Available online at www.elixirpublishers.com (Elixir International Journal)

Civil Engineering

Elixir Civil Engg. 94 (2016) 39954-39959

ISSN: 2229-712X

Mechanical Properties of Self Compacting and Self Curing Concrete

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ARTICLE INFO

Article history:

Received: 14 March 2016;
Received in revised form: 22 April 2016;
Accepted: 30 April 2016;

Keywords

Ann,
Scc,
Vma.

ABSTRACT

Self compacting concrete, also referred as self-consolidate concrete, is able to flow in and consolidate under its own weight and is almost completely while flowing in all type of formwork. It is cohesive enough to fill the spaces of almost any size and shape without any segregation and bleeding. This makes SCC particularly useful wherever placing is difficult, such as in heavily –reinforced concrete members or in complicated work forms. In this study it is proposed to place the constituent material by mineral admixtures and adding chemical admixtures. Also, it is proposed to use self curing compound instead of normal curing concrete. Self compacting and self curing concrete specimens in size of cubes (150mmx150mm x150mm), cylinder (300mm x150mm), and prisms (500mm x 100mmx100mm) were cast and tested. The ANN modelling also derives and compares the results.

1. Introduction

A concrete that can be compacted into every corner of a formwork, purely by means of its own weight and without the need for vibrating compaction. Self-compacting concrete (SCC) is an innovative concrete that does not require vibration for placing and compaction. It is able to flow under its own weight, completely filling formwork and achieving full compaction, even in the presence of congested reinforcement. The hardened concrete is dense, homogeneous and has the same engineering properties and durability as traditional vibrated concrete.

Proper curing of concrete structures is important to meet performance and durability requirements. In conventional curing this is achieved by external curing applied after mixing, placing and finishing. Self-curing or internal curing is a technique that can be used to provide additional moisture in concrete for more effective hydration of cement and reduced self-desiccation.

2. Literature Review

Aijaz ahmad zende, et al., (2014) had concluded, a better understanding of rheology of SCC has made it easier to know the functions of fines, superplastizisers and VMA in SCC .The compatibility between the made the designer a clear understanding of the mechanical properties including stress strain characteristics of SCC in its hardened state. They concluded SCC does not need any standard codes for mix design and effect of conventional curing days influence the mechanical properties of SCC.

Dubay sanjay kumar, et al., (2014) had investigates SCC prepared without viscosity modifying agent and Portland pozzalono cement (PPC) is used for development of self compacting concrete.SCC prepared deferent combination of silica fume and lime powder having better filling ,passing ability and higher compressive strength. They concluded continuous gain of strength up to sixty days due to slow pozzolanic reactions of Portland pozzolona cement .

Deepthi rajagopal, et al.,(2014) reports the results of several durability tests conducted on self compacting concrete specimens. It was found that initial surface absorption, chloride ingress, sulphate ingress solutions were better strength and maintained the weight loss of the specimen.

Young xie (2002) has investigated high strength self compacting concrete containing the fly ash and super plasticizers mixes having a good workability, high mechanical properties, and high durability is developed. The experimental results indicate low slump loss, low permeability, good freeze and thaw resistance, and low drying shrinkage.

Burak felekoglu et al, (2007) concluded that the adjustment of water /cement ratio and super plasticizer dosage is main key properties in proportioning of scc mixtures. Five mixtures with different combinations w/c ratio and super plasticizers dosage levels exhibit workability parameters. Mechanical properties of the concrete are obtained higher strength.

Halit Yazici et al, (2010) had concluded replacement of fly ash (class c) and silica fume in various proportions of scc mixtures having better mechanical and durability properties, high volume fly ash and 10% of silica fume mixes have freeze thaw and chloride penetration resistance.

3. Scope and Objective

The scope of the paper is to study the effect of various percentages of mineral admixtures in producing Self-compacting and self curing concrete.

The objective is study the mechanical characteristics of concrete such as compressive strength, split tensile strength ,young’s modules flexural strength test by varying the percentage of fly ash 20%, silica fume 10% quarry dust 20% and replacement in conventional concrete.

4. Materials Used

The different materials used in this investigation are given below:

4.1 Cement

Cement used in the investigation was 43 grade ordinary Portland cement confirming IS: 12269: 1987 having specific gravity of 3.15.

