JETIR.ORG ISSN: 2349-5162 | ESTD Year : 2014 | Monthly Issue
JOURNAL OF EMERGING TECHNOLOGIES AND INNOVATIVE RESEARCH (JETIR)
An International Scholarly Open Access, Peer-reviewed, Refereed Journal

PREDICTION OF COMPRESSIVE STRENGTH OFCONCRETE CONTAINING USED ENGINE OIL USING ANN

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ABSTRACT:

In an effort to lessen the negative effects that disposing of used engine oil (UEO) for the atmosphere has on marine, human, and underwater life as well as agricultural productivity, this study suggests using such waste material as a chemical mixture in concrete manufacturing. In order to ascertain the impact of UEO on the various new characteristics of concrete (consistency, the rate of slump loss, settling time, and air content), a study is originally presented. The effectiveness of concrete having UEO in the state of hardening will next be carefully examined through evaluation of the different material properties, namely the compressive strength after 3 days, 7 days, and 28 days. Artificial neural network (ANN) models are used to forecast the strength qualities of concrete mixes created with varying amounts of UEO (0%, 0.25%, 0.50%, 0.75 %, and 1%). The output layer, input layer, and hidden layer are the three layers of an ANN. The cement, fine aggregate, coarse aggregate, water content, and chemical admixture (UEO) percentage make up the input layer. Concrete's compressive strength is the result. 45 samples are utilized as training and testing data sets for creating an ANN model. One assessment looks at how many neurons are actually needed in the hidden layer to forecast the network system, while the other assesses how accurate the predicted network is under various load situations. Artificial neural networks typically learn through training and produce incredibly good outcomes. The experimental data can be advanced using ANN to figure out the compressive resistance of concrete. When results are compared to experimental findings and results from neural network training, high accuracy is seen.

Keywords: Compressive Strength, Used Engine Oil, Artificial Neural Networks (ANN),

I. INTRODUCTION

1.1 GENERAL

Concrete was a composite substance made of water, aggregate (such sand and gravel or broken stones), binding material, and occasionally additives. The water helps create the chemical reaction which hardens and reinforces the concrete while the cement serves as a binder to keep the aggregates together. Concrete is renowned for having exceptional compressive strength, allowing it to support enormous loads. Additionally, it is very flexible, affordable, and durable. 90% of the final strength of concrete has been attained after around four months of water curing. But as calcium hydroxide gradually transforms into carbonate of calcium as a result of the absorption of oxygen over time, it keeps getting stronger for decades after that. As a result, it is suggested for a variety of construction activities. After water, concrete is the material that is utilized the most on Earth. In the current world, concrete is still a crucial material, and there is constant research and innovation being done to enhance its performance and sustainability. The options for concrete uses continue to grow as new technologies and methods are developed, influencing the future of architecture.

Environmentally friendly technologies are more common these days. The readily available resources on the market are being replaced by a variety of trash. Although prior researchers had suggested the effective superplasticizer function, replacement admixtures are a fresh notion that has to be looked into. New varieties of cost-effective admixtures could have an economic and technological impact on the construction industry as well as the worldwide adoption of concrete.

The oil that is taken out of an engine after lubricating and cooling its components is known as used engine oil. utilized Engine Oil (UEO) is a waste product that is frequently produced in developed cities and may be recycled and reconditioned to be utilized once more. Transportation and industrial processes will produce about 40 billion kg of UEO yearly. 55% of spent engine oil is directly disposed of into landfills and waterways globally. It has been a severe problem to improperly dispose of spent engine oil, including by pouring it into the sewers or dumping it in landfills. It might include environmentally risky materials. In addition to endangering plants and animals, it can have an effect on the ecology. Additionally, aquatic or marine life suffers when engine oil and water come into contact.

1.2. ARTIFICIAL NEURAL NETWORK:

Artificial neural networks were created as a result of research into and inspiration from the human nervous system. By taking into account prior examples, neural networks are trained to carry out tasks and provide results under various sampling conditions. Hundreds of thousands of connected working nodes, or neurons, make up ANNs, which are capable of learning to recognize patterns in input data. Edges are the connections between nodes. The weight of each node controls how strongly it is connected to other nodes. Each neuron receives input signals, weights them, and then sends the weighted aggregate to an activation mechanism to generate an output signal. One or more hidden layers may exist between the input layer, which gets the initial data, and the output layer, which creates the final output. The network may learn hierarchical structures for the input data with the help of the hidden layers, which also offer intermediate processing. A neural network made up of computers learns by modifying the weights linked to every neuron based on its input data and desired output throughout the training process. Numerous tasks and applications, such as image identification, facial recognition, classification, regression, and prediction, make extensive use of ANNs.

