Making of a detailed DSM of a partially collapsed road embankment and correlation with 3D GPR data

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We conducted an urgent but detailed field survey at a site where 8 m high road embankment slope had been partly collapsed by heavy rainfall along with strong motion of 2016 Kumamoto Earthquake 2 months before. The field measurements consisted of high-density surface photogrammetry and near-surface geophysical surveys. We employed a telescopic pole camera system and RICOH GR2 to take digital photographs in the air up to 6 meters. Finally, we made an orthophoto image and a DSM of a road surface which had escaped from collapsing at a spatial resolution of 2.86 mm using a commercial SfM-MVS (structure from motion and multi-view stereo) software package (Agisoft PhotoScan Professional). We used a total of 218 pole camera images and 7 GCPs to create the DSM. In addition, we processed UAV imagery taken on the day after the collapsing to generate a DSM of 2.5 cm spatial resolution of the site. The DSM, which covered 110 m x 90 m area, clearly imaged the embankment collapse and heaving of the ground in front of the failure caused by compression and thrusting. It was helpful to clarify the failure mechanism of road embankment and the role of geotextile-anchored concrete wall set at the foot part of the embankment to avoid entire collapsing of the embankment. Furthermore, we could identify non-tectonic structures from the road surface DSM. Number of cracks and small bulges were traced behind the failure crown, which indicated the co- or post-failure movement of the remained embankment. Then we conducted dense grid GPR survey on the road surface. As a result, cracks extended in the pavement up to 75 cm and the surface pavements were interpreted to be segmented and detached from the underlying road beds. Joint investigation and interpretation of the surface DSM and the near-surface geophysical data was capable to assess the safety conditions of remained road embankment. Namely, which types of restoration works were needed and what extent should be reinforced. In conclusion, combined analysis of surface DSM with the near-surface geophysical survey data is crucial to understand such surface deformation structures as slope failure.

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