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THE IDENTIFICATION OF THE DYNAMIC MODEL IN THE MINING PRESSURE REGIME IN ORDER TO ASSURE THE STABILITY OF THE UNDERGROUND MINING CONSTRUCTIONS

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Abstract: The paper presents some theoretical considerations regarding the evaluation of the underground mining constructions' stability and practical aspects about identifying experimentally the dynamic regime of the pressure. The identification represents an experimental technique to determinate the dynamic models of the process, an important stage in designing and implementing an elastic performing supporting

Keywords: identifying, dynamic, mining pressure, stability, underground construction.

1. INTRODUCTION

The restructuring process aiming to make the economic activity more efficient has marked the mining reform.

In the future the coal mining will function in certain competitively conditions, reducing the production costs. The costs can be reduced mainly by reducing the costs of the supporting in mining constructions and also by improving their parameters.

The improvement of the actual supporting parameters and the designing of new supporting models relies on a deep knowledge about the working conditions, able to create an interdependence between the forms of the mining pressure and the stability of the rock massive and the supporting parameters.

The complexity of the phenomenon during the interaction process between rock-supporting system, determined by the great number of parameters, does not allow the complete description of the systems, their modeling using evaluation models. Thus, for most of the practical situations, parametrical models have to be accepted, a direct identification of the models being necessary.

Such interdependence claims knowledge about the geomechanic conditions of the underground constructions. The accuracy of designing and optimizing the supporting parameters depends on the interaction model between the rock massive and the supporting system.

The dynamic models of the processes describing the relations between the command variations (depth of the mining work, its shape) and the output variations (rock pressure, rocks displacement around the contour of the mining work), also taking in account the numerous perturbations (physical-mechanical characteristics of the rocks), [1] [2].

2. THEORETIC CONSIDERATIONS ABOUT EVALUATING THE STABILITY OF THE UNDERGROUND MINING CONSTRUCTIONS

In order to analyze the geomechanic conditions of the rocks in the Jiu Valley, some parameters evaluating the stability of the mining constructions have been considered.

The geomechanic conditions regarding the position of the underground mining constructions have been included in a general geomechanic classification; this classification has a practical value when choosing the interaction models and the prognosis of the mining pressure regime.

The geomechanic classification regarding the conditions the position of the mining constructions is shown in Table no. 1.

3. DATA ACHIEVEMENT AND IDENTIFICATION OF THE PROCESS

In order to determine the pressure regime, an underground mining construction with an opening of 5 m, situated at 900 m deep from the surface, placed in argillaceous gritstones, has been chosen After the measurements and the laboratory studies the result show a medium stability of these rocks.

Two stations measuring the mining pressure have been placed in this mining construction. The first one functioned according to the dynamometric principle and the second one to the hydraulic principle.

Table no. 1

Duration from The beginning of supporting [days]	Dynamometric station		Hydraulic Station
	P [MPa]	U [mm]	P[MPa]
0	0	0	0
1	0.42	1.9	0.29
2	0.484	4	0.5
5	0.675	10	0.59
6	0.8917	16.2	0.852
7	0.917	16.3	0.907
8	1.0191	20.2	1.0
9	1.1592	25	1.125
12	1.9108	49.3	1.734
16	1.9745	50.8	1.859
20	2.0509	52.8	2.011
23	2.2292	60.3	2.1947
27	2.484	66.2	2.3594
30	2.5477	68.1	2.362
34	2.5477	68.1	2.394
40	2.5477	68.1	2.4115