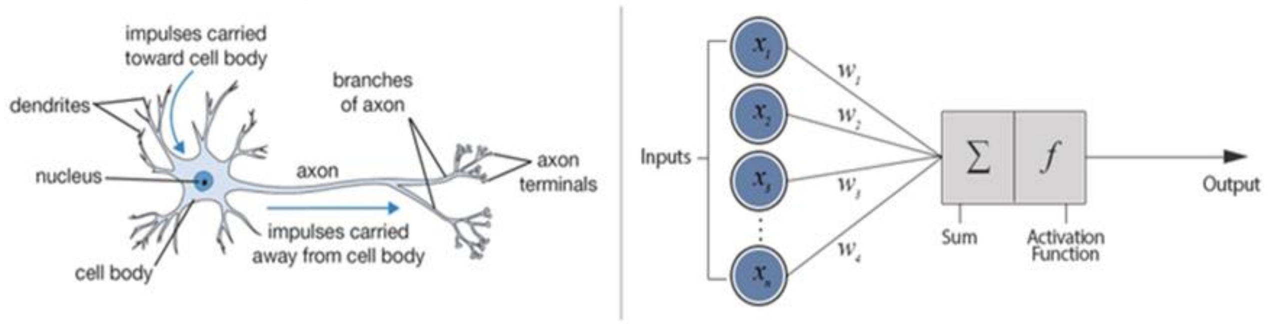

Fig.1: Biological neuron and artificial neural network.

1.3. SCOPE OF THE WORK

The experimental results of mixing used engine oil mixed concrete and the application of artificial neural networks (ANNs) to predict the future strength of concrete are the main topics of this study.to determine the compressive strength of the concrete after it has been mixed with engine oil.To determine the most suitable amount of used engine oil.

- ANN approach to future strength prediction.
- ANN and experimental results are compared to determine the deviation in compressive strength.

1.4. OBJECTIVES OF RESEARCH

In this present study used engine oil as a chemical additive in concrete. ANN is used to predict the future strengths.

- Examine the effects of used motor oil addition on the properties of freshly produced and cured concrete.
- Using experimental data, an artificial neural network can forecast compression strength.
- optimizing the output of artificial and experimental neural networks.

II. LITERATURE REVIEW

[1]Mohammed Noori Hussein's (2014), this study found that concrete will achieve 29.7 MPa in 28 days with a typical compressive strength for 0.75% using motor oil. The findings of the slump experiment demonstrate that injecting motor oil will render working with concrete simpler. Engine oil will act as a lubricant in the concrete to improve its workability. Absent motor oil, concrete has the highest final compressive strength. Because the usage of oils that lube in the concrete will weaken the bonding between aggregate and C-S-H gel, concrete made with new engine oil and concrete made with old engine oil have lower compressive strengths compared to the control sampling. The study's findings also show that old motor oil has a viscosity that is lower than new engine oil, and that cement with used lubricating fluid has a higher compressive strength than concrete with fresh engine oil. Additionally, because there are fewer voids in the concrete when the W/C ratio is low, the aggregate with a 0.48 W/C ratio possesses a strength under compression that is higher than the control sample.

[2]Deepti Singh (July 2016(Burned Engine Oil) was added to six different concrete combinations (a control mix was made without any admixtures, and the BEO concentrations ranged from 0.20 to 0.40 to 0.60%), along with commercially available air-entraining additives. The cement utilized was OPC43 Bangur Cement, a normal Portland cement that complied with IS-8112:1989 specifications. In accordance with the standards of IS-383:1970, the sand was used as fine aggregate while 10mm and 20mm aggregates were used as coarse aggregates. Cement, sand, and coarse aggregate with a weight-to-mixture ratio of 1: 1.4: 2.498 were used to create concrete of grade M35. Fresh concrete's air content was found to be better after BEO was added to the concrete mix. According to results on compressive strength, BEO maintained the mix's strength with a minimal loss of approximately 2-8%, but the same amount of commercial air encircling admixture resulted in a strength loss age roughly 7–20% at the age of 28 days. As a result, BEO-made concrete had higher compressive strength than concrete that had an additive for commercial air-entraining. Flexural strength of the concrete mix dropped by around 9–20% when commercial air–entraining additive was employed, compared to a 2-9% decrease when BEO was added to the concrete mix. BEO looks to be an extremely efficient air-entraining additive, saving about 32% of the admixture cost.

