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RELIABILITY OF CLOSING SEALS AND QUESTION SELF-RESCUER APPARATUS IN USA COAL MINES

Summary. In USA originated some very unpleasant mining accidents at last time. The occasions on these events are not clear still. From information who we obtained from Unite State Mining Rescue Association (USMRA) is clear that the sizable attention is applied to the explosions on Sago and Darby mines. As a response was accepted the new law so called MINER Act of 2006 by Congress of USA.

ZAGADNIENIE NIEZAWODNOŚCI ZAMKNIĘCIA TAMAMI PRZECIWWYBUCHOWYMI I APARATURA SAMOKONTROLUJĄCA W KOPALNIACH WĘGLA USA

Streszczenie. W tym roku w kopalniach głębinowych w USA doszło do kilku wybuchów gazu w przestrzeni, która była zamknięta tamami przeciwwybuchowymi. Dokładne okoliczności zaistnienia tych wypadków nie są jeszcze znane. Według informacji, które można było uzyskać drogą internetową od USMR, możliwe jest rozeznanie sposobu budowy takich tam w USA i porównanie go z wymogami przepisów, które obowiązują w Republice Czeskiej.

1. Short description of the events

After explosion on Sago mine No. 1 in Upshur County, West Virginia at 2. January 2006 together 13 miners waned. Twelve miners died from carbon monoxide poisoning and one was left brain damaged after the event. The further explosion on the Darby mine No. 1 in Harlam County, Ky. occurred at 20. May 2006 and required 5 victim on life. The closing seals were destroyed in the both incidents.

The seals were constructed from Omega Block, a cement-and-fiber foam block favored by many mine operators because they are lighter than the traditional cement blocks used to seal abandoned areas of mines. Material for producing of these seals was manufactured by Burrell Mining products New Kengsington Westmoreland County. These seals are in USA 15 years in use at least.

The Mine Safety and Health Administration (MSHA) first approved the blocks for use nearly a decade ago, but more recently allowed the installation of the blocks without the traditional "hitching" - the practice of digging a notch into the mine wall and ceiling to secure the seal. Unhitched Omega Block walls were approved after one such wall withstood the minimum **20 pounds per square inch blast pressure** during a test of seals meant to be erected during mine emergencies.

Unite State Mining Rescue Association (USMRA) has published after second blast in the colliery this information:

The counteraction of 20 pounds per square inch (psi) is one half of requirement withstood according to Australian safety rules only. In Australian the requirement withstood of seal is 50 psi. The safety regulations in Europe expectant the resistance of seal 72 psi.

According to our information experimental blasts of coal dust in Australian fetch result of maximum pressure 690 kPa (0,69 MPa) = (100 psi). (1 psi = 0,0069MPa.).

In response to the USMRA information, authors of this paper sent to our colleagues following opinion:

To your information "Sago mine blast Focus on failed seals" we would wanted in advance respond that supplication of USA federal requirement to achieve the resistance of seal 20 pounds per square inch it is according to European unions 0,138 MPa (MegaPascal) is problematic.

Strongest explosion of methane proceeds according to equation

$$CH_4 + 2O_2 + 8N_2 = CO_2 + 8N_2 + H_2O$$

At first moment of explosion has gas mixture temperature about 2650^0 C.

As far as was in closed area before explosion temperature for example 15^0 C then is ratio absolute temperature of mixture before and up explosion like (15+273) to (2650+273) it is 288^0F to 2923^0F. Gases then intensify during explosion volume more than 10 times. According to Mariott law must originates pressure answer the changes of volume. So that if the authentic pressure in the sealed area was 0,1 MPa than after explosion it can be 1 MPa. Explosive mixture but after occurred explosion in explosively space chills vapour condensing

on water and it gets to reducing of volume. From original 11 cubical units on 9. If first explosion express in like crash wave from one's parties then backward emergency wave reacts from second parties. It can on already once interference seal function adversely. After older Europe pieces of knowledge the resistance of closing seal in the district where is the possibility of occurrence of explosion mixture should be **150 psi.**

It isn't but sure that damage of seal was due to dimensioning it resistance only. To the destruction could contribute the manner of it make too, such as contact of seal with perimeter of roadway. It is possible determine this by detailed examination on the place of explosion.

As far as is for example in roadway profile 12 m^2 perimeter of work 10m built seal which has widths 3,5m and is anchorage into cutting that is effected till on firm rock, will on seal at explosion exposure effects stress in shoot. If pressure at explosion is 1MPa then on dike reacts the force F.

$$F = S.p_e = 12.1 = 12MN$$

This means after American units F=12megaNewtons it is $2{,}64.10^6$ pounds

S - is surface of seal

p_e - is pressure during the explosion

For expected stress on shoot τ we can write

$$\tau = \frac{F}{O.l} = \frac{12}{10.3{,}5} = 0{,}342MPa$$

After American units τ 0,324 megaPascual is 49,5 psi.

