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IMAGING OF ROCKSLIDES BY MEANS OF SEISMIC REFRACTION INVERSION USING HOMOGENEOUS FUNCTIONS

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Introduction

Investigations of structure of rockslides are conducted in engineering geophysics to estimate slope stability and to predict a failure. Seismic refraction studies have important place in these works. However interpretation of seismic refraction data in such regions meets considerable difficulties stipulated for complex geological structures, changeable seismic velocity and mountainous relief. Using the inversion method based on approximation of velocity fields by homogeneous functions for such seismic data we can receive detailed velocity cross sections allowing to estimate an inner structure of rockslide, slice line, surface of water table and seismic structure of bedrock.

Method of inversion of refraction data and imaging of seismic structures

The inversion method was worked out in Moscow State University in 70- 80th. It is the method of simple inversion automatically transforming traveltime curves of first arrivals into 2-D velocity field of seismic cross section (Piip, 1991). We note that the method do not demand a more detailed system of observations then usually accepted in engineering seismics. Preliminary selection and identification of refraction wave in the traveltime curves from different sources are not required, it is produced automatically. The method is based on piecewise approximation of real velocity field by homogeneous functions of two coordinates. As a result we receive the practically arbitrary velocity distribution in seismic cross section. Such seismic cross section represent a field of velocity contours drawn with small constant interval (usually from 0.01 to 0.1 km/s). It allows to estimate both velocity values and velocity gradient values for points of cross section. Geological interpretation is produced for computer developed seismic cross section. Seismic boundaries are distinguished as line with high density of contours or as lines where gradient values change sharply. Faults and fractures are imaging as line where contours are shifted. Folds , karst and other local nonhomogeneities have their images in such cross sections. Accuracy and reliability of such cross sections were verified by drill hole data and ray tracing tests (Piip & Efimova, 1990).

Investigation of rockslide area in the north India

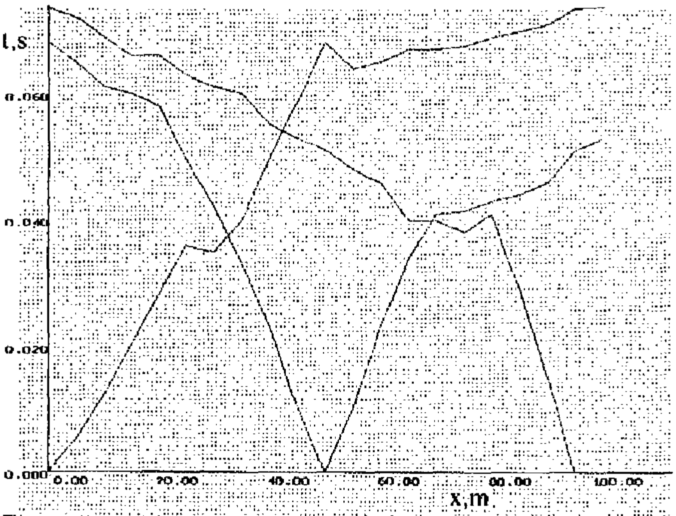

Fig. 1. Traveltime curves along profile 35r.

Interpretation of refraction traveltime curves along profiles located at the right bank of hydrotechnical dam in the valley of Bhagiraty river (north India) was conducted. Homogeneous functions technique allowed to study a detail structure of rockslide area. Seismic works were made by Institute "Hydroproekt" (Moscow) in 1990-1991. The bedrock of area consist of phyllites of the Earlier Palaeozoic age. They are broken on blocks by fractures and cracks, are altered at their surface and covered by quaternary rocks of different genesis. The rockslide structure is visible in the relief of steep slope: the head scarp and the toe are present.