[3]Chia-Ju Lin et al., (2021), This study establishes an ANN (artificial neural network) model in forecasting concrete's compressive strength. The structure for the ANN is a Back Propagation (BP) network having one hidden layer. The ANN is trained and tested using the database of actual concrete mix proportioning stated in earlier research from another author. While the weights of synapses and thresholds are finalized by examining the features of over-training, the right number of neurons in the layer that is hidden is established by checking the features of over-fitting. After that, we check and verify our ANN model using experimental data from previous works. All of the thresholds and synaptic weights' results from the ANN are listed. Therefore, by applying them and the formulas in this article, everyone can independently forecast the compressible strength of concrete based on the mix proportioning.

III. METHODOLOGY

The methodology used in experimental procedure is to determine compressive strength of concrete in comparison with ANN results with minimum error obtained are used to predict future mix strengths.

3.1. MATERIALS USED

A. Cement:

The 53 Grade Ordinary Portland Cement from Penna is used throughout the experiment. The specific gravity of Portland cement is 3.14. It wasbrand-new and lump-free.

B. Fine aggregates:

As a fine aggregate, locally - obtained natural sand with a maximum size of 4.75 mm was chosen, which complies with IS 383-1970 grading zone II. The specific gravity of fine aggregate is 2.57, which may be purchased from nearby vendors.

C. Coarse aggregates:

Locally available crushed granite with a maximum particle size of 20 mm was utilised as coarse aggregate. The specific gravity of coarse aggregate is 2.73.

D. Water:

Oils, acids, alkalis, salts, biological matter, and other pollutants that might harm concrete should not be present in the water used to mix concrete, including the free water on the aggregates.

E. Used Engine oil:

In the making of concrete, they serve as additives. The auto shop is a good place to get old engine oil. From service stations, used engine oil was collected in this work.

F. Super plasticizer:

In order to make high-strength concrete, superplasticizers (SP) are added to fresh concrete to enhance its workability and enable the water content to be dropped. Fosrac Conplast SP 430 Dis is the material utilized in this investigation.

3.2. MIX PROPORTIONS

To attain M50 grade strength, the concrete was designed in accordance with IS 10262- 2009, and a water-to-cement ratio of 0.35 was employed. Seven distinct mixes of Concrete with varying proportions containing UEO (0%,0.25%,0.50%,0.75%,1%)were tested to analyse the strength characteristics in terms of Compressive Strength. Nine cubes are cast for each mix and tested for hardened properties. The table shows the designed proportions of the basic ingredients in concrete.

Table.1: Mix proportions of different mixes.

S. No	Material	
1.	Cement	443Kg/m^3
2.	Fine aggregate	621Kg/m^3
3.	Coarse aggregate	1224Kg/m^3
4.	Water	155Kg/m^3
5.	UEO	0%,0.25%,0.50%,0.75%,1%.
6.	Super plasticizer	4.43Kg/m^3

A. Casting of specimen

The necessary components were weighed for these mixed proportions. All components were blended into a homogenous mix after being added to the water and used engine oil. Before being added to the dry components in the mixer, substance like spent engine oil diluted with water. The final casting of the mixtures was carried out right away after the testing for fresh characteristics. Test samples were cast, and they were then kept in the casting chamber for 24 hours at a temperature of around 20°C. After 24 hours, the specimens were removed from the mould.

B. Curing:

The test samples are maintained in moist air for 24 hours, following which they are marked, taken out of the moulds, and remain immersed in water throughout the duration of the test. The curing water should be 27±2°C in temperature and ought to be examined every seven days.

IV. RESULTS & DISCUSSIONS

4.1. GENERAL:

Listed below is a discussion of the properties that were evaluated while concrete was in its fresh condition and its hardened state, along with the experimental findings that were made.

4.2. FRESH PROPERTIES OF CONCRETE:

The test of freshly laid concrete is related to the workability test. The workability test in this inquiry was the slump test. The slump value of concrete reveals the fluidity and consistency of the material. It gauges the ease of shaping concrete. More workable concrete is indicated by higher slump values, whilst less workable concrete is indicated by lower slump values. Below are figures for slumping for different concrete compositions.