4.2 Fly ash

Fly ash produced from the burning of younger lignite or sub bituminous coal, in addition to having pozzolanic

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Table 1. Details of specimens cast

S. no	Nature	M30		
		Cubes	Cylinders	Prisms
1	Conventional concrete	6	6	6
2	Self compacting concrete	18	18	18
3	Self curing concrete	18	18	18

properties, also has some self compacting properties. In the presence of water, fly ash will harden and gain strength over time. In this study fly ash replaced 20% of cement content.

4.3 Silica fume

Silica fume imparts very good improvement of rheological, mechanical properties. It improves the durability of concrete by reinforcing the microstructure through filler effect and thus reduces segregation, bleeding and attained the early strength. In this investigation silicafume replaced 10% of cement content.

4.4 Chemical admixtures

Super plasticizers or high range water reducing admixtures are in essential component of SCC. Conplast 430 was used as super plasticizers and auromix v100 was used as viscosity modifying agent. Concure WB used as a self curing agent.

4.5 Fine aggregate

The fine aggregate used was obtained from a nearby river source. The fine aggregate conforming to zone II according to IS: 383-1970 having specific gravity of 2.65

4.6 Quarry dust

The granite fines referred to as quarry dust, by product in the production of concrete aggregates during the crushing process of quarry. Addition of quarry dust improves the quality of concrete. In this study quarry dust replaced 20% of fine aggregate content.

4.7 Coarse aggregate

Crushed granite was used as coarse aggregate. The coarse aggregate according to IS: 383-1970 having specific gravity of 2.78. Maximum coarse aggregate size used is 12.5 mm.

4.8 Water

Ordinary portable water was used have pH value of not less than 8.0

5. Experimental Programme

The experimental program was designed to investigate the strength of self compacting and curing concrete by adding the percentage of fly ash 20%, silica fume 10% weight of cement and quarry dust 20% replacement sand of to the concrete. The experimental program was aimed to study the workability, compressive strength, split tensile strength, flexural strength test. To study the above properties mixes M30 are considered. The scheme of experimental program is given in Table 1

5.1Fresh 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, L-Box, V funnel and fill box tests for SCC as per Europian guidelines in table 2.

Table 2. Workability test result

Methods	Typical range of values	Test values
Slump flow	650 to 800 mm	740 mm
T50 cm slump flow	2 to 5 sec	4 sec
v- funnel	7 to 12 sec	10 sec
L- box	0.8 to 1.0	0.9

Fig 1. Slump flow

Fig 2. L- box test

Fig 3. V-Funnel test

6.2 Compressive strength of cubes

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.

Fig 4. Specimen in compressive testing

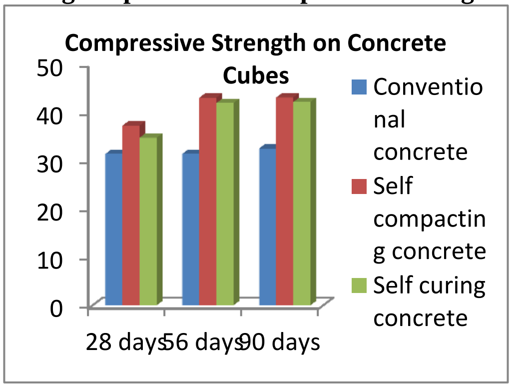

Fig 5. Compressive Strength on Concrete Cubes

6.3 Compressive strength of cylinders

Compressive strength tests were carried out on cylinders of 150 mm dia and 300 mm height on a compressive testing machine of 2000 kN capacity as per IS516:1959.

