Annual of the University of Mining and Geology "St.Ivan Rilski"
vol. 44-45, part II, Mining and Mineral Processing, Sofia, 2002, pp. 37-39

CHANGE OF PARAMETERS OF ROCK DEFORMATION IN GIPSUM MINE "KOSHAVA" DEPENDING ON THEIR STRAINED STATE

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ABSTRACT
The results of experimental laboratory researches for definition of some parameters of deformation (modulus of elasticity and Poisson's Ratio) of gypsum raw materials from "Koshava" deposit are adduced. Parameters have been measured when appearing different values of stress in trial samples put on monoaxial impact. The same results have been received about changes of these parameters depending on values of stress when using static and dynamic methods. These dependences can be used for efficient definition of rock massif strained state around mine workings and pillars with help of seismic and acoustic methods.

Improvement of system for exploitation and technology of underground mining is connected with prognostication of rock massif state when changing of some parameters of applying systems or their perfected variants.

Except this for guaranteeing of safety during working it is necessary to receive information about strained and deformated state of rock massif around mine workings.

For receiving fast and constant information about state of rock massif large volumes different physical method are used. Especially successful is application of acoustic methods. They are based on the fact that parameters of elastic wave spreading in rock medium change when changing medium strained state. Important characteristics defining passing waves trough given rock are the velocities of their spreading. They depend to great degree on parameters of medium deformation. Thus, in order to judge about strained state of massif it is necessary to determine changes of these rock parameters depending of stress. For the purpose experimental laboratorial researches has been made. The main results of researches are adduced in this work.

Subject of researches is gypsum raw material from "Koshava" mine. The necessity of solving a number geomechanical tasks have appeared when working this mine.

It is exploited by the chamber and pillar system. The most using are band pillars, which length is 100 m, width is 17.5 m, height is 15 m and square pillars with section 20 x 20 m. Removed spaces are filled up by sand. This raise the coast price of raw material. Physical and mechanical properties of gypsum are studied by a number of authors but in spite of practical needs purposeful researches for determination of strained state influence upon the mechanical parameters using physical methods haven't been made.

In laboratorial conditions modulus of elasticity and Poisson's ratio have been determined. For this purpose cylindrical samples have been loaded with impact force P. Four indicators of clock type for measuring of longitudinal deformation and also four of such indicators for measuring transversal deformation have been fastening with the help of special device. Samples have been loaded by stepped way. Load has been increased until utter destruction of samples. Indicator readings have been averaged and relative longitudinal deformation $\varepsilon^{\uparrow} = \Delta l_{av} / l$ has been calculated by average Δl_{av} of base of measurement change. By average Δd_{av} of diameter d change relative transversal deformation $\varepsilon^{\rightarrow} = \Delta d_{av}/d$ has been calculated. After calculation of impact strain a static modulus of elasticity has been calculated as $\sigma/\varepsilon^{\uparrow}$ and μ ratio as $\varepsilon^{\rightarrow}/\varepsilon^{\uparrow}$. The strength of monoaxial impact Rc (σ_H) has been determined by value of destroying force P. Parameters of deformation are determined by ratio: strain/strength of monoaxial impact. Generalized diagram expressing typical dependence between this ratio and deformation (longitudinal and transversal) in the widest spread variety fine-crystalline gypsum with mediofoliated texture is shown on figure 1.

Independently of the fact that studied samples have been taken from different drills and are different to a certain extent in their structure, a number of common appropriateness's can be determined. Curvilinear part is observed at the beginning of diagram (picture 1). Further function becomes practically linear up to value of strain that is 80%-90% of strain impact. Experimental ratio strain / transversal deformation also has linear part but it is shorter. When value of strain reaches 60%-80% of destroying strain, the sharp growth of this deformation is observed – function becomes curvilinear. Ratio of transversal deformation $\mu = \varepsilon^{\rightarrow}/\varepsilon^{\uparrow}$ in linear parts of both dependences is constant, which corresponds to Poisson's ratio. Sharp growth of $\varepsilon^{\rightarrow}$ when strain is (0,6-0,8)Rc causes quick growth of transversal deformation ratio and it reaches values greater than 0,5. This is confirms by other investigators e.g. (Baklashov, I. V., 1988).

