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THE INFLUENCE OF BLASTING ON BUILDINGS AND CONSTRUCTIONS

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Summary. Blasting at mining and quarrying in the Krivoy Rog iron ore basin is the cause of numerous subsidence of bases, destruction of foundations and load-carrying members of buildings and constructions in Krivoy Rog. It is aggravated with water-bearing sands deposited under the major part of city area.

They occur at a depth of between 1.5 and 30 meters and overlapped by plastic clays of low load-carrying capacity. The frequency of base subsidence, foundation destructions and cracking in walls and spans of installations located in places of intensive blasting is two times higher than that in remote districts. 40 to 65 percent of buildings and constructions are situated in the zone of seismic activity with the magnitude of 3-6 balls, which is equal to failure of two or three earthquakes of the magnitude 7-8 balls per year.

Spectrum analysis of seismograms shows that frequency spectrum of explosions is 9.1 to 24.7 times higher than that of the first frequencies of natural oscillations of buildings. Therefore the explosions exert destructive influence not on buildings as a whole, but on their separate elements. During a definite time the damages are being accumulated and then manifested with visible defects of foundations and load-carrying constru-ctions.

The measures are worked out of to reinforce building constructions functioning under complicated geological engineering and seismic conditions.

Review of the researches in the field of industrial seismic was realized by Shcherbina S.V., Nesmashny E.A., Kutas B. B., Boyko V.V., Kuzmenko A.A., Boyko V.V., Isakhanov G.V., Melnik- Melnikov P.G., Chyrva V.N.

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INTRODUCTION

One of the main tasks of construction in Krivoy Rog (Ukraine) is ensuring strength and reliability of buildings and structures which are under the action of industrial seismics. Most building installations situated in the city are under systematic seismoexplosional actions caused by blasting for mining of ore mineral resources and building materials in the Krivoy Rog basin. It should be noted that every seismoexplosional action in about 3-4 balls. As the result many buildings and structures require overhaul repair either with partial substitution of buildings and structures or their strengthening. That is why the research of seismic stability of buildings and structures in the zone of industrial seismics is very actual.(4) рис. 1

Fig.2.Scheme of location on the Ukrainian shield(4)

1. Areas of industrial explosions,
2. Earthquake epicenters
3. Seismic observation points
4. Main fault zones separating megablocks
5. The contour of the slopes of the shield
6. Outline of the exposed part of the shield

Megablocks:

I – Volynsky, II - Podolsky , III-Rosinsky, IY- Bugsky, Y – Ingulsky,YI – Sredneprideprovsky, YII – Priasovsky, YIII-volcano-plutonic belt

Рис. 2.Схема розташування на Українському щиті (4)

1- Зони промислових вибухів
2- Епіцентри землетрусу
3- Пункти сейсмічних спостережень
4- Основні зони розломів, що розділяють мегаблоки
5- Контур схилів щита
6- Обрис відкритої частини щита

Мегаблоки:

I – Волинський, II – Подільський, III – Росинський, IV- Бугський, V – Інгульський, VI. – Середньопридніпровський, VII – Приазовський, VIII-вулкано-плутонічний пояс

To solve this task it is necessary to study and analyze the action of explosions, to work out dynamic models of the structures discussed and to determine stress and strain state of the members of buildings and structures taking into consideration multifrequency of explosions.

THE ACTION OF SEISMIC OSCILLATIONS ON STRUCTURES

The seismic action on buildings and structures at earthquakes are usually valuated according to the acceleration of the shift of a member or the earth. All the existing scales of the earthquake intensity in balls are based on the acceleration of the earth. It is admitted that the action of earthquakes is equal to the inertial force.

The value magnitude of these forces is admitted equal to the product of the mass of the given member multiplied by the acceleration of the earth shift. Besides the acceleration of building oscillations is substituted for the acceleration of the earth shift. This method is used when the frequency of natural oscillations is much higher that the frequency of earth oscillations.

An earthquake acts as static load and the acceleration of earth and structure members are equal.

In case the frequency of building oscillations is lower than the frequency of seismic earth oscillations this method of valuation is not acceptable. In such cases the frequency of building oscillations are similar to the frequency of natural oscillations and not to the frequency of forced oscillations. The acceleration of structure oscillations and the inertial forces caused by them differ greatly from the ones used at statistic account of seismic actions.

