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# Numerical simulation of debris flow initiation caused by up-welling ground water and surface runoff

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Due to the fragile geological condition and heavy rainfall caused by severe weather, Taiwan is prone to debris flow hazard. Debris flow has been a significant hazard causing severe losses of human lives and properties, especially after the Chi-Chi earthquake, 1999. The initiation of debris flow is closely related to the water flow and pore water pressure induced. Takahashi (1991) suggested that the surface flow was the main factor for triggering of debris flow, while Sitar, et. al. (1990) observed that up-welling of ground water could induce pore water pressure in the bedding layer and trigger debris flow. In this research, numerical model was established to simulate generation and transport of the pore water pressure from the up-welling ground water and surface runoff. Based on the pore water pressure generation and distribution, the state of stress of the soil layer could be determined and the condition of debris flow initiation could be defined.

For the construction of the numerical model, the finite element method was used by applying a commercially available software ABAQUS. The material was assumed to be a two dimensional, poro-elastic material, and the Darcy's law applied. The results of flume test on different water supply mechanism by Lin and Wang (2002) were used in the simulation and verification of the numerical model. Both types of water supply as up-welling of ground water and surface runoff were simulated, and the pore water pressure generation and transportation during the processes were calculated. The results of the numerical model of pore water pressure generation and accumulating tendency appeared to be consistent with the laboratory measurements. The failure phenomenon in the numerical model could be observed following the resulting stress path of the soil mass and agreed well with the observation of debris flow initiation

in the flume test. Thus, with the model and proper monitoring of field conditions, the initiation of debris flow in the field could be simulated. Such model could provide as a support to the early warning system along with the monitoring of pore water pressure generation in the field.