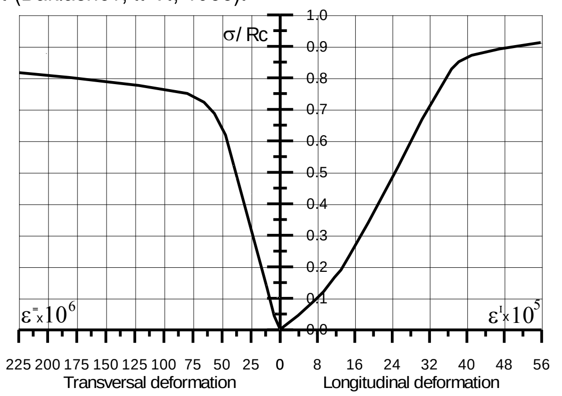
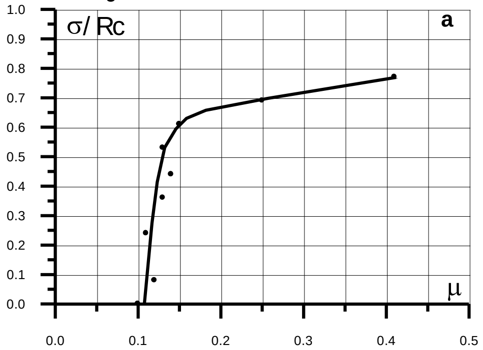


Figure 1. Dependence between ratio strain σ to strength monoaxial impact Rc – longitudinal $\varepsilon^{\uparrow}=\Delta l/l$ and transversal $\varepsilon^{\rightarrow}=\Delta d/d$ deformation

The character of received dependences strain/deformation gives possibility to judge about processes proceeding in samples. Primary curvilinear part of diagram of $\sigma(\varepsilon^{\uparrow})$ is conditioned by consolidation of sample as the result of micro fractures and pores closing. Linear parts of both diagrams characterize elastic pressing of mineral skeleton of rock medium. It is interesting to mention that almost right lines in dependences $\sigma(\varepsilon^{\uparrow})$ are approximately parallel, when loading and unloading accomplishes by stepped way. This mean that modulus of elasticity, which depends on quantity of reversible deformations, is close to modulus of deformation which depends on total deformation, and this correlation keeps up to great values of strain. Fast growth of transversal deformation when strain is 60% - 80% of destroying one can be explained by formation and solution of vertical microfractures which are parallel to acting load, since the dependence $\sigma(\varepsilon^{\uparrow})$ remains linear. Process of microfractural formation up to certain strain values to some extent is reversible, that is fractures close after external force stops acting. This is determined after unloading of sample. Presence of considerable remanent deformation is evidence of the fact that closing is not complete. Further growth of strain up to values that are 80% - 90% of strength when dependence $\sigma(\varepsilon^{\uparrow})$ also deviate from linear, loads to process of swift formation of fractures. These values of strain can be taken for long-term strength of strain. If value of strain is bigger than this, then destruction begins. Quickness of destruction is proportional to increase of the strain.

Changes of Poisson's ratio and modulus of elasticity depending on increase of strain (which is to destroying strain) is shown on the figure 2.



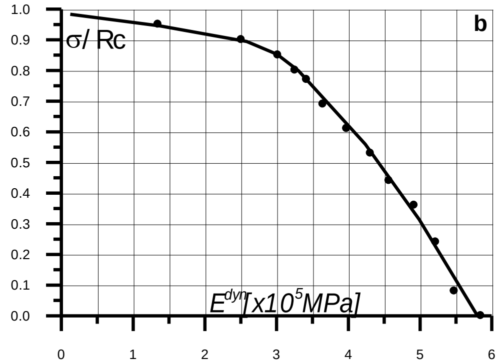


Figure 2. Dependence between a) Poisson's ratio and ratio strain/strength of monoaxial impact; b) static modulus of elasticity and ratio – strain/ strength of monoaxial impact.

