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Investigating the interaction of geomechanical factors influencing the underground mining method selection using fuzzy DEMATEL method

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ABSTRACT: In the occurrence of geomechanical risks in underground mines, not only one factor but a set of factors are closely related to each other. Therefore, choosing a suitable underground mining method and studying the relationship and interaction between the geomechanical and geological factors affecting it, before starting the mining process, can maximize profit and recovery, increase productivity, reduce production costs and ore losses, and finally create a safe environment for underground miners. Therefore, according to the importance of the subject, in this research, using the fuzzy DEMATEL method, the structure governing the factors was analyzed from the point of view of their influence and how they relate to each other, and also the importance of them. To implement this technique, first questionnaires were designed and distributed among experts, and then 18 questionnaires were received to evaluate the factors. Finally, by implementing this method, the vectors of R , C , R+C , and R-C were calculated for each factor. The results show that the factors of rock mass tensile strength, discontinuity spacing, and geological structures of the deposit have the highest (cause factors), and the criterion of rock mass deformation modulus has the lowest impact (effect factors), respectively. The causal diagram drawn for the geomechanical factors influencing the underground mining method selection and the occurrence of geomechanical risks in underground mines, also shows that the shear strength of the main discontinuities factor has the highest prominence value and therefore has the most importance among all other parameters.

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1- Introduction

The interaction between the rock mass and the excavation determines the stability and behavior of the excavations in underground mines. From the perspective of geomechanical risk, there are a number of interrelated factors that might cause geotechnical accidents in underground mines, such as roof collapse, subsidence, rock burst, etc. In order to maximize profit and recover mineral resources, boost productivity, decrease production costs and ore losses, and finally ensure safe working conditions for miners, selecting an appropriate underground mining method can be very helpful. [1, 2]. Therefore, before beginning a safe mining operation, it is crucial to recognize the main factors in the selection of underground mining methods and to research how they interact and relate to one another. In the current article, the fuzzy decision-making trial and evaluation laboratory (DEMATEL) method is used to study the relationship and interaction between the parameters impacting the stability of underground excavations.

2- Methodology

To determine the best and safest underground mining method, the fuzzy DEMATEL technique is utilized in this study to examine the cause-and-effect relationship of geomechanical parameters affecting the stability of underground excavations [3-5]. The conceptual flowchart of the methodology's steps is shown in Fig. 1. The fuzzy DEMATEL method is used after recognizing the important criteria and asking the experts for their opinions. After identifying the contributing criteria, the cause-and-effect diagram is created.

3- Results and Discussion

for each factor, the vectors of R, C, $R+C$, and $R-C$ were computed using the fuzzy DEMATEL method. To determine the cause-and-effect criteria, each factor's importance was also calculated. The calculated values for the total-relation matrix's elements are displayed in Table 1.

Additionally, causal diagrams were shown in Figure 2 based on the findings from Table 1 and the outcomes acquired there. The vertical axis of the diagrams displays the cause-and-effect criteria, while the horizontal axis depicts the significance of the criteria.

The findings indicate that the causes are dip/dip direction of major discontinuities, discontinuity spacing, in-situ stresses, rock mass tensile strength, hydrologic conditions (surface and underground water) and geological structures

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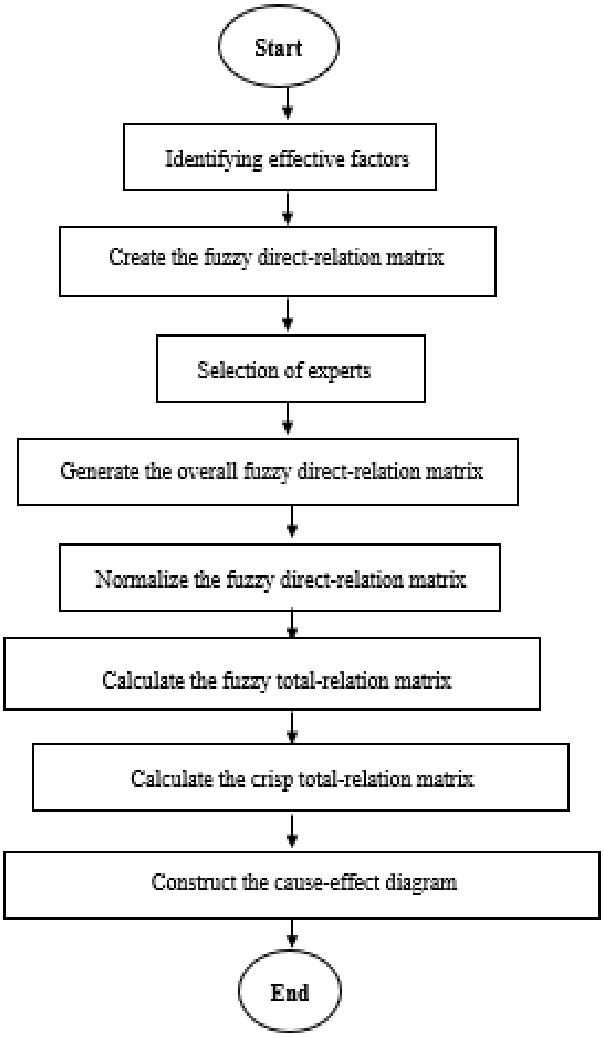

