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Project Report On

DESIGN AND DEVELOPMENT OF AN ANDROID APPLICATION FOR PREDICTION OF WORKABILITY AND SLUMP VALUE OF FRESH CONCRETE USING AI TECHNIQUES

In the partial fulfillment of the requirement for Bachelor of Technology in Civil Engineering

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ABSTRACT

The system or an application for automatically measuring workability and slump values of concrete. It mainly comprises of three models i.e. Regression Model, Image Classification Model, and An Android Application Model. An android application provides a user friendly interface to the users where users just need to capture the image of fresh concrete before pouring it into the formwork. This image will go to the image classification model and will get classified into appropriate workability types. At the same time user need to input numerical values of mix proportion taken, W/C ratio, plasticisers amount & degree of moisture. This numerical data will go from regression model and predicts slump value accordingly workability type will be predicted as per the standard table. An android application also has third input which is taking users point of view over workability types. The final result of workability type is taken by averaging these previous three results. This system or an application will be useful for site engineers as well as students for doing cross check in laboratory testing.

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1. INTRODUCTION

Soft computing is the foundation of conceptual intelligence in machines. Today**,** soft computing algorithms are becoming important classes of efficient tools for developing intelligent systems and providing solutions to complicated civil engineering problems. In last few years, big data and deep learning technologies have been successfully applied in various fields of civil engineering with the great progress of machine learning techniques.

Workability of Concrete is a broad and subjective term describing how easily freshly mixed concrete can be mixed, placed, consolidated, and finished with minimal loss of homogeneity. Workability is a property that directly impacts strength, quality, appearance, and even the cost of labour for placement and finishing operations.

- **Different Test Methods For Workability Measurement**

Depending upon the water cement ratio in the concrete mix, the workability may be determined by the following three methods.

1. Slump Test
2. Compaction Factor Test
3. Vee-bee Consistometer Test

From above method slump cone test method is most preferable method.

- Slump Cone Test

The test primarily measures the consistency of fresh concrete, hence detecting changes in the workability of concrete. It consists of a 300mm high frustum metal cone of internal diameter, 200mm at the base and 100mm at the top. The procedure was basically done by filling the frustum with fresh concrete in 3 layers of equal volume with each layer compacted with 25 strokes of a tamping rod. Thereafter, the frustum was removed and the concrete subsided. The slump or subsidence was measured as the difference between the top of the frustum and the subsided concrete according to BS 1881-102, EN 12350-2 (2000).

Table 1. Showing Degree of Workability as per Slump Value

Degree of workability	**Slump in mm**
Very low	0-25
low	25-50
Medium	50-80
High	80-100

Fig. Showing Equipement Used For Slump Cone Test

- Limitations Of Slump Cone Test

Following are the limitations

- Not suitable for concrete containing aggregates larger than 40 mm.
- Not suitable for concrete of dry mix.
- Not suitable for very wet concrete.
- Not reliable because slump may be of any shape.
- Errors in taking reading
- Feasibility of mechanical instrument
- Vertical Jerk force.

Due to limitations of slump cone test and present condition of RMC and site conditions such as site engineer mindset towards the test, we found a solution for this particular test **"ANDROID APPLICATION TO PREDICT SLUMP VALUE AND WORKABILITY OF FRESH CONCRETE BY USING AI TEHINIQUES"** Using this techniques we can able to find the workability of concrete digitally .

1.1 Objectives :-

- To develop User friendly interface to get final result
- To Getting final result in just few seconds
- To keep the record of result in digital format
- To eliminate Manual errors like misreading of observation, strong jerk force will be
- To improve quality management at site
- To find out workability and slump value

1.2 Scope of the project work :-

This invention will help us to get a final results in just a second because of its feasibility. It provides user friendly interface so that observation errors can be eliminated as we are getting results automatically. The result can be stored digitally thus it can be used for further process of quality management. As it provides easy interface it can be used by any technical or non-technical persons. Single person can get result quickly.

1.3 Limitations of the study.

- High initial cost of experimentation
- Requires huge dataset to process and train neural network.
- Considerably more time required to collect all training data
- More accurate for that region where training data will be collected
- Requires Android Smart Phone

1.4 Expected Outcomes

- Determining the workability of concrete very quickly and easily.
- Determining slump value of the concrete.
- Overcome slump cone defect.
- Fast and easy method to get the final results.
- Bridge the gap between site engineer and supervisor for effective quality management.
- Providing platform for the students as well as researchers.
- Cross check the results very quickly.

CHAPTER NO. 2
LITERATURE REVIEW

2. Literature Review

Patents

Boh wan O.H. et.al. (2008)

They developed a system for and method of automatically measuring a slump flow of concrete. The automatic measurement system includes: a digital camera for taking a photograph of concrete flowing on a slump plate every predetermined cycle. And computing device for dividing the photographed image into a predetermined number of pixels and analysing locations of the pixels on a boundary line between the slump plate and concrete in each photographed image to thereby measure the slump flow of the concrete. The computing device includes a digital camera control module, a slump flow analysing module, and a course aggregate distribution ratio evaluating module, and so can measure the slump flow of the concrete and a distribution ratio of course aggregate in the concrete by controlling photographing of the digital camera and analysing photographed images. Accordingly, the slump flow measurement system and method according to the present invention can provide a quantitative data through the systematic method and also provide the same result irrespective to testers or test equipment. They considered VI factors like flow rate of concrete, coarse aggregate area, colour of base plate for their experimental work.

Hikotsugu Hyodo (2018)

They provide a method of easily and accurately evaluating workability of fresh concrete. The workability of fresh concrete is a concept that includes various properties of fresh concrete such as consistency, material separation and is usually evaluated by the slump cone test. Their present invention provides a workability evaluation method of fresh concrete for evaluating the workability of the concrete on the basis of a ratio of a dark part determined by binarizing a digital image of the fresh concrete into the dark part and a bright part. Preferably, the present invention provides the workability evaluation method of fresh concrete that uses, as an index for evaluating the workability of the fresh concrete, the dark part area ratio calculated by an image picking up process , a binarization processing process , and a dark part area ratio calculation process. The important factor considered in their experimental work is dark part and bright part of the image of fresh concrete.

Shigehiro Sai (2015)

By measuring automatically and non-contacting the flow velocity and volume of concrete flowing through a chute using an image, all agitator vehicles can be easily tested, and the degree of material separation is determined by image processing. Therefore, their present invention provides a test method and apparatus for fresh concrete, which is unlikely to cause individual differences in evaluation unlike the case of qualitative confirmation by visual observation.

A camera for photographing a concrete surface flowing through a chute at regular intervals, a flat laser distance meter for measuring the height of the concrete surface in the chute, and an inclinometer for measuring the inclination of the chute. The data from the camera , the flat laser distance meter , and the inclinometer are processed, the flow rate per unit time is

calculated from the flow velocity and the cross-sectional area of the concrete flowing through the chute , and the calculated flow rate is calculated. Comparing with the standard flow rate determined for each inclination of the chute, the computer displays whether the result is acceptable or not when it is acceptable if the standard flow rate is acceptable. They considered VI factors like flow velocity and cross-sectional area of the concrete , flow rate of concrete .

Yoshimitsu Nakajima (2019)

Their object of the present invention is to enable evaluation of workability based on an image of a specimen in a slump test. Conventionally, in order to obtain information other than the slump value from the appearance of concrete in the slump test, it is necessary for the engineer to have knowledge and experience. The present invention has been made in view of such a problem, and an object thereof is to make it possible to evaluate workability based on an image of a specimen in a slump test.

An operability evaluation program includes an imaging step for imaging a specimen of a ready-mixed concrete formed by a slump cone in a slump test, information indicating an evaluation of the workability of the ready-mixed concrete, and a test specimen in a slump test of ready-mixed concrete. An evaluation step for evaluating the workability of the ready-mixed concrete forming the test body and outputting information on the workability using the reference information that has been machine-learned in advance in association with the image of the image and the image data captured in the imaging step And let the computer run. The important factors are Appearance slump , Appearance slump flow , coarse aggregate dimensions, High viscosity , Amount of floating water.

