COMPREHENSIVE EVALUATION METHOD FOR EXPLOITING CONDITIONS OF SURFACE COALMINE

Wang Zhihong   Peng Shiji   Zhang Daxian
.Beijing Graduate School, China University of Mining and Technology

ABSTRACT. In the paper, the model of fuzzy comprehensive evaluation has been constructed by using the method of fuzzy comprehensive evaluation, according to the coal seam geological conditions, mining conditions and outside exploiting conditions of explored coal resources. The comprehensive evaluation for exploiting conditions of a surface coal mine in china has been made by using the model. The result shows that this method has applied value.

1. INTRODUCTION

The mining object of open coal mines is the coal deposits in natural state, the deposited conditions of those deposits are quite different. The economical benefit of surface coal mines is affected by many internal factors, such as hidden conditions of the coal seam, geological structure, reserves, quality and grade of deposits, production stripping ratio, selectivity, and external factors, such as distance to consumer, market demand, transportation condition, in different degree. Therefore, it is necessary for an open coal mine investor to make a comprehensive evaluation to an explored and minable coal field before development, according to the internal and external condition (listed above).

2. DETERMINATION OF EVALUATION INDICATORS

The main evaluation indicators on geological conditions of deposits are exploed degree, reserves, ore quality and geological structure.

The main evaluation indicators on exploiting technical conditions are stripping ratio, deposited state of deposits, coal seam structure, hydrology and engineering geological conditions.

The main evaluation indicators on devaloping external conditions are market demand, transportation, supply of water and power, and developed state of the mining area.

The goal of comprehensive evaluation on an open coal mine development condition is to make judgment on the reliability of developing a coal field which is minable proved by exploration, according to the evaluation of advantages and disadvantages on geological, exploiting technical and external developing conditions.

On above main evaluation indicators, determined the comprehensive evaluation indicators of open coal mine developing condition as shown in figure 1.
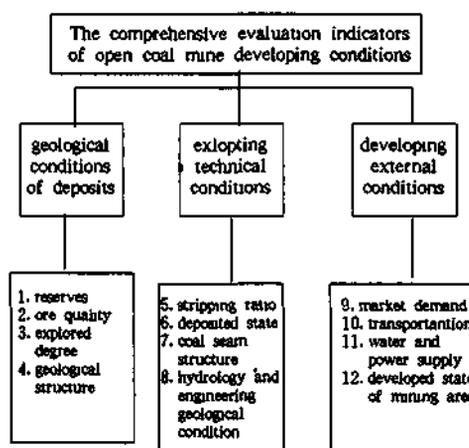

figure 1. The comprehensive evaluation indicators
of open coal mine developing conditions

3. CONSTRUCTION OF EVALUATION MODEL

The fuzzy comprehensive evaluation model was

constructed by using fuzzy comprehensive evaluation method in this paper, The foundmental method and process of modelling as bellow.

3. 1 Determination of Evaluation Factor Sets and Remark Sets

Representing the 12 evaluation indicators (shown in figure 1) in symbols as u_i, U_2, $\cdots$, ui_2, then geting the evaluating factor sets as: $U = \{$reserves, ore quality, explored degree, geological structure, stripping ratio, coal seam structure, hydrology and engineering geological condition, market demand, transportation, water and power supply, developed state of mining area $\} = \{$ U_i, u_2, $\cdots$, $u_{12}\}$. Discribing remark sets as- $V = \{$ best, better, ordinary, worse, worst$\} = \{$ v_1.v_1, $\cdots$, $v_5\}$.

3. 2 Construction of Evaluation Matrix

At first, to each factor u, $(i = 1, 2, \cdots, 12)$ in evaluation factor sets U, passes single factor judgment on the basis of factor ui and determinate the factor's subordinativity (degree of possibility) r_u relate to rank v, $(j=1,2,\cdots,5)$, then the single factor judgment sets ri of factor u, is got.

$$r_i = (r_{i1}, r_{i2}, \cdots, r_{i5})$$

The sets $\{r_i\}$ is a fuzzy subsets of the remark sets V. Based on the 12 single factor judgment sets, the general fuzzy evaluation matrix R is got:

$$R = \begin{bmatrix} r_{11} & r_{12} & \cdots & r_{15} \\ r_{21} & r_{22} & \cdots & r_{25} \\ \cdots & \cdots & \cdots & \cdots \\ r_{121} & r_{122} & \cdots & r_{125} \end{bmatrix}$$

R is a fuzzy relationship matrix from evaluation factor sets U to remark sets V, ri,is the subordinativity of factor u, corresponding to choosed rank v,.

3. 3 Determination of Evaluation Factor's Power

To each evaluation factor Ui $(i = 1, 2, \cdots, 12)$, the effectiveness in matrix R is different. Therefore, it is necessary to give each factor Ui a different power value, and those power values consist of the power sets of evaluation factors $A = \{a_1, a_2, \cdots, a_{12}\}$, where, ai is the power value corresponding to factor ui.