O - is perimeter of roadway

l - is width of seal (dike)

Permission stress on shoot at concrete is depending on mixture proportion and is 0,6 till 0,8 MPa (87 till 116 psi) so that dike would in of such conditions meeting. The value of permission stress at dike type Omega we have not to disposal.

It's indeed very theoretic presumption for absolutely first-rate fabricated dike with unyielding contact to surrounding rock. As far as such stationary contact we do not secure and make dike without cutting then is allowable stress on flat between dike and perimeter of work expressively lower. According to our present experience it is even half of permission stress and it is already state which can inflict failure of dikes.

For computation the width of seal (dike) we in Czech republic use after Mining Rescue Manual formula:

$$l = 0{,}9 \cdot b_{max} \cdot (p_e / \sigma_{tl})^{1/2}$$

b_{max} - is the maximum width of profile

σ_{tl} - is stress on pressure of material used for building of seal. (it can be 4 to 8 MPa).

This we can determine after graph on the figure 1.

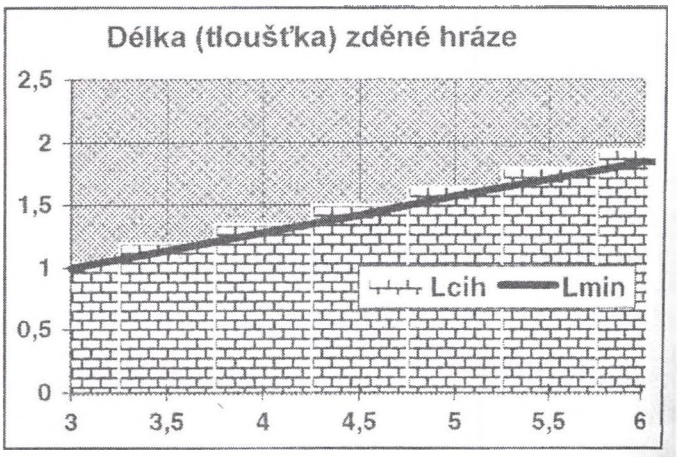

Fig. 1. Graf for development of the width of seal after Czech regulation. On the x axis is width of roadway (m), on the y axis is the width of seal (m)

Rys. 1. Wykres zależności grubości tamy wg wymogów czeskich. Na osi x jest szerokość wyrobiska (m), na osi y grubość tamy (m)

On the figure 2 is the view on the face of seal.

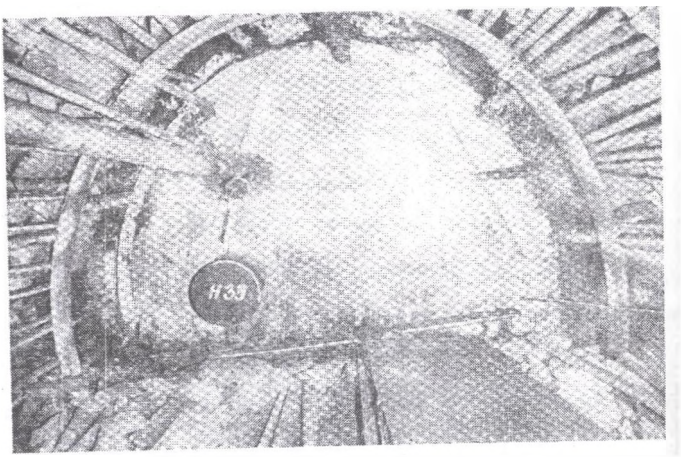

Fig. 2. Facing of the seal in the roadway

Rys. 2. Widok tamy w wyrobisku

2. Self-rescuer breathing apparatus

In connection with tragic event on mines Sago and subsequently on Darby arise the question credibility of self-rescuer breathing apparatus. From testimony of miner who was left results, that some of the involved with poisoning tried to put on the apparatus but they were functionless.

Mr. David G, Dye administrator of Mine Safety and Health Administration (MSHA), state the apparatus of Mr. Ledford who suffocate in atmospheres CO was in good order. This statement leans with about additionally carry out of competitive examinations.

The self - rescue apparatus type SR – 100 were manufactured by CSE company.

To this question we sent to USMRA RobMcGee following experience:

According to our experience it is important train using rescue apparatus in handicap conditions. We've for the object on surface practiced gallery. Behind closed door is creation environment with temperature rise and dense smoke. Once yearly yourself in it every worker must learn setting rescue apparatus. We know that in substandard conditions is behaviour of individuals other than in ordinary situation. During training the miners were not successful for setting of rescue apparatus for firs attempt. At least two or three attempts were necessary for reliable setting.

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