Ji Tao , Luo Shurong (2014)

Their invention relates to the technical field of a concrete mixing ratio design, in particular to a concrete mixing ratio design method based on artificial intelligence, which comprises the following steps of : (1) adopting an artificial neural network method to establish a relation between concrete performance index and concrete mixing ratio so as to obtain a concrete performance prediction artificial neural network model; (2) based on the concrete performance prediction artificial neural network model, adopting genetic algorithm, aiming at meeting all performance requirements and leading the cost to be lowest, designing and optimizing to the concrete mixing ratio; and (3) retraining the concrete performance prediction artificial neural network model if the concrete mixing ratio obtained by optimization is not in the learned range of the artificial neural network. The concrete mixing ratio design method based on artificial intelligence is beneficial to quickly and accurately designing a concrete mixing ratio which can meet a plurality of performance requirements and has lower cost. The present invention relates to mix Design technical field, particularly a kind of concrete mixing proportion design method based on artificial intelligence. Density of concrete, bulk density and the specific surface area of handstone, large stone and sand, the air content in the ratio of high efficiency water reducing agent and Binder Materials and unit volume concrete these factors are considerd in their invention

Per Just Andersen (2009)

A concrete composition having a 28-day design compressive strength of 3000 psi and a slump of about 5 inches is optimized to have high workability and a high strength to cement ratio. The concrete composition contains about 340 pounds per cubic yard hydraulic cement (e.g. Portland cement), about 102 pounds per cubic yard pozzolanic material (e.g., Type C fly ash), about 1757 pounds per cubic yard fine aggregate (e.g., FA-2 sand), about 1452 pounds per cubic yard coarse aggregate (e.g., CA-11 state rock, ¾ inch), and about 294 pounds per cubic yard water (e.g., potable water). Workability and strength to cement ratio were increased compared to one or more preexisting concrete compositions having the same 28-day design compressive strength and similar slump by optimizing the ratio of fine aggregate to coarse aggregate. The concrete composition is further characterized by high cohesiveness, resulting in relatively little or no segregation or bleeding . The important factors considered are compressive strength of concrete , amount of course aggregate , fine aggregate and water .

Indian Journals

M .A. FArediwala . et.al. (2012)

This paper presents the results of an experimental research on the workability and compressive strength of selfcompacting concrete. The work focused on concrete mixes having water/binder ratios of 0.40 and 0.50, which contained constant total binder contents of 500 kg/m3 and 550 kg/m3 , respectively. The concrete mixes contained three different dosages of a superplasticizer based on carboxylic with fly ash. The percentage of fly ash that replaced cement in this research was 15%. The workability tests utilized in this research were the slump flow, V-funnel and L-box which can be used to evaluate the passing ability of self-compacting concrete. Based upon the experimental results, there are some linear relationships between compressive strength and each of the workability tests executed here.

Sanjeev Gill. et.al. (2015)

This experimental study on workability of concrete on different water-cement ratio concrete mixture. it is usually expressed in litre of water required per bag (50 kg) of cement. A rich mix of concrete gives a higher strength than a lean mix of desired workability with less quantity of water. Thus, lower the water-cement ratio, greater is the strength of concrete, strength of concrete decrease as the water-cement ratio increases. This fact is illustrated by plotting a graph with water-cement ratio as abscissa and compressive strength, in case the water-cement ratio is less than 0.45 the curve is seen bending downwards. This indicates that the concrete mix having water-cement ratio less than 0.45 by weight is not workable and causes honey-comb structure, but amount of water to be added also plays an important role in this. This paper provides value of slump for various degree of workability. In this paper factor considered for workability test are : • Water content • Shape of aggregate • Size of aggregate • Grading of aggregate • Surface texture • Porosity and absorption of aggregate • Air entraining agents • Temperature.

M. Deepak .et.al. (2019)

Artificial Neural Network (ANN) is a subdivision of Artificial Intelligence are extensively used to answer a complex civil engineering concern. The following paper would predict the compressive strength and slump, having several mixtures with 28 days. ANN model with 7 different parameters that comprises: Slag (SL), Fly Ash (FL), Fine Aggregate (FA), Coarse Aggregate (CA), Super Plasticizers (SP), Cement (C), Water (W) respectively as input while concrete slump and while compressive strength as output. The same inputs are provided and are developed as another model. The slump and compressive strength of concrete are determined by ANN through its machine learning which is identified by validation, testing and training results. This kind of strength conjecture will help the concrete factories that manufactures the concrete, which when used in concrete will result in definite strength. This paper is mainly based on estimating the concrete slump and compressive strength based on concrete mix constituent data using the Artificial Neural Network. Higher the number of input variables leads to higher dimensionality and complexity of the models being developed.

Mohini Undal.et.al. (2019)

Our thirst for progress as humans is reflected by our continuous research activities in different areas leading to many useful emerging applications and technologies. Artificial intelligence and its applications are good examples of such explored fields with varying expectations and realistic results. Generally, artificially intelligent systems have shown their capability in solving real-life problems; particularly in nonlinear tasks. Such tasks are often assigned to an artificial neural network (ANN) model to arbitrate as they mimic the structure and function of a biological brain; albeit at a basic level. In this paper, we investigate a newly emerging application area for ANNs; namely structural engineering. We design, implement and test an ANN model to predict the properties of different concrete mixes. Traditionally, the performance of concrete is affected by many non-linear factors and testing its strength comprises a destructive procedure of concrete samples. various parameters they have considered such as use of plasticizer , Temperature , size of aggregate etc.

Komal Rawarkar .et.al. (2018)

This paper presents an investigation into the effect of time on the workability of different fresh concrete mixtures handled differently. To achieve this, a slump test, compacting factor test and the modified Vebe consistometer test was carried out under ambient conditions of 29-300C temperature, 95% relative humidity and less windy condition with 250kg, 350kg, 415kg, 545kg and 560 kg of cement and max. aggregate size of 40mm at w/c ratio of 0.45. The results (curves) show that in 1hr times the loss of workability of the un-agitated mixes was remarkable while the agitated concrete still retains an appreciable workability after 1hr but tends to lose its workability totally in 2½hrs time. It showed that the % loss of workability of un-agitated MX1, MX2, MX3, MX4 and MX5 dropped by 75%, 70%,75%, 66.7% and 68.2% after 1hr against the 43.8%, 40%, 40%, 38% and 40.9% of the agitated concretes respectively by slump test. Also, the workability tends to increase as the cement-aggregate ratio increases. The three results showed a similar trend even if no relationship existed between them. The study included eight mix proportions of sealed or air-cured specimens with water binder ratio (w/b) varying between 0.24 and 0.80.

Parth Thaker, et.al. (2015)

This paper states Cement paste and mortar fresh properties governs concrete characteristics. Selection of test method to measure workability is based on mix characteristic. Very low workability mix test method differs from the high workable mix. First attempt was made by authors to develop correlation between two tests and cover entire range of workability i.e. from very low to high workable mix. Mini flow table to stand marsh cone test were selected for cement paste and mortar . Marsh cone test is applicable beyond W/C ratio 0.50 for cement paste. Mini flow table test shows same flow diameter above W/C ratio 0.50 for cement paste. It is possible to evaluate flow behaviour of cement paste up to W/C ratio 0.62 by modifying cement paste cone volume. Marsh cone test was applicable beyond W/C ratio 0.72 for cement mortar having cement to fine aggregate proportion 1:1. Mini flow table test has diameter 250mm which is useful to measure low to medium workable mix of mortar. High workable cement mortar mixture spread is more than 250mm therefore it is necessary to do dimension change in mini flow table test. Modified mini flow table test having diameter of 450mm was applicable for entire range i.e. very low to high workable mix. In this paper they have used factors affecting workability like fine aggregate and coarse aggregate based on this factors they have calculated the values of w/c ratio and predicted the workability from low to high.

