PARAMETERS OF DEFORMATIONS OF GYPSUM MASSIFFE IN CONDITIONS OF "KOSHAVA" MINE

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ABSTRACT

The results of an experimental research of deformation parameters of gypsum massifie in mine "Koshava", determined by the use of speeds of elastic waves. These results are compared to the data received for the same parameters in laboratory conditions with the help of a static and dynamic method. The established ratio enable to estimate a degree of destruction of the certain volumes of a massifie. The deduced dependences can be used for the decision of practical tasks connected with supervision over stability of pillars and mine workings.

INTRODUCTION

The necessity of operative management of rocky pressure in underground mines requires regular reception of the information about the strain and deformation condition of a rocky massiffes near mine workings. There are various physical methods for this purpose. First of all - acoustic, based on change of parameters of distribution of elastic waves in rocks dependent of their strain condition. The basic characteristics determining distribution of elastic waves in environment are their speeds. They in the large degree depend from deformation of parameters of environment. These parameters of rocks in the most cases are determined in laboratory conditions. For this purpose use the rather not broken samples with the limited sizes. The deformation characteristic of rocks in a massiffes differs from the characteristics of samples used in laboratory, mainly because of presence of infringements in a massiffes, first of all of cracks. In order to get information about values of deformation parameters in the gypsum layer, investigation works in mine "Koshava" were carried out.

RESULTS OF EXPERIMENTAL RESEARCHES.

For definition of deformation parameters (module of elasticity and Poison ratio) gypsum massiffes static measurement by pressiometter $\Pi\Pi$ E-76 and measurement of speeds of elastic waves were made. According to the data of pressiometric measurements (Daskalov, Iv. etc. 1969) on depth 0,5 - 0,9 m from a wall of pillars the static module of elasticity has average value *E*^{stat} = 15,3 *GPa*, and on depth 5 m - *E*^{stat} = 21,4 *GPa*. For the same conditions the average values of dynamic module of elasticity determined by the use of seismic-log method are the next : for an external zone of development *E*^{dyn} = 19,6 *GPa*, and in depth of massiffes *E*^{dyn} = 25,0 *GPa*.

If it is impossible to drill, then either the method of seismic profiling of walls of mine workings or the method seismic ring

out of a massiffes, located between two various developments is used .

The method of seismic profiling allows to define a situation of external border of a zone of basic pressure and to receive an estimation of dynamic parameters of rocks in the weakened zone and in a massifies. In area 103 galleries on a method seismic profiling the following results are received: for an external part $E^{dyn} = 5,0$ GPa, and for internal - $E^{dyn} = 14,5$ GPa. The depth of border between both structural types varies from 1,5 up to 2,5 m and its contrast changes considerably.

Integrated estimation of parameters of deformation of pillars turns out on a method seismic ring out. At ring out of the not broken part of pillars, located between by galleries 103, 109 and 110 for the dynamic module of elasticity the value E^{dyn} = 31,9 Gpa is received. At ring out barrier pillars, crossed by several cracks filled by clay: if one crack - E^{dyn} = 19,1 GPa, if some cracks, located by a fan, - E^{dyn} = 17,0 GPa.

Poison ratio in a massiffes has rather high values. For a strong massiffes its value is about $\mu = 0.30$, and for broken massiffes as a result of influence the mining works, or tectonics processes $\mu = 0.32 - 0.34$.

The significant interest represents comparison of the received results with deformations parameters of gypsum determined in laboratory conditions with use of drilling samples. For this purpose the significant volumes of test works were carried out. Both static and dynamic method Were used. Deformation parameters were determined at the various strained conditions. Some of the received results are shown in the publication of the authors in 2002.

The similar dependences describing change of deformation parameters of gypsum, determined were established both at static loading, and through measurement of speeds longitudinal V_{ρ} and transversal V_{s} of a wave and at change of

the intense condition, namely: significant increase Poison ratio μ at pressure, making 60-80 % from durability on one-axial compression, and reduction of the module of elasticity at pressure reaching 80-90 % from durability of a material (figure 1).



Figure 1. Dependences between: a) Poison ratio μ and pressure, per limit to compression Rc; b) static module E^{stat} of elasticity and strain σ to limit of compression Rc.

To compare given deformation parameters of gypsum massiffes with received at research of separate samples from boreholes 3473 and 3474, located near to a researched site (crossing between 103 gallery and gallery 205) the in addition experimental works in laboratory conditions for definition of the module of elasticity and Poison ratio by speeds of elastic waves in samples and static method were carried out, at pressure close to expected in a massiffes. Average results of experimental researches in laboratory and miner conditions are shown in the table 1.

Table 1. Average values of the module of elasticity E and Poison ratio μ for samples of gypsum and gypsum massif's

	V _p m/s	V₅ m/s	μ	E ^{dyn} GPa	E ^{stat} GPa	V_p^{mass}	Ai
						V_p^{lab}	
Samples	3100	1660	0.30	21.6	20.0	-	
massiffes (interior)	2950	1570	0.31	14.5		0.95	0.90
massiffes (periphery)	1850	910	0.34	5.0		0.60	0.36

The given results show, that dynamic module of elasticity of a gypsum massiffes is less what characterizes samples, it is more essential in the broken zone (peripheral part). Thus, on change E^{dyn} it is possible to estimate coming changes in a

condition of a massiffes and first of all processes of infringement of its solidity. For a quantitative estimation of a degree of cracks of a massiffes an acoustic parameter of cracks, A_i (Турчанинов И.А etc. 1989) often is used.

$$\mathbf{A}_{i} = \left(\frac{V_{p}^{mass}}{V_{p}^{lab}}\right)^{2},\tag{1}$$

Where: V_p^{mass} is a speed of a longitudinal wave in a massiffes,

 V_{p}^{lab} - is a speed of a wave in a sample measured in laboratory conditions.

