Near surface geophysical survey of the ground in front of a road embankment partially collapsed by a heavy rainfall

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We conducted an urgent but detailed near surface geophysical survey at a site where 8 m high road embankment slope had been partly collapsed by a heavy rainfall along with strong motion of 2016 Kumamoto Earthquake 2 months before. Owing to a geotextile-anchored concrete wall preset at the foot part and 8 m long preventative pile arrays penetrated in front of the road embankment, the slope failure was minimized and debris runoff stayed in a limited zone. Meanwhile, the embankment collapse caused a half-moon shape deformation, 20 m in radius, and upheavals up to 2 m, to the ground in front of the collapse. We set a total of 4 short survey lines in and outside of the deformation zone to identify the extent of the deformation in depth direction. Employed methods were DC resistivity and “Hybrid Surface Wave Survey” recently proposed by the authors. The Hybrid Surface Wave Survey method is characterized as the combination of active and passive surface wave survey simultaneously conducted along the same seismic line. A number of geophones, set along a line at 0.5 m intervals, were used to record active surface hitting waveforms and passive microtremor. Two dispersion curves, one is for a higher frequency part calculated from active survey records, and the other is for the lower frequency part calculated from passive seismic records, were combined to form a single dispersion curve for a specific CMP in a survey line. As a result, DC resistivity measurements provided clear layered structures along the lines. Resistivity sections were concordant with estimated geologic structures but no difference was observed between the sections in and outside the deformation zone. In contrast, S-wave velocity sections showed a characteristic structure in the deformation zone. Namely, the S-wave velocities were as low as 30 m/s in the deformation zone. Thicknesses of the low velocity layer increased toward the major axis of the collapsed body up to 10 m in depth. These features were not obvious along the line set outside of the deformation zone. The field survey results demonstrates that near surface geophysics is helpful for the site characterization of landslides or slope failures on the basis of not only surface evidences but also of near surface structure.

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