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Design and Implementation of ANN Based SCC with GGBS using Auromix 400

Mohanraj A, Karthiga N, Durgadevi S, Dhivyabharathi S, Senthilkumar V

Abstract*: *Concrete is the main building material. When concrete becomes hard, it gives strength to the structure. Many times it is a difficult task to pour the concrete into the formwork and compact it perfectly. This has been overcome by using Self-Compacting Concrete (SCC). Such a concrete is one of the advanced building materials in the field of construction industry. Unlike the other type of concrete, this kind of concrete compact's effectively under its own weight. There is no need of any external vibration or compaction procedure to minimal the concrete in formwork. It can easily flow in every corners of the formwork without blocking. This project deals with SCC in which, the binary material used is Ground Granulated Blast Furnace Slag (GGBS) as mineral admixture at various percentage of replacement. To reduce the measure of water used in concrete, Auromix-400 is used as Super Plasticizer at a constant dosage. Several tests were carried out to study the behavior of fresh and hardened concrete. Test for fresh concrete includes slump flow, V Funnel tes• Similarly, the properties of concrete were also determined b conducting compression and Spit tensile test. At the same time th simulation model was also developed to test the proposed syste using the artificial neural network (ANN) protocol. The AN model is built on six objects with multiple output-multiple. Sing Output Type - In the second method, the artificial neural networ model is a single input neural network that is built on top multiple inputs - where multiple inputs has been predicte separately based on various types of neural function - Secondly, the ANN model is built on multiple inputs. The results indicate the superiority of the neural network method in terms of the accuracy of publication prediction results.

Keywords: SCC, ANN, Workability, Compressive strength, Split tensile

I. INTRODUCTION

The Self-Compacting Concrete (SCC) is a stream capable concrete. To increase the flow ability and ease of placement of concrete, we use super plasticizers and stabilizers in it. By using SCC, we can attain perfect compaction in all the parts of the formwork without any segregation of aggregate. Following are the advantages of using SCC.

- Better compaction
- Ease of flow
- Increased durability

The hugeness of self-compacting cement is that it meets all the required presentation of cement. If concrete segregates, there will be loss in strength. To avoid this, mix design should be done in a proper manner. It must have high deformability and excellent stability characteristics.
SCC finds its application in We can use SCC in the accompanying applications in the area of congested reinforcement.

The objectives of this project are
To acquire functionality of self-compacting concrete with GGBS and Aura mix 400.
To study the characteristics of mineral admixture (GGBS) and super plasticizer (Aura mix 400) in self-compacted concrete.
To find out the optimum percentage of GGBS and Aura mix 400 that can be used in self-compacting concrete.
Further, it is likewise expected to think about quality parts of self-compacting concrete utilizing GGBS and Aura mix 400.
To contrast the consequences of ordinary concrete and self-compacting concrete.

The ANN convention is enlivened to comprehend the structure of natural neurons in the human brain and how it functions. As of late, it has been of interest to researchers in the ANN, a nonlinearly modelling approach, due to its ability to predict roughly or with an acceptable error, between nonlinear mapping (or straightforward) inputs and any complex problem output. The estimation is performed utilizing a learning calculation with the assistance of a dataset. Inputs and outputs from the training dataset are used in the form of training data pairs. Inaccurate or not complete, ANN can be used in situations where there is no information. ANN Approximate High Capacity The similarity between inputs and outputs when making it an optimal tool.

II. LITERATURE REVIEW

The exploratory examination dependent on SCC with GGBS demonstrates that 80% of bond can be supplanted by GGBS to accomplish the quality of 30MPa. The quality addition of GGBS based blend may have higher pozzolonic action when contrasted with traditional blend. [1]. Self-compacting cement can be compacted under its very own load with any outside compaction [2].

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***** Correspondence Author
Mr. A. Mohanraj*, Department of **Civil**, Bannariamman Institute of Technology, Erode, India. mrmohanpro29@gmail.com
Mrs. N. Karthiga, Department of Civil, Bannariamman Institute of Technology, Erode, India. karthis47@gmail.com
Mrs. S. Durdadevi, Department of Civil, **Bannariamman** Institute of Technology, Erode, India. durgadevi@bitsathy.ac.in
Mrs. S. Dhivyabharathi, Department of Civil, **Bannariamman** Institute of Technology, Erode, India. dhivyabharathi@bitsathy.ac.in
Dr. V. Senthilkumar, Department of Civil, Sri Shakthi Institute of Engineering and Technology, Coimbatore, India. civilvsk@gmail.com

Expansion of mineral admixtures displays palatable outcomes in usefulness perspective – Literature audit on Self – Compacting Concrete [3]. The flexural quality of SCC shafts increments as the level of bond substitution increments – Effect of incomplete substitution of concrete in SCC by utilizing Fly ash and Metakaolin [4].

