APPLICATION OF ARTIFICIAL NEURAL NETWORKS IN PREDICTING SUB-BASE CBR VALUES

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Abstract: Establishing a realistic working profile of soil properties has been, and is still, one of the most challenging problems facing Geo-technical engineers, especially for CBR results. In the present study a neural-network approach is used to tackle this problem. Source data of a series of California Bearing Ratio Tests (CBR) performed at the Laboratory and Geo-technical Experimental Site.

This will be useful for training and testing an artificial neural network. The developed neural network will be showing the prediction of CBR values of the site studied. Data are then generated for constructing the profiles of the CBR values using the trained neural network. This study might be useful for the future as this process will reduce the work on procedure and graphical calculations.

Keywords: **ANN, CBR, Neural power, GEP, SVM, Soil index, SPSS, Sub-base.**

1. INTRODUCTION

1.1 California Bearing Ratio:

The California Bearing Ratio (CBR) test is a penetration test used to evaluate the subgrade strength of roads and pavements. The results of these tests are used with the empirical curves to determine the thickness of pavement and its component layers.

The CBR test is one of the most commonly used methods to evaluate the strength of a sub grade soil, sub base, and base course material for design of thickness for highways and airfield pavement. The California bearing ratio test is penetration test meant for the evaluation of subgrade strength of roads and pavements

Soaked CBR values represent the strength of an aggregate in a fully saturated condition. Unsoaked CBR values represent the strength of an aggregate in an unsaturated state. It is more time-consuming to perform a soaked CBR test than an unsoaked one, because each sample needs to be soaked for 4 days

It is a penetration test wherein a standard piston, having an area of 3 in (or 50 mm diameter), is used to penetrate the soil at a standard rate of 1.25 mm/minute. The pressure up to a penetration of 12.5 mm and its ratio to the bearing value of a standard crushed rock is termed as the CBR.

The sub grade strength characteristics is one of the most important component in permanent design. The CBR is most common test used for characterizing sub grade pavement materials, being the ratio (Expressed as a percentage) of stress needed to penetrate a soil mass with a 50mm dig, plunger at a rate of 1.25mm/min to the stress needed for correspondent penetration of a standard material (normally defined as crushed stone) generally , the ratio of is calculated penetrations of 2.5mm & 5mm while normally

the ratio at 2.5mm is considered, when at 5mm is reliably greater, the ratio at 5mm is considered. The correct load values (at 2.5mm & 5mm penetration) are then extracted from load penetration curve, & the CBR is determined using the formula;

CBR= (Applied load/Standard load) *100

1.2 Artificial Neural Network:

ANN represents a simplified model of human brain, consisting complex communications network that consists of hundreds of simple processing units wired together. Neural network works as simple as human brain. It consists of numerous interconnected neurons which works simultaneously to solve the problems.

ANN works on almost every aspects of Civil Engineering works, but the limited number of studies have been made on predicting the CBR values of soil. Taskiran developed the ANN & Gane Expression Programming (GEP) model for predicting the CBR values of soil. ANN predict the relationship between the soil data & their respective CBR values. Most attempts are made on sub grade soil. However, few research attempts have been made on using ANN to predict CBR from soil indices for local sub-base soil.

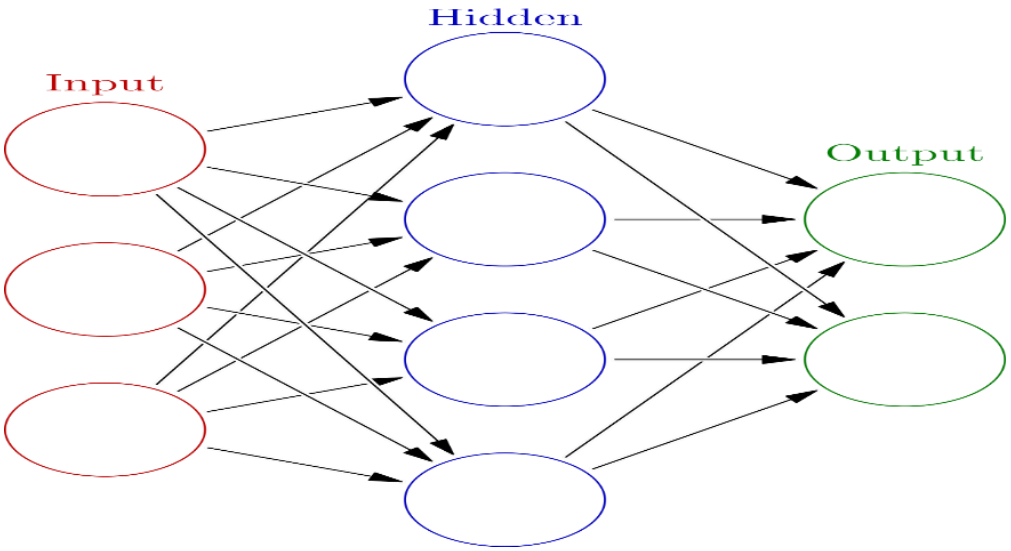

Fig.1 structure of ANN

1.3 MATLAB

What Is MATLAB?