Stability criteria									Compressive Strength [MPa]	Strength of long time σ_{lld} [MPa]	Rocks stability
n	i	m [m]	U [mm]	S	t [hours]	RQD [%]	RMR	Q			
0.7-1	< 0.2	> 3	0	> 70	∞	90-100	81 – 100	> 40	> 200	> $0.9\sigma_{re}$	Very stable
0.4-0.7	0.2-0.25	1-3	0 – 50	5-70	5000	75-90	61 – 80	10 – 40	100 – 200	$(0.85..0.89)\sigma_{re}$	Stable
0.3-0.4	0.25-0.3	0.5-1	50 – 200	1 - 5	360	50-75	41 – 60	4—10	50 – 100	$(0.8...0.85)\sigma_{re}$	Medium stability
0.2-0.3	0.3-0.6	0.3-0.5	200-500	0.05 – 1	24	25-50	21 – 40	1 – 4	25 – 100	$(0.75..0.8)\sigma_{re}$	Unstable
< 0.2	0.6-1	< 0.3	>500	< 0.05	12	< 25	< 20	< 1	< 25	$(0.5..0.75)\sigma_{re}$	Very unstable

Table no.2

Figure No. 1

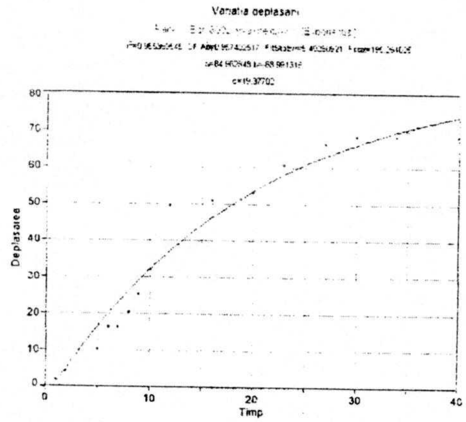


Figure No. 2

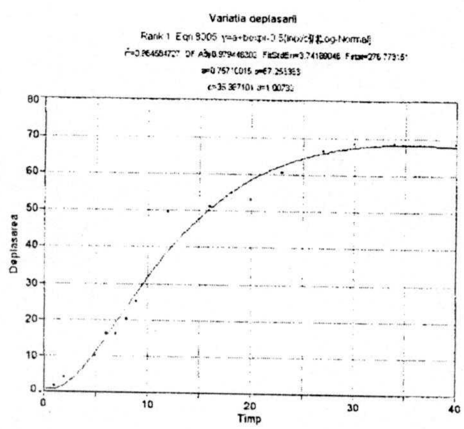
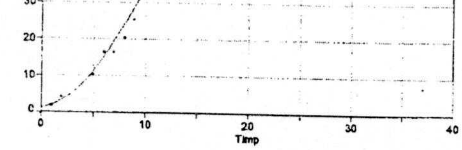


Figure no. 3



The variation pattern of the mining pressure depending on time is shown in Table no. 2

Besides the values of the mining pressure in the dynamometric measuring stations it also has been measured the rocks movement on the contour. The paper presents the processing of the experimental results, the output elements and the simulation of the pressure regime behavior, evaluating analytically the stability of the studied mining work.

Using the results and proper software, diagrams regarding the rock's displacements in time were obtained, as shown in fig. no. 1,2,3. We also established the equations describing the pressure values depending on time and on the rock displacements in the underground mining construction contour.

The equations have been selected from a number of 308 equations, according to the results obtained by computing simulation.

4. PRACTICAL ASPECTS OF IDENTIFYING THE PROCESS

The dependence of the rock's displacements on the contour in time is described by a polynomial function obtained from the computing calculation of the measured data. This function has been selected from a number of 308 equations fitting the best the phenomenon described by the data measurements inserted in table no. 1. Fig. No. 2 shows that the function selected from a number of 40 equations is an exponential one. Fig. No.3 represents a rational function selected from a number of 48 equations.

Taking in account the random character of some perturbations of the dynamic system rock- support making the modeling process very difficult, the solution is obtained by using a numeric computer in order to implement the estimating algorithms of the modeling parameters. Therefore, using the TABLE- CURVE software, a calculation of the statistical indicators associated to the random variable characterizing the evolution of the system has been realized.

All the calculated indicators for the processing of the 308 equations using the polynomial equation are shown in Table no. 3.

Taking in account the presented mathematical models [1] and also the geomechanic characteristics related to the rocks from the Jiu Valley region, a model of the pressure regime has been realized through an experimental identification the model allows the correlation and the correct option regarding the type of support.