The idea of Self – Compacting Concrete has built up itself as imaginative material in the field of solid innovation. SCC with the expansion of mineral admixtures accomplishes the ideal quality when contrasted with typical blend. [5]. As per the trial study the blend of SCC with 30 % of GGBS in complete bond substance invigorates satisfactory at 28 days. So the blend of fly slag with GGBS can be utilized as trade material for bond in the creation of SCC. From the study it is demonstrated that the pressure and split elasticity of solid increments when sand is supplanted by quarry residue up to 40% in SCC. The cost of SCC is more when compared with concrete made with ordinary cement. Be that as it may, it very well may be overlooked by thinking about its exhibition. This exploration has demonstrated that the mix of the two materials and substitution of bond up to 30 % invigorate required with great quality and less cost of binder. In light of the test examination, mechanical and solidness properties of SCC increments for ideal blend of 10% fly cinder and 10 % GGBS for bond substitution. Be that as it may in the event that we increment the level of mineral admixtures, the quality reductions. The consolidated substitution of FA and GGBS concrete shows increment in quality by increment in level of substitution [6]. The ideal estimations of SCC blend as pursues: 80% OPC, 10% GGBS and 10% FA. The exploratory outcomes demonstrate that the quality properties of SCC with fractional substitution of concrete by Granite powder and GGBS expand the quality up to certain level.[7]By watching the exploratory outcomes 40% substitution concrete by lake slag is ideal. Above 40% substitution, decline the quality. Substitution of lake fiery debris by weight of fine totals in different rates, for example, 20%, 40% and 60%, GGBS, lime stone powder of same rates, for example, 20%, 40% and 60% by weight of bond is supplanted as a mineral admixture to accomplish self – compacting solid properties to foresee the stream conduct with the expansion of super plasticizer by 1% weight of concrete. Partial substitution of concrete by GGBS expands the pressure, split elastic and flexural quality of SCC. Compressive quality, split rigidity and flexural quality was expanded when 40% of fine totals were supplanted by copper slag. This blend mix gives preferable outcomes over the traditional self-compacting concrete. Scientists utilizing ANNs in foreseeing the accompanying sorts of properties: Normal, High-Performance and Self-solidifying [11-13].ANNs have also been used for structural damage detection and further identification of system structure [14, 15], modeling of material behavior [16], groundwater [17] monitoring system [18], and making underwater [19] structures of foldable concrete model.ANNs have been reached out to different applications in civil engineering to foresee the compressive quality of concrete, for example, the assessment of superior concrete with chloride particle diffusion coefficient [20], and the long haul sulfate assault [21] because of the wear of black-top through the revelation of concrete [22].

III. SELECTION OF MATERIALS AND METHODS

A. Cement

53grade of Portland cement [8] is used in manufactured SCC All the preliminary and necessary tests are carried out. The properties of Portland cement are as shown in table 1.

Table- 1: Properties of Cement

Characteristics	Value
Specific gravity	3.15
Consistency (%)	24%
Setting time A. Initial (min) B. Final (min)	 65 240

B. Fine aggregate

Characteristic sand is utilized as fine aggregate. The sand pass through 4.75 mm strainer is taken and evaluating was done all through the work. Table 2 demonstrates the properties of fine aggregate.

Table-2: Properties of Fine aggregate

Properties	Value
Specific Gravity	2.85
Fineness	2.58
Absorption of water	1%

C. Course aggregate

Coarse aggregate are acquired from squashed rocks. It must be held on 4.75 mm sifter. The greatest size of coarse aggregate is commonly restricted to 20 mm [9]. The coarse aggregate invigorates volume and to the solid. The properties of coarse aggregate are classified and are shown in table 3.