International Journals

P.G.Dip.(2011)

They said the variations of the compressive strengths of concrete and lateritic concrete mixes with watercement ratios of range 0.55 and 0.80, within 7 to 28 days after casting, were experimentally investigated in this research work. The experiment was carried out at the same ambient temperature and the compressive strengths of both concrete and lateritic concrete mixes were found to increase with age but decrease as the water-cement ratio increases. However, water-cement ratio above 0.65 was observed to have a very significant reduction effect on the compressive strength of the lateritic concrete mixes. This is in contrast to the performance of the concrete mixes which shows consistent decrease of compressive strength in water-cement ratio. Also, the degrees of workability of both concrete mixes were investigated using slump test.
Though laterites ings of this research are usually used for brick making, they are not recommended for making concrete in construction

Nhat-Duc Hoang .et.aI.(2016)

They said Concrete workability, quantified by concrete slump, is an important property of a concrete mixture. Concrete slump is generally

known to affect the consistency, flowability, pumpability, compactibility, and harshness of a concrete mix. Hence, an accurate prediction of this property is a practical need of construction engineers. This research proposes a machine learning model for predicting concrete slump based on the Least Squares Support Vector Regression (LS-SVR). LS-SVR is employed to model the nonlinear mapping between the mix components and slump values. Since the learning process of the LSSVR necessitates two hyperparameters, the regularization and the kernel parameters, the grid search method is employed search for the most desirable set of hyperparameters. Furthermore, to construct the hybrid model, this research collected a dataset including actual concrete slump tests from a hydroelectric dam construction project in Vietnam. Experimental results show that the proposed model is capable of predicting concrete slump accurately.

Suiwei Pan .et.aI.(2019)

Featured Application: Steel slag self-compacting concrete (SSCC) with relatively ideal workability was prepared by substituting steel slag for natural fine aggregate to realize solid waste resource utilization. It is beneficial to solve the problems of steel slag abandonment, land occupation, environment pollution and low utilization rate, and realize utilization of a large amount with low-energy consumption for traditional material saving and sustainable development. SSCC has very high application value and economic significance. They said There is important application value and economic value in exploring the potential use of steel slag to prepare self-compacting concrete (SCC) and make full use of solid waste resources. In this paper, steel slag self-compacting concrete (SSCC) with relatively ideal workability is prepared by using ste slag instead of natural fine aggregate based on mix proportion optimization and SSCC performance research. The filling ability, passing ability and resistance segregation were tested to evaluate the workability of SSCC. The results show that when the content of is 20%, the workability performance of SSCC is similar to that of SCC with natural aggregates. When the content of steel slag sand is less than 60%, the performance of SSCC can also meet the workability

requirements after adjusting the amount of raw materials.This design method of SCC is called the 'Japanese prototype method' or 'step-by-step method. In this paper, the workability of the fresh mixture and the strength of hardened self-compacting Concrete with different substitution rate of steel slag sand were studied. By adjusting the water—binder fine—coarse aggregate ratio and the amount of u er lasticlze , steel slag Self-compacting concrete with ideal workability can be obtained, which can meet the workability design goal.

Cuong H.N. et.al.(2019)

They said the paper presents a new application of classical multi-layer perceptron neural network to approximate the parameters of fresh self-compacting concrete. The approximation is needed to determine the working parameters at construction site and can be used to estimate the components used at mixing station to achieve the desired concrete quality. A number of real field tests were conducted and six basic parameters were measured for each test. The numerical results showed the high accuracy of proposed solution.In this paper, they present a method using artificial neural networks (ANN) to predict the parameters of the SCC.

Zhongcong Ding and Xuehui An(2018)

They said a deep learning approach to better utilize the spatial and temporal information obtained from image sequences of the Self-compacting concrete- (SCC-) mixing process to recover SCC characteristics in terms of the predicted slump flow value (SF) And V-funnel flow time (VF). +e proposed model integrates features of the convolutional neural network and long short-term Memory and is trained to extract features and compute an estimate. +e performance of the method is evaluated using the testing Set. +e results indicate that the proposed method could potentially be used to automatically estimate SCC workability. They considered diff concrete mixes and RGB images.

Jacek GOŁASZEWSKI (2016)

They said the rheological properties of fresh ordinary concrete are closely affected by temperature and Time. The paper presents the study of consistency of fresh concrete mixtures made with Portland Cement and cement with calcareous fly ash. Two types of admixtures were used. It was proven that The temperature has a clear effect on workability and compressive strength concrete. Influence on Workability can be reduced by selecting the appropriate superplasticizer and cement.

2.1 Critical Literature Review

Factors Taken	Repetition Number	Repetition Percentage
Mix proportion	9	50
w/c ratio	8	44.44
Plasticizers amount	6	33.33
Shape of aggreagate	1	5.55
Grading of aggreagate	2	11.11
Size of aggreagate	2	11.11
Surface texure	1	5.55
Porosity	1	5.55
Fine aggreagate	3	16.66
Course aggragate	3	16.66
Degree of Moisture	3	16.66
Flow Velocity	1	5.55

Fig. Shows Percentage of Repetition of each factor

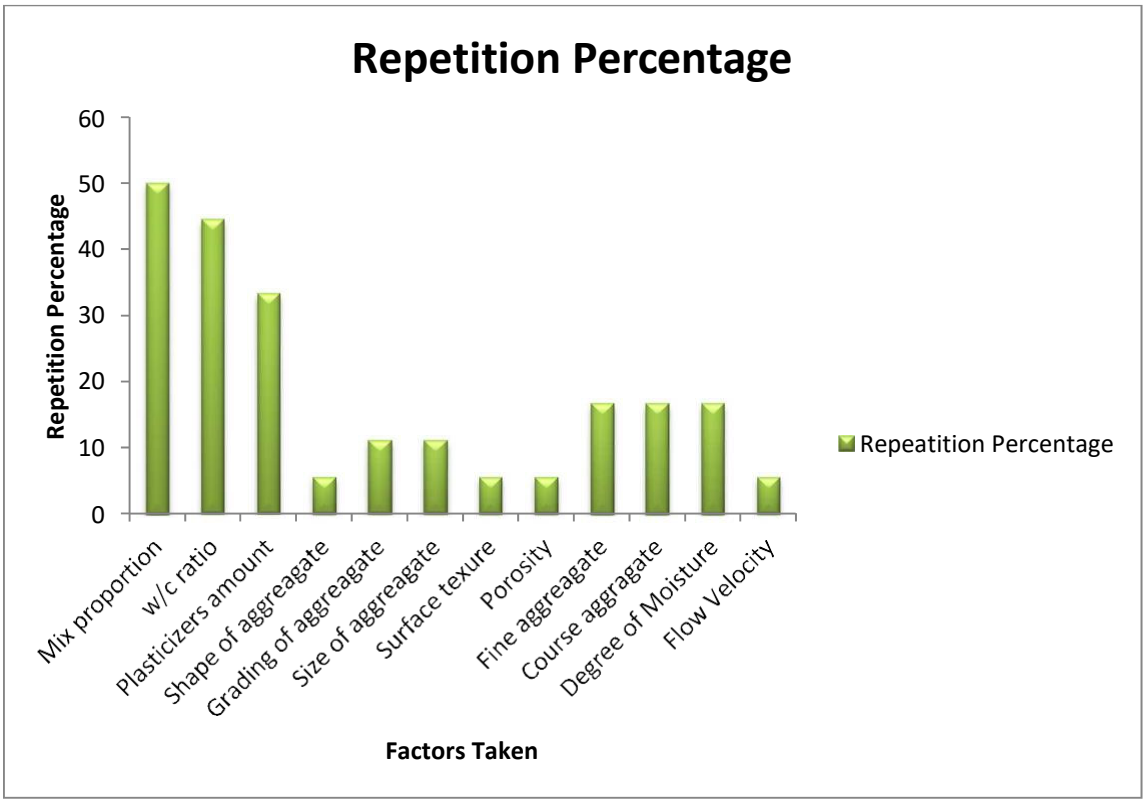

Fig. Shows Graph of Factors VS Percentage of Repetition

The above graph is plotted by studying 18 Research works including 6 Patents, 6 Indian Research Papers, 6 International Research papers. Repetition Percentage is calculated by no. of time factor comes in varios research papers devided by total no. of research papers studied (18) multiply by 100. It has been noticed that many of the authors, Inventors taken mix proportions, w/c ratio, plasticisers amount, Degree of moisture for their experimentation work. The above graphs gives us most influencing factors on workability. These factors are :

- Mix Proportions
- W/C Ratio
- Plasticisers Amount
- Degree of Moisture

Thus we are considering these factors for our further experimentation work.
Also lot of researchers used machine learning approach as well as soft computing approach. But we doesn't find anyone develop any kind of application to find out workability. There are any researchers did their works in video processing but not develop any application with image processing techniques. Thus we found that the application will be novel, because no one made it before.

