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Preliminary investigations and numerical analysis of a landslide reactivation in the Rječina River Valley, Croatia

A large landslide occurred at the south-western slope of the Rječina River Valley in outback of the City of Rijeka, Croatia, on 13 February 2014 after long term period of heavy rain. The landslide is located in the Rječina River Valley which is very well known as an area prone to sliding with a lot of landslides recorded in the past and recent history. The toe of the landslide reached the bank of the Valići Reservoir 250 m upstream of the Valići Dam. The landslide movements of approximately 12 to 15 m down the slope caused the complete damage of the local road over the landslide body (Figure 1). In the course of urgent measures, the preliminary surface observation was carried out immediately after sliding appearance enabled estimation of site condition, dimension of the landslide as well as an assessment of a hazard and risk of further landslide movements and impact on reservoir and dam. The estimated dimension of landslide body are length of 350 m, width of 135 m and 20 to 30 m of soil deposits to the slip surface.

Figure 1. Road damages caused by landslide

Even if the detailed filed investigations were not carried out, the analysis of possible further development of sliding was conducted. To establish the engineering geological model of the landslide, engineering geological mapping in combination with visual analyses of existing airborne LiDAR scanning data (performed in March 2012) were carried out. It was identified that the recent landslide is the reactivation of the dormant landslide which contours were clearly visible on LiDAR images. Borders of both dormant and reactivated landslides were confirmed by engineering geological mapping on the new topographic map. The reactivated landslide included only part of the dormant landslide area. Since a slip surface position was not identified by the field investigation, a numerical analysis of a slope using the strength reduction method was introduced to determine the shape of the zone of rupture which would be used in landslide simulation.

As a main hazard of further landslide movements, the filling of the Valići Reservoir, forming a landslide dam and overflow of the downstream located dam were identified. To determine possible scenarios those could be realized, numerical simulations of further landslide development were conducted using LS-Rapid simulation software. While the foot of the landslide is submerged in the reservoir, the magnitude of motion, run off sliding path and deposition of sliding mass significantly depend on the reservoir water level. The landslide simulations were conducted for four different reservoir water levels correspondent to full reservoir, overflow level, and two lower safety levels. In case of high reservoir water level correspondent to the dam overflow, the sliding mass would significantly fill the reservoir and cause the landslide dam, while the water level rising and landslide caused waves (tsunamis) would overflow the Valići Dam and cause significant damage downstream the Rječina River channel (Figure 2). Conducted numerical simulation results enabled a selection of relatively safe reservoir water level at which, in case of further landslide movements, no current harmful consequences would be realized but the reservoir filling by sliding mass would cause significant reduction of reservoir volume, disturbances in the Rječina River and Valići Reservoir flow regimes so as long term disruption of hydro power plant working.

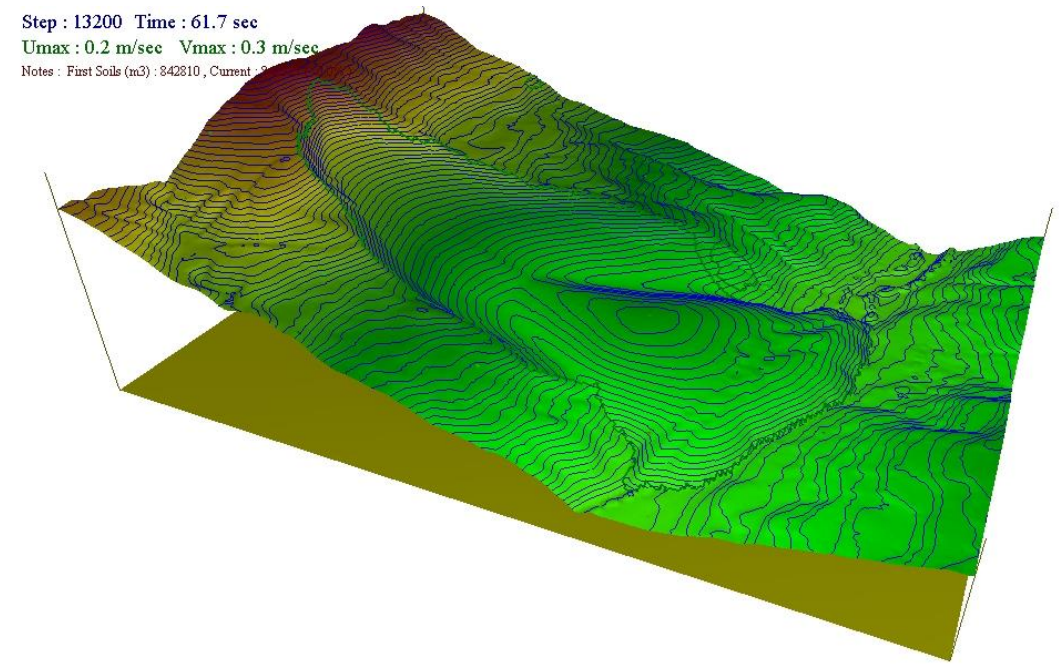

Figure 2. Result of numerical analysis of a landslide reactivation with LS-Rapid simulation software