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CALCULATION OF THE WIDTH OF THE CRACK PROPAGATION ZONE DEPENDING ON THE DRILLING AND BLASTING OPERATIONS IN ORDER TO ENSURE THE STABILITY OF THE QUARRY BOARDS

Scientific leader: ***Khakimova Sabina Zaynitdin kizi***
Navoi State University of Mining and Technology, student
Davronova Gulchehra Jurabek kizi
Navoi State University of Mining and Technology, student
Abruyev Samandar Shodmon ugli
Navoi State University of Mining and Technology, student

Abstract: In this article, the influence of drilling and blasting operations in the field of mining on the stagnation of the quarry board.

Key words: dynamic, tensile strength, crack expansion zone, drill bit diameter, well walls, carbon shale

The width of the crack development zone is recommended to be determined by the formula [1, 2]:

$$r_{\max} = r_c \frac{kP}{\sqrt{\sigma_p}}, \text{ m,} \qquad (1)$$

where $r_{\max}$ is the radius of the fractured zone around the well with one exposed surface, m;

r_c – well radius, m;

k is the dynamism coefficient, k = 2;

P is the maximum pressure on the well walls during the explosion, Pa;

p _ – tensile strength under dynamic loading , Pa (Table 1).

Table 1

Tensile Strength under Dynamic Loading for Rocks of the Muruntau and Kalmakyr Deposits

No.	Rock types	tensile strength under dynamic loading , $\sigma_p \cdot 10^6$, Pa
1.	Carbonaceous-micaceous shales, quartz-micaceous shales with layers of carbonaceous shales	5.5-7.2
2 .	Carbonaceous-mica metasomatically altered schists, siltstones	6.8-7.8

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3 .	Carbonaceous-micaceous shales metasomatically altered to quartzites, carbonaceous siltstones	7.5-9.2
4 .	Quartzites, hornfelses, siltstones, carbonaceous-mica and mica-quartz schists	8.4-10.6

According to [3; With. 181], the diameter of blast holes depends on the physical and mechanical properties of rocks and the height of the ledge and is determined by the formula:

$$d_c = K_r d_\partial \text{, mm,} \qquad (2)$$

where K $_r$ is the expansion coefficient of wells, depending on the properties of rocks and drilling technology (Table 2) [3; With. 182]; d $_d$ – bit diameter, mm.

table 2

Well expansion ratios for roller drilling

No.	Strength coefficient of rocks according to the scale of M.M. Protodyakonov , f	Expansion coefficient, K $_r$
1.	6	1.12
2.	7	1.12
3.	8	1.11
4.	9	1.10
5.	10	1.09
6 .	eleven	1.09
7 .	12	1.09
8 .	13	1.09
9 .	14	1.08
10 .	15	1.08
11 .	16	1.07

Taking into account formula (2), the width of the crack development zone is determined by the formula:

$$r_{\max} = \frac{K_r d_\partial}{2} \frac{kP}{\sqrt{\sigma_p}} \text{, m.} \qquad (3)$$

The magnitude of the pressure on the walls of the well during the explosion can be determined by the formula [4; With. 287-288]:

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$$P=\left(13\frac{Q}{r^3}+3{,}9\frac{Q^{2/3}}{r^2}+0{,}95\frac{Q^{1/3}}{r}\right)\cdot 10^3$$, Pa, (4)

where Q is the mass of the explosive charge in the well, kg; r – distance, m.

Taking into account formula (4), we determine the width of the crack development zone by the formula:

$$r_{\max}=\frac{K_r d_\partial}{2}\,\frac{k\left(13\frac{Q}{r^3}+3{,}9\frac{Q^{2/3}}{r^2}+0{,}95\frac{Q^{1/3}}{r}\right)\cdot 10^3}{\sqrt{\sigma_p}}$$, m. (5)

k is the dynamism coefficient, k = 2;

