

An Integrated Geophysical Investigation for Earthen Dam Inspection: A Case Study of Huai Phueng Dam, Udon Thani, Northeastern Thailand

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Abstract : In the middle of September 2017, a tropical storm named 'DOKSURI' swept through Udon Thani, Northeastern Thailand. The storm dumped heavy rain for many hours and caused large amount of water flowing into Huai Phueng reservoir. Level of impounding water increased rapidly, and the extra water flowed over a service spillway, morning-glory type constructed by concrete material for about 50 years ago. Subsequently, a sinkhole was formed on the dam crest and five points of water piping were found on downstream slope closely to spillway. Three techniques of geophysical investigation were carried out to inspect cause of failures; Electrical Resistivity Imaging (ERI), Multichannel Analysis of Surface Wave (MASW), and Ground Penetrating Radar (GPR), respectively. Result of ERI clearly shows evidence of overtop event and heterogeneity around spillway that implied possibility of previous shape of sinkhole around the pipe. The shear wave velocity of subsurface soil measured by MASW can numerically convert to undrained shear strength of impervious clay core. Result of GPR clearly reveals partial settlements of freeboard zone at top part of the dam and also shaping new refilled material to plug the sinkhole back to the condition it should be. In addition, the GPR image is a main answer to confirm that there are not any sinkholes in the survey lines, only that found on top of the spillway. Integrity interpretation of the three results together with several evidences observed during a field walk-through and data from drilled holes can be interpreted that there are four main causes in this account. The first cause is too much water flowing over the spillway. Second, the water attacking morning glory spillway creates cracks upon concrete contact where the spillway is cross-cut to the center of the dam. Third, high velocity of water inside the concrete pipe sucking fine particle of embankment material down via those cracks and flushing out to the river channel. Lastly, loss of clay material of the dam into the concrete pipe creates the sinkhole at the crest. However, in case of failure by piping, it is possible that they can be formed both by backward erosion (internal erosion along or into embedded structure of spillway walls) and also by excess saturated water of downstream material.

Keywords : dam inspection, GPR, MASW, resistivity

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