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Research Article

A LITERATURE REVIEW ON APPLICATION OF ARTIFICAL NEURAL NETWORK IN SELF COMPACTING CONCRETE

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Abstract

Self-compacting concrete originated from Japan in the late 80's. because it does not require the vibrator to be consolidated. it was mostly used from 2000.Since there is no specific code for the mix design. The application of ANN will help to predict exactly the mix design of SCC. The application of artificial neural networks in self-compacting concrete began from the year of 2001.From the beginning the study shows that the ANN is a reliable method to predict the optimum admixture in a fast manner. When compared to do experimentally which is costlier and time consuming. ANN is programmed with the two modulus that is the output of the first ANN program will be the input of the second program are mostly used. Self-compacting concrete has been produced using the different types of mineral and chemical admixtures in order to reduce the material wastage and time. Glass powder is an excellent admixture. Using glass powder will increase the strength of SCC by 15 % and it also reduces the absorption of carbon dioxide .There should be application of ANN in SCC made with admixture of glass powder will help to develop an eco-friendly concrete.

Introductions

Self-compacting concrete is now used world-wide because of its self-consolidating nature. It is the most preferred where conjunction of reinforcement is more. To make a mix design needed to follow EFNARC guidelines, that is if a self-compacting concrete is prepared it has to pass all the abilities like passing ability, segregation resistance and flowing ability. Various tests are carried out to satisfy this ability like slump flow by Abrams cone,V-funnel test and L- box test . If a concrete passes all the three tests then the concrete is said to be self-compacting concrete. There is a wide range of material through which SCC can be produced. In order to reduce the time and the material the support can be obtained from artificial intelligence. From the journal there are two methods which are widely used that area root square mean error and the fuzzy logics of using artificial intelligence. The studies show that there are many types of admixtures used to increase the flexure and compressive strength of SCC.

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some of them are like raw rice husk, GGBS micro silica etc in reasonable ratios. usage of superplasticizers are also restricted to the percentage of less than 2. In order to increase the hardening properties.

Literature survey in Application of ANN in SCC

P.G. Asteris(2016) et al has arranged out an investigational study on mechanical characteristics of Self compacting concrete by applying artificial neural networks (ANNs) to predict these characteristics. Specifically, ANN models were used to predict the 28-days compressive strength of a special type of self-compacting concrete which based on experimental data available and collected from the literatures present in the web. The comparison of the arrived results with experimental results and the possible of using back propagation neural networks which was demonstrated and it gave the promising, reliable and estimate of the compressive strength of SCC.

Mahmoud Abu Yaman,(2019)et al presented a study which comparing the two different methodologies which has been applied on data sets two in number completely different from each other of SCC mixtures, which were collected from the datas literature, using (ANN) and also discussed about accuracy in forecasting the ingredients of SCC with the help of data's of the 28-day strength of compression and slump flow distances as inputs of the ANN.

Yu Zi-ruo, (2019) et al carried out an artificial neural networks study to predict the strength of self-compacting concrete. Also supported an experimental study to show the optional application of artificial neural networks to predict the ingredients for the self-compacting concrete. The results which are statistical values for compressive strength projected by the ANN are also compared to those obtained through the regression models. admixture to be used for the self compacting concrete the program which was use consist of 9 inputs and 3 outputs and this system is used for to predict the compressive strength ,L.box ratios.The ANN has showed the excellent performance by predicting the effect on the properties due to different admixture.which has been used.

K. Raghu Prasad(2017) et al has trained the data which is being collected from the available in literature on Self compacting concrete application or use of ANN, the main alternative materials used where normal volume was used because the data on SCC with high volume fly ash was not available in enough amount. While guessing the strength of HPC with the same data sets for SCC has been used to train cut back on computational effort. The compressive strengths of SCC and HPC as well as Workability of SCC estimated by the proposed neural network are validated by results of experiment.

Pratyush (2016)et al has reviewed the literature which shows that ANNs have been used successfully not only predicting the strength but also in the pile size prediction, modelling soil conduct, site characterization, earth retentive structures, settlement of structures, slope stability, design of tunnels and underground openings, liquefaction, soil permeability and hydraulic conductivity, soil compaction, soil swelling and classification of soils .The need of neural networks, and important formula used in realizing neural networks along with identifying limitations.