The determination of evaluation factor u,'s power a, is one of the key link in comprehensive evaluation. The accuracy of power sets A has a direct affect to the result of comprehensive evaluation. There are several methods to determinate sets A, often used methods are. expert investigating method and analysis method of judgment matrix. In this paper, expert investigating method is choosed.

First, draws up an evaluation factor's table; then sends the tables to experts and ask them to determinate the importance according to their person experience; finally synthesizes results of expert's judgment, determinates the power of each evaluation factor.

The calculation formula of power value as follow ·

$$a_i = \sum_{k=1}^{p} a_{ik}/p, \quad i = 1,2,\cdots,12$$

where

a_{ik} ——the kth expert gave the power value which corresponds to factor u, and the requirement to a_{ik} is

$$\sum_{i=1}^{12} a_{ik} = 1 \quad a_{ik} \geqslant 0 \quad (k = 1,2,\cdots,p)$$

p —— the number of experts who joined the judgment.

By which, the fuzzy sets A of evaluation factor's power is got, here $A = \{a_1, a_2, \cdots a_{12}\}$

3. 4 Comprehensive Evaluation

When fuzzy sets A and fuzzy relationship matrix R is got, the comprehensive judgment can be carried out by follow fuzzy transformation.
B = A o R

$$= (a_1, a_2, \cdots a_{12}) \circ \begin{bmatrix} r_{11} & r_{12} & \cdots & r_{15} \\ r_{21} & r_{22} & \cdots & r_{25} \\ \cdots & \cdots & \cdots & \cdots \\ r_{121} & r_{122} & \cdots & r_{125} \end{bmatrix}$$

$$= (b_1, b_2, \cdots b_5)$$

The element b, in sets B is the calculating result of broad tense fuzzy synthesis calculation. B is called rank fuzzy subsets of remark sets V, b, $(j = 1,2,\cdots, 5)$ is the subordinativity of the rank Vj corresponding to rank fuzzy subsets B which is got from comprehensive judgment.

Say on theory, there are several kinds of methods which can be used to carry broad tens fuzzy synthes is calculation mentioned above, in this paper, the comprehensive judgment model of "weighted average" is used, that is, the model $M(\gg +)$.

$$b_j = \sum_{i=1}^{12} a_i \cdot r_{ij}, \quad j = (1,2\cdots,5)$$

then, matrix B= (b1,b2, "-bs)) is the result of comprehensive evaluation.

The evaluation model has following feature.

(1) When making decision on the subordinativity b, of every evaluating factor corresponding to rank $v_{j(}$ the effect of every factor u,Çi= 1,2,··*, 12) is taken into account.

(2) Since the effect of all factors is considered, the value of every a have the meaning of power coefficient on representing the importance of each factor Ui.

4. APPLICATION

The developing conditions of an open coal mine project

in china has been evaluated by using this comprehensive evaluation model.

According to expert's judgment, got the general evaluation matrix as follow;

$$R = \begin{vmatrix} U5 & 0.3 & 0.2 & 0.0 & 0.0'' \\ 0.1 & 0.3 & 0.4 & 0.2 & 0.0 \\ 0.4 & 0.5 & 0.1 & 0.0 & 0.0 \\ 0.3 & 0.4 & 0.2 & 0.1 & 0.0 \\ 0.5 & 0.4 & 0.1 & 0.0 & 0.0 \\ 0.2 & 0.4 & 0.3 & 0.1 & 0.0 \\ 0.0 & 0.3 & 0.4 & 0.2 & 0.1 \\ 0.0 & 0.1 & 0.3 & 0.4 & 0.2 \\ 0.4 & 0.4 & 0.2 & 0.0 & 0.0 \\ 0.5 & 0.4 & 0.1 & 0.0 & 0.0 \\ 0.5 & 0.4 & 0.1 & 0.0 & 0.0 \\ 0.0 & 0.2 & 0.4 & 0.3 & 0.2. \end{vmatrix}$$

Then, the power of each evaluation indicator got by expert investigating method is

$A = (0.1, 0.11, 0.08, 0.06, 0.11, 0.08, 0.06, 0.06, 0.09, 0.11, 0.08, 0.06)$

Therefore, the result of evaluation derived from the comprehensive evaluation model is

$B = A \circ R$

$= (0.313, 0.351, 0.222, 0.09, 0.024)$

Known from the evaluation result, most of expert's viewpoint on the exploiting condition of the mining project is best, next of viewpoint is better, the percent thought the exploiting condition of the mining project over better is 66. *4%.*

5 CONCLUSION

(1) Evaluating exploiting condition of open coal mine by using fuzzy comprehensive evaluation model, can evaluate simultaneously both on ration and on nature.

（2） The evaluation with workload less, high accuration and practicality.

(3) The method with scientific, advanced and easy to operate feature.

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