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STABILITY ANALYSIS OF SECURITY PILLARS WITH DIMENSION 10 × 10 m FROMED BY ORE OF MINERAL BODY DURING THE EXPLOITATION OF THE "TREPÇA" MINE IN STANTËRG

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Abstract: The "Trepça" mine in Stanterg consists from several mineral bodies, which if compared to the mineral bodies in the North and South part of mine can be found in different size. Their size in the horizontal plane ranges from 300–7000 m^2 and as a matter of fact in the primary exploitation phase, only about two of thirds part of ore is used, while the remaining ore is used like pillars in the secondary stage with special methods. Since the beginning of exploitation at "Trepça" mine landfill, the security pillars are left in dimensions 10 × 10 m, on the schedule of chess fields, at distances from 16 to 20 m and all pillars at those distances are stable and over-dimensioned. In this paper we investigate the stability of the securing pillars with dimensions 10 × 10 m, with surface $S = a * b = 10 * 10 = 100$ m^2 with a distance between them of 10 to 22 m. Pillar stability analysis aims to increase the safety factor along with the increase of exploitation depth.

Keywords: *mines, exploitation, pillars, security*

1. INTRODUCTION

"Trepça" mine in Stanterg has the form of an asymmetric anticline which is plunged into the North-South. At the nucleus of the anticline we have the penetration of the

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andesite followed by shredded and excrucible horns. In the geological structure of "Trepça", volcanogenic members and sediments are embedded (integrated) that provide an important controlling factor for economic mineralization of interest to search. Depending on the metasomatic processes in limestone, mineral bodies appear in these contacts:

- In contact between the bark-lime and
- Between limestone and limestone in limestone.

2. GEOLOGICAL CONSTRUCTION OF ORE SOURCE

Polymetallic mineralistaions of lead–zinc in Kosovo are concentrated in the North--East and South-East area of the country. This site (ore source) is interpreted in different ways and by many authors it is ascertained that it belongs to Paleozoic era and corresponds to the "Veles series" (Zeqiri 2012). In the "Trepça" mining series, we distinguish three types of rocks: glittering rocks, Lime-dolomite and green shrub formations. In horizontal cut plane, the ore landfill has the shape of an extended horseshoe, which with increase of depth branch out while ore body branch increasingly (Fig. 1a).

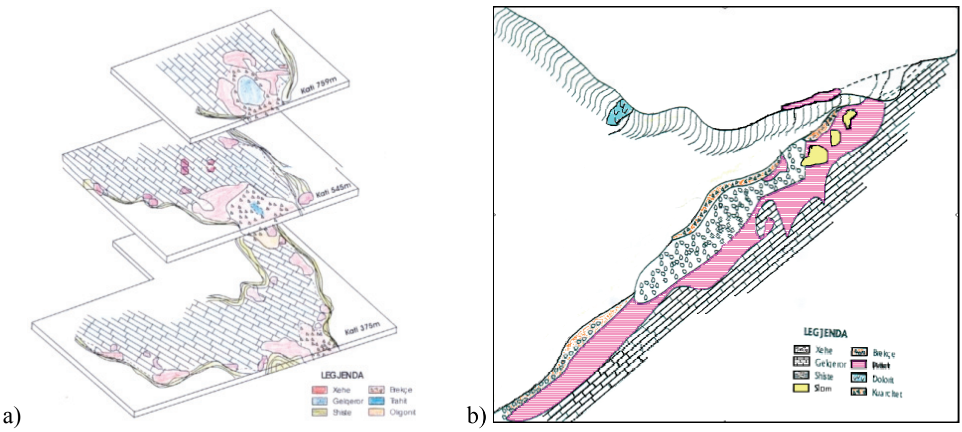


Fig. 1. a) Presentation of the mineral body in levels, b) Landfill Position

These ore bodies are in contact with: limestone-sold; limestone-limestone and its limestone, the limestone boundary which consist shields of the ore is quite clear, whereas the limestone floor it's unclear and irregular (Fig. 1b).

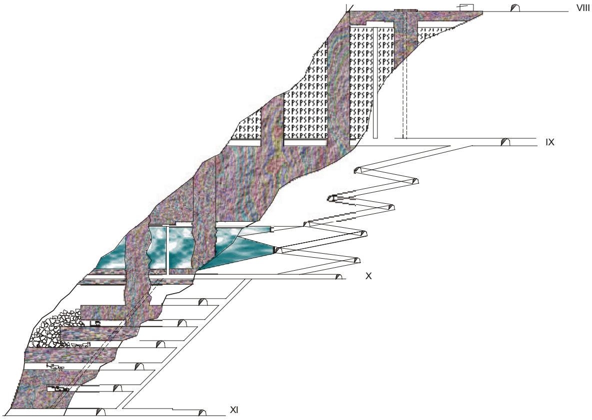


Fig. 2. The exploitation method in “Trepçës” mine

Use methods of “trepça” mine

Historically, the exploitation of the ore in the Stanterg mine has been conducted with several methods of exploitation that are based on cutting horizontal fevers of the ore bodies with filling of created spaces (Zeqiri 2004; 2008).

