Geomechanical terms of use of the mill tailings for preparation

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Abstract
Geomechanical conditions of use of the utilized tails of enrichment of metallic mineral raw materials as the hardening stowage mix are proved. The grounds for the geomechanical balance control of the mountain mass preserving the Earth's surface by way of dividing it into safe areas according to their stress rate are indicated. The model of defining the economic and ecological efficiency of the technology using recycled processing tailings is suggested.
Keywords: ORE, UTILIZATION, THE MASSIF, PROCESSING TAILINGS, TENSION, THE HARDENING MIX, DURABILITY

From the Earth's interior is about 200 kinds of mineral resources, the annual volume of world mineral production reaches 17-18 billion. t. rock mass. Two-thirds is extracted by underground mining of non-ferrous and rare metals, more than 50% of chemical ores, about 60% of coal, nearly 100% of potassium salts.

Therefore, the main purpose of the mountain mass state control must be preservation of the Earth's surface from destruction. Ground pressure control comes to ensuring the optimal parameters of the system "natural mountain masses – artificial mountain masses – surface" to meet the Earth's surface preservation criterion [1]. The wide-spread criterion of the efficient mountain mass state control is the cost value of the works connected with it or the amount used on 1 cubic meter of filled voids. This criterion makes most preferable the failure of ore and rock with raw materials loss, ore dilution and ecological balance change on the Earth's crust plot. Estimating the efficiency of this method may include the systematic error as the actual cost of land, raw minerals and ecological environment change cannot yet be expressed in material measurement.

Due to the Earth's surface preservation criterion the mountain mass state control methods are placed in comparable conditions meeting the humanity concept in using the subsoil and land. According to this criterion the number of possible control methods does not include those using the rock failure when going onto the Earth's surface, which bring ecological problems in mining regions [2].

The rock construction existence condition is their self-locking in the layer adjoining the untouched mountain mass [3]. Usage conditions for the residual bearing capacity are created right along, but this phenomenon is not always used that leads to the ores dilution and metals loss. Strengthening the rigidity of the ore construction is performed by the injection of connecting materials between the rock parts, timbering and limiting the mine working span. But the drastic method of mountain mass control is the creation of artificial masses using solidifying mixtures. So far as filling the gaps with solidifying mixtures is notable for the high cost, the problem is in justifying the possibility of using the cheap mixtures with small bearing capacity under the certain conditions. In practice geomechanical balance control of the mountain mass preserving the Earth's surface is ensured by dividing the masses into the plots meeting the following conditions:

$L_f < L_u$ and $H>h_r$, (1)

where H, h_r – are the depth of the mine working from the surface and the height of the mine working influence, m; L_f, L_u, L_o – respectively, factual spans, utmost on condition of natural balance vault formation and preserving the flat top [4].

Ensuring of the mountain mass stability is brought to fixing the technology parameters under which the tensions in the system elements do not exceed the critical ones. This task is solved by cutting the deposit into geomechanically balanced plots with the help of the pillars: the ore ones or those made of solidifying filling. The construction stability is checked for the possibility of overlying rock failure by building the mine working zones of influence.

Within the geomechanically balanced plots one can use the compositions of solidifying mixtures of reduced stability minimized by the labor and material costs. The approach of this kind permits using the mixtures made on the basis of the low activity components, most often, ore beneficiation rejects, for the mountain mass control as well as the Earth's surface over it [5].

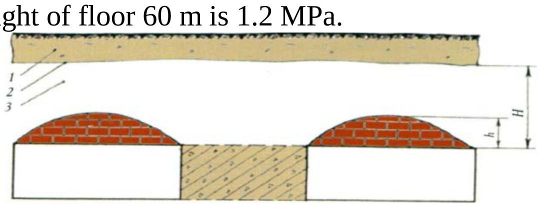
Consolidating stowing is in widespread use in Canada, USA, Australia, Sweden, Japan, Finland, Bulgaria etc. [6]. The main problem of the stowage technologies is the relatively high cost (up to 55-65% of total production costs) of the cementing component (cement), reaching 25-60% of the cost of the stowage materials. The range of works proves the recovery efficiencies of metals from the mill tailings by integrated chemical leaching and mechanical activation of minerals.
Leaching of metals from the mill tailing in disintegrator significantly increases the strength of the concrete blocks composed of the self-hardening mixtures on the base of the recoverable mill and leaching tailings.