MATLAB, short for MATrix LABoratory is a programming package specifically designed for quick and easy scientific calculations and I/O. It has literally hundreds of built-in functions for a wide variety of computations and many toolboxes designed for specific research disciplines, including statistics, optimization, solution of partial differential equations, data analysis.

MATLAB is a high-performance language for technical computing. It integrates computation, visualization, and programming in an easy-to-use environment where problems and solutions are expressed in familiar mathematical notation. Typical uses include:

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- Math and computation
- Algorithm development
- Modeling, simulation, and prototyping
- Data analysis, exploration, and visualization
- Scientific and engineering graphics
- Application development, including Graphical User Interface building

MATLAB is an interactive system whose basic data element is an array that does not require dimensioning. This allows you to solve many technical computing problems, especially those with matrix and vector formulations, in a fraction of the time it would take to write a program in a scalar noninteractive language such as C or Fortran.

The name MATLAB stands for matrix laboratory. MATLAB was originally written to provide easy access to matrix software developed by the LINPACK and EISPACK projects, which together represent the state-of-the-art in software for matrix computation.

MATLAB has evolved over a period of years with input from many users. In university environments, it is the standard instructional tool for introductory and advanced courses in mathematics, engineering, and science. In industry, MATLAB is the tool of choice for high-productivity research, development, and analysis.

MATLAB features a family of application-specific solutions called toolboxes. Very important to most users of MATLAB, toolboxes allow you to *learn* and *apply* specialized technology. Toolboxes are comprehensive collections of MATLAB functions (M-files) that extend the MATLAB environment to solve particular classes of problems. Areas in which toolboxes are available include signal processing, control systems, neural networks, fuzzy logic, wavelets, simulation, and many others.

The MATLAB System

The MATLAB system consists of five main parts:

The MATLAB language.

This is a high-level matrix/array language with control flow statements, functions, data structures, input/output, and object-oriented programming features. It allows both "programming in the small" to rapidly create quick and dirty throw-away programs, and "programming in the large" to create complete large and complex application programs.

2. RESEARCH METHODOLOGY

When we were looking for problem statements for this project, we came across various loop holes in investigation of soil properties. We found that civil engineering field lack in use of new technologies. So, we did research especially on CBR tests and its correlated properties. We are in the process in learning artificial neural network software.

3. OBJECTIVES

1. Application of ANN by preparing optimized model.
2. Reduce the time for actual performance of ANN
3. It is alternative to statistical and traditional methods as well as in combination with numerical simulation systems.
4. Simplicity, the positive aspects and the reliable results of the usage of neural networks for solving engineering problems.

4.DESCRIPTION OF PROJECT WORK / EXPERIMENTATION

The software used for the processing of acquired data from the laboratory is MATLAB. The software contains a toolbox for performing & processing of the data but before this we have to give inputs that we have decided these are MDD, OMC, LL, PL, PI, MC, etc. it works as same as human brain.

4.1 we can derive the methodology in following steps:

1. collection of data: we have visited a laboratory where the in-situ testing had been conducted. We had brief discussion with the technicians & lab assistance. They made us clear about the CBR concept & the correlated parameters. They have provided us a bunch of recorded data of their laboratory results, which we will be using as our input data.

2. We have learnt the basic programming which is used for building of ANN. Also, we trained on MATLAB software which is one of the basic tool for ANN programming.