These methods are:

1. The exploitation system with horizontal slicing from bottom to top with dry filling;
2. The exploitation system with storage utilization;
3. Frontal method of leaving spaces without filling;
4. Horizontal slicing system with hydro filling.

The exploitation method in “Trepça” mine is shown in Fig. 2.

3. APPLICATION OF ELASTICITY THEORY ON APPLICATION OF FINITE ELEMENT METHOD

The presentation of the basic equations of elasticity theory in matrix form has great importance in the theoretical presentation of finite elements method and at the same time help to clarify the problems that are being considered by this method. Figure 3 shows the *D* area bounded by the contour *S*. In the S_σ part by forces are given the contour conditions, while in the S_u part the contour conditions according to the displacements. In the body, like outer force acts surface force *P*, in the contour part S_σ, and volume force *F* in *D* zone.

The surface forces components P_x, P_y, P_z in the directions *x*, *y*, *z* appear as components of the vector *P*.

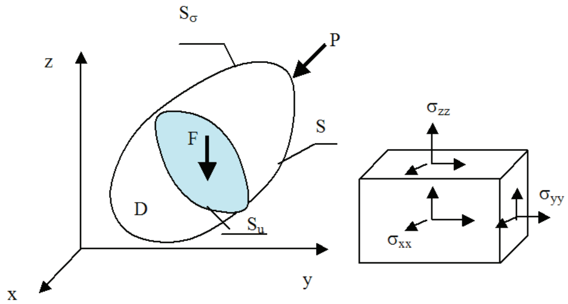


Fig. 3. The contour area according forces

4. DEFORMATIONS METHOD

In Figure 4 is shown the domain *D* of an elastic continuum, which is bounded with contour *S*, so that in the contour part S_σ are given the contour conditions by forces, and in S_u part are given the contour conditions according to the displacements. In part *D*, act volume forces F (F_x, F_y, F_z), and in the contour S_σ surface forces p (p_x, p_y, p_z).

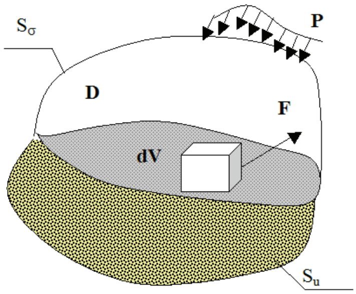


Fig. 4. Elastic contour domain

For displacements **u** in *D* zone they are assumed to be uninterrupted function of the coordinates (x, y, z), $u = u\ (x, y, z)$, $v = v(x, y, z)$ and $w = u(x, y, z)$.

When the problem is formulated according to the displacements, respectively according to the deformations method, the task of elasticity theory consists in assigning displacement functions that meet the equilibrium conditions and conditions in the contour, (Hughes, 2001).

The reviewed domain *D*, is divided into a number of finite elements, which are linked to a certain number of points which are called nodes (Fig. 5).

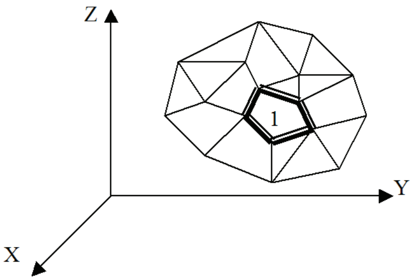
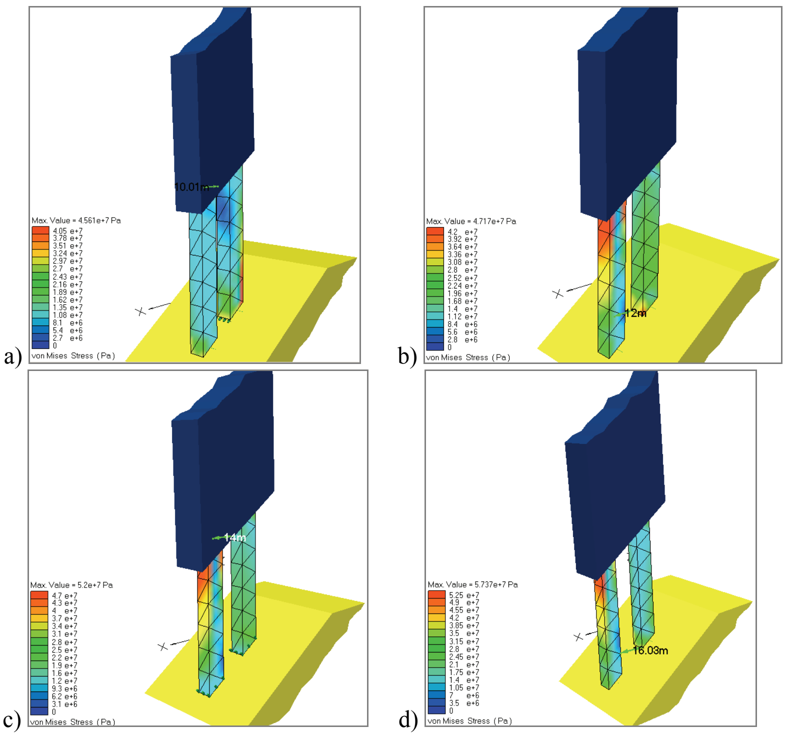


