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THE EFFECT OF MAGNITUDE OF THE EXPLOSION LOAD ON THE DEFORMATION OF ROCK MASS

Abstract: *The deformed state of the rock mass after the passage of explosive waves of varying intensity through it is considered in the article. The displacement of inner layers and the area of propagation of compressive and tensile forces in the mass are represented as contours.*

Key words: *rock mass, load, explosion, deformation, pressure.*
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Introduction

Blasting operations in geology are used in the exploration of deposits and terrain changes [1-3]. The purpose of blasting is the crushing of rocks during the sinking of mine workings.

The estimated amount of explosive is placed in pre-drilled wells to initiate an explosion. The complexity of blasting operations is mainly determined by the configuration and hardness of rocks, which leads to an increase in the labor intensity of planning blasting operations.

The use of special engineering applications in geology makes it possible to simulate the dynamics of an explosive wave and the degree of rock destruction during blasting operations [4-11]. Three-dimensional modeling of the explosion process in these applications makes it possible to predict with high accuracy the propagation of the explosive wave in the media of rock mass and, thereby, determine the optimal number and location of blast wells.

Materials and methods

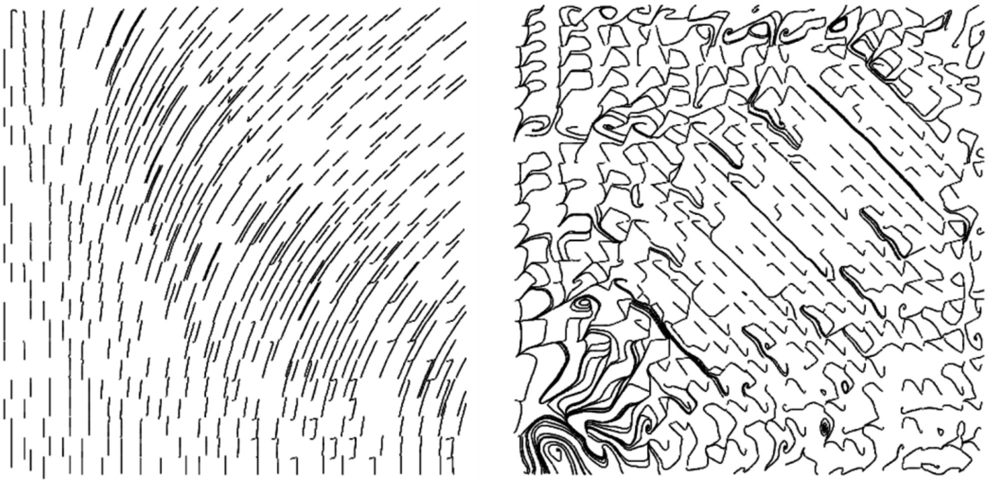
A simulation of the propagation of an explosive wave in a 3,000×3,000×3,000 mm rock mass was performed. The rock mass was an isotropic solid model with the following properties: Young's modulus – 50 GPa, Poisson's ratio – 2/7, density – 2700 kg/m^3. The short-term load on the rock mass caused by the explosion was 500, 1000, 1500, 2320.8, 4641.6, 6962.4, 10772, 21544 and 32317 kN. Depending on the amount of explosive, the loading time ranged from 0.0817 ms to 0.37597 ms at a decay rate of 1.86.

Results and discussion

The simulation results were presented in two-dimensional form. The model of the volume of the rock mass was represented by a plane on which the calculated contours of the rock deformation at the beginning and at the end of the explosion were derived.

The Figure 1 shows the contours of the rock mass deformation at the moment of the explosion and at the end of the estimated explosion time.

At the moment of the explosion, the inner layers of 2/3 of the volume of the rock mass are displaced along the arc trajectory. At the end of the estimated time of the explosion, significant displacements of inner layers of the rock mass are observed throughout the volume. The formation of compacted local zones of layers (thickened layers) along the front of the propagation of the blast wave is noted. At the epicenter of the explosion, there is a significant displacement of inner layers of the rock mass, which causes the rock destruction.



