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GIS-based seismic shaking slope vulnerability map of Sicily (Central Mediterranean)

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Earthquakes often represent very dangerouses natural events in terms of human life and economic losses and their damage effects are amplified by the synchronous occurrence of seismically-induced ground-shaking failures in wide regions around the seismogenic source. In fact, the shaking associated with big earthquakes triggers extensive landsliding, sometimes at distances of more than 100 km from the epicenter.
The active tectonics and the geomorphic/morphodinamic pattern of the regions affected by earthquakes contribute to the slopes instability tendency. In fact, earthquake-induced groun-motion loading determines inertial forces activation within slopes that, combined with the intrinsic pre-existing static forces, reduces the slope stability towards its failure.
Basically, under zero-shear stress reversals conditions, a catastrophic failure will take place if the earthquake-induced shear displacement exceeds the critical level of undrained shear strength to a value equal to the gravitational shear stress.
However, seismic stability analyses carried out for various infinite slopes by using the existing Newmark-like methods reveal that estimated permanent displacements smaller than the critical value should also be regarded as dangerous for the post-earthquake slope safety, in terms of human activities use.
Earthquake-induced (often high-speed) landslides are among the most destructive phenomena related to slopes failure during earthquakes. In fact, damage from earthquake-induced landslides (and other ground-failures), sometimes exceeds the buildings/infrastructures damage directly related to ground-shaking for fault breaking.
For this matter, several hearthquakes-related slope failures methods have been developed, for the evaluation of the combined hazard types represented by seismically ground-motion landslides.
The methodologies of analysis of the engineering seismic risk related to the slopes instability processes is often achieved through the evaluation of the permanent displacement potentially induced by an seismic scenario. Such methodologies found on the consideration that the conditions of seismic stability and the post-seismic functionality of engineering structures are tightly related to the entity of the permanent deformations that an earthquake can induce.
Regarding the existing simplified procedures among slope stability models, Newmark's model is often used to derive indications about slope instabilities due to earthquakes.
In this way, we have evaluated the seismically-induced landslides hazard in Sicily (Central Mediterranean) using the Newmark-like model.
In order to determine the map distribution of the seismic ground-acceleration from an earthquake scenario, the attenuation-law of Sabetta & Pugliese has been used, analyzing some seismic recordings occurred in Italy. Also, by evaluating permanent displacements, the correlation of Ambraseys & Menu has been assumed.
The seismic shaking slope vulnerability map of Sicily has been carried out using GIS application, also considering max seismic ground-acceleration peak distribution (in terms of exceedance probability for fixed time), slope acclivity, cohesion/angle of internal friction of outcropping rocks, allowing the zoning of the unstable slopes under seismic forces.