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"PREDICTION OF DRILLABILITY IN ROCKS USING ARTIFICIAL NEURAL NETWORK AND FUZZY LOGIC TOOL"

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ABSTRACT

Drillability of rock is one of the important parameter to decide the progress and economics of excavation. It depends on number of parameters like ground condition, drill geometry and other rock parameters. In this study the important physico mechanical properties are determined. It is found that Uniaxial Compressive Strength, Point load index, tensile strength, shear strength, cohesion are strongly correlated with Penetration Rate , however elastic modulus, P and S wave velocity indicate moderate correlation. This paper describes a fuzzy logic prediction model and artificial neural network for evaluating of rock drillability. Six parameters; Uniaxial Compressive Strength (UCS), tensile strength, hardness, Elastic constant, modulus of rigidity and grain size have been used.

1. INTRODUCTION

Rock drillability is defined as the ease of drilling a hole in the rock mass. Studies have shown that the drillability of rock and the penetration rate of a drill are affected by 1. Rock hardness 2. Rock texture and density 3. Rock fracture pattern 4. General structure of the formation/rock mass Drillability is defined as penetration rate of a drill bit into the rock. It depends on compressive strength, hardness; mineral, drilling weathering. It is property of drill bit. It depends not only on rocks but also tool characteristics and operational variables: thrust force, Neural networks in predicting the drillibality of rocks and wear factor using engineering properties of rocks. Drillability of rocks is a useful guide for evaluating the suitability of drills for different ground operations. The wear factor of different materials subsequently helps in the selection of proper drills for different drilling operations an accurate approach for drilling rate prediction using fuzzy logic and artificial neural Network are introduced in this work. Drilling rate prediction is an important issue due to its crucial role in minimizing drilling cost.

The data is used to train and test the neural network and fuzzy logic interface system. Results from the analysis demonstrate that soft computing systems are an effective tool in the prediction and suitability of drilling operation. Application of these predictive models can be a useful tool to obtain the value of these important parameters; they can save time and help to avoid the difficult process of instrumentation.

The choice of drilling method is primarily based on rock characteristics, type of operation, specific production requirement and equipment availability. The quality and quantity of the site inv conditions will be a factor in the proper selection of drilling, excavation and support systems and the identification of economic criteria and technical estigation data determines to a large extent the choice of a drilling method and its economic implementation. A prior knowledge of ground specifications

Drillability

Drillability is defined as penetration rate of a drill bit into the rock. It depends on compressive strength, hardness; mineral, drilling weathering. It is property of drill bit. Depends not only on rocks but also tool characteristics and operational variables: thrust force, Drilling velocity is dependent on a lot of geological parameters: Those principal parameters include jointing of rock mass, orientation of schistosity (rock anisotropy), degree

of interlocking of microstructures, porosity and quality of cementation in elastic rock, degree of hydrothermal decomposition and weathering of a rock mass. Drilling bit wear increases with the equivalent quartz content.

2. LITERATURE REVIEW

S. S. Roy [1] studied modelling of tool life, torque and thrust force in drilling: a Neuro-fuzzy approach in this paper presents the application of Neuro-fuzzy approach for modelling tool life, torque and thrust force in drilling operation for set of given process parameters, namely cutting speed, feed rate and drill diameter. The proposed approach uses a hybrid-learning algorithm i.e., combination of the back-propagation gradient descent method and least squares method, to identify premise and consequent parameters of the first-order Sugeno-fuzzy inference system. The least square method is used to optimize the consequent parameters with the premise parameters fixed. Once the optimal consequent parameters are found, the back-propagation algorithm gradient descent method is used to adjust optimally the premise parameters corresponding to the fuzzy set in the input domain. The predicted tool life, torque and thrust force values obtained from neuro-fuzzy system were compared with the experimental data. This comparison indicates that the proposed approach can produce optimal knowledge base of fuzzy system for predicting tool life, torque and thrust force in drilling operation

S.H. Hoseinie, M.Ataei, M.Osanloo [2] studied a new classification system for evaluating rock penetrability in this paper presents a new classification system called the Rock Penetrability index (RPi). An evaluation model based on the fuzzy Delphi analytic hierarchy process (FDAHP) has been used for estimation of penetrability and drillability of rocks. For this purpose, five parameters of the rock material, including uniaxial compressive strength, Schimazek's F-abrasivity, mean Moh's hardness, texture and grain size and Young's modulus have been investigated and rated. In the RPi system, a number from 10.25 to 100 can be assigned to each rock, with higher values corresponding to greater ease of drilling and penetration into rock. Based on the RPi classification, rocks are classified into five modes from the view point of penetrability: very poor, poor, medium, good and very good