Fig 6. Specimen in compressive testing

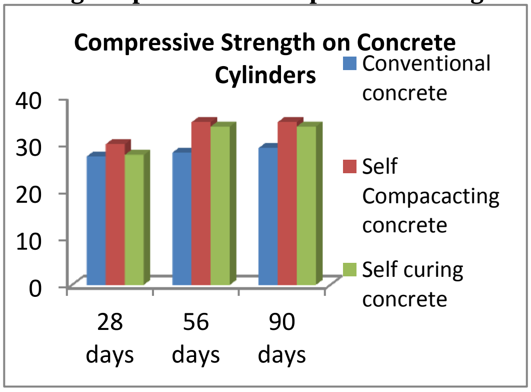

Fig 7. Compressive Strength on Concrete Cylinders

6.4 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

Fig 8. Specimen in compressive testing

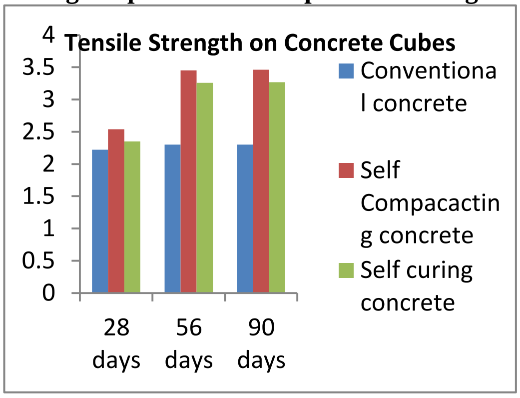

Fig 9.Tensile Strength on Concrete Cubes

6.5 Tensile strength of cylinders

Tensile strength tests were carried out on cylinders on a compressive testing machine of 2000 kN capacity as per IS516:1959.

Fig 10 . Specimen in compressive testing

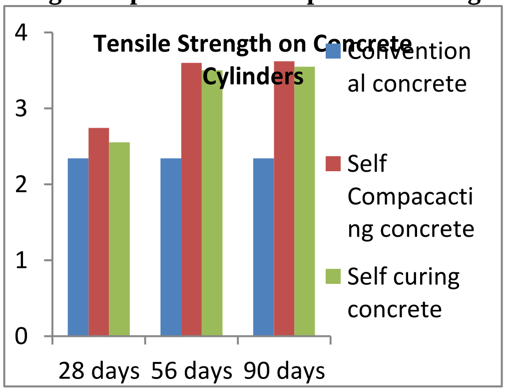

Fig 11. Tensile Strength on Concrete Cylinders

6.6 Flexural strength test

Flexural strength tests were carried out on beams of size100mm X 100 mm X 500 mm were cast to determine the flexural strength of concrete .test were conducted as per IS 516-1959.

Fig 12. Specimen in flexural testing

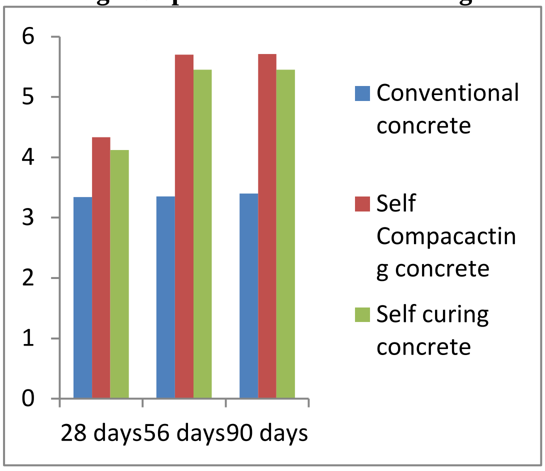

Fig 13. Flexural Strength on Concrete

Result and Discusion

The experimental programme consisted of casting and testing of conventional concrete specimens, self compacting and self curing specimens.

- Workability test for fresh concrete on scc was carried out as per ENFRAC FEB 2002 specification, its fulfil the all requirement of the fresh properties.
- Mechanical properties of the self compacting and self cutting concrete slightly increase the when comparing the conventional concrete.

7. Analytical Investigation

Artificial neural network (or simply neural network) offers an alternative to mathematical modelling. The idea of the neural network is to present it with input data as well as the right Answer, and it will learn the relation between input and output. Subsequently, the trained Network can be used to predict the outcome of other sets of input, where the answer is unknown .Being based on empirical data, the neural network has the same weakness as the mathematical model. The validity of predictions is limited to cases comparable to cases, where the input data were collected. But the advantage over the mathematical model is that the human programmer making the model doesn't have to declare every action of the program, state the correct function from the beginning. When using neural network applications for problem solving, one needs to understand the problem to such a level that one can choose the relevant parameters as input. But when the network is trained, one can learn more about the problem by studying the way the network generalises. In a way, the neural network summarises the experience hidden in the input-output relation. The neural network has been called the second best way to do just about anything. The best way is of course to attain a full understanding of the problem and then find the right formula or optimum algorithm for the particular problem. However, this may not always be possible, and it leaves plenty of problems to be solved by the second best approach. A simple neural network based on radial basis fewer neurons is shown in fig:

