

Modelling Overlay Flexible Pavements Using Artificial Intelligence Technique

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Abstract:

This study presents an effort to use artificial neural network to recommend asphalt overlay thickness. Though noted common methods need time, reliable and a few essential data to be ready to start designing process but Artificial Intelligence (AI) Technique especially artificial neural network (ANN) may be a method supported learning process which may find possible relation between input and output sample data and is in a position to predict the output with none time with founded relation quickly. Results of this study reveal that artificial neural network is acceptable for implementation in predicting flexible overlay thickness.

Keywords —Artificial Intelligence, Artificial neural network, Flexible pavements, Modeling

I. INTRODUCTION

Pavements are of 2 varieties, flexible and rigid. In flexible layers, the common ones are mineral sporting course on top of base and/or sub-base that rests on subgrade layer. Generally, failure of pavement occur due to factors affecting useableness like traffic loading and atmospheric condition. For preservation, Maintenance Rehabilitation (MR) activities should be done in well-timed manner. The most popular M and R activities is use of Hot combine Asphalt (HMA) overlays. This improves the roadway by utilizing the existing layers of asphalt concrete and aggregate base as support for a replacement wearing surface. Adding a defined thickness of asphalt concrete provides structural reinforcement to the roadways, permits the designer to allow modification in traffic use, addresses increasing traffic volume and weights, corrects riding qualities, and efficiently extends structural performance of the roadway for ten or even twenty years while maintaining factors just like the structural capacity of every layer, and the variation

of fabric properties thanks to seasonal and environmental changes, especially the temperature and wetness variations. A significant thought throughout style and ultimately construction of overlay is that the potential for existing pavement cracking of various severity to replicate through new sporting surface, with obvious aesthetic impacts. HMA overlay provides a reasonably quick, lucrative suggests that of restoring satisfaction of user, rectifying deficiencies of existing surface, and promoting structural load-carrying capacity reckoning on the designed thickness.

This study integrates the feasibility of application of ANN approach for approval of correct pavement overlay thickness based mostly on information from overlay style cases. For developing countries like India wherever devoted utilities inaccessible, this methodology is useful in every manner.

II. FLEXIBLE PAVEMENTS

The main structural function of a pavement is to support the elicited load by traffic and to

distribute these loads safely to the foundation. Figure 1 shows the typical crosswise of a versatile pavement system. This pavement comprises a range of hydrocarbon layers placed over the road base over an identical unbound sub-base material placed on the natural subgrade. This pavement is referred to as "flexible" because the bituminous materials are capable of flexing just below traffic loading. For thinly surfaced pavements, the road base is often unbound granular material.

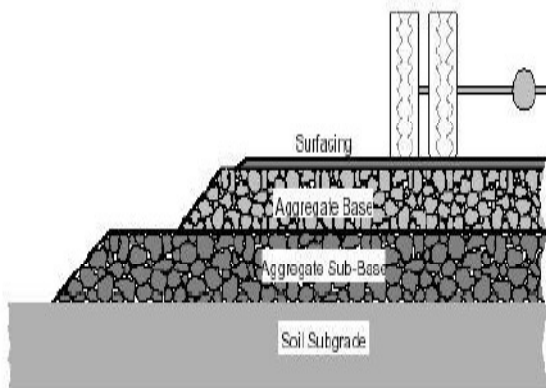


Fig. 1A flexible pavement system

III. METHODOLOGY

The basic rule of the impulse loading equipment is to drop a mass on the pavement to supply an impulse load and measure the surface deflections. The mass is dropped on a spring system, which in turn transmits the load to the pavement through a loading plate. The resulting deflection bowl characteristics area unit ascertained and used in the back-calculation of.

A. Overlay Design Procedure

In overlay design procedure, thicknesses are so calculated to put damages within the allowable limits in the existing pavement and the new overlay. There are many Parameters affecting overlay thickness like temperature, moisture, material properties of each layer etc.

