ГЕОТЕХНОЛОГІЯ

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RESEARCH EFFICIENCY SEISMIC-PROTECTIVE SCREEN FROM THE EXPLOSION

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ДОСЛІДЖЕННЯ ЕФЕКТИВНОСТІ СЕЙСМІЧНО-ЗАХИСНОГО ЕКРАНА ВІД ДІЇ ВИБУХУ

Studied species protect buildings from seismic effect of explosions at quarries and evaluated efficiency of seismic screens. We describe the advantages and disadvantages of using this type of protection to reduce the strength of seismic waves. Proved the feasibility of the event in the quarries.

Keywords: *heap; quarry; blast; soil; seismic waves; seismic-protective screens.*

Досліджено види захисту будівель від сейсмічного впливу вибухів на кар'єрах та оцінено ефективність використання сейсмічних екранів. Описано переваги та недоліки використання даного виду захисту для зниження сили сейсмічних хвиль. Доведена доцільність застосування даного заходу на кар'єрах.

Ключові слова: *відвал; кар'єр; вибух; ґрунт; сейсмічні хвилі; сейсмозахисні екрани.*

Исследованы виды защиты зданий от сейсмического воздействия взрывов на карьерах и оценена эффективность использования сейсмических экранов. Описаны преимущества и недостатки использования данного вида защиты для снижения силы сейсмических волн. Доказана целесообразность применения данного мероприятия на карьерах.

Ключевые слова: *отвал; карьер; взрыв; земля; сейсмические волны; сейсмозащитные экраны.*

Introduction. There are regions with the developed mining industry in Ukraine. The question of destruction of a massif was and remains to one of the most important problems of mining. Now explosive works is the dominating method of separation of rock from the massif. As a result of such influence possible deformations of slopes which have an insufficient stock of stability, liquefaction of water-saturated sand that can lead to destructive consequences. Seismic fluctuations extend on considerable distances from venues of explosive works therefore the buildings and constructions getting to a zone of seismic fluctuations will be exposed to regular concussions.

The work purpose - search and the description of effective ways of protection of constructions against the seismic influence arising when conducting explosive works on pits, an assessment of the chosen method, its advantages and disadvantages.

Research results. Mechanism of seismic waves from industrial explosions quite complex has its own peculiarities and insufficiently studied. It is characterized by repetition and dispersed sources of major fluctuations in space and time. The first source of tension-compression waves are very charge that affects the neighborhood surrounding the explosion. Under the influence of initial momentum created around the exploded charge region stressed state or seismic center of the explosion, which is involved in the formation of other types of waves. The amplitude and period of oscillations depend on time, volume and velocity of detonation of the explosive. Vibrations, spreading destruction on surfaces within the seismic center of the explosion, dump the array of stresses created by the elastic-plastic wave voltage. As a result, the accumulated mountain range elastic energy is converted into energy vibrations, helping to reduce the intensity of damping of oscillations, waves and periods reduce the occurrence of supercritical tensile stress, under which the array is created of residual deformation - cracking.

The main organizational and technical actions when planning and performing explosive works is preliminary seismic microdivisions into districts of the built-up areas and drawing up detailed seismoexplosive zonality of career fields, reflecting influence of properties in the plan and for depth.

Danger of earthquakes can be estimated in points of a seismic scale. Division of earthquakes according to points it is based on various criteria: to the size of a landslide, speed of fluctuations of the soil, energy of seismic waves. In Ukraine for an assessment of danger of earthquakes the scale of seismic intensity of MSK-64 developed at Institute of physics of Earth of Academy of Sciences of the USSR is used.

Resulting action of earthquakes on constructions depends on dynamic properties and characteristics of own fluctuations of constructions under the influence of external force. The scale of seismic intensity is constructed according to nature of transfer of fluctuations to a one-pendular seismometer.

The most acceptable criterion of seismosafety at EW (explosive works) for buildings is the size of speed of shift of particles of the soil in their basis. Damages of constructions comes in that case, when the speed of shift of particles of the soil (*U*, cm/s) exceeds its admissible size (*U)*. Especially dangerous situation becomes when the frequency of fluctuations of the soil foundation of the building comes nearer to its own. Concerning rocks, their seismic stability is determined by lack of residual deformations when passing seismic blast waves. Criterion of seismic stability of rock is relative elastic deformation (E_0) which is calculated on a formula:

$$\mathrm{E} = \frac{U}{V_{\mathrm{p}}},$$

where *U* - velocity of particle oscillations ground at the observation point, m/s; *Vp* - velocity of propagation of the wave which is investigated, m/s.

For protection of constructions against seismic impact of explosions use various ways. In particular, systems of seismoprotection can be divided on traditional and special, which in turn can be divided on active and passive. Work of passive systems of seismoprotection of buildings is based on seismoisolation and a seysmogaseniye.

One way to reduce the impact of seismic explosions is to build a seismic shields. They are used to improve the earthquake resistance of buildings. They are made in the form of shields, which are due to the material properties of the screen and provide a form of reflection and absorption of the energy of the seismic action. Known shielding performance in the form of slits or trenches filled with damping (energy-absorbing) material and disposed around the object scatter and absorb the seismic waves.

The screen includes the trench placed round a base contour filled with the material absorbing fluctuations. The trench is executed in the soil from the curvilinear sections connected by the final sites, and curvilinear sections can be turned towards fluctuations as camber, and concavity.