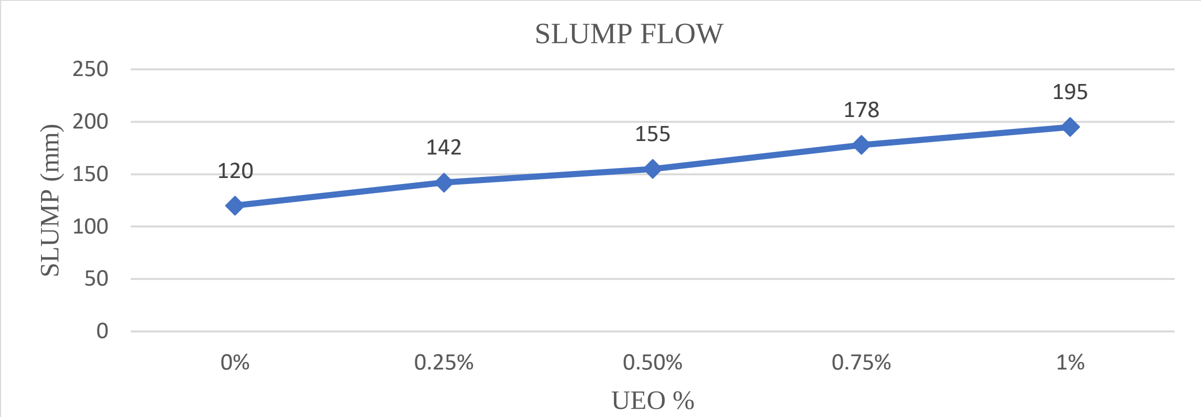

Fig.2: Slump values of different mixes in mm.

The results show that the slump values of the mix were improved by the addition of recycled engine oil as compared to the slump of the unaltered mix. The value of the droop steadily grew from 120 mm to 195 mm as the dose of engine oil that was used was increased to 0%, 0.25%, 0.50%, 0.75%, and 1%.

4.3. HARDENDED PROPERTIES OF CONCRETE:

In the current study, 45 samples were examined after curing for 3, 7, and 28 days to determine the strength at compression of concrete when engine oil is applied. By cement weight, the amount of UEO ranged from 0% to 1%. In this study, the M50 mix design is created by incorporating UEO with various percentages into the concrete while maintaining the mix design's original qualities. The graph showed the strength of compression on the Y-axis and the percentage of UEO on the X-axis. The graph displays the compressive strength experimental findings as they relate to UEO fluctuation. By raising the percentage of UEO, the strength gradually declines at 0.25% of UEO, increases to 0.75%, and then abruptly reduces to 1% of used engine oil.

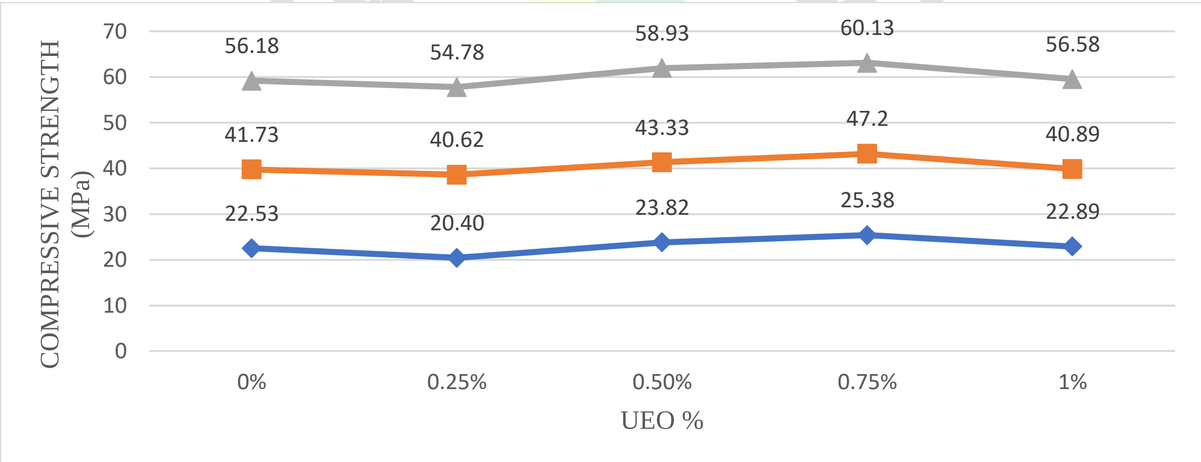

Fig.3: Compressive strength values of different mixes in Mpa.

4.4. ANN Training procedure:

An MFFNN (multi-layer feed-forward neural network) has at least three layers: an input layer, an output layer, and a hidden layer. Each neuron gets weighted inputs from a layer below and sends its result to neurons in the layer above. A nonlinear function of activation transfers the summations of the weighted input signals that have been generated. The network inefficiency is trained until it achieves an acceptable value by comparing the outcome of the network with the outcomes of the actual observations.