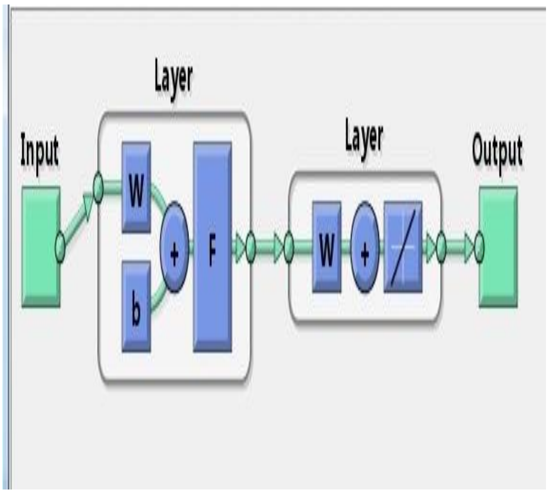

Fig 14. Creating Network data and Training process

7.1 Building a Neural Network

The neural network analysis is performed by using a commercial software package, Brain Maker, from California Scientific Software .Brain Maker is not a very sophisticated Program, but it is easy to use and can carry out all necessary functions to build a plain neural Network.

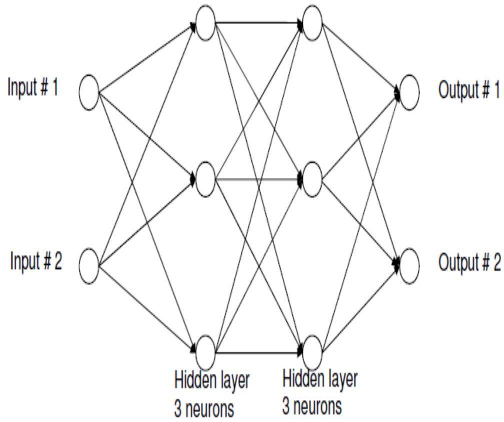

Fig 15. General schematic diagram of neural networks

7.2 Input data

To train a neural network, it is necessary to have a large number of data sets of high quality. It was difficult to collect the necessary number of data sets, because as mentioned in section it is common practice either to prove the air void structure or to measure the scaling in an accelerated test, but not both. This means that only seldom both results are known for concrete for normal construction purposes. Instead the data collected originate from research and development projects in Denmark, Norway and Sweden, e.g. from testing of concrete for large civil structures or the preceding laboratory investigations of concrete before a field test.

7.3 Network architecture

The network consists of neurons in layers, each neuron being linked to a number of neurons in the subsequent layer. The training consists in adjusting the way a signal is processed in each connection, when the signal passes through the network. A large network with many Connections demands a high number of data sets for training, whereas a smaller network can be trained satisfactorily with proportionally fewer data sets.

7.4 Comparison of observed values vs predicted values from ANN

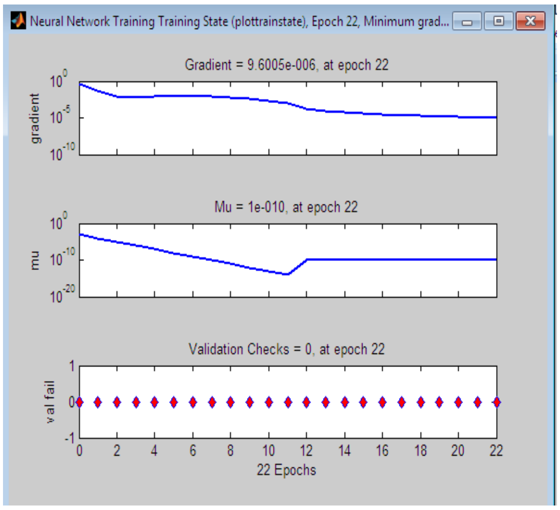

Table 3. Comparison of concrete cubes with ANN

	Conventional Concrete N/mm²	Self compacting Concrete N/mm²	Self curing concrete N/mm²
EXP value	31.33	37.18	34.66
ANN value	31.46	37.26	34.74
Error	0.13	0.08	0.08

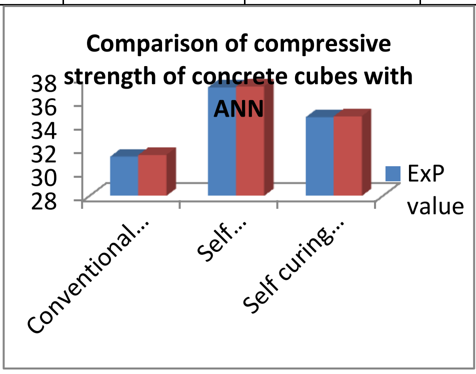

Fig 16. Comparison of compressive strength of concrete cubes with ANN

Table 4. Comparison of concrete cylinders with ANN

	Conventional Concrete N/mm²	Self compacting Concrete N/mm²	Self curing concrete N/mm²
EXP value	27.16	29.80	27.53
ANN value	27.16	30.10	27.59
error	0	0.3	0.06

