6. The predicted results ANN compared with the experimental results were quite satisfactory.
8. The percentage errors of predicted values through ANN when compared with the experimental results varies between 0.8% to 16.60%

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