Fig. 1. The framework of the study

Table 1. Results of total-relation matrix for geomechanical criteria influencing the underground mining method selection and occurrence of geotechnical accidents in underground mines or excavations

No.	Symbol	Factors	R	C	R+C	R-C	Result
1	SSMD	Shear strength of the main discontinuities (faults & large-scale joints)	5.715	6.034	11.750	-0.319	Effect
2	DDMD	Dip/Dip Direction of major discontinuities	5.297	4.715	10.012	0.583	Cause
3	DS	Discontinuity spacing	5.706	4.880	10.586	0.826	Cause
4	ISS	In-situ stresses	5.502	5.056	10.558	0.446	Cause
5	RMTS	Rock Mass Tensile strength	5.787	4.846	10.632	0.941	Cause
6	RMDM	Rock mass Deformation Modulus	5.115	6.095	11.210	-0.979	Effect
7	RMFA	Rock mass friction angle	5.274	5.600	10.874	-0.325	Effect
8	RMC	Rock mass cohesion	5.387	5.816	11.204	-0.429	Effect
9	HC	Hydrologic conditions (surface and underground water)	5.566	5.116	10.682	0.449	Cause
10	GSD	Geological structures of the deposit	5.855	5.166	11.021	0.689	Cause

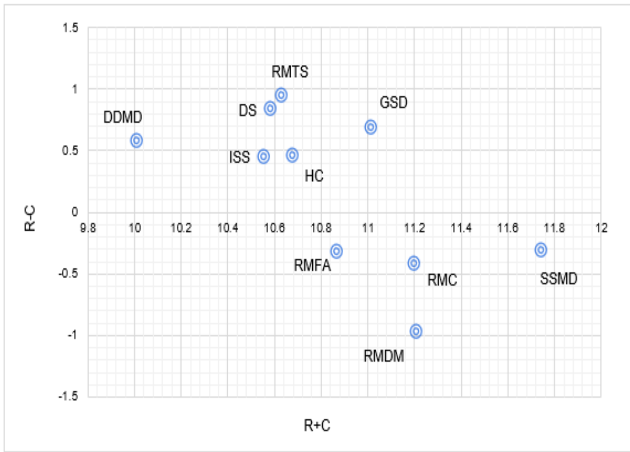

Fig. 2. The cause-effect diagram of the geomechanical factors

of the deposit parameters. Additionally, the factors of shear strength of the main discontinuities (faults & large-scale joints), rock mass deformation modulus, rock mass friction angle, and rock mass cohesion are as the effect parameters.

4- Conclusion

If underground mining procedures are carried out at greater depths, geomechanical hazards are more likely to materialize. Numerous factors affect the stability of underground excavations, the likelihood of geomechanical hazards, and the choice of an effective and safe underground mining method. In this study, the relevance of the cause-and-effect relationship between these crucial criteria is determined and quantified. The fuzzy DEMATEL methodology was used to study the interaction between the geomechanical criteria influencing the stability of underground excavations and selecting the best and safest underground mining method. The computations were performed using fuzzy numbers after recognizing the important parameters and consulting the experts. Subsequently, the fuzzy DEMATEL approach was used. The cause-effect diagram was then created after the cause-and-effect factors had been identified. The vectors of R, C, $R+C$, and $R-C$ for each factor were generated using the fuzzy DEMATEL technique. As a result, in addition to the cause-and-effect requirement, the importance of each factor was also determined.

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