Table-3: Properties of Course aggregate

PROPERTIES	VALUE
Specific weight (g/cm^3)	2.70
Sieve 200	1.29%
Absorption of water	1.15
Fineness	3.24
Specific gravity	2.66

D. GGBS

It is a side-effect got in the assembling of pig-iron. It is gotten by warming iron-mineral and limestone motion at high temperature in the shoot heater (around 1500^0 C) which is exceptionally pozzolanic in nature [10].

Table-4: Properties of GGBS

Physical Properties	Value
Specific Gravity	2.62
Fineness	321
Wet sieve analysis %	2.9%

The reaction of GGBS with water is a very slow process when compared to OPC.The properties of the GGBS is shown in the given below table 4.

E. Auramix 400

Auramix 400 is considered to be one of the advanced super plasticizer used in concrete at present.This super plasticizer is mainly based on a polycarboxylic ether polymer. Addition of this super plasticizer reduces the amount of water used to prepare concrete mix and also gives higher workability of concrete.

F. Water

Water plays a major role in construction. It is used for preparing mortar, mixing of concrete and curing work etc., during construction work. When water is added with cement heat of hydration takes place. Addition of water makes the concrete workable.

IV. CASTING PROCEDURE AND MIX RATIO

The concrete mix was casted into respective moulds. The mix design was done as per IS: 10262-2009. After casting process, the specimens were allowed to set. Then the concrete piece was cured in water for seven, fourteen and twenty eight days after demolding.

A. Mechanical Properties

To predict the characteristics of concrete SCC mix are subjected to various tests.

- Compression test
- Split tensile test

B. Mix proportions

The mix proportions for M40 grade of SCC is as shown in table 5.

Table-5: Mix proportion of SCC

Grade	M40
Cement(Kg/m^3)	404.34
Fine aggregate(Kg/m^3)	557.12
Coarse aggregate(Kg/m^3)	1249.36
Water (Lit/m^3)	186
GGBS 15 % (Kg/m^3)	60.6
GGBS 30 % (Kg/m^3)	121.20
GGBS 45 % (Kg/m^3)	181.8

V. TEST ON FRESH AND HARDENED CONCRETE

This test is led to discover the usefulness of cement. The estimation of droop means the progression of SCC, sturdiness of blend, isolation and seeping in the blend. This is nearby test to decide the stream capacity of cement. The finess in high level and practically spherical shape of GGBS results in good cohesion and segregation resistance (EFNARC). Table 6 and 7 shows the workability properties of SCC as per EFNARC Standard. The test performed is as shown in figure 2 and 3.

Fig .2 Slump test

Fig .3 V funnel test

A. Compression test

This test is utilized to decide the pressure quality of cement. 150 × 150 × 150 mm cube were casted for testing. In the wake of demoulding, the shapes were relieved upto the predetermined date of testing in the restoring tank.

Fig .4 Compression test on concrete cube

At that point the example was taken out from the restoring tank for testing. The example was set on pressure testing machine. The heap was connected upto which the example starts breaking. The heap at which the example breaks is noted and the pressure quality of cement was controlled by utilizing the recipe.

B. Split Tensile Strength

Cylinders were casted to decide the part elasticity of the solid. The tallness and distance across of the chambers were 300 mm and 150 mm separately. At first the chamber form was readied. Oil was connected on the shape to abstain from splitting of concrete during demoulding. From that point onward, the chambers were loaded up with concrete in three layers. For each layer, compaction is finished by packing bar by giving 25 blows. At long last leveling is done in the form. It is permitted to set for 24 hours and afterward de-formed. Presently the tractable test is done.

Fig .5 Split tensile strength test on cylinder

VI. TRAINING AND TESTING OF THE ARTIFICIAL NEURAL NETWORK

There are two diverse redundant neural system models utilized in this examination. Fig. 6 has multiple publications illustrates the ANN architecture with simple re-diffusion
On the other hand, the figure 7 shows single output features simple repeat diffusion although the ANN has a second proposed structure. Both include the output layer, the input layer, a hidden layer and the connections between. The training (or learning) process differs from the test dataset in a learning algorithm using the Levenberg Marquardt to find the ANN model updated during the prediction process. To achieve the best accuracy, tests are necessary.