The neural network is trained using the feed forwards reverse propagation technique with one hidden layer, and the optimum number of neurons is determined by trial and error. Two neurons are initially added to the hidden layer of an

ANN model, and over time, the number of synapses grows up to twenty. To identify which model is most suitable for an ANN model, many performance parameters are compared against each model.

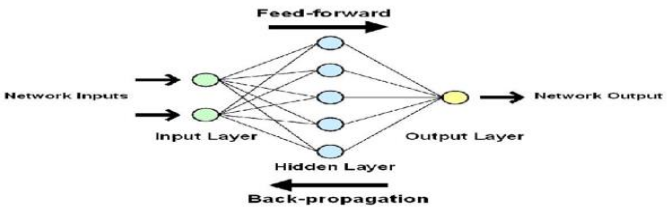

Fig.4: Multilayer feed forward neural network back propagation

Using MATLAB network is generated in Neural Network (NN)tool, which supports four ways of usage that are listed below,

- GUI method
- Command Script
- Training custom networks
- Modifying functions in a network

GUI means Graphical User Interface; this method is quick and easy to access the nntool. To get started with GUI method, enter nnstart in command box. To access the power of toolbox there are four tasks,

- Function fitting
- Pattern recognition
- Data clustering
- Time series analysis

Command Script is the method using command line operations, this method is more flexible than GUI method. In addition to GUI method, command line operation also generated.

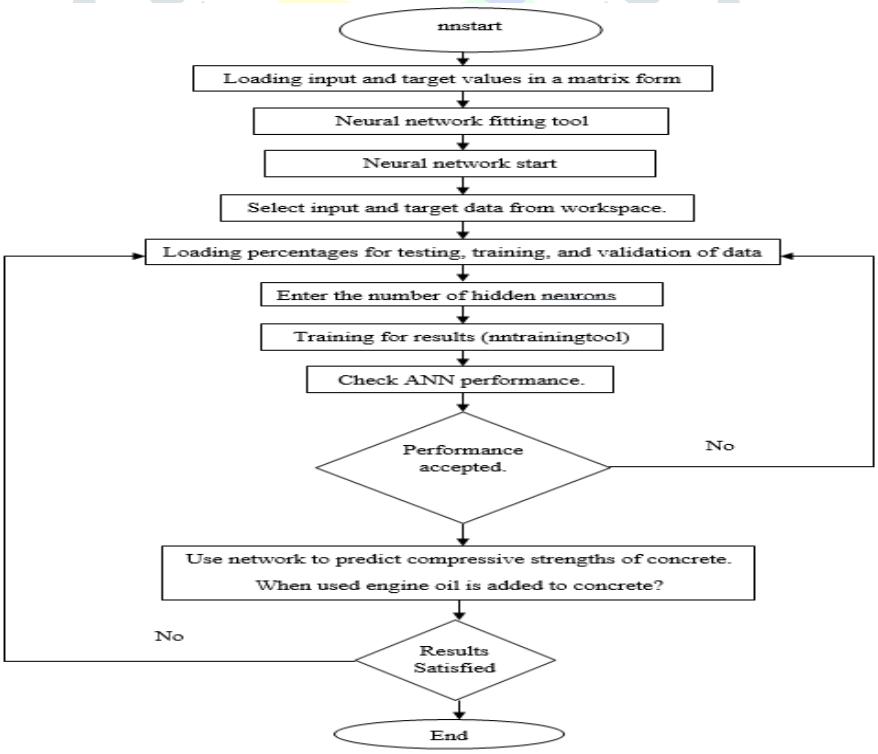

Fig.5: Matlab step by step procedure flowchart

Command line operations: Using command script, the command line operations also generated in the workspace. It is the easiest way to understand the design of ANN. This code can be customized based on requirement of network and future use. After generating the code by just clicking on RUN the program runs and the result of performance is shown in the command window.

Mean square errormeasures the average of the squares of the errors-that is, the average squared difference between the estimated values and the actual value. MSE is a risk function, corresponding to the expected value of the squared error loss.

4.5. ANN results:

Using the ANN approach, the strength of concrete with used engine oil was predicted. Cement content, coarse aggregate, fine aggregate, water content, the age of the concrete, super plasticizing agent, and the percentage of used engine oil are among the inputs. Compressive strength is the goal. Thus, utilizing tools, the prediction is accomplished through the use of GUI or Command Script methods. To produce an output that is acceptable and error-free, experimental data are trained and tested repeatedly. The network's performance plot shows three separate-coloured lines. The colours blue, red, and green stand for the training, test, and validation data, respectively, for the whole set of data. The graph shows test, training, & validation check lines that are straight and parallel. The term "epochs" describes the total number of times that information has undergone mean square error modification. The compression strength performance plot, as required the following shows the error histogram for the compression strength test after learning, testing, and training the data. The kind of error plot that may be seen in the finished network is the histogram plot. The error is divided into 20 bins, or 20 divisions, according to the total number of errors. The plots also include color-coded test, training, & validation areas.