Guard condition for the ore-hosting massif and surface above it:

H > h, (2)

where H – measured depth of the higher bound of the cavity from the weathered rocks bound; h – zone of influence of the driftage, m;

This condition is provided by dividing an ore field into the sill mats consisting of the self-hardening high-strength (no less than 1.5 MPa) mixtures, in order to the rocks stuck in roof would be able to hold nondestructive surcharge (Fig.1, top). Liquidation of the cavities within the relieved lots can be carried out using the sot self-hardening mixtures, including those prepared on the basis of mill tailings. An optimal control model is that, when the massif is divided into several lots, where the strength is determined only by strain of the lower layer of the rocks structure blocks. In case of the reliable blocks fastening when saving the flat roof it's possible to backfill the cavities with the mixtures having the minimum strength, f.e 0.5 MPa (Fig.1, mean)[6]. The non-reliable fastening can lead to the rock fall within the arch and otherwise, that's why the strength of the mixture should be no less than 1.5 MPa (Fig.1, bottom). Stabilization of the massif boils down to setting at the design stage of the development parameters, whereby strains in the system elements don't exceed the critical and are not accompanied by the deformations, destructing the massif on the lot of ground plane above it [7]. The term "soft" backfilling signifies the composite, which straight is determined only by its initial stress. The minimum strength is 0.2 MPa, the maximal at the height of floor 60 m is 1.2 MPa.



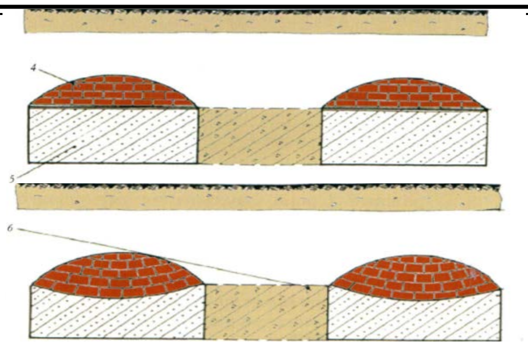


Figure 1. Duties of the concrete blocks by different rigidity of rocks: 1-capping material; 2-soft sediments border; 3- top formation; 4- structure blocks of rocks; 5- soft self-hardening mixtures; 6- hard self-hardening mixtures; H – operating depth, m; h – natural balance arch height.

Stabilized solid mixtures with strength of 0,5-1,5 MPa (and more, if necessary, under the special processing conditions) carrying sufficient plasticity, working compression properties, not flammable, not toxic and affordable. The investigations and adoption of modern innovative mining and processing technologies enable to reduce man-made load of the mining enterprises on the environment and to improve geo-ecological conditions in the mining regions.

Improving of the effectiveness of the technologies with consolidating stowing is possible through the implementation of technological measures, which are classified according to the nature of the impact on the massifs (Table 1) [8-13].

Table 1. Typification of the technological actions of massifs enforcement

Action type	Group	Option	Terms of use
Preliminary	preliminary strengthening	self-hardening mixtures; rock bolts	crumbly enclosing rocks
	consolidating stowing massifs	in the roof or the footwall of the deposit	
Simultaneously with stooping zone outcropping	backfilling with self-hardening mixtures hardening of the massif	ore feed; chamber walls inclination; with screening gapping rock bolts walling	without limitations; soft ores; unstable rock; softores and rocks
Following	backfilling with self-hardening mixtures	very hard; hard; soft	without limitations; in the particular instances
Combined	Combination of one / several classes options		Depending on the competence

Conclusions

The area of use of the utilized tails of enrichment of metallic mineral raw materials as the hardening stowage mix can be increased by creation of geomechanical conditions during development of a field. Preservation of a terrestrial surface from destruction is provided with geomechanical balance of the massif by its division into sites and bookmarks, safe in size of tension, the hardening mixes of the differentiated durability. Efficiency of technology of development of a field with use of the utilized enrichment tails correctly is described by economic-mathematical model.

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