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Economic Criteria of Ore Deposits Mined with Consolidated Stowing

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ABSTRACT: In the paper worked out approach is presented which allows solving a problem of determination ol" optimal characteristic properties of filling mass (its compressive strength, shrinkage and so on). This approach takes account of both geomechanical characteristics and economic criteria.

I INTRODUCTION

Mining method with consolidating stowing was widely propagated for thick ore deposits mining in the Republic of Kazakhstan at the end of the 20·h century. Bui in new economic conditions different variants of this mining method became very expensive, especially because of large consumption of structural cement per I nv[1] of tilling mixture. Level of ore losses and ore dilution depends on compressive strength of filling mass, and compressive strength, in turn, depends on cement consumption. Consequently, criterion for determination of optimal characteristic properties of filling mass is a balance of profit at the expense of decreasing of cement consumption per 1 nr[1] of filling mixture and loss of additional ore losses and ore dilution.

2 DETAILS OF PROBLEM

When mining of thick ore deposits by room and pillar method with consolidating stowing it is necessary to determine normative compressive strength for particular mining-and-gcological conditions. Filling mass interacts with surrounding rock mass, changing its stressed-dcforming condition and increasing its support ability. Studying of behaviours of this interaction and worked out compositions of tilling mixtures with necessary properties we may act on a "weak" element of a system, which is in limiting condition. For milling by room and pillar method such element is ore pillar (or a group of pillars) which is extracted in the final (urn. So, a problem of determination of normative characteristics of tilling may be formulated as: strength characteristics and deformation properties of filling must ensure maximum concentration of stresses in pillars, extracting in the final turn, not to go over the permissible limit.

Economic factor plays an important role in determination of normative characteristic of filling's compressive strength. It is known that in cost of filling operations more than 50% falls at costs on filling materials and cement consumption is the main factor, defining both costs of filling mixtures and level of ore losses and ore dilution. So, normative compressive strength (a'_a) must be not only technologically justified but economically expediency. That is why the following additional condition is taken into account:

$$a_n \quad SCT,;(C,,L>,,'VC,,„) \qquad (1)$$

where; C_n, optimal value of normative filling strength, depending on its cost c, , economic damage at the expense of ore losses and ore dilution $U_rL),i$ and binding agent (cement as a rule) consumption c_{ha} .

Economic loss at the expense of ore losses may be considered as received less profit. Economic loss at the expense of ore dilution we may consider as unproductive costs for extracting of additional volume of barren rock, poor ores and broken filling material and also costs connecting with decreasing of ore quality. On the basis of carried out analysis we may establish a fact that changing of a level of ore losses has less influence on profit than changing of a level of ore dilution.

When using of mining method with consolidating stowing changes of strength characteristics and cost of filling mixtures may be carried out by variation of cement consumption. In this case when decreasing cement consumption per 1 nr of tilling mixture.

compressive strength decreases, because it bears an exponential f relationship to cement consumption. Correspondingly ore losses and ore dilution increase and it causes economic loss. So, economically expedient condition of cement consumption decreasing is the following - economy at the expense ol'decreasing of cemeni consumption (E_c.) must not be less than damage at the expense of additional ore losses and ore dilution:

$$E_c \geq D_i + D_d \qquad (2)$$

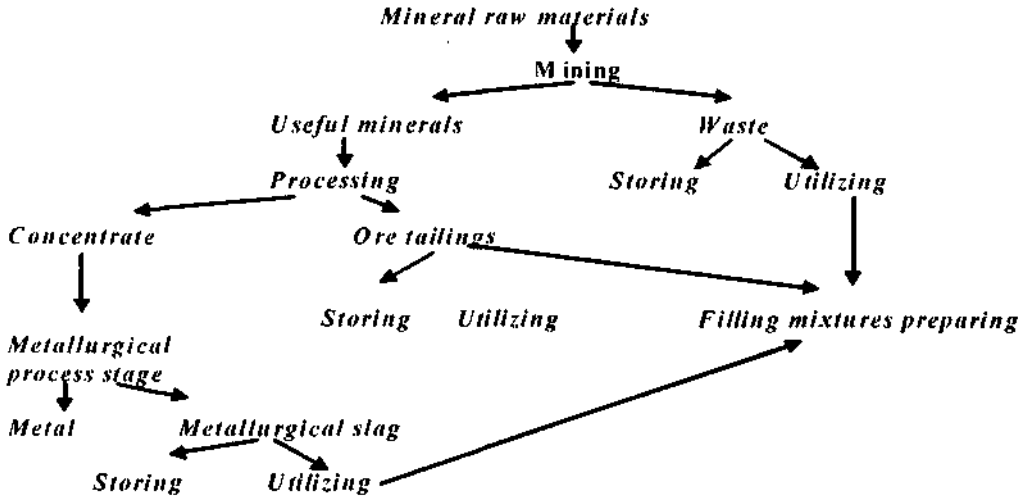

Figure I Scheme of solid waste of mining, processing and metallurgical utilization

To decrease the costs of filling mixture, it is possible to prepare multi-component filling mixtures at the basis of solid waste using. Today level of waste processing accounts 4.9%*of rocks, 3% of waste of coal processing, 3.7%' of ash, 9% of waste of phosphorous production. Investigations showed that industrial solid waste (rocks, "ore tailings, ash. metallurgical slag) may be used for producing of special sorts of cement for filling mixtures preparing. It will decrease costs of fiiline operations and increase profitability of a number mining enterprises of the Republic of Kazakhstan. Negative influence of enterprises of mining-and-metallurgical complex on environment is one of the very important economic and social problems. That is why it is necessary to introduce ecologically clean technologies, providing full utilization of industrial waste. Scheme of one of such variants of mineral raw materials using is presented in Figure 1.

Solid waste using for filling mixtures preparation may be considered as a measure for improvement of ecological situation in mining regions and at the same time economical factor, increasing effectiveness of ore extraction by mining methods with consolidating stowing using. Technological indexes of mining systems with consolidating stowing depend on both of cement consumption and composition of filling mixtures. Working out and using different compositions of filling mixtures for different mining-and-gcological conditions at the same deposit we may ensure safe technological requirements of ore extraction with optimal economic indexes and receive maximum profit per I ton of mined ore.

3 CONCLUSIONS

Determination of normative compressive strength of filling must be carried out in the following sequence:

Stressed-deforming condition of rock mass is evaluated with due account of dynamics of mining operations development, mining-and-geological and mining-and-technical characteristic properties of a deposit for determination of the "weakest" element, depending on stability of a system as a whole:

Condition is determined for saving the stability of this element, taking account of its interaction with physical-mechanical properties of filling;

Values of deformation and strength characteristics of filling arc determined, which should conform to given gcomechanical requirements and are practically normative characteristics;

Compositions of filling mixtures with given physical-mechanical characteristics are worked out and selected and economic expediency of their utilization is evaluated.