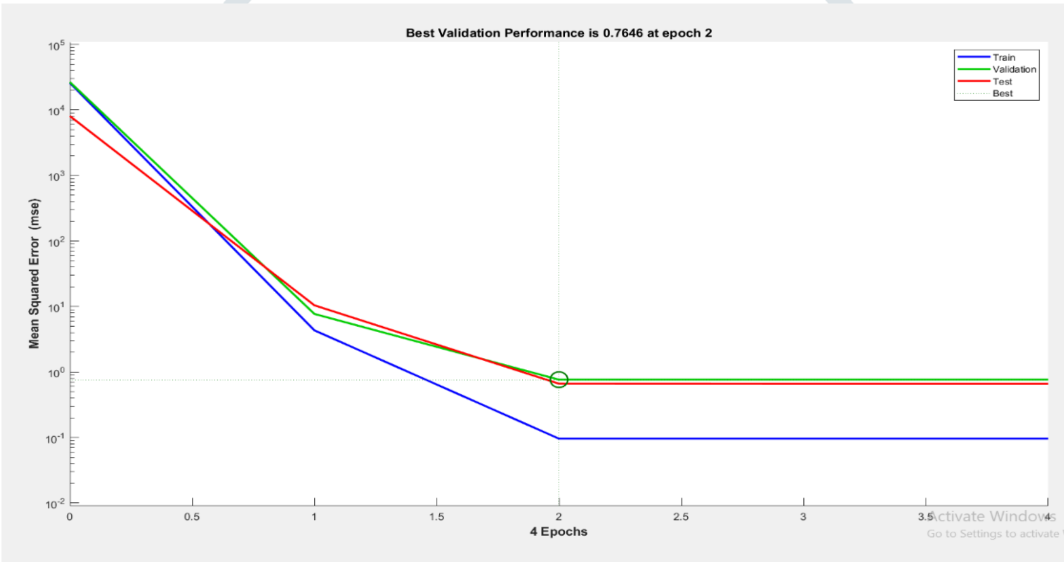

Fig.6:Performance plot for compressive strength

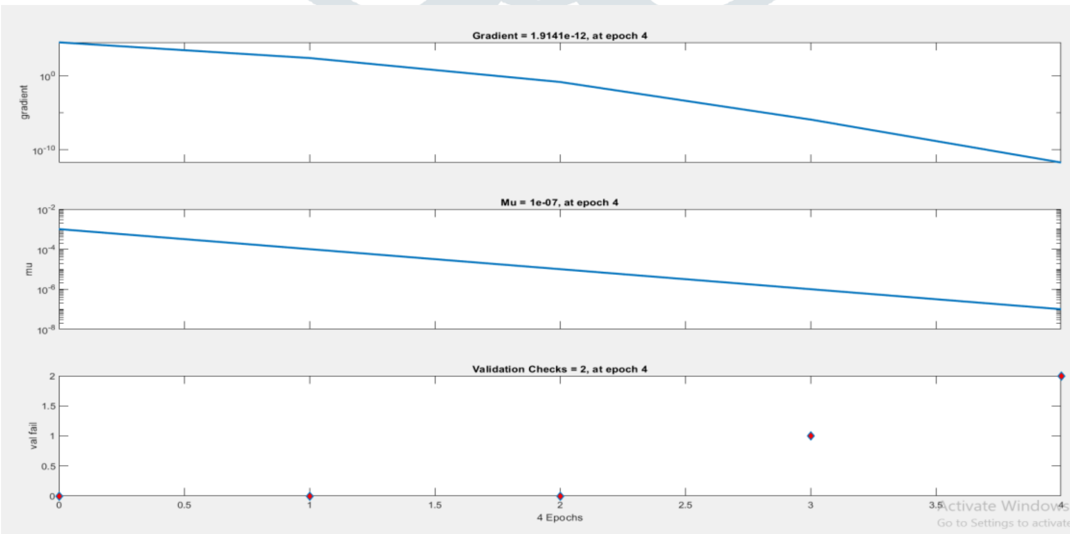

Fig.7: Training state for compressive strength

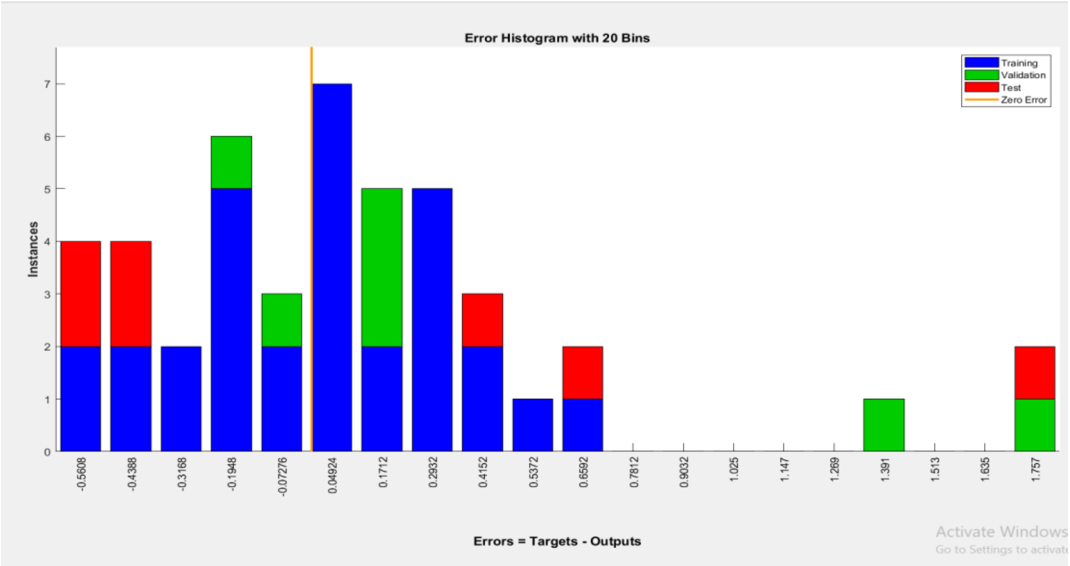

Fig.8: Error Histogram for Compressive strength test.