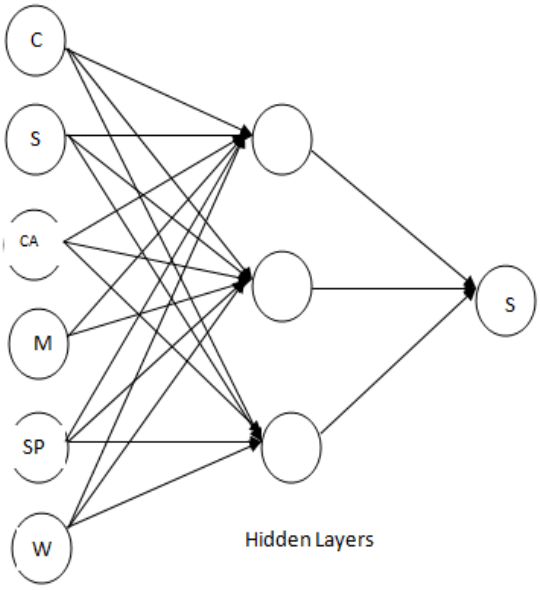

Figure 6 Architecture ANN-I model.

Products that perform weights and viscosity better will be To demonstrate the exhibition of ANN in SCC composite proportioning, the genuine qualities are anticipated against the anticipated diagrams. Incorporated diagrams draw three lines with the right qualities, just as two lines joining 20% ± from the right one. Root Mean Square Error (RMSE), NRMSE and relationship coefficient (R2).

VII. RESULTS AND DISCUSSIONS

The simulation was developed using matlab to validate the performance of proposed experimental system and the following chapters discuss the experimental results of proposed system.

The Workability properties of SCC are conducted and found to be satisfied to the EFNARC standards. The slump flow of normal concrete is 480mm.The concrete with additon of GGBS shows 40 mm flow difference and is shown in Table 7. Addition of Light weight aggregate does not show greater variation in slump flow. Even though the slump flow of such mixes are less than the concrete with SAP it satisfies the EFNARC Criteria

Table-6: Slump Flow test of SCC

Mix	Slump flow
NC	660
M1	640
M2	635
M3	620

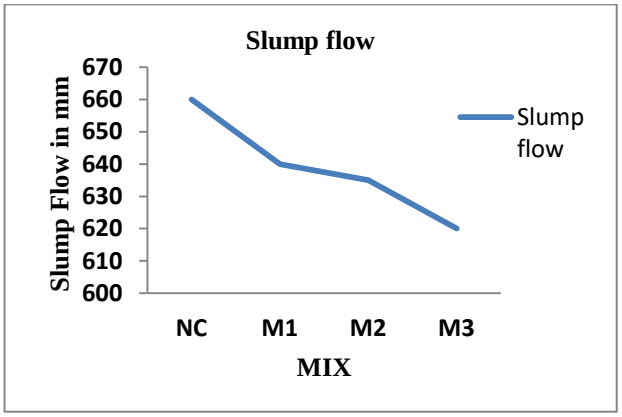

Fig. 7 Slump Flow of SCC

Table-7: V Funnel test of SCC

Mix	V Funnel Test in sec
NC	9
M1	10
M2	11
M3	12

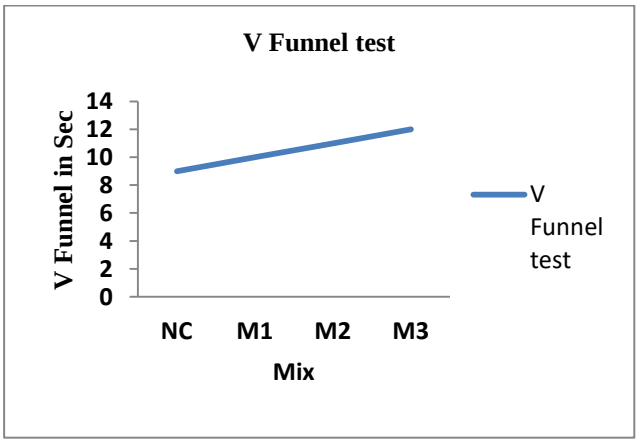

Fig. 8 V funnel test of SCC

The strength of ordinary cement and GGBS based concrete is organized beneath. These test outcomes obviously shows that the GGBS based SCC invigorates superior to typical concrete. It might be noticed that the outcomes are high when contrasted with ordinary concrete.