Experimental determination of parameter of deformation of gypsum samples has been made with the help of dynamic method. For this purpose the velocity of elastic waves spreading has been measured when loading samples. Generalized results receivied during ultra-sonic research of samples are shown on figure 3.

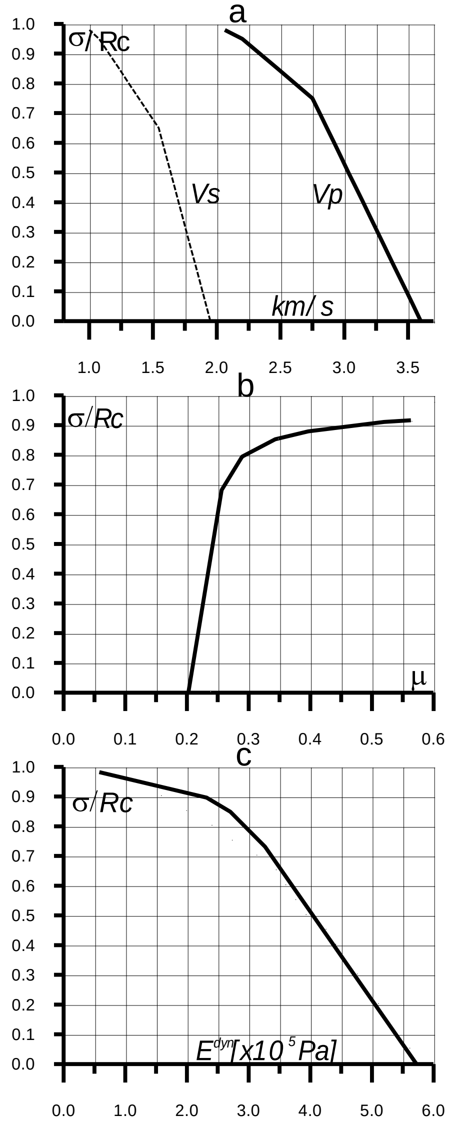


Figure 3. Dependences between ratio strain/strength of monoaxial impact and a) velocity of longitudinal (V_P) and transversal (V_S) waves; b- Poisson's ratio (μ); c- dynamic modulus of elasticity (E^{dyn}).

On adduced diagrams it could be seen that character of change of dynamic elastic characteristics that are determined by measuring of velocities of elastic waves is the same as that for static elastic modules and ratios that are determined by mechanical test of samples, to wit: there are considerable increasing of Poisson's ratio when strain is (0,6-0,8)Rc and decreasing of dynamic modulus of elasticity E^{dyn} when strain is (0.8-0.9)Rc.

The conclusion can be made that you can judge about change of strain state of rock massif (e. g. in pillar) by change of velocities of elastic waves and also by change of modulus of elasticity and Poisson's ratio, which have been measured using these velocities.

These open wide possibilities for constant periodic control of strain state of massif by seismic and acoustic methods.
It is very favorably in this case that accumulated potential power in the loading volume is released gradually. That is why it is possible to measure deformations when strain in rock massif approximate to destroying strain.

The undesirable processes in rock massif (formation of fractures, first stage of destruction) can be established when strain in rock massif is considerably less than destroying strain. This gives possibility to take measures for safe working in mine. When destroying samples frequent of waves is changed. These changes are the same that where described by R. Goodman, 1080.

Researches that have been carried out in laboratorial conditions give possibility to make conclusions that seismic and acoustic methods can be used successfully for division of pillars in two classes by degree of loading accordingly smaller and larger that conventional level 0.7Rc. Using measuring values of Poisson's ratio directly in massif can make this division.

For caring out researches of pillar's state mine "Koshava" is provided with specialized three- canal seismic station, set of geophones for registration of longitudinal and transversal waves and also with method of measuring. It is necessary to work out technological software, which gives possibility to receive space distribution of strain in massif automatically, and which doesn't demand special knowledge and skills from operator.

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