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Calculating the Soil Strength for standing Support in Underground Mine Using Artificial Intelligence Approach

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ABSTRACT: As we know that, Mining is an important process by using which we are extracting the most of the valuable product from the core of the earth. It is the process which deals with many steps of extraction. To extract the product from the core of earth, we need to create the tunnel. We also know that, in mines area the strength of the soil in all location is not always same. So due to this reason, the major accidents are always happen in the mines area[10]. Hence before going to create the tunnel we have to identify the soil strength. In the current paper a neuro-fuzzy technique along with the back propagation technique has been explored for prediction of setting load in standing support in underground mines. Cause-wise analysis of underground mine accidents reveals that roof falls continue to remain the single largest killer[11]. Ground control operation is an 'imprecise' area of engineering due to the fact that we are dealing with a material produced by nature (the ground). Hence in the mines the major accidents are happen due to because of roof fall as well as explosion due to presence of highly flammable gases. So to reduce the chances of roof fall in mines the Support selection is one important aspect of mine design and planning[12]. To date, the automatic computerization of this task has received little attention. This may be because the relevant knowledge is not yet completely formed, particularly of ground strata mechanics. In any cases, rule of thumb and accepted practices are still widely used. In order to avoid personal bias and to make full use of available human expertise, an expert system would seem to offer a sensible route to computer-aided selection. Empirical approaches to design has been widely used in these mines since long.

This paper discusses about Neuro_Fuzzy system using Back Propagation Network (BPNN) to train the network for optimization the mine support parameters. Some of the variable parameters associated with the underground excavation work have been taken as input/output parameter for the network. The technique of simulation of the result has also been discussed.

KEYWORDS: mine support parameters, Neural Network, Fuzzy logic, Back Propagation network, Artificial Intelligence.

I. INTRODUCTION

Engineers throughout the world are trying to find out a suitable methodology for prediction of load in support. Some of the engineers [1-8] have discussed about the load in mines area.
Before going to start any work we have to make a study about the zone and its specific environment. As we know, that A mining project can only commence with knowledge of the extent and value of the mineral ore deposit[2]. Information about the location and value of the mineral ore deposit is obtained during the exploration phase. This phase includes surveys, field studies, and drilling test boreholes and other exploratory excavations.

It has been observed that safely exploitation of coal in India has been a big problem since years. In terms of the method of winning coal, the share of opencast mining, which was as low as 14% in 1951, increased to current high level of above 80% whereas the share of underground mining declined from 77% in 1971 to current 20%[3]. Even if, we can't ignore the underground mine coal production due to its good quality of coal as well as for societal reasons. In

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underground operation ground control problem is an important factor affecting safety, production and efficiency .A view of underground mines with sufficient support and drilling operation have been shown in Fig. 1.

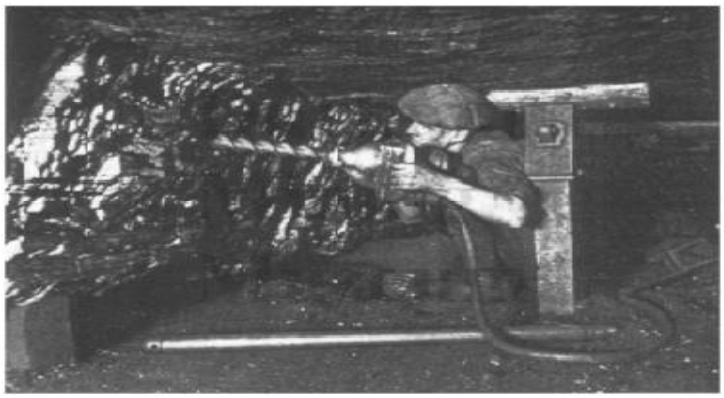

Figure 1: Undergroud Mine with Support and Drilling Operation

II. RELATED WORK

In terms of number of mines, out of about 595 operating mines, about 384 are underground mines. In underground coal mining technology, bord and pillar mining method is one of the major technology being used in India, with about 91% of the underground coal production, employing about 57% of total work force[8].
As per statistics of accident data "fall of roof / sides" is one of the major cause of mine accidents. A major consideration in supporting mine roofs is limiting the movement and expansion of the rock strata immediately above the roof[9-11]. Cause-wise analysis of mine accidents reveals that roof falls continue to remain the single largest killer, As many as 61% of the incidences, which is 28.5% of total fatalities are due to roof fall. Such accidents can be obviated using the accurate measurement and optimization of data and its analysis using Artificial Intelligence. Since artificial intelligence (AI) techniques can make use of heuristic knowledge (rules of thumb) or pattern matching techniques, as opposed to solving a set of mathematical equations, they should be ideally suited for application in the field of geotechnical engineering. Many aspects of mine design are based upon empirical data. The availability of data and knowledge are two important considerations in implementing many engineering and scientific applications.
The techniques of AI that are adopted here is Neuro-Fuzzy system. Neuro-Fuzzy system analyzes data a predictions based on previous results.

III. DATA SETS

III. I. Inputs

Rock Mass Rating (RMR) Before going to create the tunnel or any mines operation, we first calculate the strength of the rock. As we had already discussed in this paper that the strength of the soil is not always identical in all resoect, so RMR is very essential factor. Rock mass classification systems such as Geomechanics classification (RMR) act as a useful tool for initial estimation of support requirement immediately after tunnel excavation [11].It bases on five parameters. These parameters are:
1. Uniaxial compressive strength of the rock
2. Rock quality designation (RQD)
3. Spacing of discontinuities
4. Condition of discontinuity
5. Ground water conditions.
6. Orientation of discontinuities
These factors are given a numerical value and

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totaled together to get an RMR value. This value will be a number between 0 and 100 with zero being very poor rock and 100 being extremely good rock. The ground water conditions were assumed to be dry conditions. Table.1 shows the ranges of RMR. Based on the value of RMR, we can easily calculate the density factor about the rock and then only we can find the better mining process in the mine. Mining is the very important process which provides us various goods, but to make the mining safe we have to calculate the RMR first.