CHAPTER NO. 3

RESEARCH METHODOLOGY

3. Research Methodology

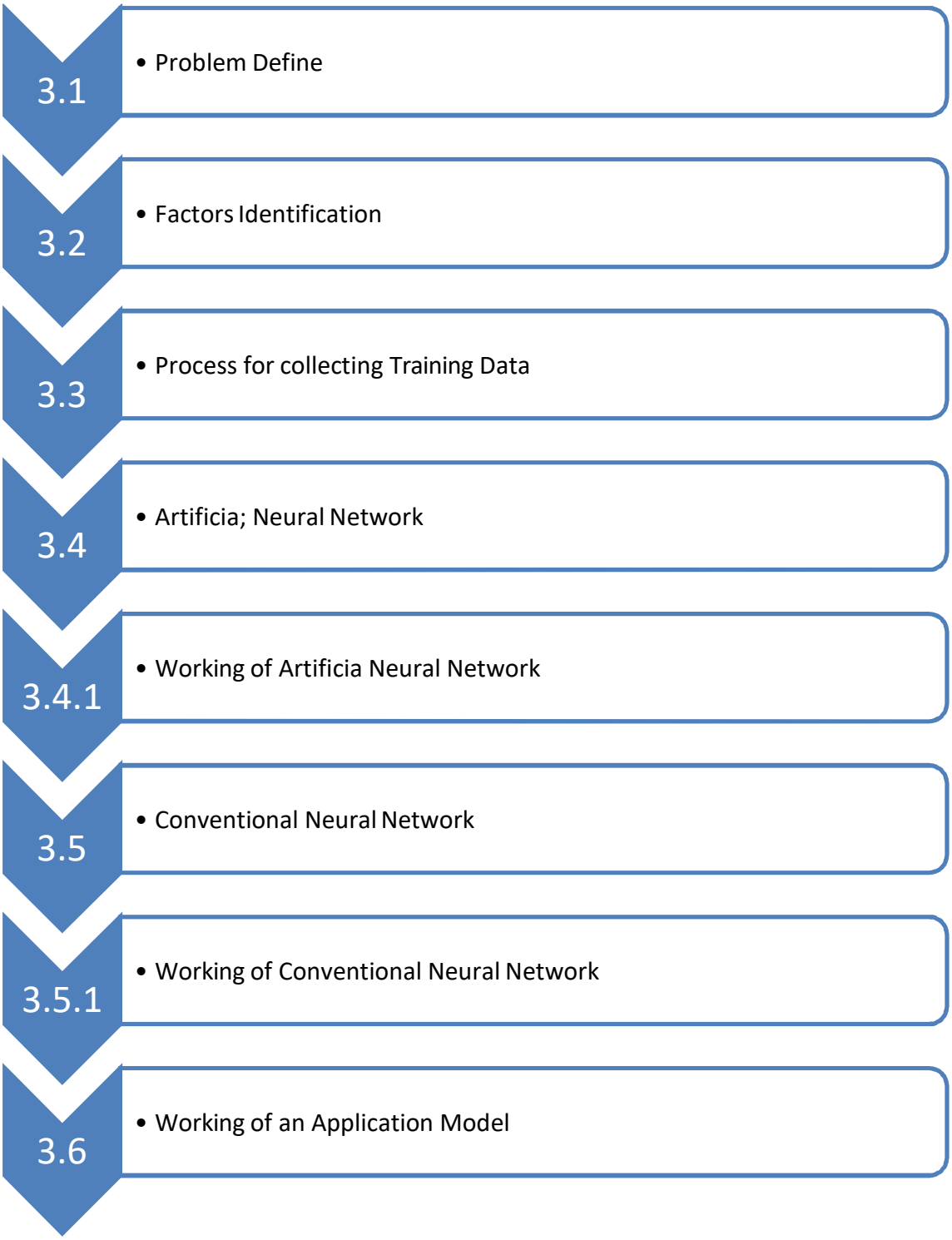

Fig. Showing Flow Chart of research methodology

3.1 Problem Define :

On a number of construction site, basically for the small-scale construction work it has been seen that, the site engineer or supervisor avoid this kind of test, because they think that they are confidential enough to predict workability of concrete just by observing it and further they ignore about slump and compaction factor values. Thus, the serious problem may occur in concrete structure due to pouring of incorrect workability of concrete.

Fig. shows Honecombing Failure

Fig. Shows Exposed faces of Reinforcement

Also the quality of fresh concrete at RMC plant is too high beacause it is prepared in automative environment. But its quality gets reduced when its going to transported on

the site due transportation losses and many more other environmental factors. So to check its quality at site we have to perform slump cone test and need to check whether the slump value of fresh concrete at site is same that of the RMC or not.

The main problem in the construction industry is that many peoples avoid this slump cone test. Another side is, When Project Manager place an order for the concrete from RMC and uncertainly if he couldn't able to maintain his contact with RMC throughout the process. Then its site engineer's responsibility to check that wheather the RMC vehicle approach at site within 90 minutes or not. If not then they have to check its workability but they can't do that. Thus there is no automative platform to resolve this issue and connect site engineer to project manager digitally and update them about every batch quality which is coming to the site.

3.2 Factors Identification :

From the critical literature review we have got most suitable factors for making our ANN model. That is

- Mix Proportions
- W/C Ratio
- Plasticisers Amount
- Degree of Moisture

From literature review we also observed that lot of peoples using image processing techniques for fresh concrete's workability and they considered some visual inspection factors for their work i.e. color, pixels, shape of concrete, flow rate, viscocity of concrete, etc. Thus we have also taken images of various concrete in consideration for better result using CNN model.

3.3 Process for collecting Training Data :

The training data is an initial set of data used to help a program understand how to apply technologies like neural networks to learn and produce sophisticated results. It may be complemented by subsequent sets of data called validation and testing sets.

Training data is also known as a training set, training dataset or learning set. training data can be structured in different ways. For sequential decision trees and those types of algorithms, it would be a set of raw text or alphanumerical data that gets classified or otherwise manipulated. On the other hand, for convolutional neural networks that have to do with image processing and computer vision, the training set is often composed of large numbers of images. The idea is that because the machine learning program is so complex and so sophisticated, it uses iterative training on each of those images to eventually be able to recognize features, shapes and even subjects such as people or animals. The training data is absolutely essential to the process – it can be thought of as the "food" the system uses to operate.

To collect training data we need to perform slump cone test on different mix proportions with varying our considered factors. Following is the process for collection of training data for our system.

Step 1.

Prepare the mix of an appropriate proportion by following ICI Guidelines. Note down the mix proportion taken, w/c ratio, plasticisers amount.

Fig. showing mixing of concrete ingredients

Step 2.

Take the pan. Fill up these pan with mix and attach moisture sensor at top of the pan and partially deep these sensor into the concrete. Note down the moisture reading.

Fig. shows moisture sensor partially inserted into fresh concrete

Step 3.

Pour these concrete on hard base or metallic plate from 1.5 feet of height and take the photographs of these concrete.

Fig. shows pouring of concrete on hard base

Step 4.

Fill up these concrete in the cyliendrical cone and perform slump cone test. Now record slump reading and its corresponding workability type.

Fig. shows slump cone test on fresh concrete

Step 5.

Now repeat all the procedures by gradually increasing amount of w/c ratio and keeping same plasticisers amount.

Step 6.

After that repeat above process for different mix proportions.

Now we have all the required data:

Numerical data:

1. Mix Proprtion
2. W/C Ratio
3. Plasticizers Amount
4. Degree of moisture

for training ANN model;

Image data:

1. Set of images having different workability types.

For training of CNN model; analysis and classifying images to their respective workability type.