Chamarthy Krishnama Raju(2019)et al Artificial Neural Networks (ANN) tool is used. Present work establishes the use of ANN for prediction of properties of M25 SCC for various sizes of

coarse aggregates blends. The range of error for predicted compressive strengths compared to graph and ANN values is from 2.1% to 5.0%.

B.K. Raghu Prasad (2008)et al he has compared the compressive strength of self-consolidating concrete and high performance concrete which was predicted using the ANN .In both the concrete the high volume of fly ash was used . basically, the work shows the slump cannot predict the strength of SCC using slump alone water binder ratio and water cement ratio is also required. When the compressive strength is compared to for 28 days is less compared to 90days strength of SCC so it is advised when ANN is used to predict apart from water binder and coarse aggregate , fine aggregate, water binder, and water powder ratio and also include the numbers of days , because of the use of high volume fly ash is used it will retard the strength ,to reduce the error and exact prediction necessary to add numbers of days of curing.

Yu Zi -ruo (2009) et al has studied the application of ANN to predict the compressive strength of SCC. Almost 104 sets of dates were used to predict the properties of SCC out of that 84 sets of data was used to train the ANN model. The method which was used is Back propagation Neural Network (BPNN) Root mean square error(RMSE) so that the error can be reduced to 7 % in the second order regression was carried out for ANN model. The total input of the ANN program is six which also includes the percentage of superplasticizer, one hidden layer and with one output. MATLAB software was used. The superplasticizer usage was restricted to 2 % so that the SCC can reach a good strength.

Moosa Mazloom(2013)et al has worked it little bit differently that ANN was used to predict the workability of the scc that is like the filling ,passing ability and resistance to wards segression.so the ANN model with multi-layer Perceptron networks and radial basis was used almost 400 dates was use for training the Ann this consist of six input with two hidden layer and three output.since the number of dataset is high so the accuracy of the ANN exact. Since the ANN is on multiple input and multi output.

Aravind J Prakash (2017) et al conducted study on the tensile properties of SCC using ANN and Random kitchen sink algorithm (RKS) with least square method. Normally RKS is used for mapping the data sets. Using 40 sets of data was used to train the ANN model. The model was trained using Matlab software. Which consists of eight inputs and one output was obtained in the middle only one hidden layer is present. Not only the tensile strength but also filling passing and resistance for segregation also tested manually, to check with predict output. The RMSE value of both ANN and RKS are almost similar. it is suggested that ANN is good for small sets of data. Whereas RKS is good for large sets of data.

Salim T.Yousif (2011)et al also did work on to predict the28 days compressive strength of SCC .Here the mix consists of viscous modifying agent , which is added in terms of ml. The data which is used to train the model were taken from various journals consisting of 143 sets of data. 123 data were used for training the model and the output of the model was verified with 18 sets of data. There was more than 20% error deducted. Basically, the major reason for the 20 % error is the usage of viscous modified agents.

Sonebi(2016)et al investigated the workability of self compacting of concrete using the back propagation Neural Network and Root mean square error in ANN model. Almost twenty mixes

were used to train the ANN model. Which had good correlation coefficient the most of workability test L box ,Oriment flow time and L box blocking ratio. And the error for all the fresh properties almost are from 3.3 to 22%. The model consists of the seven-input component, one hidden and one output component. In the study addition lime stone powder was used in order to increase the strength of SCC. By predicting the concrete workability this will reduce the time.

Akhmad Suryadi(2011)et al has developed an Artificial neural network for predicting the initial setting time of SCC. And the model was architected with six inputs ,one hidden layer and one output. It has error of at least 3% and predicted that initial setting time to be less than a minute due to usage of admixtures . Almost 250 data sets where used to train the model. And the software used for the ANN model is Microsoft visual C#. The number of epochs was 10,000. Here also back propagation algorithm was used. This work will help in casting SCC Immediately.

Akhmad Suryadi(2011)et al has evaluated the compressive strength of SCC using the ANN.The model was trained with 120 data sets and the error was almost 2%.the momentum parameter and the learning rate coefficient is 0.01 and 0.1. the study has also predicted the running time for various number of sets.As the number of sets increase the running time is also increased.

Cuong H. Nguyen (2019) et al presented a paper on Feed forward Neural Network and Multi-Layer perceptron in predicting the workability of the SCC. First in the study that workability was obtained for almost 235 sets of data. MATLAB software was used for the ANN modelling. These types of date were for the Vietnam monsoon climate.