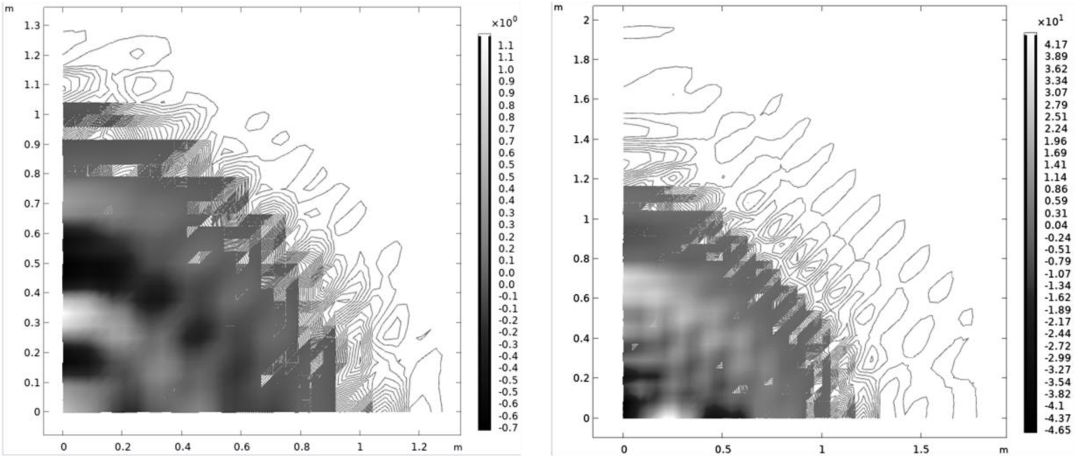
a ***b***

Figure 1. The contours of deformation of the rock mass at the moment of the explosion (*a*) and at the end of the estimated time of the explosion (*b*).

The pressure contours in the rock mass at certain load magnitudes are shown in the Fig. 2.

The calculated pressure magnitudes in inner layers of the rock mass are demonstrated in detail at explosion loads of 500 kN and 32317 kN, for the remaining calculations, the Table 1 shows the maximum pressure magnitudes in inner layers of the rock mass, characterizing the deformation of stretching and compression. The pressure contours in the figure are given in MPa.

Significant pressure in inner layers, with an explosion load of 500 kN, extends over 1.2-1.3 m of the rock mass. At the maximum explosion load, the distribution of loaded layers was observed at 1.7-2.0 m. At the same time, the stretching of layers with a minimum explosive load prevails in magnitude than the compression deformation. At maximum explosive load, the stretching and compression deformations differ slightly in magnitude.



a ***b***

Figure 2. Pressure contours (MPa) in the rock mass at explosion loads of 500 kN (*a*) and 32317 kN (*b*).

Table 1. Calculated pressure magnitudes in inner layers of the rock mass at various magnitudes of the explosion load.

Consecutive number	The magnitude of the explosion load, kN	Maximum pressure magnitude (tensile deformation)	Maximum pressure magnitude (compression deformation)
1	500	1.2	-0.7
2	1000	1.45	-2.38
3	1500	2.18	-3.57
4	2320.8	3.84	-4.89
5	4641.6	7.69	-9.78
6	6962.4	11.5	-14.7
7	10772	14.0	-14.0
8	21544	28.6	-29.5
9	32317	43.8	-46.5

Thus, it can be seen from the summary table that the compression deformation of inner layers of the rock mass is greater in magnitude after the explosion. The exception is a low-power explosion, which leads to a greater degree of the stretching deformation of inner layers of the rock mass.

4. Conclusion

The results of the study can be summarized in the following conclusions:

1. The consequence of the explosion is the displacement of layers of the rock mass over the entire area under consideration, with the formation of compacted local zones along the wave propagation front and significant rock destruction at the epicenter of the explosion.

2. The 500 kN explosion load is accompanied by deformation of the rock mass with a predominance of layer stretching. However, the maximum explosion load of 32317 kN is accompanied to a greater extent by compression deformation of the rock layers.

3. Significant deformation of layers at the maximum load from the explosion is observed in 2/3 of the volume of the rock mass.

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