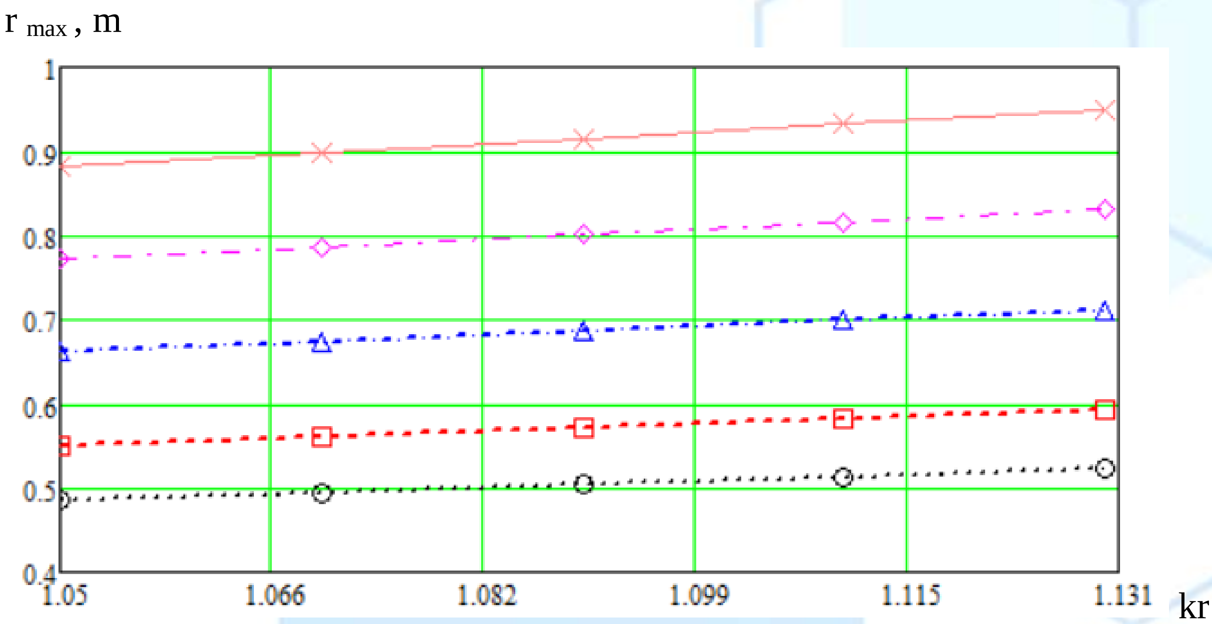
p _ – tensile strength under dynamic loading , 5.5 ÷9.7 10 [6] Pa (Table 1);

K_r – well expansion coefficient, depending on the properties of rocks and drilling technology, 1.1 ÷1.5 (Table 2) [3; With. 182];

d_d - bit diameter, 125 ÷250 mm.

Q is the mass of the explosive charge in the well, 380 ÷480 kg;

r is the distance, 6 ÷12 m;



For different well diameters ○ – d d=110 mm; □ - d d = 125 mm; Δ - d d \u003d 150 mm; ◊ - d d=175 mm; x - d d \u003d 200 mm;