Fig. 5. Reviewed Domain

5. APPLICATION OF THE NASTRAN SOFTWARE ON MODELING OF SECURITY PILLARS AND LOADING SURFACE

The stability of the security pillars with dimensions 10 × 10 m is analyzed through the safety factors for the distance between the columns, 10, 12, 14, 16, 18, 20 and 22 m (Zeqiri 2004; 2008; Zeqiri 2012). Pillar stability analysis has been carried out to evaluate strains directly on the pillar in function of their distance and depth.



e) f)

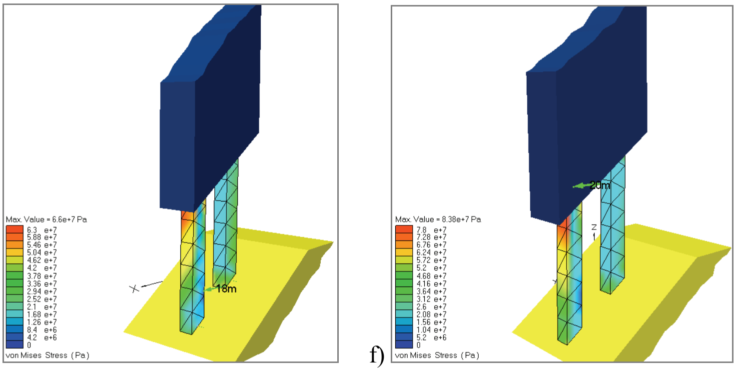


Fig. 6. a)–f) Security pillars 10 × 10 m loaded with weight in the ceiling part

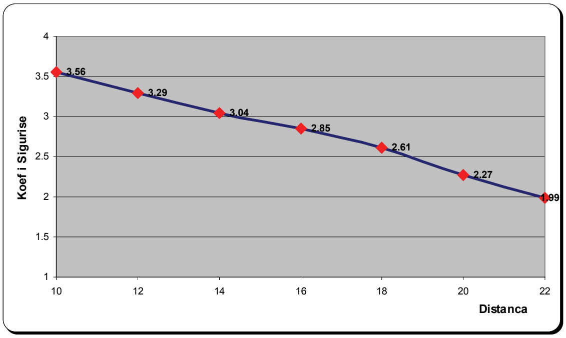
After the strain analysis in the pillars body, in below table is present the safety factor for each pillar depending on the distance between them (Tables 1 and 2).

Table 1. Safety factors for pillars 10 × 10 m in distances 10, 12, 14, 16, 18, 20, 22 m

Distance [m]		10	12	14	16	18	20	22
Volumetric weight	γ	37000	37000	37000	37000	37000	37000	37000
Specific weight	ρ	3771.66	3771.66	3771.66	3771.66	3771.66	3771.66	3771.66
Volume of measures above	V	62040	77200	97000	104600	124100	142000	163800
Volume mass	m	175600000	218500000	240000000	296100000	340000000	403000000	487000000
Pillar surface	A	100	100	100	100	100	100	100
Pillar surface on two pillars	S	800	968	1152	1352	1568	1800	2048
The surface of the mass on one pillar	S_1	400	484	576	676	784	900	1024
Maximal strength	σ_{max}	45610000	47170000	52000000	57370000	66000000	83800000	96000000
Safety factor	$K_{s\,max}$	**3.56**	**3.29**	**3.04**	**2.85**	**2.61**	**2.27**	**1.99**

Table 2. Safety factors gained with finite element method

Distance between pillars [m]	Pillars surface [m^2]	Safety factor calculated with software
10	100	3.56
12	100	3.29
14	100	3.04
16	100	2.85
18	100	2.61
20	100	2.27
22	100	1.99
The average safety factor $K_{s\,mes}$		2.80



Graph 1. Graphic interpretation of safety factors for 10 × 10 m security pillars at distances 10, 12, 14, 16, 18, 20, 22 m

It is important to note that the safety factors in the circumstances of underground exploitation range from 2.0 to 3.56 or more, this happens in conditions where the ore and the associated rocks are with many cracks and collapses, which is not the case at the "Trepça" mine, where limestone and Useful minerals have compactness, with the exception of shale which are found on ceiling part and load the pillar.

6. CONCLUSION

In this paper is analyzed the stability of security pillars with dimensions of 10 × 10 m through the safety factors for 10, 12, 14, 16, 18, 20 and 22 m distance between columns. Pillar stability analysis is carried out using the finite element method according "NASTRAN" software, and the obtained results are reasonable and logical, where safety factors range from 3.56 to 1.99 for the 22 m distance.

Based on the gained values of the safety factors, it can be concluded that with the increase of the distance between the pillars, there are decreases in safety factors, from where we can choose one optimum of pillar size and distance between them.

The further vision would have been the analysis of strain on pillar according their depth function, by measuring the strain directly on pillars. This work has given a modest contribution to the professionalism and science in the circumstances of the underground exploitation of the ore in the "Trepça" mine in Stanterg.

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