Assessment and Classification of the Coal Seams Mechanization Under Geological Conditions (Case Study: Eastern Alborz Basin and Tabas)

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Abstract

Nowadays, very important issues are considered by geological and mining engineers in extraction process of minerals (especially coal deposits). The important goals are: productivity and high production rates, improve working conditions and lower operating costs. The most suitable option to achieve these goals is to replace the traditional extraction methods with full-mechanized methods. The mechanization of the extraction operations is time consuming process and it requires high investment costs. So, pay attention to this, cause special sensitivity in all design and implementation phases. Therefore, it is important to design, investigate and identify the capability of mechanization of coal seams in the first stage. For this purpose, the engineering capabilities of the coal seams of different mines should be analyzed that is important and necessary to achieve the above goals. Therefore, criteria affecting the mechanization of coal seams were identified (such as: seam inclination, seam thickness, seam uniformity, seam extension, floor and roof quality of seam and water condition). Then, 17 Stopes were studied that located in the Eastern Alborz Basin and Tabas mine. The combined used method to evaluate mechanization capability is combination method of Fuzzy set theory and Fuzzy Delphi Analytic Hierarchy Process (FDAHP). The results of the fuzzy classification system presented in current study show that the *T* seam of Tabas has a good quality, the *K11* seam of the Takht mine is located in the moderate class and other seams have not qualify for mechanization properly. In the following, the results of this study were validated with current mining conditions. It was found to have a credible reputation for the real conditions of the mines. The results of the study showed that the multifactorial fuzzy classification system can reliably use to classify the mechanization of coal seams based on geological conditions.

Keywords: Mechanization, classification, fuzzy theory, Eastern Alborz, Tabas

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Extended Abstract:

1. Introduction

In recent years, along with extraction of different minerals, many important goals (such as: increasing production rates, reducing costs, improving working conditions and increasing the productivity of mining) are on the agenda of designers and engineers. They are required to provide solutions to achieve the goals. The mechanized extraction stopes can be a good option for achieving these goals. The mechanization is using machines and advanced equipment to carry out activities. In the mining industry, the use of advanced machinery and equipment to improve working conditions, increase productivity, and increase safety, from extraction to production of the final product. The experience gained from mine mechanization suggests that in addition to geological conditions and physical-mechanical technology, other factors such as the change in management team, organizational structures, supporting industries, access to technical knowledge of the day, planning of work and how the mining operations are carried out in the process mechanization is effective. So, pay attention to productivity and high production rates, cause special sensitivity in all design and implementation phases. Therefore, it is important to design, investigate and identify the capability of mechanization of coal layers in the first stage. For this purpose, the engineering capabilities of the coal layers of different mines should be analyzed that is important and necessary to achieve the above goals. Therefore, criteria affecting the mechanization of coal layers were identified (such as: slope, thickness and uniformity of layers, the quality of roof and floor and the water flow in the stopes). Then, 17 Stopes were studied that located in the Eastern Alborz Basin and Tabas mine. The combined used method to evaluate mechanization capability is combination method of Fuzzy set theory and Fuzzy Delphi Analytic Hierarchy Process (FDAHP).

2. Materials and methods

In the present study, in order to provide a classification system for assessing the mechanization of coal seams in the Eastern Alborz Basin and Tabas, which collectively includes 17 stopes, the fuzzy sets theory and multi-criteria fuzzy approach was used. The combined used method to evaluate mechanization capability is combination method of Fuzzy set theory and Fuzzy Delphi Analytic Hierarchy Process (FDAHP). In order to provide a fuzzy classification system for analysing the status of the coal seams of the Eastern Alborz basin and Tabas in terms of the ability to mechanize these seams, first, by presenting the methodological theory, the problem is challenged. Then, by calculating and analysing the outputs of the proposed method, they are evaluated. *A* is a fuzzy subset of the reference set *X*. The membership function *A* in the reference set *X* is defined as follows:

$$\mu_A : X \rightarrow [0,1] \tag{1}$$

Where: μ_A is membership degree of each member of the set *A* in the interval [0,1]. The zero value is used to represent the total absence of membership and the value of one to represent the full membership and all values between the two values are used to represent the average membership fee for each member of the set *A*. Usually a fuzzy set with a set of ordered pairs is represented by relation (2):

$$A = \{(x, \mu_A(x)), x \in U\} \tag{2}$$

In which, the parameter U contains a finite set of X_i's. Also, the fuzzy finite set can be represented as Eq. (3):

$$A = \sum_{i=1}^{n} \frac{x_i}{\mu_{A(x_i)}} \tag{3}$$

In this study, the sigmoid function was used to solve the disability of conventional membership functions. A sigmoidal membership function is defined as Eq. (4):

$$sig\ (x; c, d) = \frac{1}{1 + \exp[-c \times (x - d)]} \tag{4}$$

3. Tests results

According to the results, the T seam of Tabas coal mine is located in good quality category and the $K11$ seam of Takht Mine is ranked the in moderate qualitative category for mechanization capability. The reason for this results is the low inclination and relatively high thickness of the seams compared to other studied seams, taking into account the importance of these geomechanical indices, but other coal seams, which include all seams of the tangent region and other seams of the Takht mine, have weak and very poor quality categories. From these seams, the T seam of Tabas mine is fully mechanized and the other seams are traditionally extracted, indicating the alignment of the results of this classification system with the actual behavior of the studied seams.

4. Conclusion

The results of the fuzzy classification system presented in current study show that the T seam of Tabas has a good quality, the $K11$ seam of the Takht mine is located in the middle class and other coal seams have not qualify for mechanization properly. In the following, the results of this study were validated with current mining conditions. It was found to have a credible reputation for the real conditions of the mines. The results of the study showed that the multifactorial fuzzy classification system can reliably use to classify the mechanization of coal seams based on geological conditions.

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