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Landslide-triggering factors

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Landslides are one of the most important natural hazards, both for their difficult predictability and for the potentially catastrophic effects they produce. The main causes of these events can be sought into predisposing causes and causes of actual triggering: both are responsible for altering the mechanical equilibrium of the slopes but the former essentially act at time scales much more distant in time.

Among the most recurrent triggers there are undoubtedly the rainfalls that act both by imbibition and fluidification of the most superficial layers and indirectly by raising the piezometric levels and thus producing alterations in the distribution of pore water pressures and hydraulic gradients that can potentially be unbearable from the solid skeleton of the soil (Iverson, 2000; Fredlund, 1987).

The link between rainfall, groundwater levels and displacements has been widely studied with various approaches, through stochastic models and time series analysis, identifying the elements of forcing (e.g. precipitation duration, maximum rainfall intensity, rain intensity gradient, cumulative intensity, ...) that most influence the response in terms of displacement and rate of movement. These models are used in early-warning systems of some types of landslides but are continuously the subject of study and reflection (Crosta and Frattini, 2003; Guzzetti et al., 2007).

The influence of seepage and pore water pressures within the soil can be studied through simple laboratory-scale models that help visualize the possible trigger mechanisms and mechanisms that instead promote stability. A series of examples of laboratory activities that trace the possible causes of triggering will therefore be shown, especially with reference to the presence of water. The elements taken into consideration will be, the hydraulic gradient, its spatial and temporal distribution, the direction of the seepage, the presence of stratigraphic inhomogeneities through impermeable or less permeable layers, the development of overpressures under impermeable layers.

The link between the hydraulic head and the filtration forces will be retraced through a micromechanical approach and with particle numerical models like the discrete element method.

Finally, some real examples will be shown in which the search for a link between precipitation and stability and between groundwater levels and stability has produced more or less accurate forecasting models.