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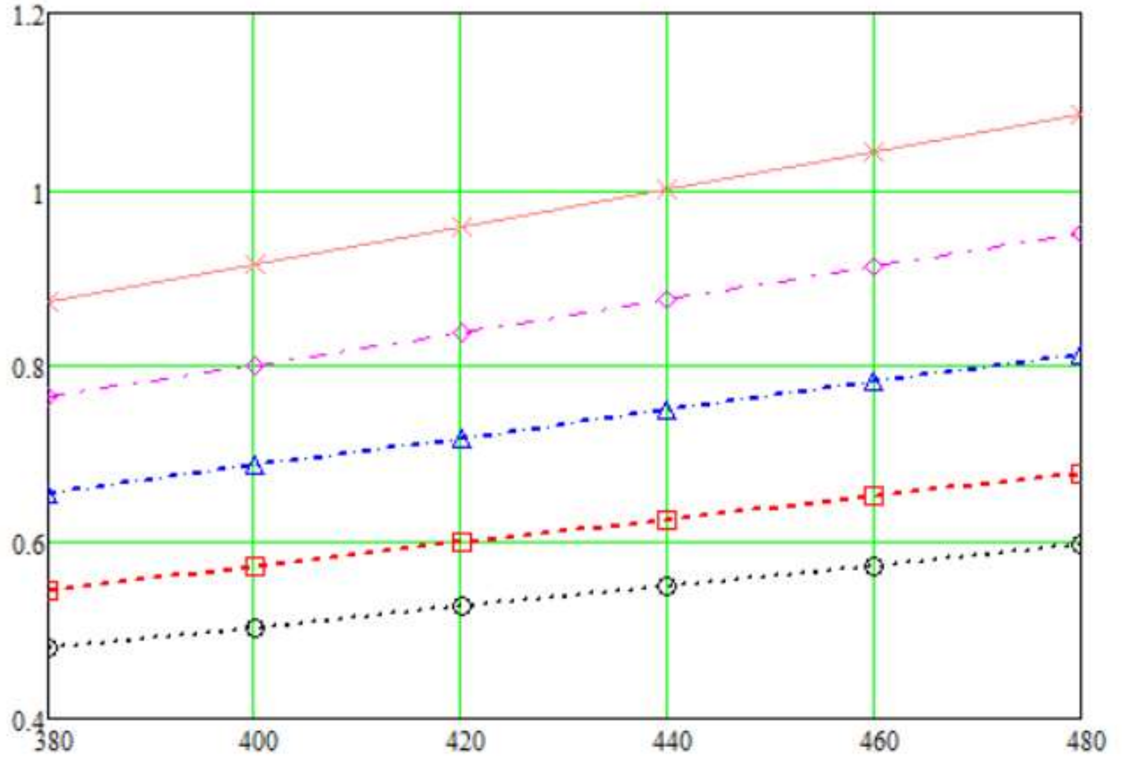
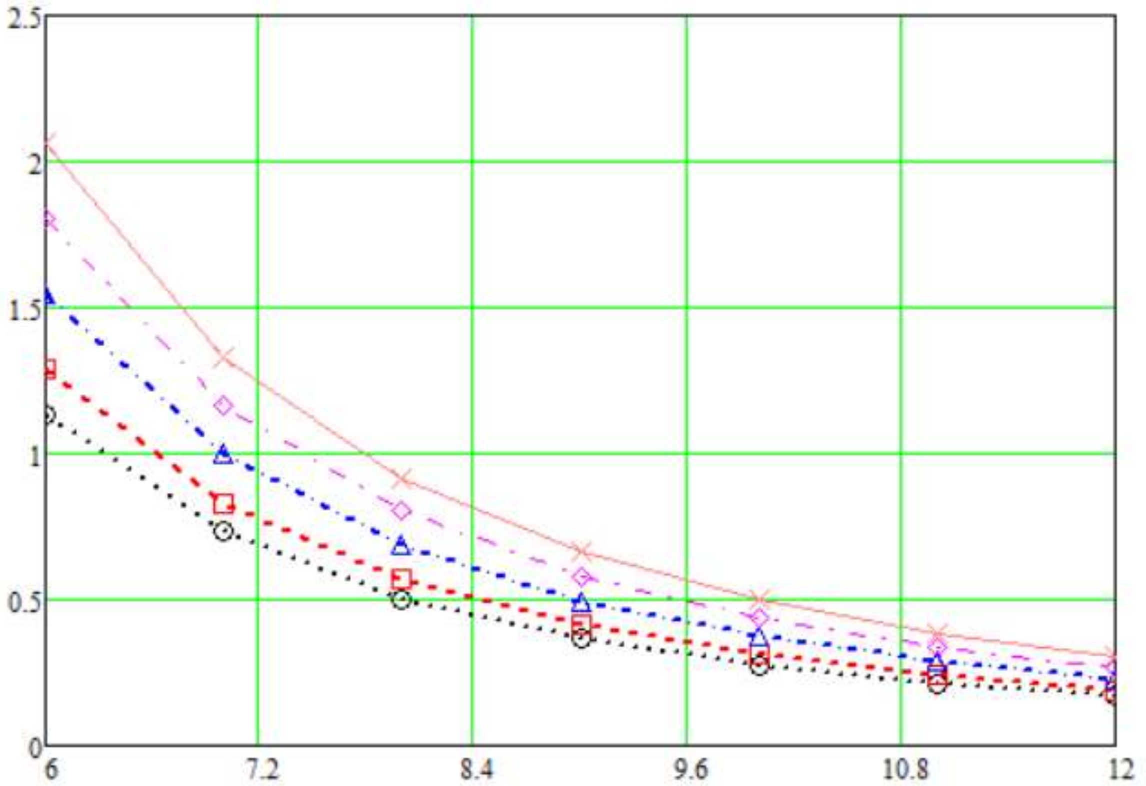


Q ,

kg

For different well diameters ○ – d d=110 mm; □ - d d = 125 mm; Δ - d d \u003d 150 mm; ◊ - d d=175 mm; x - d d \u003d 200 mm;

