3D modeling of a damaged Sabo dam with a combination of a DSM and near-surface geophysical survey data

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We conducted an integrated analysis of high-resolution digital surface model (DSM) and detailed geophysical survey data obtained on the rear wall of a sabo dam, which had been damaged by a huge debris flow occurred in July 9, 2014. An orthophotograph and a DSM of the rear wall of the dam were reconstructed from a set of surface digital photo images at a spatial resolution of 1.2 cm using commercial multi-view stereo (MVS) software (Agisoft Photoscan). The debris flow swept away the top 5 m part of the dam, and segmented the dam body into several blocks associated with horizontal cracks. Estimated surface dislocation was at most 20 cm. Our DSM covered the right half surface of the dam (left bank side), about 30 m wide and 20 m high. We also carried out GPR measurements on the surface, 10 m wide and 15m high, by hanging and moving up the tool along the surface from the top of the dam. A total of 50 lines was scanned at 20 cm intervals. In addition, high-resolution seismic measurements were conducted along 5 survey lines set horizontally on the surface. Piezoelectric type accelerometers were pasted on the surface at 20 cm intervals, and manual hit using rock hammer was employed for generating high-frequency signals.
Because the dam surface was too steep and too high to place a number of GCPs by hand, only 3 points were set on the surface at reachable distances. Then we built a DSM projected on the inclined plane defined by these 3 points. Detailed GPR measurements successfully imaged fractures at the shallow depths up to 1 m, and high-resolution seismic survey detected dipping fractures extending into the deeper portion in the body up to 8m. In addition, photogrammetric analysis clearly mapped blocked deformation. Finally, we combined these planes to create a 3D model with aid of a 3D modeling tool named Voxler provided by Golden Software. In conclusion, joint interpretation of geophysical survey results with the photogrammetric analysis was quite helpful to interpret the dislocation process of the dam body. GPR and high-resolution seismic survey results also demonstrated their applicability for the delineation of internal fracture in large concrete structures.

Keywords: Orthophoto, DSM, Sabo dam, GPR, Fracture Imaging