3.4 Artificial Neural Network (ANN) :

The fundamental unit of the brain is the Neuron. The AI Expert Maureen Caudill defines ANN as “a computing system made up of a number of simple, highly interconnected processing elements, which process information by their dynamic state response to external inputs.” Brain consists of 200 billion of neurons and neuron is formed from 4 basic parts as Dendrites, Soma, Axon, and Synapses. The neuron collect signals from Dendrites, and the Soma cells sums up all the signals collected, and when the summation reaches the threshold the signal pass through the axon to the other neurons. The Synapses indicated the strength of the interconnection in between the neurons. Similar to the brain, the Artificial Neural Network, imitates this biological Neural Network of human body. The first ANN was created so many years before by the neurophysiologists Warren McCulloch and the logician Walter Pits in 1943. They created a computational model for Neural Networks for the threshold logic which is the logic based on the mathematics and algorithms. But due to the inefficient technologies available at that time, this idea didn’t come up as a success one. The ANN formed from the artificial neurons made up of Silicon and wires which imitates the neurons and the interconnection which are formed from coefficients (weights).

The knowledge of an ANN is stored within inter-neuron connection strengths known as synaptic weights. The ANN is strongly interconnected with each other to make solutions for specific problems and complications and it is highly useful in the sectors of Pattern recognition, data classification, clustering etc. In the Neural Network, the neurons are arranged in to multiple layers. Each of the layers are connected with the other layers on both of their sides in which the layers on one side engaged in receiving input signals which are needed by the network in order to learn or process and the layers on the other side works with output and responses for the information. In between these two layers, there are hidden units. The interconnection in between the hidden units and the output unit with the all other units in the layers are known as weight. The weight indicates the dependency/connection strength in between the units. For each processor in a layer of ANN, every input is multiplied by an originally recognized weight, and it will create the internal value of the operation. This value is further altered by an initially generated threshold value and sent to an activation function to map its output. Then the output of that function is sent as the input for another layer, or as the final response of a network if the layer is the last. The weights

and the threshold values are most usually improved to produce the correct and most accurate value.

3.4.1 Working of an Artificial Neural Network (ANN) :

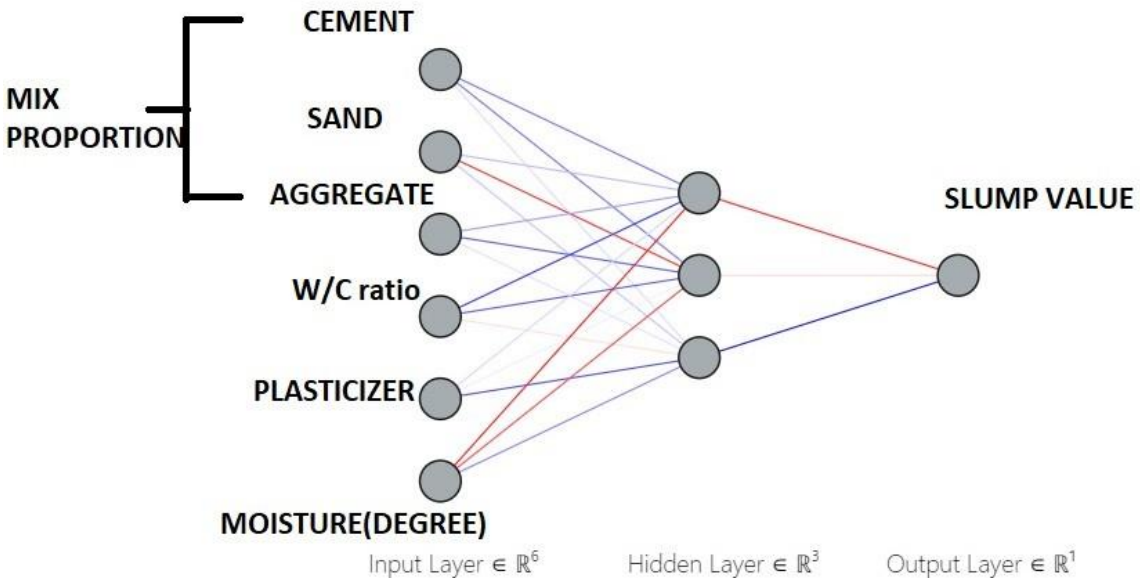

Fig. Showing ANN

Training for ANN carry out by standardizing all of the “weights” using two techniques known as forward propagation and back propagation. In Forward Propagation, sample weights are input to the ANN through the inputs and the respected sample outputs are recorded. Here, the inputs are fed and outputs for the inputs are received. In the Back Propagation as the name suggest working from the output units through the hidden units to the input units, considering the error margin of the outputs received in each layers, the inputs are adjusted in order to reduce the margin of the error. The trainer for the ANN, have the already calculated output values for the inputs. So, after receiving the output for the inputs, the trainer will analyse whether the actual output and the output produced by the ANN are the same. If not, an error value is calculated and sent back in to the ANN system. At each of the layers, the error value is investigated continuously and used to modify the threshold and weights for the subsequent input. Through this the error margin will be reduce

gradually and the ANN will learns to analyse the values and produce the accurate results for the inputs.

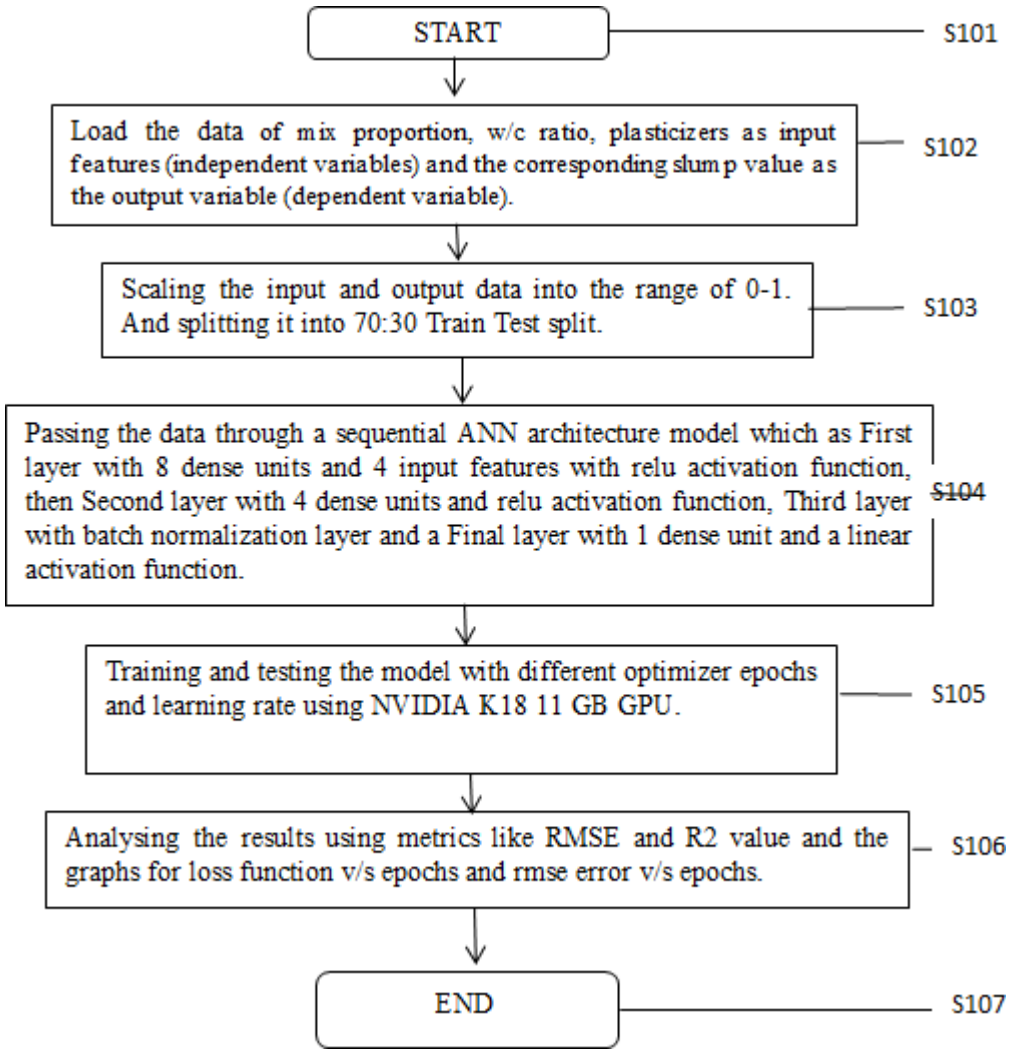

Fig. Showing Working of ANN

Preparing the data from (T208) into (.csv) format. The first task would be to load the data of mix proportion, w/c ratio, plasticizers as input features, and the corresponding slump value as output variable (S102). Applying data pre-processing techniques is applied such as scaling booth input features as well as output variables into the range of 0-1 which will help the regression model achieve good accuracy quickly and more effectively. Preparing this data for training and testing is a crucial role here we split our data into 80% for training and 20% for testing. (S103) Since the data has complex non-linear nature ANN would work well and also more complexities and non-linearity can be tackled using it. For this, we used ANN architecture as discussed in (S104). ANN models are also previously

been used for regression problems and have achieved good performance. The layers and activation function used in the ANN architecture can be modified based on the optimization of the model and its performance. Experimenting the model by varying optimizers and other tuning parameters like learning rate, batch size, epochs, etc for obtaining the optimal fit model(S105). Analysing the result with various result metrics such as RMSE and R2 value. (S106)