De – Cheng Feng(2019)et al using the boosting algorithm of ANN the compressive strength was predicted and almost 103 set of datas where used to train and run the ANN Back propagation model. The amount of training influenced the sensitivity of the model .The regression coefficient values were almost equal to 1 and the error predicted was 12%. The study also compares the learning algorithm ANN and SVM.

Ramin Tabatabaei Mirhosseini(2018)et al demonstrated the properties of the SCC by incorporating the using the silica and quick sand using ANN model.due to the influence of natural material has highly impacted the properties of SCC . Silica fume contents with low lubricant admixture dosage.Two models where used one is ANN 1 and ANN 2 to determine the mechanical and rheological properties of SCC.Three optimal network layer consist of six input and one output and one hidden layer. The correlation coefficient was calculated using RMSE and MAE.The R value for both the correlation methods is 0.92. And the error was less than 15% for both the properties.

A. Feizbakhsh(2017)et al has done comparative study on the traditional method and computing method to predict the compressive strength of concrete in SCC.The comparison was not only in the with methods nut also compared the two different logics which are used in soft computing that are fuzzy logic ANFIS ,passive congregation PSPC and Artificial neural network ANN. The mixes consist of nano material like silicon dioxide , aluminium where used in the SCC.The result of this study shows that all the methods like ANN ANFIS and PSOPC are more effective in predicting the compressive strength of concrete.

Paratibha Aggarwal (2011)et al has done various research work in SCC. Latest research was on application of fuzzy logic in predicting the compressive strength of SCC .The success of SCC is high so using the traditional method is tough for each trial. In order to that fuzzy logic is comfortable and root mean square error is used to determine the correlation coefficient value which is almost equal to 0.919.the advantage of using a fuzzy logic is that it can adjust the linear or nonlinear subsets. The strength Predict thought the fuzzy logic is compared to tradition method there is a hike of 20% in compressive strength. That means a 20% error in prediction of strength can be reduced if more sets of data used to train the model error can be reduced.

Venkatesh Subash Koneru(2019)et al assessed the characteristics of SCC using ANN.both compressive and tensile strength was determined by traditional method and assessed using ANN model. The cement used for SCC is replaced with metakaolin ,micro silica and fly ash t in order to make it a sustainable material.123 mixes of data sets where used for training the ANN model.mean root square error method was used to find the correlation coefficient is 0.99.the software used for predicting the hard concrete properties in MATLAB 2012b.The predicted characteristic was almost similar like traditional method .

Paul O,Awoyera (2020)et al has estimated the properties of self compacting concrete produce using the geopolymer by machine learning technique. In this two machine learning technique is used one is artificial neural network and genetic programming.to prepare the SCC 12m sodium hydroxide and sodium silicate solution was used.A simple equation was formed for genetic programming using ANN model.the properties of SCC using geopolymer were checked with EFNARC limits.so after that only the strength was predicted using the ANN and GEP. Both methods predicted the satisfying value of the strength. compacting concrete will increase the compressive strength and flexural strength of the SCC.The compressive strength of the SCC is 20.62N/mm^2 and flexural strength is 6.43N/mm^2. To improve the flexure strength of SCC ,2-3% of superplasticizers were used or nano particles can also be used because it will fill the inside pores of the cement structure.

V.Gokulnath(Dec2019)et al had done the experimental study on self compacting concrete using glass fibres and the glass powder, the properties of self compacting concrete is studied both fresh and hard. Now days using the M-sand is the new normal,while add glass fibre in the self compacting concrete is better than the conventional type.it increases the flexural strength, tensile and split tensile strength of the SCC.its is highly durable and it is also resists the cracks development.it also increases properties like workability of SCC. the experimental study were done on the M20 grade of SCC specimens were casted, arranged with addition of four different proportions weight (0.3%,0.6%,0.9%, and 1.2%) of glass powder with water cement ratio of 0.45..Slump cone, L-Box, U-Box, V-Funnel and J-Ring tests were performed to determine the properties of fresh concrete on both r-sand and m-sand. The fresh concrete tests are done for self-compacting concrete to know the flow and workability of the concrete. The properties of hardened concrete tests on both riversand and manufacturing sand can also be experimented by conducting the flexural strength and split tensile strength test.

Diego Carro (2016) et al-has discussed the use of fine recycled aggregate from recycled sand concrete is limited because of the quality of the sand which has the property of high absorption of the material which will reduce mechanical performance. Hence the aim of sand to produce SCC. The seven different types mix design used are equivalent mortar, which has contributed a reliable

concrete that could be comparable between different replacement ratios and useable in real-life application. when the design of the mixes of the mortars obtained had the property like workability was measured using mini-funnel test, the results were from 10 min to 90 min and the suitable ones were chosen to perform self-compacting concrete.