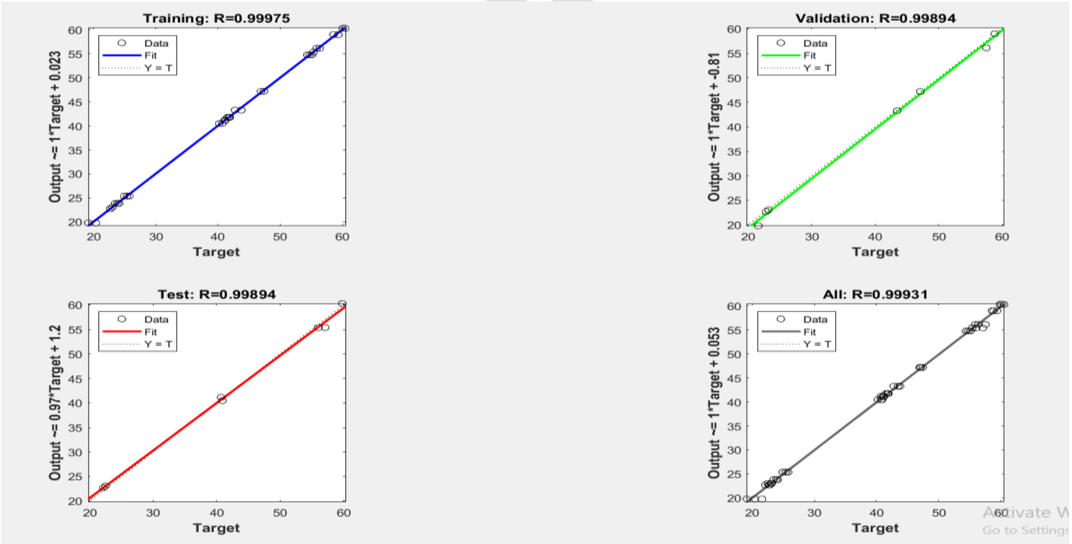

Fig.9: Regression plot for compressive strength

Table 2: Experimental and ANN results for the Compressive strength for 28 days

S. No	Quantity of cement kg/m3	Fine aggregate kg/m3	Coarse aggregate kg/m3	Water content kg/m3	Super plasticizer kg/m3	Percentage of UEO	Curing period	Compressive strength	Predicted values	Errors Noted
1	443	621	1224	155	4.43	28	0	55.38	55.3794	0.0006
2	443	621	1224	155	4.43	28	0	57.11	55.3794	1.7306
3	443	621	1224	155	4.43	28	0	56.04	55.3794	0.6606
4	443	621	1224	155	4.43	28	0.25	54.4	54.7567	-0.3567
5	443	621	1224	155	4.43	28	0.25	54.76	54.7567	0.0033
6	443	621	1224	155	4.43	28	0.25	55.11	54.7567	0.3533
7	443	621	1224	155	4.43	28	0.50	59.38	58.9802	0.3998
8	443	621	1224	155	4.43	28	0.50	58.84	58.9802	-0.1402
9	443	621	1224	155	4.43	28	0.50	58.58	58.9802	-0.4002
10	443	621	1224	155	4.43	28	0.75	60.09	60.2913	-0.2013
11	443	621	1224	155	4.43	28	0.75	60.49	60.2913	0.1987
12	443	621	1224	155	4.43	28	0.75	59.82	60.2913	-0.4713
13	443	621	1224	155	4.43	28	1	56.36	56.1146	0.2454
14	443	621	1224	155	4.43	28	1	57.51	56.1146	1.3954
15	443	621	1224	155	4.43	28	1	55.87	56.1146	-0.2446

V. CONCLUSION

- Compared to the control sample, concrete that has been exposed to used engine oil is more workable. The results of the slump indicate that the spent engine oil lubricates the concrete, making it simpler to work with.
- The recommended dosage percent of old engine oil is 0.75%, which is achieved by gradually increasing the percentage of UEO from 0.25% to 0.75% before abruptly decreasing to 1% of used engine oil. Therefore, concrete's compressive strength increases from 0.50% to 0.75% of UEO, and concrete exhibits good results for 0.75% of UEO addition.

- Concrete's mechanical properties can be predicted using an ANN model, which offers a more accurate result with minimal error.
- By taking into account the factors influencing the properties of concrete, the Artificial Neural Network model (ANN) developed using MATLAB is used to predict the compressive strength of concrete. The obtained R-value of 0.90, which is nearly equal to 1, shows that there is a solid correlation between predicted and measured values.