5. CONCLUSIONS

Besides knowing the value of rock pressure it is necessary to know the manner of rock displacement on the contour.

Practical measurements have revealed that in the manifestation process of mine pressure regime, several stages can be distinguished in time:

- the first stage corresponds to the period following shortly after the sinking stage when the rock pressure is low; this is followed by the period when rock pressure on the support increases very much, attaining maximum values, comprised between 1.3 and 2.6 MPa.;
- the next stage after a 30 to 45 days' period is characterized by a stabilization of the rock pressure regime;
- after this stage follows one which is determined by the plastic behavior of the hard rocks;

The value of rocks forming around the mine workings depends on the geomechanic and rheologic characteristics of the rocks, the load- bearing capacity and rigidity of supports.

Underground observations have constituted the main investigations means and have been meant to gain knowledge of the singular and cumulative effects of various influence factors and have also referred to the steps that can be taken with a view to increasing the stability and reliability of development workings.

Table No. 3

Rank 1 Eqn 6102
lny=a+bx+cx2+dx3+ex4

r2 Coef Det DF Adj r2 Fit Std Err
F-value
0.9868581439 0.9808845729
3.5958506768 225.27825662

Parm Value Std Error t-value
95% Confidence Limits
a 0.129912104 0.004996439
26.00093763 0.119007751 0.140816457
b 0.610034650 0.023358332
26.11636167 0.559056846 0.661012453
c -0.03555244 0.002889472 -
12.3041320 -0.04185850 -0.02924639
d 0.000917421 0.000111456
8.231199968 0.000674175 0.001160666
e -8.6528e-06 1.35569e-06 -
6.38257986 -1.1611e-05 -5.6941e-06

Area Xmin-Xmax Area Precision
1948.0996108 1.128172e-12

Function min X-Value Function
max X-Value
1.1387282890 1.29967e-10
72.630156762 36.303734730
1st Deriv min X-Value 1st Deriv
max X-Value
-3.078765310 40.000000000
4.8015145194 8.7326025232
2nd Deriv min X-Value 2nd Deriv
max X-Value
-1.009725761 40.000000000
0.6608758105 3.8027287810Soln
Vector Covar Matrix SVD Cond
SVDecomp SVDecomp
9.977188e+14

r2 Coef Det DF Adj r2 Fit Std Err
0.9868581439 0.9808845729
3.5958506768

Source	Sum of Squares	DF	Mean Square	F
Regr	11651.519	4	2912.8799	225.278
Error	155.16171	12	12.930142	
Total	11806.681	16		

X Variable: Time

Xmin: 0.0000000000 Xmax: 40.000000000 Xrange: 40.000000000

Xmean: 14.117647059 Xstd: 12.712603751 Xmedian: 9.0000000000

X@Ymin: 0.0000000000 X@Ymax: 30.000000000 X@Yrange: 30.000000000

Y Variable: Displacement

Ymin: 0.0000000000 Ymax: 68.100000000 Yrange: 68.100000000

Ymean: 33.958823529 Ystd: 27.164638292 Ymedian: 25.000000000

Y@Xmin: 0.0000000000 Y@Xmax: 68.100000000 Y@Xrange: 68.1000000

6. EXPLANATORY

- The mining pressure represents the total amount of the actions generated by the redistribution of the natural tension regime in the rock massif containing a mining work, actions producing displacements and deformations in rocks and supporting system.
- Pressure state is a consequence of the action of the gravity, tectonic, residual, water forces in time.
- The behavior of the underground mining constructions and the mining works stability depends on the geological-mining conditions, on the geomechanical rock characteristics, with the interaction between the rock massive-supporting system as an effect.
- The stability evaluation criteria have an analytical expression appreciating the degree of the rocks 'stability depending on various parameters: physic-mechanical characteristics, fissuration grade, the depth of the massif rock and so on.
- The mining supporting represents a system designed to assure the stability of the underground constructions.
- The mining supporting takes over the rocks' pressure state aiming to assure the stability of the mining work.

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