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Partition of Plastic/Elastic Energy in Mine Blasts

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Extended Abstract

The amount of energy spent in mine blasts to just demolish the rocks is not clearly known. In this study, we propose a different technique to obtain the plastic-to-elastic energy ratio, directly available from the seismic field data. It is known that, in delayed-blast techniques widely used in mining, subsequent blasts in a group interact among themselves. In such case, the seismic signal of a group blast will differ from some of the signals of the participating blasts when they were exploded individually. The reason of this difference is the failure of the superposition principle of the linear behavior. In order to overcome the problem of differences between signals of individual blast-holes, we extracted the input wavelet from the real data, instead of using one-signature hole's signal. We convolved (linear-process) this wavelet with the time series containing time-delayed spikes corresponding to each blast in the group, to obtain a synthetic time-series representing the linear behavior, hence the elasticity. The plasticity, on the other hand, is represented by the actual field data. The energy may simply be defined by the sum of the squares of the amplitudes in a time series. Therefore, the ratio of the energies related to the plasticity and elasticity, provides the partition of the energy in a mine blast. The ratio so obtained is deduced from the seismic signals. Therefore, this ratio is a measure of the elasticity. The plasticity, on the other hand, is considered as the complementary of the elasticity.

In mine blasts and seismic source considerations, the percent of energy spent for rock fragmentation (plastic behavior), and the percent of energy spent for seismic wave propagation (elastic behavior) constitute an important issue in blast and seismic source performances. From the viewpoint of miners, the former (plastic behavior) is preferable, and from the viewpoint of geophysicists, the latter is favored. In this paper, we described a technique to quantitatively determine the blast performance in terms of elastic energy percent E, and plastic energy percent P. It is proved that the group seismic signal measured in the field is sufficient to compute E and P.

The field work of the study for the application of the new formulas to determine P and E ratio of a mine blast was carried out at Turkish Coal Enterprise's (TKI's) open pit coal mine's, at Eskihisar, Yatağan and Muğla, Turkey.