Mayur B. Vanjare, (2012)et al has carried out an experimental study on the various possibilities of using waste material in a preparation of alternative concrete from the convention type. Waste material which was identified is Glass Powder. The use of this glass powder was in a different percentage of proposition as on like instead of cement for production of self-compacting concrete. The addition of glass powder in SCC mixes has little disadvantages like reducing the self-compacting properties like filling ability, passing ability and segregation resistance. The flow value decreases by an average of 1.3%, 2.5% and 5.36% for glass powder replacements of 5%, 10% and 15% respectively

A Rajathi (2014) et al has on the possibility of adding glass powder used as one of the ingredients in Self compacting concrete with different mix design and found their behaviours in self-compacting concrete. The paper also discussed the possibility of using waste material in a preparation of innovative concrete. The use of this waste (GP) was proposed in different percentages with respect to cement for production of Self compacting concrete.

Rahul Roy (2017) et al carried out experiment analysis of the feasibility of using the partial replacement of industrial waste glass powder as cement in SCC.In there is a partial replacement of cementitious material in self-compacting concrete with the glass powder in the percentage of 5%, 10%, 15%. The physical property of self-compacting concrete is determined by using slump flow test strength of aggregate by crushing and abrasion is determined by using impact test.

Arjun N(2017) et al experimental study on SCC with glass powder. Viscocrete 20 HE preferred for admixture. The percentage replacement of glass powder with cement includes10 percent, 20 percent, 30 percent, 40 percent, 50 percent. The fine aggregate is 90 percent of sand and 10 percent of foundry sand. The Mix design for SCC was arrived as per the guidelines of EFNARC. The results about the mix design and the various tests to be conducted such as material testing, strength tests are being discussed in this paper.

Er. B. Subhan Ramji (2018)et al presented a method for the design of SCC mixes based on an experimental investigation. The main focus is to use the waste product of glass factories in the preparation of the concrete in the innovative way, and the product is glass powder.The use of this Glass Powder and fly ash are the partial replacement of fine aggregate and cement was proposed in different percentages for production of self-compacting concrete. The experimental work was done on the mixtures with the following ingredients (cement, fly ash, glass powder and super plasticizer) to improve the strength is examined by their specific role in SCC.

Caijun Shi (2017) et al carried out an experiment to design a self consolidation lightweight concrete by using the fly ash or glass powder to reduce the void volume.he has compared two concrete using fly ash ,glass powder and also he has used inert powder so that it has good resistance towards the freezing and thawing as per ACI standards. As results show both satisfy the standards nut the glass powder reduces the air content. Glass powder has many advantages like exhibit higher

shrinkage so that it will increase the initial curing time by 1 week.so as a result the glass powder will be the best replacement when compared with the fly ash.

Table1.1 below gives the brief details about the journal paper which is being explained briefly in the above shows how each author has used the various methods and formulas for developing the neural network which has been created, most of them are multi input and multiple output. The recent journals have been taken for the research.

TABLE 1.1 List of Authors and their Publication

SL. NO	AUTHOR	YEAR	ANN METHOD	SOFTWARE USED	PREDICTED PROPERTIES	no of mixes	NO OF INPUT LAYEA	NO of Hidden layers	NO OF OUTPUT
1	Paul O. Awoyeraa,	2020	Back Propagation Neural Network(BPNN)Root mean square error(RMSE),Mean square error (MSE)	Matlab	strength properties of geopolymer Self-compacting	**20**	8	2	3
2	Shashikant Kumar	2020	Multivariate Adaptive Regression Spline (MARS) ,Minimax Probability Machine Regression(MPMR)	Matlab	Rapid Chloride Permeability of Self-Compacting Concrete	60	5	4	2
3	Venkata Subash Koneru	2020	Back Propagation Neural Network(BPNN)Root mean square error(RMSE)	Matlab 2012b	Strength of SCC	123	6	1	2
4	De – Cheng Feng	2019	Back Propagation Neural Network(BPNN)	Matlab	compressive strength of SCC	103	8	1	1
5	Moncef Nehdi,	2019	Back Propagation Neural Network(BPNN)Root mean square	Matlab	compressive strength of SCC	20	10	2	1