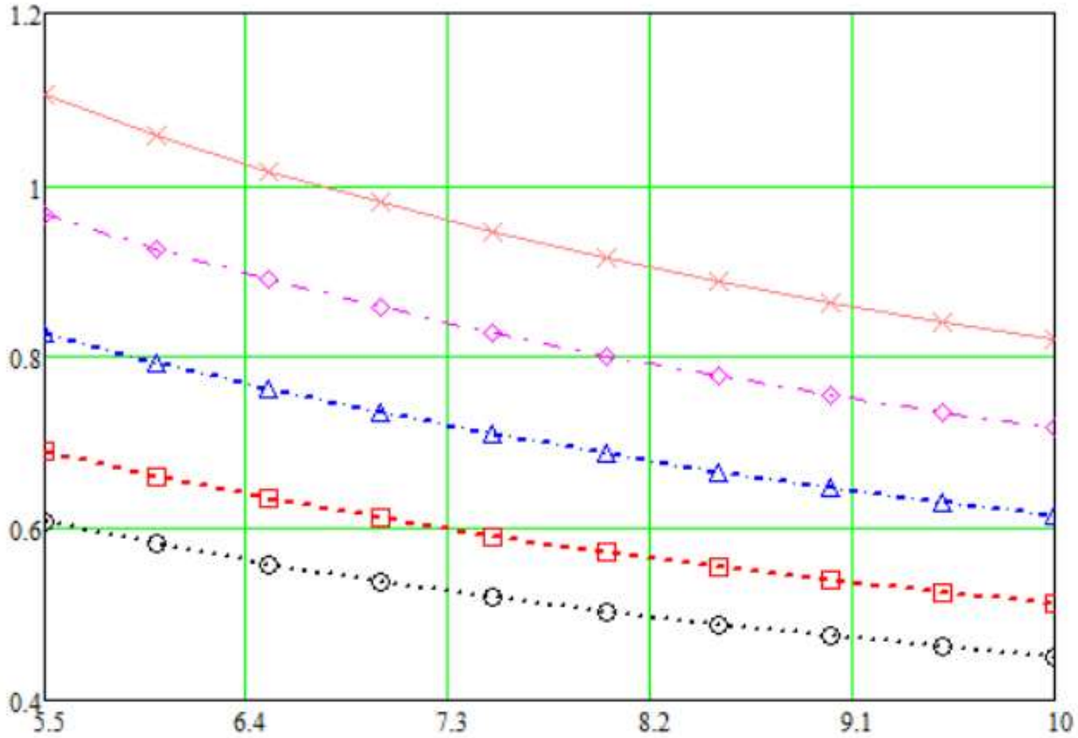
r $_{max}$, m



r ,

m

For different well diameters ○ – d d=110 mm; □ - d d = 125 mm; Δ - d d \u003d 150 mm; ◊ - d d=175 mm; x - d d \u003d 200 mm;



σ_p, MPa

For different well diameters ○ – d d=110 mm; □ - d d = 125 mm; Δ - d d \u003d 150 mm; ◊ - d d=175 mm; x - d d \u003d 200 mm;

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If the explosive charge density in wells is low, then the pressure of detonation products on the well walls can be calculated using the formula [5, 6]:

$$P = Q\omega(\gamma-1)(\vartheta_c - \alpha_k)^{-1}, \text{Pa} \qquad (6)$$

where ω is the specific energy of the explosive, J/kg; γ is the isentropic index ; ϑ_s - well volume, m ^{3}; a $_k$ – covolum (since the pressure in the well does not exceed 200 MPa, the value of α $_k$ can be neglected).

Given the ratio

$$Q/\vartheta_c = 4q/(\pi d_c^2), \qquad (7)$$

the pressure of detonation products on the walls of the wells will take the form:

$$P = 4q\omega(\gamma-1)\eta(\pi d_c^2)^{-1}, \qquad (8)$$

where q is the linear mass of the charge, kg/m; 4 ω(γ-1)η – coefficient taking into account energy losses.

Taking into account formula (8), relation (3) will take the form:

$$r_{\max} = \frac{K_r d_\partial}{2}\,\frac{k\left(4q\omega(\gamma-1)\eta(\pi d_c^2)^{-1}\right)}{\sqrt{\sigma_p}}, \text{ m.} \qquad (9)$$

k is the dynamism coefficient, k = 2;

p _ – tensile strength under dynamic loading , 5.5 ÷9.7 10 ^{6} Pa (Table 1).

K_r – well expansion coefficient, depending on the properties of rocks and drilling technology, 1.1 ÷1.5 (Table 2) [3; With. 182];

d_d - bit diameter, 125 ÷250 mm.

4 ω(γ-1)η - coefficient taking into account energy losses,

η-

ω – specific energy of explosives, 3 ÷6*10 ^{6} J/kg;

γ is the isentropic index , 1.2 ÷1.7;

q is the linear mass of the charge, kg/m;

$d_c = K_r d_\partial$, mm, diameter of blast holes,

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