3.5 Conventional Neural Network (ANN) :

Convolutional neural networks. Sounds like a weird combination of biology and math with a little CS sprinkled in, but these networks have been some of the most influential innovations in the field of computer vision and image processing. The Convolutional neural networks are regularized versions of multilayer perceptron (MLP). They were developed based on the working of the neurons of the animal visual cortex.

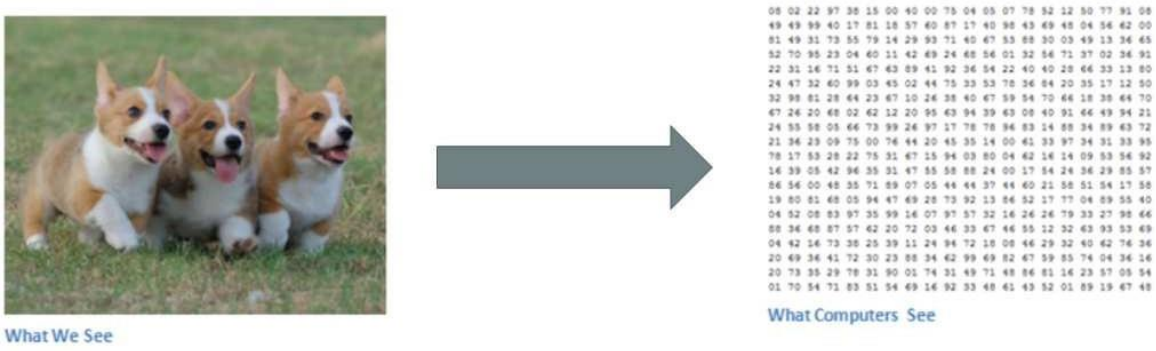

Fig. Showing CNN Example

Contents of a classic Convolutional Neural Network: -

1. Convolutional Layer.
2. Activation operation following each convolutional layer.
3. Pooling layer especially Max Pooling layer and also others based on the requirement.
4. Finally Fully Connected Layer.

3.5.1 Working of an Conventional Neural Network (ANN) :

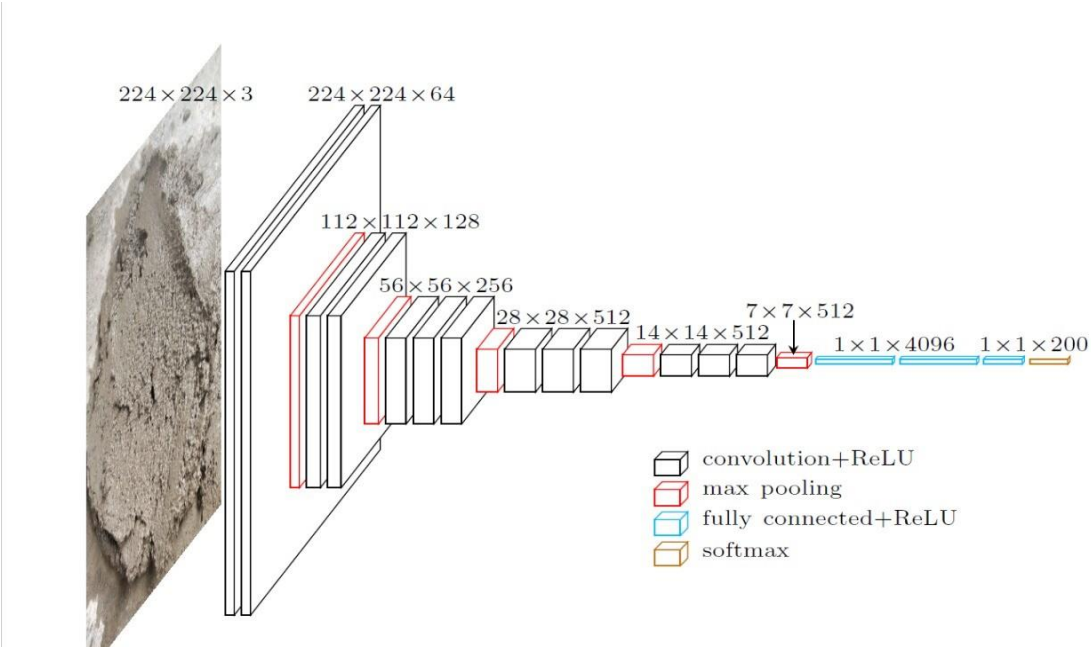

Fig. Showing CNN

First Layer:

1. Input to a convolutional layer

The image is resized to an optimal size and is fed as input to the convolutional layer.

2. There exists a filter or neuron or kernel which lays over some of the pixels of the input image depending on the dimensions of the Kernel size.

3. The Kernel actually slides over the input image, thus it is multiplying the values in the filter with the original pixel values of the image (aka computing element-wise multiplications).

The multiplications are summed up generating a single number for that particular receptive field and hence for sliding the kernel a total of 784 numbers are mapped to 28x28 array known as the feature map.

Sequential conv. layers after the first one.

1. When we go through another conv. layer, the output of the first conv. layer becomes the input of the 2nd conv. layer.

2. However, when we're talking about the 2nd conv. layer, the input is the activation map(s) that result from the first layer. So each layer of the input is basically describing the locations in the original image for where certain low-level features appear.

3. Now when you apply a set of filters on top of that (pass it through the 2nd conv. layer), the output will be activations that represent higher-level features. Types of these features could be semicircles (a combination of a curve and straight edge) or squares (a combination of several straight edges). As you go through the network and go through more conv. layers, you get activation maps that represent more and more complex features.

4. By the end of the network, you may have some filters that activate when there is handwriting in the image, filters that activate when they see pink objects, etc.

Pooling layers section would reduce the number of parameters when the images are too large. Spatial pooling also called subsampling or downsampling which reduces the dimensionality of each map but retains important information. Spatial pooling can be of different types:

- Max Pooling
- Average Pooling
- Sum Pooling

Max pooling takes the largest element from the rectified feature map. Taking the largest element could also take the average pooling. Sum of all elements in the feature map call as sum pooling.

The Forward Pass:

For the first epoch or iteration of the training the initial kernels of the first conv. layer is initialized with random values. Thus after the first iteration output will be something like [.1.1.1.1.1.1.1.1.1.1], which does not give preference to any class as the kernels don't have specific weights.

The Loss Function:

The training involves images along with labels, hence the label for the digit 3 will be [0 0 0 1 0 0 0 0 0 0], whereas the output after a first epoch is very different, hence we will calculate loss (MSE — Mean Squared Error)

The objective is to minimize the loss, which is an optimization problem in calculus. It involves trying to adjust the weights to reduce the loss.

The Backward Pass:

It involves determining which weights contributed most to the loss and finding ways to adjust them so that the loss decreases. It is computed using dL/dW, where L is the loss and the W is the weights of the corresponding kernel.

The weight update:

This is where the weights of the kernel are updated using the following equation.Here the Learning Rate is chosen by the programmer. Larger value of the learning rate indicates much larger steps towards optimization of steps and larger time to convolve to an optimized weight.

