3D modeling of an embankment failure site by combining time series DSMs with near surface geophysical survey data

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We conducted detailed near surface geophysical surveys at a site where 8 m high road embankment slope had been collapsed in June, 2016 by a heavy rainfall along with strong motion attack by the 2016 Kumamoto Earthquakes 2 months before. Field measurements were implemented 4 times since August 2016 to August 2017, during excavation and removal works of the collapsed embankment body. The measurements consisted of DC resistivity tomography (ERT), capacitively coupled resistivity (CCR) survey using OhmMapper, “Hybrid” surface wave survey newly proposed by the authors (Inazaki, et al., 2015), high-frequency surface wave survey, GPR survey, cone penetration test (CPT), and S-wave vertical seismic profiling (SVSP). Supplemental core sampling and core analysis were also carried out by ourselves. A total of 9 major survey lines were set along or across the embankment, and a number of short survey lines were placed on the crown road surface of the main scarp to delineate deformation structure in the pavement and the remained embankment body.

During repair works of the collapsed embankment, aerial photographs were taken using UAVs by a local government office 6 times. We processed them using Agisoft Photoscan Professional to create an orthophoto and a DSM at each stage.

Finally, we combined the surface DSMs and orthophotos with subsurface geophysical data to make an integrated 4D (time series 3D) model of the embankment failure site with the aid of a 3D modeling tool named Voxler provided by Golden Software. It was regretful that original 3D landform information before the collapse was not obtained, but we could barely estimate a wireframe model of the road embankment on the basis of 2D CAD data. It enabled us to evaluate the displacement vectors of not only the surface points of interest but also a number of subsurface ground improvement piles, which cropped out after the excavation. In conclusion, integrated 3D interpretation of the subsurface geophysical survey results with the time series DSMs was quite helpful to understand failure process of the embankment body and underpinned piles.

Keywords: DSM, Embankment failure, 3D model, Near surface geophysics