			error(RMSE),Mean square error (MSE)						
6	Cuong H. NGUYEN	2019	Back Propagation Multi-layer Perceptron (BPMLP),Nonlinear Approximation	Matlab	Workablility of SCC				
7	Chamarthy Krishnama Raju	2019	Back Propagation Neural Network(BPNN),Mean square error (MSE)	Matlab	compressive strength OF M25 SCC for 12.5mm &20mm	75	6	2	6
8	S.A.Ahmed	2019	Back Propagation Multi-layer Perceptron (BPMLP),Mean square error (MSE)	Matlab	Workablility and compressive strengthof SCC	65	9	2	3
9	Ramin Tabatabaei Mirhosseini*	2019	Back Propagation Neural Network(BPNN)Root mean square error(RMSE)	Matlab	Self-compacting Concrete Properties Containing Silica quicksand		10	2	2
10	Aravind J Prakash	2017	ANN and Random Kitchen sink algorithim (RKS)with least square method(LSK)	Matlab	Tensile strength of SCC	40	8	1	1
11	A. Feizbakhsh	2017	Compared the technique neuro–based fuzzy inference system (ANFIS), artificial neural network (ANN)Back propagation Neural Network(BPNN) and hybrid of particle swarm optimization with passive congregation (PSOPC)		compressive strength of SCC				

			and ANFIScalled PSOPC–ANFIS.						
12	P.G. Asteris,	2016	Back Propagation Neural Network(BPNN),Mean square error (MSE)	Matlab	compressive strength of SCC	169	12	2	1
13	Sonebi	2016	Back Propagation Neural Network(BPNN),Mean square error (MSE)	Matlab	Workablilty of SCC	20	6	1	6
14	Akhmad Suryadi1,	2015	A non-linear transfer function sigmoid curve as known as activation function, Back propagation Neural Network(BPNN)	Microsoft Visual C#.	compressive strength of SCC	250	6	5	1
15	B.Vidivelli	2014	NOT GIVEN	Matlab	flexural behaviour of self compacting concrete beam	12			
16	Mohanraj A	2014	Back Propagation Neural Network(BPNN)Root mean square error(RMSE)	Matlab	Predicting strength of Self compacting and self curing concrete	17	7	1	1
17	Gökmen Tayfur1	2014	FUZZY and ANN logic	Matlab	compressive strength of SCC	60	5	1	1
18	Abdul Rahemman	2013	FUZZY logic	Matlab	Properties of SCC	31	7	1	7
19	Moosa Mazloom	2013	Multi layer perceptron (MLP) networks and radial basis (RB)	Matlab	Workability of SCC	400	6	2	3
20	Mucteba Uysal	2011	Multilayer feed forward neural network structure.	Matlab	compressive strength of SCC	84	10	2	1

					with mineral admixtures				
21	Salim T.Yousif	2011	Back Propagation Neural Network(BPNN)levenberg-Marquardt(LM)	MATLAB R2009b]	compressive strength of SCC	143	8	1	1
22	Akhmad Suryadi	2011	Back Propagation Neural Network(BPNN),Mean square error (MSE)	Microsoft Visual C#.	Initial setting time of scc	250	6	3	1
23	Paratibha Aggarwal	2011	Back Propagation Neural Network(BPNN),Mean square error (MSE) fuzzy logic (FL-I) and neural network techniques (ANN-I)	Matlab	compressive strength of SCC	60	6	1	1
24	B.K. Raghu Prasad	2009	Multi layer feed forward system(MLFFS)	Matlab	compressive strength of SCC and HPC using high volume of fly ash	300	10	2	1
25	Yu Zi - ruo	2009	Back Propagation Neural Network(BPNN)Root mean square error(RMSE)	Matlab	compressive strength of SCC	104	6	1	1

Conclusion

From the starting of the research on ANN till now the research was done on various properties of a SCC like predicting workability ,compressive and flexural strength of the Self compacting concrete . It has found that the error in all respective research has reduced with increase in the accuracy. If more sets of dates were used to train the ANN model there will be accuracy in the results. There are various materials that have been used as replacement of course, fine, cement and admixture used for the SCC. But the use of glass powder and glass fibre are more effective in SCC. Because it reduces the emission of carbon dioxide which causes air pollution. And it is also waste material from the glass industry. It is also called eco-friendly material. Research is needed to develop an ANN model for SCC incorporating the glass powder or glass fibre.

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