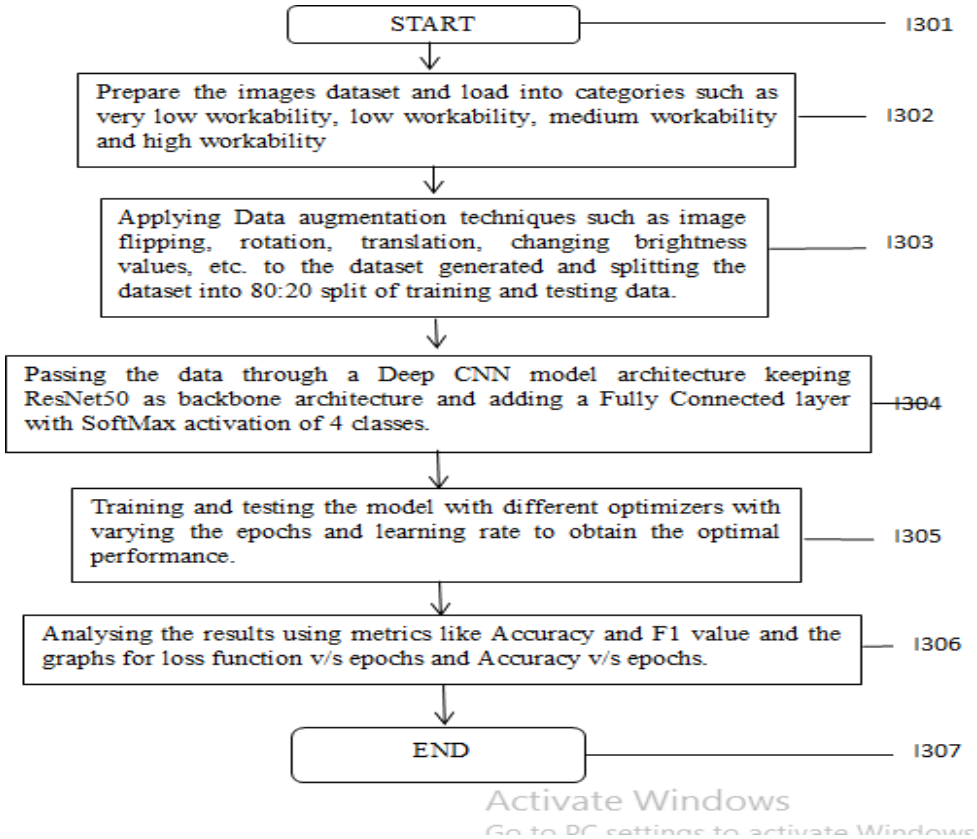

Fig. Showing Working of CNN

In Image classification model we load the data from (T206) and load them into its respective workability categories. (I302) Apply Data augmentation techniques such as flipping the images, translation, rotation, and changing brightness level. Data augmentation can help increase the data and also avoids overfitting. Further, we split the dataset into 80% for training and 20% for testing (I303) for next task we apply the Deep CNN model as discussed (I304). ResNet50 is a deeper and more complex network. The ResNet50 model has 50 layers from which 48 are Convolution layers, 1 Max Pooling layer, and 1 Average

pool layer ResNet50 has 5 stages with residual blocks after every stage. Each residual block has 3 layers with 1*1 convolutions and 3*3 convolutions. These residual blocks help to avoid information loss for deep networks, speed up the training time, and thus boost up the performance of the model. ResNet50 architecture has achieved great results, for this work more layers and overall architecture can be more optimised based on the results and performance. Further, training and testing is be done by varying over the optimizers, batch size, epochs, and learning rate to obtain the optimal model. (I305) Analyzing the results using confusion matrix, Accuracy, Recall, precision, and monitoring the loss function. (I306). Finally save the trained model and will be used for further analysis in Android Application.

3.6 Working of an Application Model :

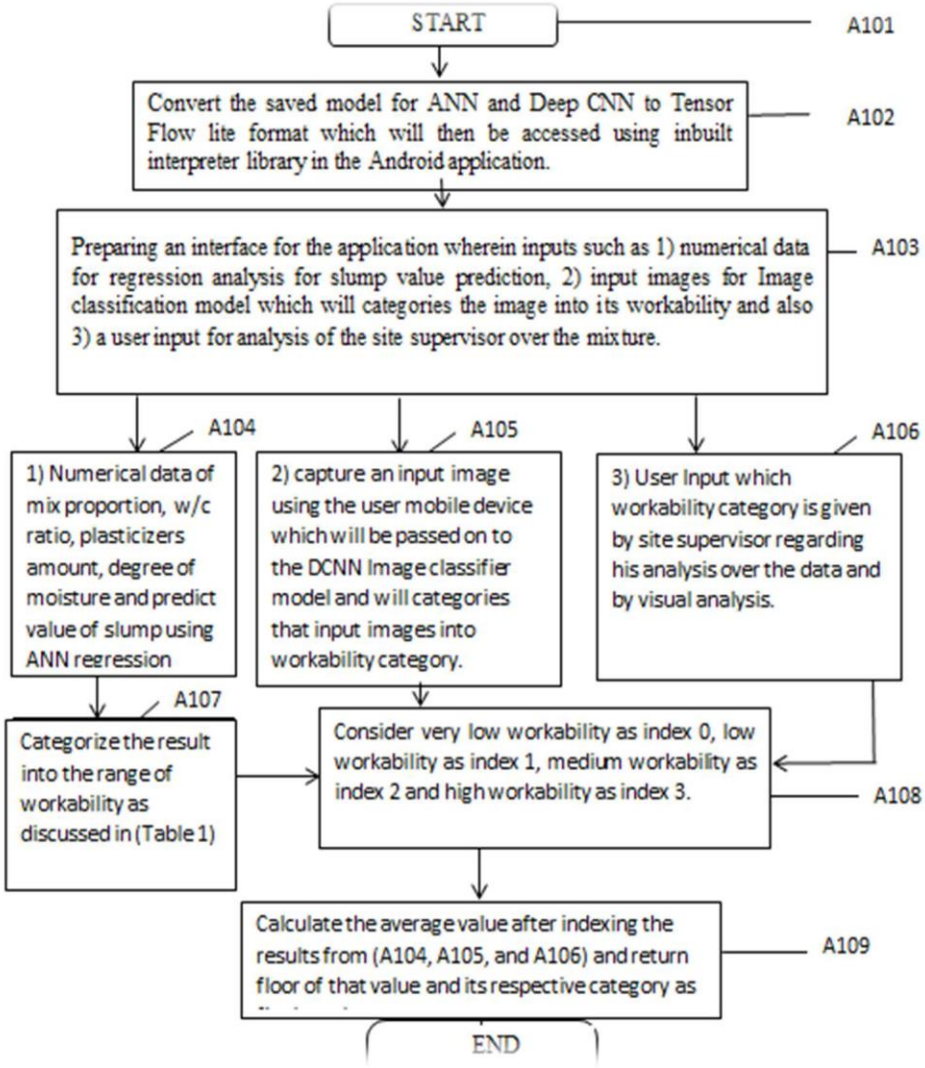

Fig. Showing Working of an application model

Once our ANN and Image Classification model is trained successfully, we have our next task of deployment over an Android application. For this, we will have to convert the saved model to the TensorFlow Lite model. Then that model can be easily deployed using an inbuilt Interpreter library. (A102). The Android application will take inputs like the numerical values of mix proportion, w/c ratio, plasticizer, and will take input image by accessing the camera of the mobile device. (A103) Another input will be taken from the user which will be his analysis for the output, preferably given by a site supervisor based on data and visual analysis. (A106). The ANN model will predict the slump value based on the numerical values entered in the application using the trained ANN model. (A104) Capture an input image using user's mobile device which can be used for Image classification model. The DCNN model will categorize the input image into the workability categories

Using the trained Inage classification model. (A105) Categorize the result achieved in (A104) into workability categories according to the corresponding range for slump value as discussed in (Table 1). (A107) Consider the workability categories into index values such as index 0 for very low workability, index 1 for low workability, index 2 for medium workability, and index 3 for high workability. (A108) Now that we have results from (A105), (A106), (A107) into index values final output can be calculated by taking the average of them and them performing floor operation which will convert the output to its whole number and the corresponding category for workability will be returned as the final output. (A109)