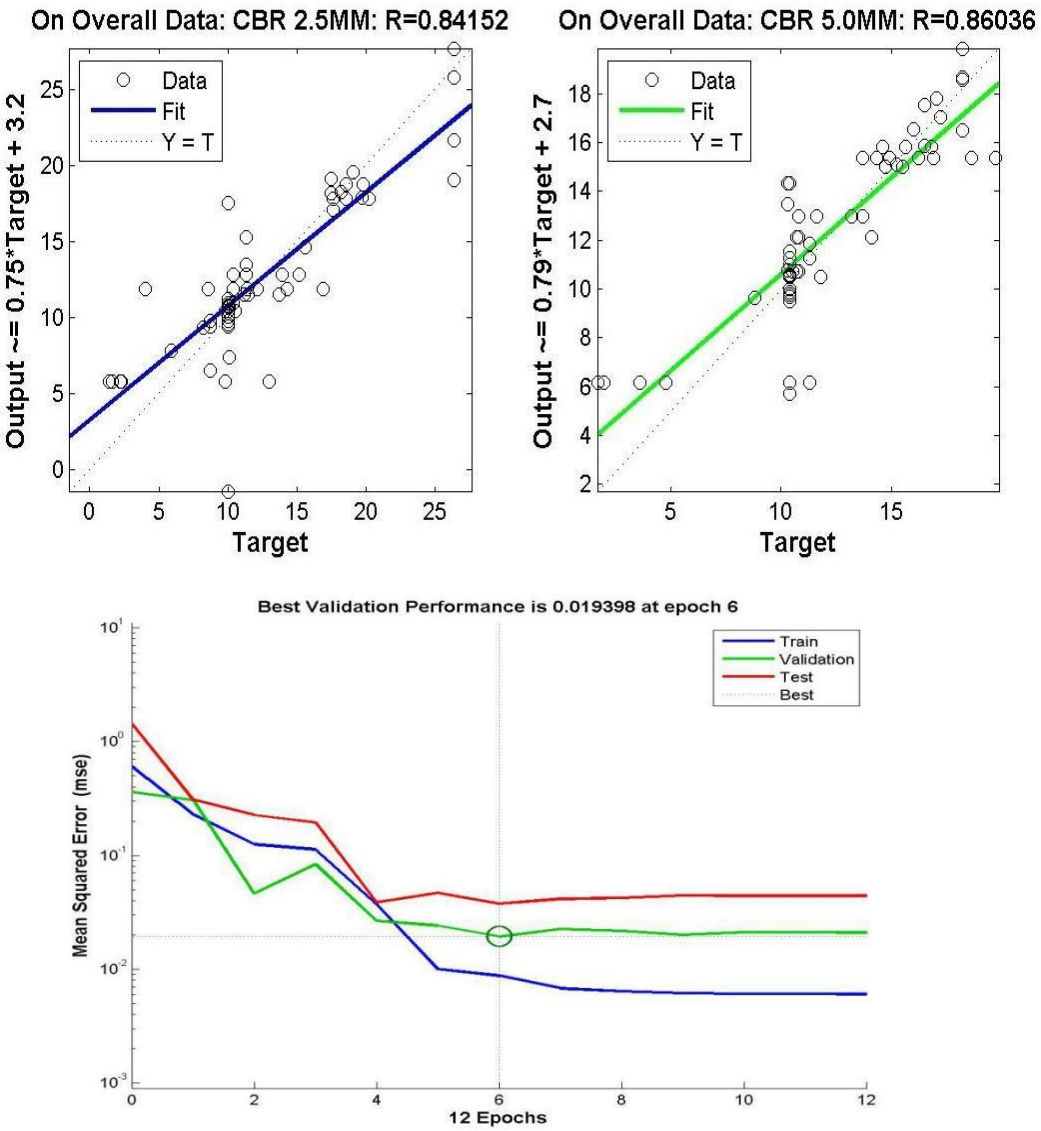
By following these two above mentioned steps, we achieved our finalized program for testing & results.

5. DATA ACQUISITION

In order to correlation between sub-base physical properties & CBR, multiple soil samples (100 samples) were collected. The data was collected from soil samples acquired by Constrologist testing pvt. Ltd. laboratory, which were tested for gradation, Optimum Moisture Content (OMC), Maximum Dry Density (MDD), Liquid Limit (LL), Plastic Limit (PL), Plasticity Index (PI). Sub-base samples are tested according to American standards for testing of materials.

6. RESULTS

1. The ANN models are successful in predicting CBR values as determined by actual CBR tests with the accuracy of 92.27%.
2. The developed ANN model is more accurate than the mathematical method. The prediction error percentage of ANN model ranged from 0.58 to 2.78%, while the mathematical method was 8.83 to 53.73%.



7. CONCLUSIONS

The main objectives of this study were the examination of ANN in terms of predicting CBR values based on basic soil tests. To establish this goal, soil samples were collected & tested in the constrologist laboratory to obtain the input parameters for the ANN model.

1. The neural network is power full tool and is easy to use.

2. The developed ANN model can be used reliably, successfully and very accurately for the prediction of sub-base CBR values.

3. The input parameters ranges play a significant role in model making.Sub-base data parameters were trained to achieve the best correlation between CBR & such soil parameters.

ACKNOWLEDGMENT

It gives me an immense pleasure to submit this project repot on **"APPLICATION OF ARTIFICIAL NEURAL NETWORK FOR PREDICTION OF SOIL PROPERTIES".** We tried our level best to represent this topic into compact & to the point framework.

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