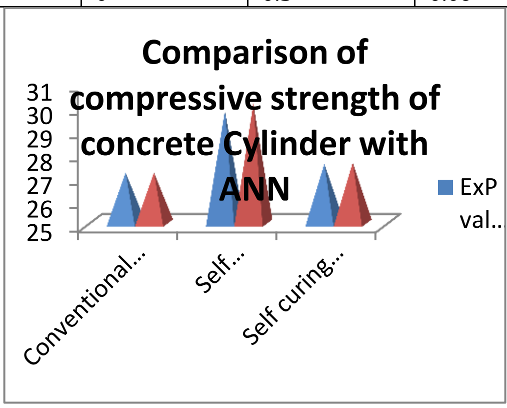

Fig 17. Comparison of compressive strength of concrete Cylinder with ANN

Table 5. Comparison of tensile strength of concrete with ANN

	Conventional Concrete N/mm²	Self compacting Concrete N/mm²	Self curing concrete N/mm²
EXP value	2.34	2.74	2.55
ANN value	2.49	3.73	2.67
error	0.15	0.99	0.12

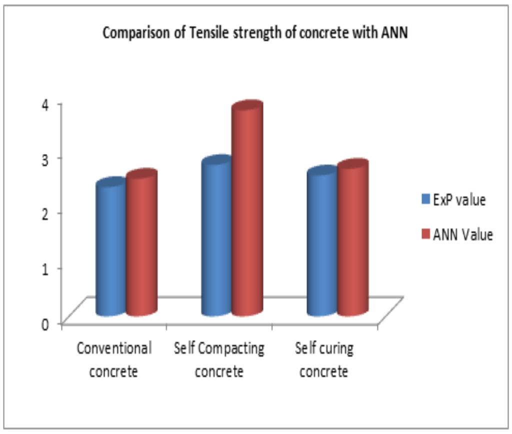

Fig 18. Comparison of Tensile strength of concrete with ANN

Table 6. Comparison of flexural strength of concrete with ANN

	Conventional Concrete N/mm²	Self compacting Concrete N/mm²	Self curing concrete N/mm²
EXP value	3.34	4.33	4.12
ANN value	3.46	5.32	4.3
error	0.12	0.99	0.18

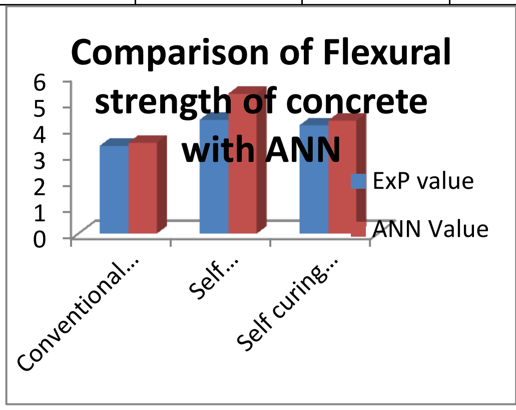

Fig 19. Comparison of Flexural strength of concrete with ANN

8. Conclussion

SCC was designed with various replacements of constituent materials and addition of mineral and chemical admixtures were casted. Self compacting concrete mixtures were designed having a constant w/p ratio is 0.40 and total powder content of 533 kg/m³. The self compact ability properties were tested in the fresh state and satisfied the SCC criteria. The following conclusions were made from test results.

- The compressive strength of Self Compacting and Self Curing Concrete was increased by 15.73% and 9.6% as compared to conventional concrete at 28 days.
- The tensile strength of Self Compacting and Self Curing concrete was increased by 14.5% and 8% as compared to Conventional Concrete at 28 days.

- The flexural strength of Self Compacting and Self Curing concrete was increased by 22.86% and 18.93% as compared to Conventional Concrete at 28 days.
- The experimental and theoretical value for Modulus of Elasticity of Self Compacting and Self Curing concrete was increased by 6.86% and 3.75% as compared to Conventional Concrete.
- In 56 days and 90 days strength gradually increased by the 28^{th} day's strength in both the concrete.
- The predicted results of ANN compared with the experimental results were quite satisfactory.
- The Self Compacting Concrete mostly used is very effective compared to Conventional Concrete.

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