3.7 Working of an Application Model :

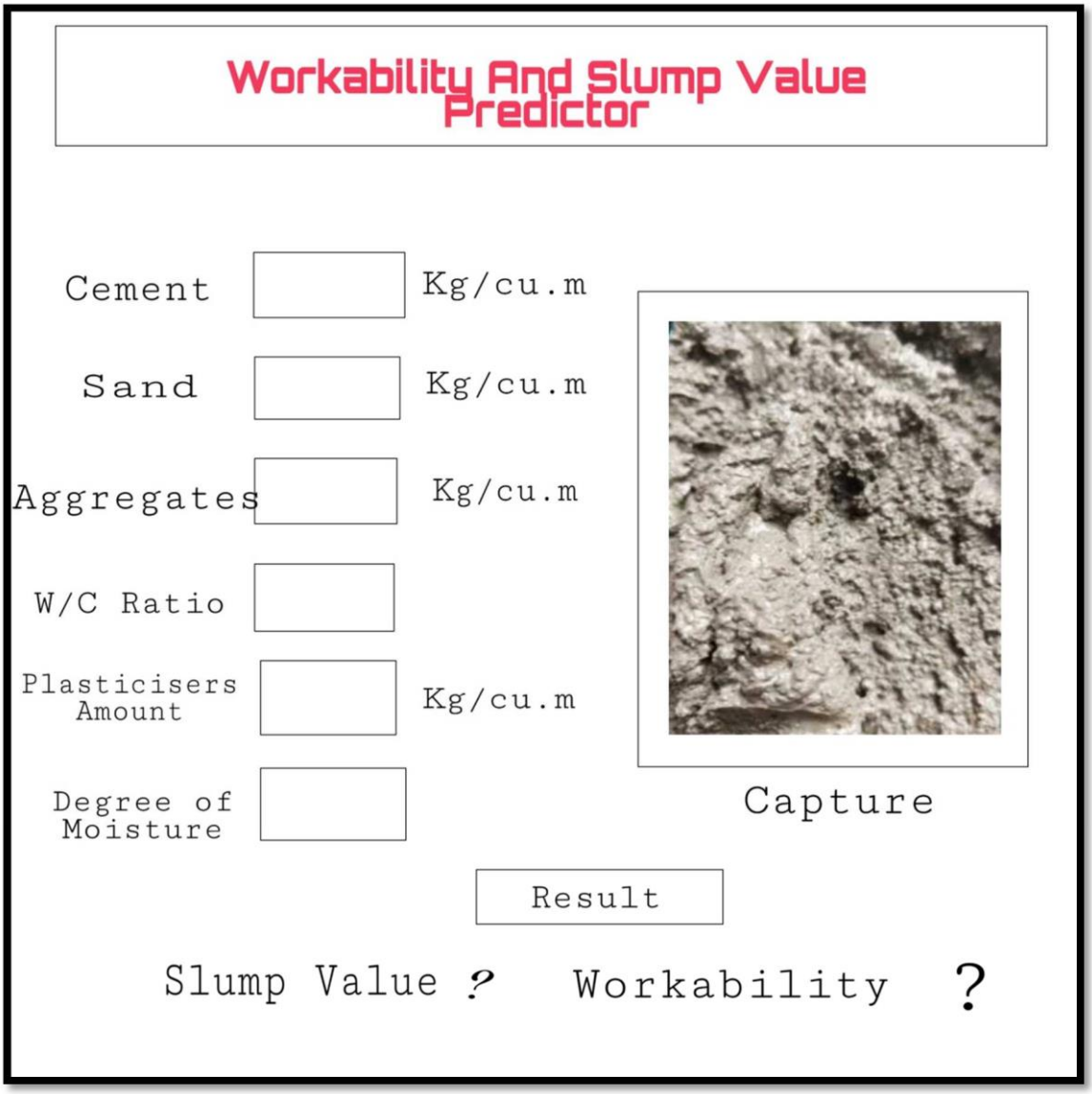

Fig. Showing interface of an application

Above is the look of an interface of the application that we will design after collecting training data and processing over it. This will give very instant result in just a one single tap on Result Button. No need to carry any mechanical instrument with us everywhere when we have our mobile phones. Thus it will proves to be a smart solution to finding out workability and slump value of fresh concrete.

Process for getting Result: Following are the steps that user need to follow for getting result using this application.

Step 1: Take a pan. Fill up this pan with fresh concrete.

Step 2 : Attach moisture sensor at top of the pan. Open the application and note input degree of moisture in the input box.

Step 3 : Remove Moisture sensor and pour these concrete on the hard base throughout from 1.5 feet of height.

Step 4 : Click the photograph of fresh concrete by clicking on capture button.

Step 5 : Input other values of parameters like quantity of cement, sand,, aggregates in kg/m^3. Also Input w/c ratio and plasticisers amount

Step 6 : Press on “Result”. User will be getting slump value and workability type of this fresh concrete.

Then user can save this result and can be able to share it to others.

CHAPTER NO. 4

RESULT AND DISCUSSION

4. Result and Discussion:

This invention will help us to get a final result in just a second. It provides user friendly interface observation errors can be eliminated as we are getting results automatically. The result can be stored digitally thus it can be used for further process of quality management. As it provides easy interface it can be used by any technical or non-technical persons. Single person can get result quickly. It provides good scope for the students to have a cross checking work over workability of fresh concrete in the laboratories. Thus, it will become the feasible method for students and some researchers also to correlate the values with their demand.

The user will get final result just by clicking photographs of fresh concrete on site and inputting some input parameters like mix proportion, w/c ratio, plasticisers amount and degree of moisture which is taken from moisture sensor reading.

And after clicking on result button they will get the final result of workability and slump value in just a seconds.

After five months of hard work we are developed whole project architecture which will help us to develop the application by collecting training data. After making an architecture we tried for filling patents. Thus we had done patentability search in all countries and found safe in India. Thus on 5 th November 2020 we filed a patent in India and we are really proud to share that this idea is now been classified as an “Invention”. It got published in Indian Patent Journal on 27 th November 2020.

Patent Certificate

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(61) Patent of Addition to Application Number	:NA
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Filing Date	:NA

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(57) Abstract :
Abstract:- The present disclosure suggest the determination of workability & slump value of fresh concrete using AI techniques, The present prototype is determine to a system of automatically describing workability of fresh concrete. More particularly, it relates to a method of automatically describing workability of fresh concrete by taking photographs of fresh concrete &analysing this with respect to the factors considered. Further it gives as slump value by equation derived from multiple regression analysis of the data obtaining from various test with slump cone. The system or an application for automatically measuring workability and slump values of concrete. It mainly comprises of three models i.e. Regression Model, Image Classification Model, and An Android Application Model. An android application provides a user friendly interface to the users where users just need to capture the image of fresh concrete before pouring it into the formwork. This image will go to the image classification model and will get classified into appropriate workability types. At the same time user need to input numerical values of mix proportion taken, W/C ratio, plasticisers amount& degree of moisture. This numerical data will go from regression model and predicts slump value accordingly workability type will be predicted as per the standard table. An android application also has third input which is taking users point of view over workability types. The final result of workability type is taken by averaging these previous three results. This system or an application will be useful for site engineers as well as students for doing cross check in laboratory testing.

No. of Pages : 18 No. of Claims : 10

Fig. Showing Patent Certificate

CHAPTER NO. 5

CONCLUSION

5. Conclusion

The idea proves to be helpful for getting the result in very less time. The application interface is to simple that it can be used by unskilled person for getting result. These application will make a bridge of communication between site engineer and project manager for further quality analysis process. As it provides easy interface it can be used by any technical or non-technical persons. Single person can get result quickly. It provides good scope for the students to have a cross checking work over workability of fresh concrete in the laboratories. Thus, it will become the feasible method for students and some researchers also to correlate the values with their demand.

The Machine learning techniques and soft computing techniques are proves to be very fast and easy to resolve many problems in civil engineering. The whole architecture of the project help us to design and develop an application using AI techniques. The application will help us to find out workability and slump value in just a second. The idea is classified as an “Invention” and published in Indian Patent Journal

CHAPTER NO. 6
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