The frequency of earth oscillations at explosion is higher than the frequency of natural oscillations of buildings and structures. That is why for all members the speed of the earth shifts at the foundation of buildings is taken as the criteria of seismic hazard.

THE ANALYSIS OF SEISMIC ACTIONS ON BUILDINGS AT MASS EXPLOSIONS

The analysis of technical condition of domestic and public buildings in some districts of Krivoy Rog shows that the main factors which cause intensive failure of buildings are seismic actions at mass explosions at open-cuts of ore-dressing plants and at open-cuts producing building materials. Besides practically 70 percent of buildings and structures have considerable damages such as cracks, sags and cockings. Every year there are 280-350 mass explosions in the Krivoy Rog basin. They cause great additional seismic actions which promote failure of buildings and structures.

The frequency of base subsidence, foundation destructions and cracking in walls and spans of installations located in places of intensive blasting is two times higher than in remote districts.40-65 percent of buildings and constructions are situated in the zone of seismic activity with the magnitude of 3-6 balls, which is equal to failure of two or three earthquakes of the magnitude of 7-8 balls per years.

The time of seismic action at many constructions of the city was registered and their statistic analysis was made to valuate the magnitudes of seismic actions. The studies of seismic explosions showed that the speed of seismic actions depends on the geological structure of the territory in the radius of explosion wave spreading, relief condition, water reservoirs availability and strength of basic rocks, technical condition of the building, location of the structure from the place of explosion, general mass and the mass of explosion wave on moderation degree, technology of mass explosions and methods of their control. All the factors mentioned above are different in every district of the city. The technical state of the domestic fond of the city is bad and the exceptional speed of seismic actions must not be more than 0,4-0,5 cm/sec, while new buildings have the speed of 2-3 cm/sec. It reaches 5-8 cm/sec for the buildings, equipped with seismic protection.

For example, one of the four -storied buildings in the city was studied according to the analysis of seismogram. It was determined that the period of natural oscillations of the buildings **T** ranges from 0,23 to 0,28 sec and the frequency of natural oscillations **f** is 3,5-3,7 hertz (fig.2).

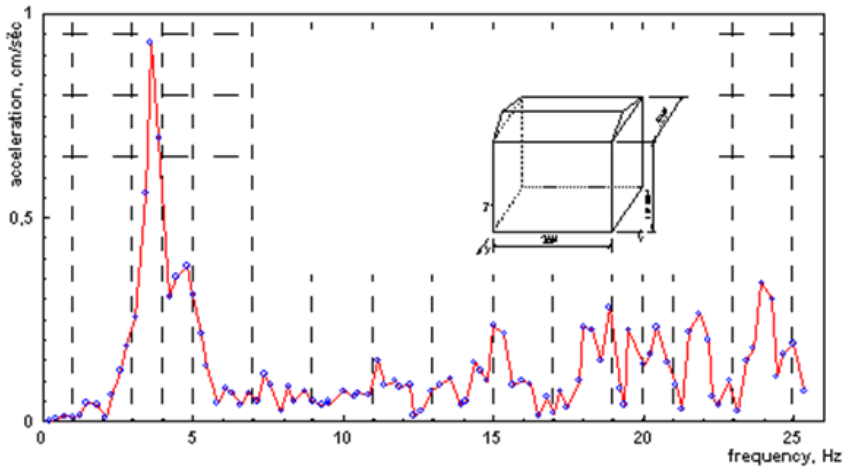

Fig.2 Amplitude spectrum for acceleration of bulding
Рис.2 Амплітудний спектр для прискорення забудови

On the amplitude spectrum of Fourie these are two points of extremum with the frequency of 3,6 and 4,5 hertz. The frequency of forced oscillations of seismic actions ranges from 32,2 to 91,3 hertz. Thus the frequency spectrum of explosions is 9,1-24,7 times higher than the natural oscillations of the building.

THE RESEARCH OF MODELS OF DYNAMIC STRUCTURE.

Numerical modeling of the conduct of a building under the explosion actions was performed to confirm the results of the measurings. The formation of multiparameter dynamic models of structures is based on the method finite elements.

