Three Dimensional Transient Seepage and Slope Stability Analysis of Landslide Dam

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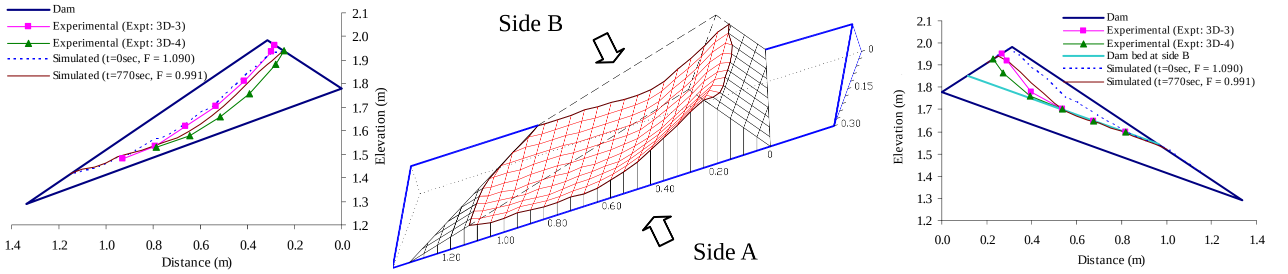
Temporary or permanent blockages of river by mass movements commonly occur in mountainous area due to heavy rains or earthquakes. Landslide dam formed by this process may fail by erosion due to overtopping, abrupt collapse of the dam body or progressive failure. Water infiltrates through the landslide dam in a transient manner, so the slope stability analysis coupled with transient seepage analysis is useful to study stability of landslide dam.

The failure of natural slopes and landslide dams confined in a narrow U- or V-shaped valley occurs in three dimensions. This study focuses on 3D transient slope stability analysis of landslide dam and prediction of the failure due to sudden sliding through flume experiments and numerical simulations.

The numerical procedure used for the identification of critical noncircular slip surface with the minimum factor of safety is based on dynamic programming and random number generation incorporated with 3D simplified Janbu method. This approach is applicable to an arbitrary shape of slip surface. This study extended model of slope stability (3D) by coupling with model of transient seepage flow (3D). Thus proposed model is capable to calculate the factor of safety, the geometry of critical slip surface and time to failure according to pore water pressure and moisture movement in the dam body.

Numerical simulations and flume experiments were performed to investigate the mechanism of landslide dam failure due to sliding. Steady discharge was supplied in the upstream reservoir.

The simulated and observed failure surfaces in the two faces of the flume are shown in **Fig. 1**. Comparisons show that results of numerical simulations and experimental measurements are quite close in terms of movement of moisture in the dam body and predicted critical slip surface. However the time to failure of the dam body is earlier in the simulation compared with experiment. 3D simplified Janbu method satisfies the horizontal and vertical force equilibrium while it does not satisfy the moment equilibrium. In addition, the method assumes that the resultant interslice forces are horizontal. These assumptions produce factor of safety that are smaller than those obtained by more rigorous method that satisfy complete equilibrium. The model can be further improved by incorporating more rigorous method of slope stability analysis so that the model can be used for the slope stability analysis of both landslide dam and natural slopes.



Critical slip surface in side A | Simulated critical slip surface at t = 770sec | Critical slip surface in side B

Fig.1 Experimental and simulated critical slip surface