Decrease in seismic influence is reached because the barrier to protection of the built-up territories against superficial seismic waves surrounds the protected territory, and its upper edge is at the level with a soil surface. The barrier in the plan is executed convex, depth of a barrier is carried out not less than 0,2 wavelengths, and barrier wall width - not less than one wavelength. Wavelength is accepted to the corresponding low frequency from the most dangerous frequencies of fluctuations for this area, are determined by ranges accelerograms earthquakes. The distance between borders of constructions and internal border of a barrier makes not less than 0,35 width of a barrier, and material of a barrier is carried out flush with a surface of the soil (fig. 1) protected.

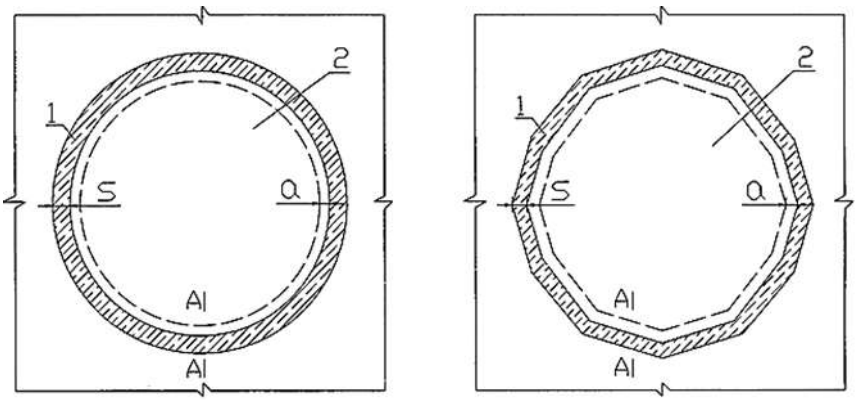

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Fig. 1. Scheme of seismic shield

Increase of efficiency of protection is reached due to modification of physical properties of a blanket that leads to decrease in energy of waves of Rayleigh which

can't extend if a half-space surface the restrained. A Rayleigh wave are one of the essential factors connected with transfer of energy at earthquakes.

If the wavelength is larger than the width of the barrier part of the wave energy passes through the barrier, and the barrier effectiveness decreases dramatically. When the barrier width over the wavelength, the effectiveness of the barrier increases, but after the barrier width exceeding 1.6 wavelength protection efficiency increases significantly.

Depth of a barrier is carried out not less than 0.2 wavelengths. If depth of a barrier appears less than 0.2 wavelengths, the part of wave energy passes through a barrier, and efficiency of a barrier sharply decreases. When performing depth of a barrier more than 0.2 wavelength, efficiency of a barrier grow, but after excess of depth of a barrier of 0.4 wavelengths, efficiency of protection increases slightly.

The safe distance between borders of constructions and internal border of a barrier makes not less than 0,35 width of a barrier as at distance is closer specified the soil and a barrier experience the considerable deformations caused by seismic waves. The barrier feels deformations because it perceives on itself the main energy of superficial waves. Surrounding the soil feels deformations because: a) the part of wave energy passes under a barrier and b) deformations of how it is made are told. The essential increase in efficiency of a barrier is reached when its material has density at least twice more, than density of surrounding soil.

We will give calculation of the sizes of a barrier to effective protection against seismic waves. Speed of distribution of longitudinal waves in soils of a galechnik with water saturated sand (density of 1500 kg/m^3) makes about 120 m/s, cross - 70 m/s, Rayleigh waves - 65 m/s. Then, width of a barrier is equal to L = CR/min(f) = 65/1,5 = 43,3 m, depth - not less than 8,66 m, and density - not less than 3000 kg/m^3. It should be noted that at close earthquakes the frequency range corresponding amplitudes of peaks, usually above and lies in the range from 3 to 8 Hz. In this case width of a seismic barrier becomes significantly less: for a water-saturated galechnik (density of 1500 kg/m) with a peak frequency of 3 Hz (the lowest frequency of a wave of the range of 3-8 Hz), wavelength will be about 21,7 meters, width of a barrier respectively demanded will be also not less than 21,7 meters, barrier depth - not less than 4,34 m, and density - not less than 3000 kg/m^3.

We will consider the principle of work of a protective barrier to the constructions standing on the sandy soil with a density of 1800 kg/m^3. The barrier to this soil is made of concrete with a density of 4000 kg/m^3. For superficial waves the frequency of fluctuations lies in the range from 3 to 8 Hz, and from 11 to 25 meters long, the most effective geometrical parameters of a barrier make: wall width s = 25 meters, depth h = 5 meters, the upper edge of a barrier is located directly at the level of a soil surface. At interaction of waves to a barrier there is a fading of amplitude of seismic waves and in the protected territory (after a barrier) there is a decrease in wave energy and directs it down, and only the insignificant part of wave energy gets into the protected territory due to passing of waves on the lower bound of a barrier. Thus in a barrier there are zones of big deformations which main part is localized in

forward part of a barrier. The waves reflected from a barrier go in the opposite direction, or deep into lands.

It should be noted that kinetic energy of a wave field is square function of amplitude. The conducted researches show that by means of a horizontal barrier it is possible to receive reduction of magnitude of movements behind a barrier by 1.5-2 times (depending on physical properties of the soil and a barrier) in comparison with the unprotected zone before a barrier. It means reduction of kinetic energy of seismic waves in the protected territory by 2.25-4 times respectively.

Conclusion

Decrease in seismic impact of explosions on the buildings which are near a sanitary zone of pits is possible as a result of establishment seismoprotective screens round these buildings. The offered installation of screens allows to reduce the magnitude of seismic waves behind a barrier by 1.5 - 2 times that allows to prevent destruction of buildings, with rather small costs of their construction.

After interaction of waves with a barrier perhaps partial and even final fracture of structure of a barrier therefore after end of the period of seismic activity it is necessary to hold events for restoration of a barrier.

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