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Seismic effects of industrial explosions in a granite quarry in Belarus

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The paper deals with an instrumental estimation of the seismic effect of massive industrial explosions in the Mikashevichy granite quarry. The observations have been carried out with digital stations being integral parts of a short-period three-component velocity-type seismometers LE-3DLite/1s [1] and seismic recorders GeoSig GMSplus [2], as well as LE-3DLite /1s as a unit with a recorder Delta-03M [3].

In order to obtain valid data about the nature of the seismic effects of explosions of varying power at different rock mining horizons in a quarry some parameters mentioned below have been studied:

1. A character of decay of the total vector velocity and its components in dependence on distance both for some separate explosions, and for all the explosions under consideration.

2. A dependence of the total vector velocity on the reduced distance.

The network of stations named “Granite” and intended for monitoring the industrial explosions and estimation of their impact on the dwelling zone was developed at the Mikashevichy building stone deposit in August, 2023.

A software package SeisComP of 5 version [4] was used for data processing.

During the primary processing of the seismic records the “useful” signal is selected from the microseismic noise with the subsequent interpretation of the amplitude variations as an arrangement the P-wave and S-wave phase arrivals.

A high level of vertically polarized seismic wave amplitudes is a characteristic feature of the majority of explosions recorded by the network stations, the horizontal components contribute insignificantly to the values of the total vector velocity of the ground motion.

Such initial data as the explosion power (average explosive charge of a single borehole, charge mass in a block), position of an explosion, distance to the seismic observation stations, instrumentally recorded ground motion velocity were used to determine the seismic impact rate.

The ML magnitude values obtained from the results of the cameral treatment of explosions were compared with charge masses actually applied in industrial explosions taken from the mining enterprise documents with the subsequent linear approximation within the specified confidence interval ± 0.2σ. The results obtained cause the author to state that the planned explosions with an average charge in one borehole from 150 to 750 kg (or a charge mass in block from 10,000 to 1000,000 kg) fall within the confidence interval considered with probability of 98%, which coincides with the magnitude measurement range from 2.25 to 3.05.

It is important to mention that when studying the seismic effect of industrial explosions it is necessary to have available microseismic background data in the region of works. Explosions which ground motion total vector velocity is not higher than 0.3 cm/c were selected for the similar spectral analysis. The frequencies below 15 Hz make the greatest contribution to the spectrum. In all the spectra a small peak can be noted about 100 Hz. Absolutely all the Nakamura spactra [5] show a maximum frequency around 2.5 Hz, which permit a conclusion that for the buildings and constructions located near some seismic stations of the network this frequency is as a resonance one and should be taken into consideration when estimating the seismic impacts.

[1] Technical documentation of the company «Lennartz electronic GmbH», 2012.

[2] Seismic signal recorder GeoSig. GMSplus User Manual V24, 2021.

[3] Seismic signal recorder «Delta -03», 2007.

[4] Helmholtz Centre Potsdam GFZ German Research Centre for Geosciences and gempa GmbH (2008).

[5] Nakamura, Y. A method for dynamic characteristics estimation of subsurface using microtremor on the ground surface, 1989.