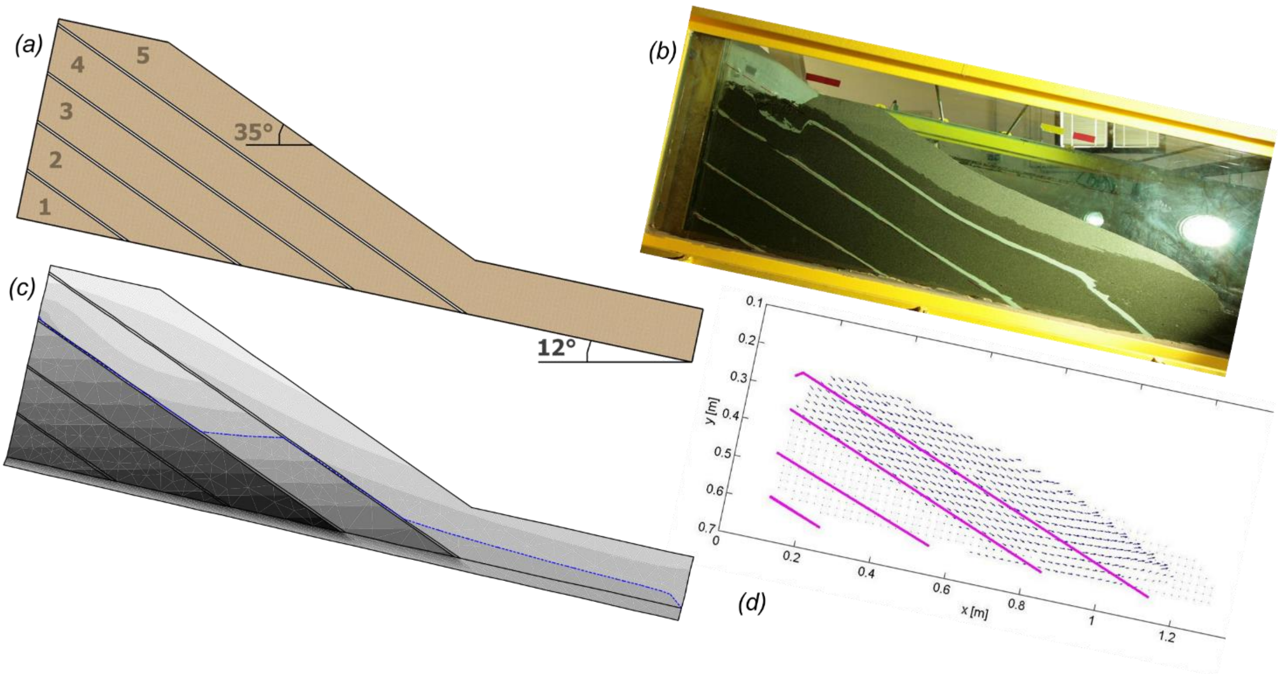

Fig. 1: (a) Layout, (b) final configuration, (c) pore water pressure at the collapse and (d) displacement field for a laboratory layered sandy-clayey slope (adapted from Gabrieli et al, 2010).

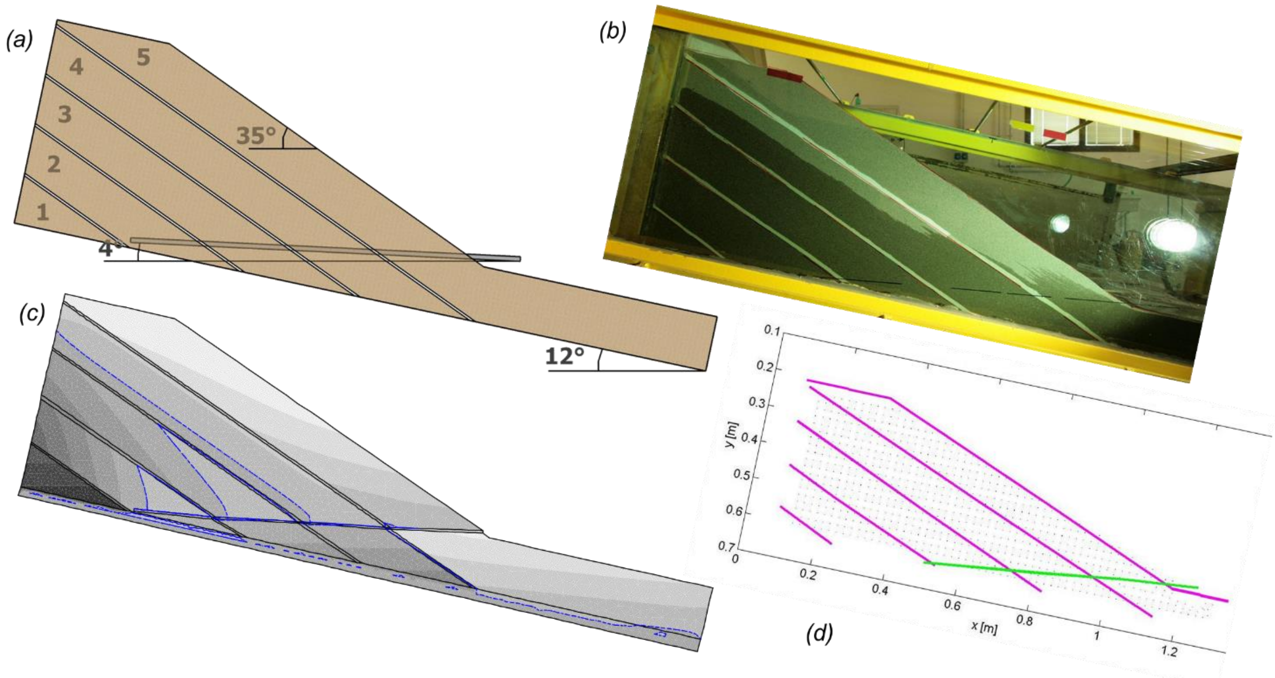

Fig. 2: (a) Layout, (b) final configuration, (c) pore water pressure and (d) displacement field for a laboratory layered sandy-clayey slope with low inclined drains (adapted from Gabrieli et al, 2010).

References

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