T. N. SINGH, A. R. GUPTA and R. SAIN [9] studied a comparative analysis of cognitive systems for the prediction of drillability of rocks and wear factor this paper demonstrates the applicability of cognitive systems or neural networks in predicting the drillibality of rocks and wear factor using engineering properties of rocks. Drillability of rocks is a useful guide for evaluating the suitability of drills for different ground operations. The wear factor of different materials subsequently helps in the selection of proper drills for different drilling operations. Cognitive systems are a very effective tool to establish non-linear and complex relationships between the various rock engineering properties and drillability of rock and wear factor of drill.

3. RESULTS AND DISCUSSIONS

Results: Using Fuzzy Logic Tool Box In Matlab 2010 Mamdani Fuzzy Model

As discussed above that the Mamdani fuzzy inference is used for predicting drillability of rock solids by using different input parameter which is affected to drillability.

Table 5.1 Inputs and output parameter and experimental value

Rock type	P-Wave	S - wave	Uniaxial	Tensile	Porosity
Milky Quartzite	3465.10	1855.64	93.7	12.35	5.25
Quartz-Biotite-	2407.10	1453.11	61.16	6.62	8.63
Granulite	2525.00	1367.98	69.36	8.36	7.37
Biotite-Gneiss	2716.00	1468.12	80.15	11.47	8.09
Quartz-Mica-	2490.12	1475.11	64.92	7.32	8.20

FIS (Mamdani Method)

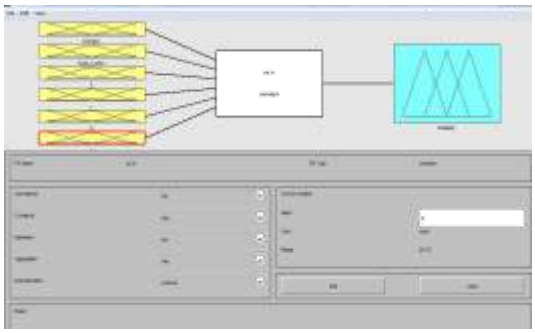

Figure 3.1 Membership function for Cohesion (Input), range is 22 to 38

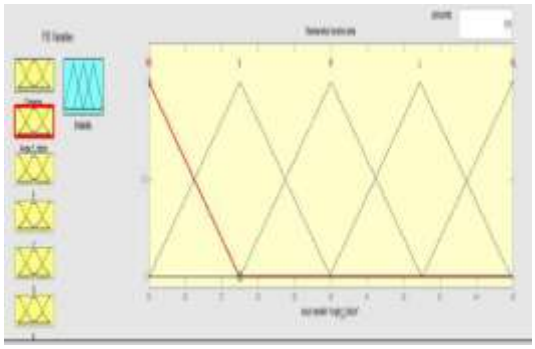

Figure 3.2 Membership function for angle of friction (range 35 to 45)

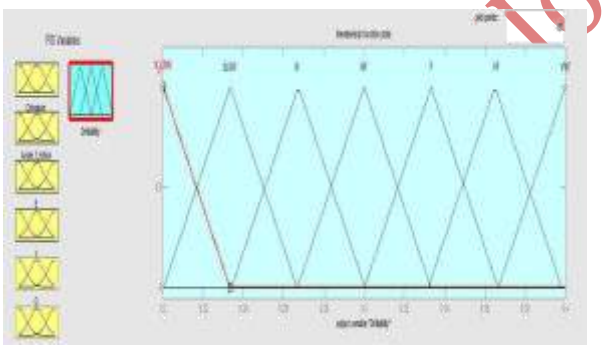

Figure 3.3 Membership functions for Drillability (output)

4. CONCLUSION

In order to deal with such problems fuzzy set theory has been implemented and the evaluations are expressed in linguistic terms. In this research an efficient Mamdani approach, under fuzzy environment has been implemented to deal with both qualitative and quantitative criteria and a suitable supplier has been selected successfully. Experimental data is obtained and is used to train the prediction system. Recent data are given as input to the prediction system. Fuzzy rules can be integrated to serve a real time application the prediction capabilities of these models are verified by comparing their results with the experimental values. The main contribution of this study introduces a new method based on Neuro-Fuzzy logic to predict the drillibality accurately. These results prove that Artificially Intelligence is very effective tool to established non linear and complex relation between various rock properties and drillability of rocks.

Using artificial neural network can be predict drillability accurately.

5. REFERENCES

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