- This model aids in quality control and economics (i.e., saving time and money) in construction, allowing for the adoption of necessary modifications in mix percentage to prevent situations where the requisite design strength is not obtained by concrete or to prevent concrete that is unnecessarily strong.
- Based on influencing factors, multi-layered feed-forward network models offer quick predictions. To avoid multiple mixes, which is more cost-effective, civil engineers can benefit from these kinds of computational issues.

VI. REFERENCES

[1] Tendring District Council. 2011. Waste Engine Oil.

[2] Flexnews Website. 2009. Malaysia HRI Food Service Sector Food Service Malaysia 2009

[3] Wild Asia. 9 February 2011. Biofuel: Deriving from Recycling Used Engine Oil.

[4] B. Salmia. The effects of used engine oil on various types of concrete 2012 PHD Thesis, UniversitiTeknologi PETRONAS, Malaysia

[5] S.C. Chin, N. Shafiq and M.F. Nuruddin 2010. “Performance of Fresh State Properties of Normal and Blended Cement Concrete Containing Used Engine Oil”. Malaysia Conference on Advanced Processes and Materials 11. World Engineering Congress 2010, Kuching, Sarawak.

[6] Torre A., Garcia F., Moromi I., Espinoza P., Acuña L. Prediction of compression energy of excessive overall performance concrete the usage of artificial neural networks. J. Phys. Conf. Ser. 2015; 582:012010. doi: 10.1088/1742-6596/582/1/012010.

[7] Khademi F., Jamal S.M., Deshpande N., Londhe S. Predicting energy of recycled combination concrete the usage of Artificial Neural Network, Adaptive Neuro-Fuzzy Inference System and Multiple Linear Regression. Int. J. Sustain. Built Environ. 2016; 5:355–369. doi: 10.1016/j.ijsbe.2016.09.003.

[8] Getahun M.A., Shitote S.M., Gariy Z.C.A. Artificial neural network based totally modelling strategy for energy prediction of concrete incorporating agricultural and development wastes. Constr. Build. Mater. 2018; 190:517–525. doi: 10.1016/j.conbuildmat.2018.09.097.

[9]Iruansi O., Guadagnini M., Pilakoutas K., Neocleous K. Predicting the Shear Strength of RC Beams barring Stirrups Using Bayesian Neural Network; Proceedings of the 4th International Workshop on Reliable Engineering Computing, Robust Design— Coping with Hazards, Risk and Uncertainty; Singapore. 3–5 March 2010.