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Relief energy of slope failures area affected by the Mid Niigata Prefecture Earthquake in 2004

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The Mid Niigata Prefecture Earthquake in 2004 caused various scales many slope failures in the Chuetsu area. The distribution of them was interpreted by aerial photographs and the disaster condition maps of the earthquake were published by the Geospatial Information Authority of Japan. In this study, we investigated the characteristics of the relief energy at the slope failures using polygon or polyline data indicating them in the disaster condition maps. The large scale slope failures indexed by polygon data are considered landslides and the small scale ones indexed by polyline data are considered surface failures.

For analysis on the relief energy, elevation data of 10m-mesh digital elevation model in the fundamental geospatial data were used. Two kinds of relief energy were calculated. The first relief energy is defined as the elevation difference between maximum elevation and minimum elevation in the unit area whose sizes are 0.01km^2, 0.25km^2 and 1km^2. The second relief energy is defined as the elevation difference between the two landform models of summit level and valley level. In the calculation on the models, we set the minimum watershed area whose sizes are 0.04km^2, 0.09km^2 and 0.25km^2. We overlaid the scarps of the large scale slope failures, the landslide masses of them and axes of active folding with these relief energy maps by GIS. We clarified two results in the calculation cases of 1km^2 of the unit area or 0.25km^2 of the minimum watershed area. It seems that the relief energy is larger at the area between anticlinal axis and synclinal axis, and it is easy to confirm that the relief energy tends to be larger at the area where the large slope failures occurred in comparison with the surrounding areas.

The coordinates of the centroid, the distance from the epicenter and the two kinds of relief energies at the centroid on scarps, landslide masses and the small scale slope failures were analyzed by GIS. Many graphs plotted with relief energy on their landforms and random points for as the vertical axis and the distance from the centroid as the horizontal axis were prepared. By analyzing these graphs, it was clarified that the occurrence of the landslides concentrated within about 11km distance from the epicenter. This trend appeared more clearly on the large slope failures. We clarified two results by the comparison of their landforms and random points. The slope failures tend to occur in the area where is larger than some value of the relief energy and to be difficult to occur in the area where is smaller of the relief energy at far distance from the epicenter. The latter trend appeared more clearly on the small slope failures. It is easy to understand these characteristics from the graphs on larger unit area or watershed area in the calculating relief energy.

Consequently, we pointed out a possibility that the basic factor of the slope failures induced by the earthquake is not only the erosion by rivers but also the active folding and that the incentive of them is the seismic ground motion by the overlay analysis between various kinds of relief energy and landforms such as large landslide, etc.

Keywords: relief energy, DEM, slope failure, landslide, The Mid Niigata Prefecture Earthquake in 2004