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The numerical-statistical approach for hazard prediction of landslides and its application in Ukraine

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More than 90% of the territory of Ukraine has complex ground conditions. Unpredictable changes of natural geological and man-made factors governing ground conditions, may lead to dangerous deformation processes resulting in accidents and disasters. Among them, landslides are the first by the amount of the inflicted damage in Ukraine and the second only to earthquakes in the world. Totally about 23 000 landslides were identified in the territory of Ukraine. The standard deterministic procedure of assessment of the slope stability, especially with the lack of reference engineering geological data, results in obtaining estimated values of stability coefficients differing from the real ones in many cases. Application of a probabilistic approach will allow to take into account the changeable properties of soils and to determine danger and risk of landslide dislocations. The matter of choice of landslide protection measures is directly connected with a risk: expensively but reliably or cheaper but with a great probability of accidents. The risk determines the consequences either economic, social or others, of a potential landslide dislocation on the slope both during construction of a retaining structure on it and in the process of its further maintenance.

The quintessence of risk determination consists in the following: study and extrapolation of the past events for each specific occurrence. Expected conclusions and probable damages as a result of a calculated and accepted risk can be determined only with a certain level of uncertainty. Considering this fact improvement of the accuracy of numerical and analytical estimates when calculating the risk magnitude makes it possible to reduce the uncertainty. Calculations of the Chernivtsi shear landslides (Ukraine) were made with an application of Plaxis software and due account of a risk of its displacement was performed for the typical distribution diagram of the landslide-prone slope. The calculations showed that seismic events of intensity up to 6 points are able to significantly impair the characteristics of soil along the sliding surface and affect the slope stability and the value of landslide pressure onto supporting buildings. The further improvement of the site seismicity (up to 7-8 points) results in the substantial decrease of the stability coefficient. The slope, which firstly was stable, turns into a limiting equilibrium state, and then its state becomes unstable.

Based on the calculation results, it is possible to follow step-by-step the process of stress redistribution in the landslide slope with its seismicity increase, which eventually causes the slope motion (unloading of accumulated stresses).

Measures of landslide risk management are aimed at ensuring and maintaining acceptable or in some case an allowable risk level. In addition to calculations of soil masses stability, parameters of structures, creation of drawings and making of estimates, it is also necessary to take measures aimed at compensation of uncertainties and prevention of unforeseen situations due to incomplete (unreliable) surveys, etc. Depending on the initial situation or requirements the landslide risk management is to solve the following three problems: prevention of negative consequences; reduction of danger and risk; rectification of consequences, and prevention of a new danger development.