This method is considered to be one of the leading methods of numerical analysis of stress and strain state and stability of complex systems. To describe hardness and elasticity of structures it is necessary to create initial dynamic models of larger sizes. Their reduction to the systems of smaller sizes is carried out by the method of generalized coordinates. Natural forms of oscillations and their modifications are used as basic functions.

Iteration method is used to determine load-carrying natural forms and the frequency of structures. Which enables to reduce the solution of the generalized problem of proper meanings of larger sizes to the sequence of tasks on proper meanings of smaller sizes.

A design dynamic model is a system of independent second-order equations in regard to generalized co-ordinates (9):

$$\ddot{y}_j + 2\alpha\xi_j\varpi_j\dot{y}_j + \beta\varpi_j^2 y_j = m_j^{-1}P_i(t), \qquad (1)$$

where α , β are value magnitudes permitting to take into account different kinds of damping factor;

ξ_j is a coefficient damping factor by j – form;

ω_j is j - natural frequency;

$m_j=u_j^T M u_j$;

M is a matrix of inertial model;

u_j is a vector of j - natural of form oscillations;

$P_j(t)$ is j - generalized force.

Having done the integration of the simultaneous equations of motion we shell get the time realization parameters of stress and strain state of building members. The results of experimental researches and numerical modeling practically coincide.

CONCLUSIONS AND RECOMMENDATIONS

1. For cities, subjected to explosions, it is necessary to make up a general map of the city, picking out places favorable for construction and potentially dangerous places.

2. It is imperative to valuate regularly the actual state and the degree of damages of domestic fond of cities, located in a zone of seismic actions of mass explosions.

3. The construction of new districts should be carried out with buildings seeppling with seismic defense.

4. New methods on strengthening of building structures and installations damaged by explosion actions have been worked out. These methods are based on introduction of additional elements of hardness.

5. Some recommendations were given as to the location of additional structures. Monolithic ferro-concrete diaphragms located in the places of existing partitions were chosen as basic strengthening structures. Location of diaphragms depends on conditions of asymmetry of hardness in the plan of a building. The reduction of the period of natural oscillations of a building was taken as the criteria of means of strengthening.

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ВПЛИВ ВИБУХОВИХ ХВИЛЬ НА БУДІВЛІ ТА СПОРУДИ

Тетяна ЧИРВА, Вячеслав МАРТИНОВ, Віра КОЛЯКОВА, Володимир ЧИРВА

Вибухові роботи при видобуванні корисних копалин у Криворізькому залізорудному басейні є причиною численних просадок основ, руйнування фундаментів та несучих елементів будівель та споруд Кривого Рогу. Вона посилюється водоносними пісками, що відклалися здебільшого території міста. Вони залягають на глибині від 1,5 до 30 метрів і перекриті пластичними глинами низької здатності, що несе.

Частота просадок фундаментів, руйнувань фундаментів та тріщин у стінах та прольотах споруд, розташованих у місцях інтенсивних вибухових робіт, у два рази вища, ніж у віддалених районах. Від 40 до 65 відсотків будівель та споруд перебувають у зоні сейсмічної активності силою 3-6 балів, що дорівнює аварійності двохтрьох землетрусів силою 7-8 балів на рік.

Спектральний аналіз сейсмограм показує, що частотний спектр вибухів у 9,1-24,7 разів перевищує спектр перших частот власних коливань будівель. Тому вибухи надають руйнівний вплив не так на будівлі загалом, але в окремі їх елементи. Протягом певного часу пошкодження накопичуються, а потім проявляються видимими дефектами фундаментів та конструкцій, що несуть.

Розроблено заходи щодо посилення будівельних конструкцій, що функціонують у складних інженерно-геологічних та сейсмічних умовах.

Огляд досліджень у галузі промислової сейсміки здійснили Щербина С.В., Несмашний Є.А., Кутас В. В., Бойко В.В., Кузьменко А.А., Бойко В.В., Ісаханов Г.В., Мельник-Мельников П.Г., Чирва В.Н.

Ключові слова. Сейсмовибухові дії, сейсмічні коливання, динамічна модель, сейсмічна безпека, сейсмічні хвилі, зони розлому

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