EXPERIMENTAL INVESTIGATION INTO THE OPERATION REGIMES OF BOREHOLE-SLOT SOURCE OF SEISMIC WAVES

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The results are presented for the experimental investigations into the regimes of underground borehole-slot vibrosource with elastic cases and volume electrohydraulic drive. Means of its engineering design realization are proposed.

Borehole-slot vibrosource, emission efficiency, design and engineering parameters

Borehole-wave methods of vibroseismic action of productive strata (oil reservoirs, gas pools, coal-methane, uranium, copper and other mineral deposits) have become more and more frequently used. In this connection, of interest is the work on creation of vibroseismic oscillation sources and investigation of their operation regimes within the frames of the State Scientific and Engineering Program “The Earth’s Vibration Sounding”.

One of the known ways to excite seismic waves in a rock mass is a borehole-slot method. Boreholes are driven at a certain depth from the surface. In boreholes there are actuating mechanisms creating an alternating load on the medium. Contiguous boreholes may be connected by a crack. Such sources have the following advantages:
— elimination of losses for generation of stray surface waves and for absorption of volumetric waves by low-velocity zone. These losses are more than 80 % of full emission power when the sources are arranged on the daylight surface;
— uselessness of powerful load-carrying structures or bolting systems that complicate design and decrease reliability of the surface sources;
— design simplicity and great magnitude of action on the massif.

The testing was aimed at investigating the amplitude-frequency characteristics of vibroseismic oscillations of a rock mass at various distances from the source arranged in a single borehole or in many boreholes, including the variant when boreholes were connected by a slot cavity.

The experiments have been conducted with the use of electrohydraulic vibroseismic source (EHVS) [1] placed at a depth of 145 m (level +290 of the “Sibruda” mine). The enclosing massif is mainly composed of diorites, velocity of longitudinal waves is 4500 m/s.

1. EHVS consists of control electric drive I, kinematic oscillator 2, and actuating mechanism 3; 4 is a rock mass (Fig. 1). To sustain initial static pressure \( P_{\text{min}} \) in the system, low-power pumping facilities are used. Control electric drive involves a direct-current electric motor, thyristor converter, and a system of automatic adjustment of the motor rotation frequency by feedback signal from a phase sensor mounted on the motor shaft.
Oscillator feeds a variable volume of liquid into cavity of the actuating mechanism according to the following law:

\[ \Delta W(t) = W_a \sin \omega t, \]

where \( W_a \) is a volume pulsation amplitude; \( t \) is a time; and \( f \) is an oscillation frequency. This causes an alternating pulsing pressure in the cavity:

\[ P(t) = P_a \sin \omega t, \]

where \( P_a \) is a magnitude.

Design of the actuating mechanism is based on drilling hoses with internal diameter of 76 mm. Drilling hose is preliminary squeezed by segments to the value of \( x_0 \) (Fig. 2). Before putting into a borehole with a diameter \( D = 175 \) mm, the segments are held in radial direction relative to one another by a special device which is destroyed when pressure is fed into the hose. The pulsing pressure in the borehole element of the actuating mechanism is transformed into an alternate force of thrust type on the borehole contour. The force causes deformation of enclosing rock and generates seismic waves. As compared with other EHVSs, such as hydraulic cylinders, membranes, and cord chambers, the described actuating mechanism has small dimensions, is sealed, and is distinguished by technological effectiveness of assembling.