B. Distance of the prop fror
C. Working Height
D. Rock Density
E. Seam Thickness
F. Width of Gallery
G. Charge per blasting hole

Table 1
Geomechanical Classification of Roof Rock Mass
(after CMRI, 1987)

Rock Mass Rating	*Class*	*Description*
0-20	V	Very poor
20-40	IV	Poor
40-60	III	Fair
60-80	II	Good
80-100	I	Very good

To Set load on prop Sample data were taken arbitrarily for training the Neuro-Fuzzy system by selecting the proper transfer function[11]. The advantage of the sigmoid function is that its derivative can be expressed in terms of the function itself (Saro Lee et al., 2004)[4]. Output data i.e. appropriate setting load can be approximated with the available input data after simulation. Sample datasets were shown in table 2. Distances from the faces has been shown in Fig. 3 below. Here each face represent the prop and its distance.

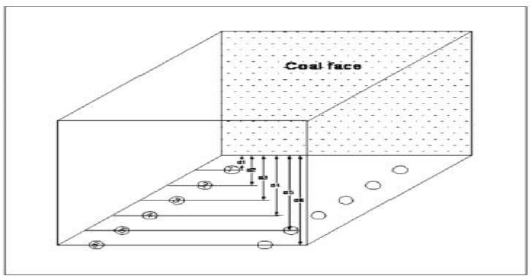

Figure 3

Table 2

Sl. No.	*Parameters*	*Set 1*	*Set 2*	*Set 3*	*Set 4*	*Set 5*	*Set 6*	*Set 7*	*Set 8*	*Set 9*	*Set 10*
1.	RMR	42	55	43	56	42	57	49	38	58	47
2.	Distance of first prop from the face (d1) (m)	0.6	0.8	0.4	0.6	0.4	0.6	0.8	0.8	0.6	0.6
3.	(d2)	1.2	1.4	1.0	1.0	0.8	1.2	1.2	1.2	1.2	1.4
4.	(d3)	1.8	2.0	1.6	1.4	1.2	1.8	1.6	1.6	1.8	2.2
5.	(d4)	2.4	2.6	2.2	1.8	1.6	2.4	2.0	2.0	2.4	3.0
6.	(d5)	3.0	3.2	2.8	2.2	2.0	3.0	2.4	2.4	3.0	3.8
7.	(d6)	3.6	3.8	3.4	2.6	2.4	3.6	2.8	2.8	3.6	4.6
8.	Working Height (m)	2.7	2.6	3.0	2.4	2.6	4.5	3.0	4.5	3.0	3.0
9.	Rock Density(gm/cc)	2.2	3.0	2.4	2.8	2.6	2.2	2.4	3.0	2.3	2.8
10.	Seam Thickness (m)	3.4	4.1	4.8	3.4	3.8	4.8	4.4	5.4	3.6	3.6
11.	Width of Gallery (m)	4.2	4.2	4.5	4.2	4.2	4.2	4.0	4.2	4.2	4.2
12.	Charge per Hole (g)	400	400	450	450	400	500	400	400	500	500
13.	Target – Setting load on standing prop (1) (Ton)	09	07	10	06	10	07	08	10	06	08

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IV. NEURO-FUZZY CONTROLLER

The Neuro-Fuzzy system to be designed has the following functionality
1. Prediction modeling
2. Classification modeling
3. Data conceptualization
4. Data filtering
The Neuro-Fuzzy controller has been shown in Fig. 2.

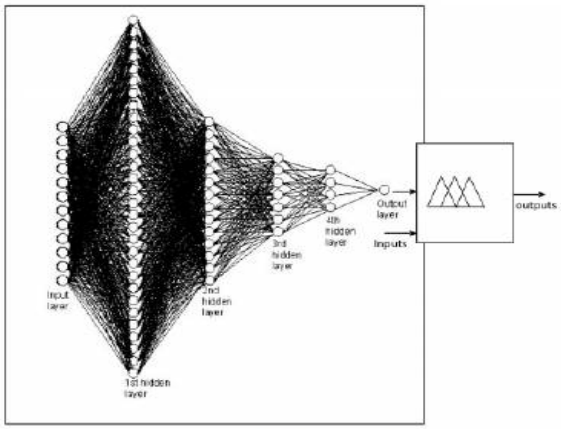

Figure 2: Neuro-Fuzzy Controller

V. CONCLUSIONS

As we know that the mining is an important process to extract the ore from the core of earth. Without mining we cannot able to get the valuable product for our benefit as well as growth of our nation. Now a day we are fully depends on the mining process. For example if we take the case of LPG gas to get our day to day activity[6]. Or even if the take the transport then also we depends on fuel which a product of mining. Now a day we use the nuclear reactor for the production of electricity, but to do so we depends upon the Uranium isotopes which is an ultimate gift of mining[7-8]. But to get all these product we have to go for the mining process and hence we have to go for the good mine. We also can't ignore about the safety about the tunnel, so before going to create the tunnel we have to calculate the soil strength and also the RMR about the soil and rock. In the current analysis of the paper, we conclude that, the Neuro-Fuzzy system has been designed for load prediction of the support. But we also take an help of BPNN(Back Propagation Network) to create the Hybrid controller which can be efficiently used for prediction of the load[10]. The Hybrid system helps the human being for automation of the system. In the future more robust controller will be developed for prediction of load.

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BIOGRAPHY

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