

Study on Piping Failure of Natural Dam

○Ripendra AWAL, Hajime NAKAGAWA, Masaharu FUJITA, Kenji KAWAIKE, Yasuyuki BABA and Hao ZHANG

Natural dams may fail due to seepage or piping because they have not undergone systematic compaction and they may have high porosities. This may cause seepage through the dam that could potentially lead to failure by internal erosion (piping). This study focuses on piping failure (internal erosion) of natural dam with an assumption that a pipe leading from the upstream to the downstream face already exists. In-depth knowledge of the mechanism of the dam failures by piping and measured data are still lacking. Extensive laboratory experiments are carried out to study enlargement of the pipe due to internal erosion and resulting outflow hydrographs by varying water level in the upstream lake, size of initial pipe, lake water volume, slope and location of the pipe. In all experiments fine sediment is used to prepare dam, so the top part of the dam above the pipe is stable. The schematic diagram of the flume and other accessories used in the experiments are shown in Fig. 1.

For the same lake water level and volume, the size of the enlarged pipe and peak discharge is slightly lower in the case of smaller initial pipe size. However peak discharge occurred just after sufficient enlargement of the pipe, so there is time lag between occurrences of peak discharge in different sized pipes. For the same lake water level, same size and slope of the pipe the failure process depends on location of the pipe. Dam may fail by i) enlargement of piping, ii) enlargement of piping and headcut erosion and iii) headcut erosion based on the location of the pipe at different level. Enlargement of the pipe in the case of steeper flume/pipe slope is faster, so the peak discharge occurred earlier and magnitude of the peak discharge is also higher even if the volume of upstream lake

water is smaller for steeper slope. When flow changes from pressure flow in the pipe to free surface flow and the material above the enlarged pipe is stable, the flow discharge may increase based on progress of seepage flow in the dam, headcut erosion and size of the enlarged pipe.

Experimental results show non uniform enlargement of the pipe along its length, different magnitude and occurrence time of peak discharge for different initial size, location and slope of the pipe. Headcut erosion of the pipe occurs internally during the erosion process. The assumption of unrealistic failure of the material above the pipe may underestimate peak discharge if the remaining part of the dam is stable even if pressure flow in the pipe changed to free surface flow. For the improvement of model to predict outflow hydrograph due to piping failure of the dam we have to consider these phenomenons. The experimental results and data set will provide an opportunity to improve existing model to estimate flood hydrograph due to piping failure of natural dam.

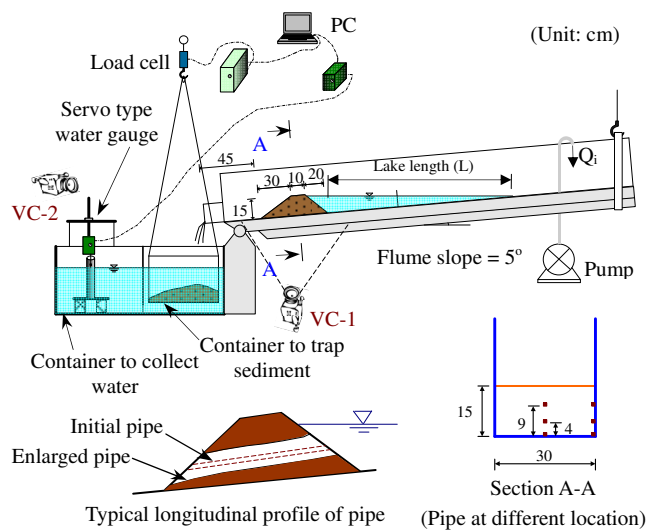


Fig. 1 Schematic diagram of the experimental setup.