Table 8 Compression strength on cube

Concrete mix	Mix	Compressive strength in N/mm^2		
		7days	14days	28days
M40	NC	19.6	29.4	39.8
	M1	22.4	34.5	45.6
	M2	23.5	35.4	46.8
	M3	24.0	37.2	48.20

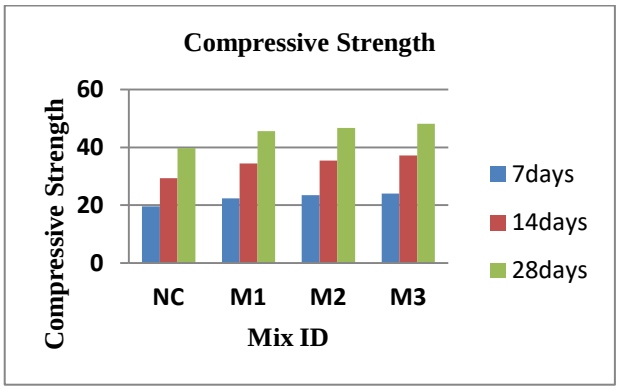

Fig. 9 Compressive strength of SCC

The split rigidity at 28 days for different blends is appeared in table 9. This shows that GGBS based SCC having higher tensile strength (4.68 N/mm2) when compared to normal mix (4.20 N/mm^2)

Table 9 Split tensile strength of SCC

Concrete mix	Mix	Split tensile strength in N/mm^2		
		7days	14days	28days
M40	NC	2.2	3.7	4.20
	M1	2.35	3.86	4.38
	M2	2.46	3.95	4.5
	M3	2.5	4.05	4.68

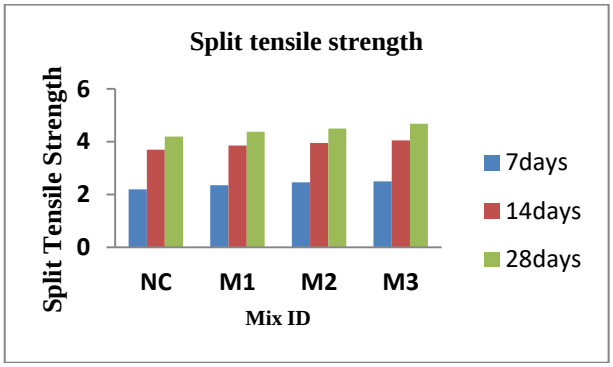

Fig. 10 Split tensile strength of SCC

VIII. CONCLUSION

Slump flow of concrete is increased with respect to increasing the GGBS content in concrete. This trial study demonstrates that the quality of concrete increments with the most extreme substitution of mineral admixtures. The strength of concrete increased for 45% replacement of GGBS to cement. Henceforth, the following are the conclusions that are made out of this work.

- The ideal level of GGBS that can be replaced to cement can be 45%.
- The workability property is greatly affected because of more fines. But all the values arrived satisfies the EFNARC Codal provision.
- The compressive and split tensile strength of concrete gave positive response in terms of strength aspect.
- The Artificial Neural Network performs better in predicting the strength of the concrete.

Thus it has been verified, by using the slump flow and Funnel tests on fresh SCC that self-compacting concrete (SCC) achieved consistency and self-compactability under its own weight, without any external vibration or compaction.

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AUTHORS PROFILE

Mohanraj A is currently pursuing his PhD on Self Compacting Concrete. He works as an Assistant Professor at Bannari Amman Institute of Engineering Erode. He has published three journals and presented more than ten papers in International Conference.

Karthiga N had completed her PhD on Optimization techniques. She works as an Assistant Professor at Bannari Amman Institute of Engineering Erode. She has published nearly twenty journals and presented more than thirty papers in International Conference. She had delivered about six guest lectures on structural optimization.

Durgadevi S is currently pursuing her research on Fiber Reinforced Concrete. She works as an Assistant Professor at Bannari Amman Institute of Engineering Erode. She has published two journals and presented more than three papers in International Conference.

Dhivyabharathi S is currently working as an Assistant Professor at Bannari Amman Institute of Engineering Erode. She has published more than five journals and presented more than ten papers in International Conference.

Senthilkumar V had completed his PhD on Microbial cement. He works as an Associate Professor at Sri Shakthi Institute of Engineering and Technology, Coimbatore. He has published more than ten journals and presented more than ten papers in International Conference.