SELECTION OF MINING METHOD AND JUSTIFICATION OF ITS PARAMETERS FOR MULTI-SEAM DEPOSITS WITH SMALL DIP ANGLES

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Abstract. *This scientific thesis examines the selection of effective underground mining methods for multi-seam deposits with small dip angles (0–15°) and provides scientific justification for their key parameters. Taking into account geological conditions, rock mass strength, and economic efficiency, the room and pillar system has been identified as the most suitable. Parameters such as pillar dimensions, room width, and inter-seam staggered distance are justified based on the Bieniawski formula, numerical modeling, and practical experience. The results make it possible to significantly reduce mineral losses, increase safety, and improve the efficiency of resource utilization. The thesis concludes with recommendations for practical application.*

Keywords: *multi-seam deposits, small dip angle, room and pillar system, pillar design, underground mining, geomechanics.*

Аннотация. *В данном научном тезисе рассматривается выбор системы разработки для многопластовых месторождений с малыми углами падения (0–15°) и обоснование ее основных параметров. С учетом геологических условий, прочности горных пород и экономической эффективности наиболее подходящей признана камерно-столбовая система (room and pillar). Параметры столбов, ширины камер и расстояния между пластами обоснованы с использованием формулы Bieniawski, численного моделирования и практического опыта. Результаты позволяют существенно снизить потери полезного ископаемого, повысить безопасность и эффективность использования ресурсов.*

Ключевые слова: *многопластовые месторождения, малый угол падения, камерно-столбовая система, дизайн столбов, подземная разработка, геомеханика.*

Annotatsiya. *Ushbu ilmiy tezisda kichik qiyalik ya'ni, 0–15° ga ega ko'p qatlamli konlarni yer ostidan qazib olishning samarali usullarini tanlash va asosiy parametrlarini ilmiy jihatdan asoslash masalalari ko'rib chiqilgan. Geologik-sharoitlar, tog' jinslarining mustahkamligi va iqtisodiy samaradorlikni hisobga olgan holda room and pillar (kamerali-ustunli) tizimi eng mos kelishi aniqlangan. Ustun o'lchamlari, kamera kengligi va qatlamlar orasidagi siljish masofasi kabi parametrlar Bieniawski formulasi, numerik modellashtirish va amaliy tajribalar asosida asoslangan. Natijalar kon yo'qotishlarini sezilarli darajada kamaytirish, xavfsizlikni oshirish va resurslardan foydalanish samaradorligini yaxshilash imkonini beradi. Tezis amaliyotda qo'llash uchun tavsiyalar bilan yakunlanadi.*

Kalit so'zlar: *ko'p qatlamli konlar, kichik qiyalik, room and pillar tizimi, ustun dizayni, yer osti qazib olish, geomexanika.*

INTRODUCTION

In Central Asia, particularly in the territory of Uzbekistan, multi-seam deposits are widespread. In most of these deposits, the dip angle of the seams is low (around 0–15°), which complicates the mining process. In such conditions, an incorrectly selected mining method can lead not only to high losses (sometimes up to 20–40%), but also to safety problems. For example, if factors such as rock pressure, water pressure between seams, and rock strength are not taken into account, miners' lives are put at risk.[1][2]

The main objective of this thesis is to select the optimal mining method for multi-seam deposits with small dip angles and to scientifically justify its technological parameters.

For this purpose, the following tasks were defined:

1. Analysis of existing mining methods;
2. Assessment of geological and geomechanical conditions;
3. Calculation and justification of room and pillar system parameters (pillar dimensions, room width, inter-seam layout);
4. Consideration of economic and safety aspects.

The relevance of the thesis lies in the growing need for effective methods that take into account resource conservation and environmental requirements. The research is based on empirical formulas, numerical models, and international experience.[3]

MAIN PART

In multi-seam deposits with small dip angles, the seam thickness is usually 1.5–8 meters, and the thickness of the rock between seams is 4–25 meters. Although a low dip angle facilitates transportation and ventilation, it increases the load on pillars and the risk of surface subsidence. Rock mass strength is assessed using systems such as RMR (Rock

Mass Rating) or GSI (Geological Strength Index).[2][4] When comparing existing methods: The **longwall** system is good for single-seam or medium-dip deposits, but in multi-seam conditions, interburden pressure becomes very high, increasing risk. The **cut and fill** method is suitable for high-quality ores, but it is expensive and slow. **Sublevel stoping** is preferable for narrow and steep seams. The room and pillar system is the most suitable for flat and small-dip multi-seam deposits. In this method, the deposit area is divided into rooms and pillars. It is flexible, allows easy use of mechanization (LHD, jumbo drill), and can achieve extraction rates of 45–75%. According to the selection methods of Nicholas and other scientists, this system receives high scores in terms of geological suitability, safety, and economics.[5]

Room width is usually selected in the range of 8–16 meters. This indicator depends on the stability of the rock mass. According to the recommendations of Bieniawski and Esterhuizen, empirical calculations are used for span stability. For example, in strong rocks, the width can be increased up to 12–14 meters, while in weak rocks it should not exceed 8–10 meters. Pillar dimensions are the most important parameter. The pillar height is equal to the seam thickness. The width is calculated using the following formula:

Mark-Bieniawski formula (adapted for coal and soft rocks):

$$S_p = S_0 \left(0.64 + 0.36 \frac{\omega}{h}\right)$$

where:

- S_p- pillar strength (MPa),
- S_0- laboratory sample strength,
- ω −pillar width (m),
- h - pillar height (m).[2][7]

In practice, the safety factor (FOS) is maintained in the range of 1.6–2.0. For example, at depths of 100–150 m, a pillar width of 12–22 meters is recommended. In multi-seam conditions, pillars are placed in a staggered pattern. The inter-seam staggered distance (CPSD) is important in multi-seam deposits so that pillars do not overlap directly. Studies show that a stagger of 40–55 meters reduces surface subsidence, decreases stress by up to 25%, and increases safety. This distance is determined through three-field (stress, displacement, surface) coupling analysis.[8]

Mechanization: Sandvik or similar jumbo drilling machines and LHD loaders are used. Apparent dip layout (45° angle) can increase efficiency by 2–3 times.[5]

With correct parameters, extraction costs decrease and losses drop to 8–15%. For safety improvement, continuous monitoring (sensors) and numerical modeling (FLAC3D, Phase2) are recommended. In Uzbekistan, this approach can be applied at the Angren and other coal mines.[1]

CONCLUSION

During the study, the scientific justification of parameters led to important results. Room width is recommended in the range of 8–16 m, while pillar dimensions, based on the Mark-Bieniawski formula, are around 12–22 m. In multi-seam deposits, placing pillars in a staggered pattern and maintaining an inter-seam distance (CPSD) of 40–55 m reduces surface subsidence, decreases stress by up to 25%, and maintains the safety factor (FOS) at 1.6–2.0.[8] The practical significance of this approach is high: it reduces mineral losses to 8–15%, increases resource utilization efficiency, reduces environmental load, and ensures miner safety. Applying these recommendations in the conditions of Uzbekistan's Angren, Boysun, and other coal mines can significantly increase economic benefits. In the future, research can achieve even higher results by deepening three-dimensional numerical modeling using FLAC3D or 3DEC programs, introducing real-time monitoring systems, and developing artificial intelligence-based optimization algorithms. In general, a correctly selected and justified mining method not only improves technical and economic indicators but also contributes to the sustainable development of the mining industry.

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