B. Artificial Neural Network (ANN)

Artificial Neural networks are valuable intelligent tools that have been used considerably in engineering applications once it's troublesome to prosecute typical strategies showing inferior performance (Fwa and Chan, 1993). Also ANNs have proved to outperform traditional modelling counterparts in solving various complex engineering problems. ANNs are intelligent systems based on uncomplicated computing models of biological structure of the human brain (Venayagamoorthy et al, 2002). The highly connected, distributed nature of it imparts high degree of fault tolerance, noise immunity, and generalization capability. It consists of parallelly operating straightforward parts, inspired by biological nervous systems. The network function of ANN is determined by the connections between parts which may be trained by adjusting the values of the connections (weights) between the weather. Batch training of a network payoff by creating weight and bias changes primarily based on a whole set (batch) of input vectors. Figure 2 shows the typical structure of a multilayer feed forward neural network

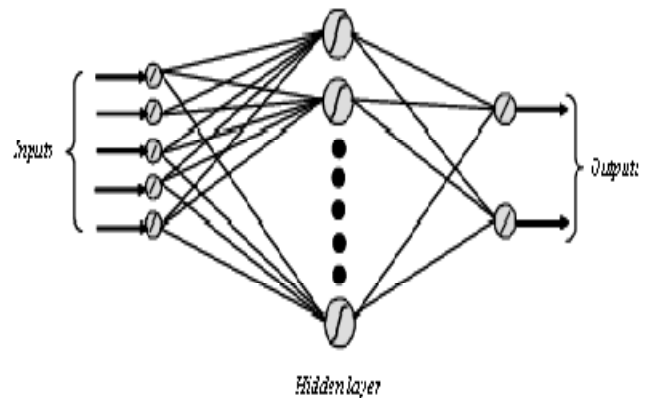


Fig.2 Multilayer feed-forward neural network

There is an input layer, one or more intermediate layers referred to as the hidden layers associate degreed an output layer, which outputs the

network's response to its inputs. The activity of the input units represents the raw information that is fed into the network, while that of each hidden unit is set by the activities of the input units and also the weights on the connections between the input and also the hidden units. Behaviour of the output units depends on both. The different layers structure allows flexibility, more info capturing and relationship identification between variables.

IV. RESULT AND DISCUSSION

The analysis indicates that changing the transfer function has a noticeable effect on the accuracy. Furthermore, the number of hidden nodes has an effect on the accuracy, where using more number of hidden nodes gives high accuracy. To achieve high accuracy, the number of hidden nodes is preferable to be more than 25 nodes. On the other hand, ANN predicts much better with the two hidden layers. Hence for different transfer function (TRAINLM and TRAINSCG) for each design-cases ANN analysis was done using MATLAB. The no of hidden nodes were also changed for each transfer function. As number of nodes above 20 gives better results hence when plotted the Percent Accuracy Vs no. of hidden nodes, the transfer function which gave better accuracy between 20 to 50 was selected for that specific design-case. Graph between Percent accuracy and no of hidden nodes are presented here for different cases.

For building design cases database, three different pavement cross sections have been suggested: 3-layer and 4-layer. Graph between Percent accuracy and no of hidden nodes are presented here for different cases where x_y means the database refers to (x+1) layered initial structure and y design base, criteria of which is given earlier.

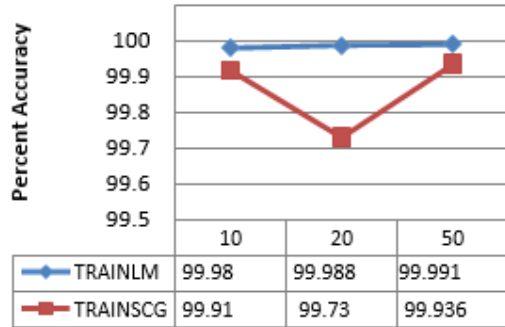


Fig.3 Graph of Percent Accuracy Vs No. of Hidden Nodes for 3layered pavement

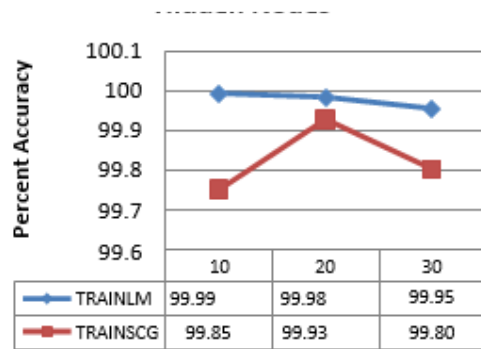


Fig.4 Graph of Percent Accuracy Vs No. of Hidden Nodes for 4 layered pavement

V. CONCLUSIONS

ANN has recently received lots of attention and it's also contributed in a very wide selection of applications in applied science yet as in other fields. In this study, ANN-based pavement overlay design tool has been developed using MATLAB computer code. Several network architectures were trained exploitation coaching knowledge sets developed using overlay style program. The calculated and the predicted overlay thicknesses have been compared together to come up with the accuracy rate. The average accuracy is found to be between 90 to 100% for almost all the design-cases.

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