The values of this parameter for a concrete case are given in the table 1. With the help A_i factor of structural easing of rocks in a massifies is defined also.

The substantial growth of Poison ratio and reduction of the module of elasticity at the certain values of strain established in laboratory conditions (a figure 1), in determined of a degree is ascertained and at definition of these parameters in a massiffes. And their essential change is connected to course of separate stages of process of destruction.

The opportunities of operative use of acoustic methods for definition of a condition of various volumes in amassiffes are illustrated by results received at research of separate parts is whole, located between the chamber 44/1 and gallery 194. The chambers are filled with sand. On the part of panel gallery in pillar the niche is made out. The acting parts of pillar have the sizes 3.8 m and 10.5 m. The smaller part of pillar is located on the part of the chamber 44/1 is strongly destroyed. For measurements four items of excitation of elastic waves are used and four items of reception (pulse generated in each of items of excitation are accepted in each of items of reception) three - dimensional by a geobackground made of devices "CB-30". In the tables 2, 3 and 4 the results ring out of these parts and seismic profiling of pillar from the party Gal. 194 (figure 2) are given.

Table 2. Results of definition of dynamic parameters of gypsum in pillar, located between chambers 45/1 and 46/1.

Parameters	V _₽ [m/s]	V₅ [m/s]	μ	E ^{dyn} [Gpa]
Average value	1910	939	0.335	5.3
Deviation	481	221	0.037	2.5
Range of change	1120- 2580	610-1220	0.28- 0.37	1.9-8.7

Table 3. Results of definition of dynamic parameters of gypsum in massiffes between the chamber by 45/1 and panel gallery 1.

Parameters	V _p [m/s]	V₅ [m/s]	μ	E ^{dyn} [Gpa]
Average value	2495	1172	0.330	9,0
Deviation	576	435	0.063	4,7
Range of change	1660-4150	870-1480	0.23-0.40	4,2-16,1

ANNUAL of University of Mining and Geology "St. Ivan Rilski", vol. 46 (2003), part II, MINING AND MINERAL PROCESSING



Figure 2. Scheme of a researched site.

Table 4. Average values of dynamic parameters of gypsum determined seismic profiling of pillar along gallery 194.

Parameters	Vp [m/s]	Vs [m/s]	μ	E ^{dyn} [Gpa]
Walls	2164	998	0.360	6,0
Internal part	2735	1327	0.335	11,0

The results of researches show that the processes of destructions in between chamber pillars are shown more intensively on the part of panel galleries, and the central parts remain are more saved. Presence it is enough large (width 10 m), monolithic pillars not broken by miner works protects from destruction of crossings between galleries.

The impression makes a significant range of changes of speeds of elastic waves received at measurements. It is possible to explain it by the fact, that ring out are spent in various directions, in which directions of property and the condition of a massiffes differ essentially. It testifies to high sensitivity of a method and assumes its use for detailed research of structural features of a massiffes about miner developments.

From the given data it is visible, that between results received in laboratory conditions and at direct research in mining conditions the essential distinctions are observed. For understanding and practical use of this fact follow to pay attention to physics of interaction and condition of measurements. The elastic waves cooperate with commensurable with their lengths not by uniformity. Seismic of a wave cooperate with macrodefects of environment - layers different litology of structure, borders between them, tectonic cracks and zones of basic pressure, while ultrasound waves cooperate with mezo and micro not uniformity, commensurable on the sizes with the sizes of crystals, microcracks and zones of the raised permeability. The distinctions in structural levels of interaction define various mechanisms of transfer elastic energy and absorption by its environment. Therefore it is necessary to pick up conditions of similarity - scale factors between lengths of waves, sizes not uniformity base of measurements and thermodynamic interactions.

One of features of registered speeds of elastic waves and deformation of parameters, in particular of module of elasticity, is their basic nonlinearity and natural variability with removal from walls of development.

In a vertical direction of value of modules is described monotonous exponental by a curve and dispersion of parameters it is possible to explain by change of material structure. In horizontal chinks of curve spatial distribution essentially more complex, similar on sinusoid. The characteristic maximum of modules of elasticity determined as with the help static is observed, and dynamic methods, after which the local minimum and following increase to an interior целика follows. The generalized curves of the module of elasticity are shown on a figure 3 a, b.



It is possible to explain this distribution of parameters of deformation by representations zonal disintegration of rocks about mining developments (Шемякин Е.И and др, 1986).

Zonal disintegration is obliged to formation of compression, alternating by zones, and stretching caused by character of a wave of deformation. This implies, that in various zones of value of an intermediate main pressure σ_2 will change not linearly and not monotonously. Same concerns and to distribution of parameter Nadai-Lode, intense condition, determining a kind, and mechanism of destruction.

The analysis of distribution of deformation parameters in pillar shows, that the maximal destructions in pillars are shown at $\sigma_3 = 0$, in the field of the generalized shift, and the zone of fragile destruction is formed in depth of a massiffe, practically simultaneously in several consecutive zones, with decreasing intensity. The research of these processes is especially important in conditions of the greater intensity of production or transition to use of system with minimization of volume of filling.

CONCLUSIONS

1. The seismic and acoustic methods can be used for operative definition of deformation parameters of rocks in massiffes, which differ from parameters measured in samples, in laboratory conditions, in the various degrees dependent on strained and deformed condition of a researched massiffes.

2. The continuous measurements of changes in deformation of parameters of a rocky massiffes provide the information about development of processes of deformation and destruction.

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