Seismic measurements included next parameters. Shot points were located at distances from 45 to 100m and geophones were spaced at 5m intervals. Interpretation was made along 10 seismic lines: 6 were located on rockslide surface and 4 were outside. Traveltime curves along profile 35r located on rockslide surface are shown in the fig. 1. Quality of received cross sections we can evaluate examining cross sections along two profiles 35r and 36r (fig. 2) that pass parallel with the long axis of the rockslide, distance between them is about 40 m. One (35r, fig 2a) locates at the surface of rockslide and the other (36r, fig. 2b) is outside of it. Structures of bedrock in these cross sections are similar. The same blocks and fractures (F1, F2 and F3 in fig. 2a and 2b) are distinguished. Thin lines in fig. 2 indicate velocity levels and their angle of inclination is the same at both sections. In the cross section of the profile 35r the rockslide is present and in the cross section of profile 36r it is absent. The rockslide consists of two layers. Upper one is low velocity layer (debris) and lower one represent by displaced rocks characterised by high velocity values near base of the layer. Subsurface layer in the cross section of profile 36r (fig. 2b) has small thickness and velocity values ranging from 1000 to 1500 m/s. It is interpreted as layer of altered rocks. Two zones of cracks with low velocity gradient we distinguished in the bedrock structures of cross section of profile 36r (fig. 2b).

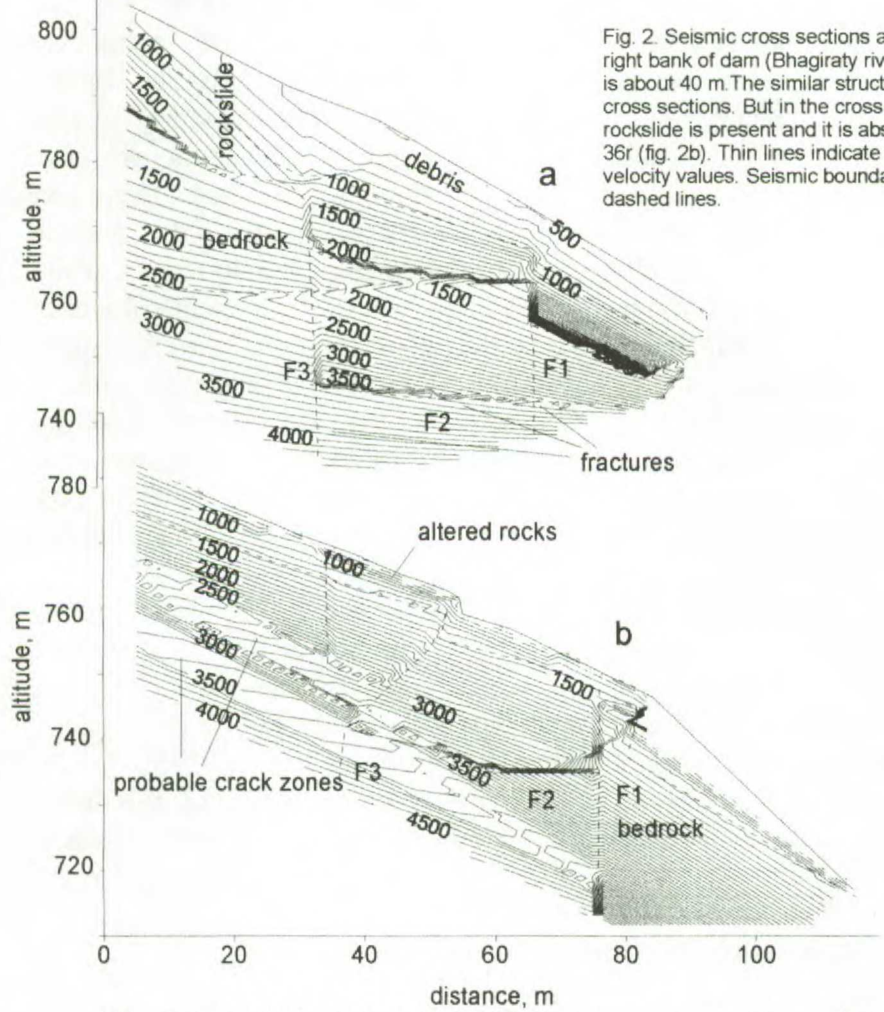

Fig. 2. Seismic cross sections along two longitudinal profiles at the right bank of dam (Bhagiraty river, India). Distance between profiles is about 40 m.The similar structures of bedrock are seen in the both cross sections. But in the cross section of profile 35r (fig. 2a) the rockslide is present and it is absent in the cross section of profile 36r (fig. 2b). Thin lines indicate velocity contours, the digits are velocity values. Seismic boundaries and fractures are shown by dashed lines.

We may conclude that such detailed seismic cross sections allow to evaluate: thickness and structure of rockslide, structure of bedrock, location of network of fractures and crack zones and thus to estimate stability of slopes and possible hazard.

References

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