For Clarification of the Mechanism of Seepage Failure in Levees
- Undertaking Full-scale Experiment -

SUWA Yoshio, Head, FUKUSHIMA Masaki (Dr. Eng.), Senior Researcher, SASAOKA Shingo, Researcher, UENO Toshiyuki, Guest Research Engineer
River Division, River Department

Key words: river levee, seepage, piping, full-scale experiment

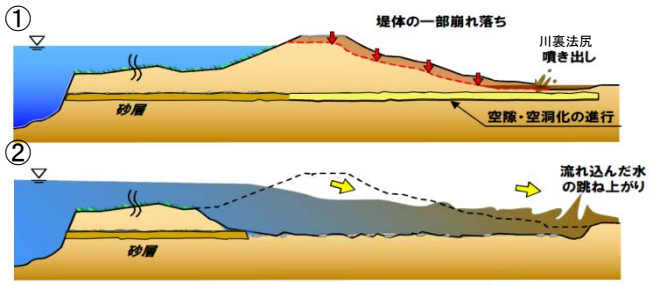
1. Introduction

The process of levee failure in case of a flood is roughly divided into "overtopping," which means the river water flowing over the levee and "infiltration" or "erosion," which occurs when the river water is lower than the levee height. In recent flood damages, still fresh in our memory is the Kinu River, Northern Kanto Region, in September 2015, Sorachi River, Hokkaido, and Omoto River, Iwate-ken, both in August 2016. These flood damages were caused mainly by "overtopping." On the other hand, there are cases of levee failure caused by "infiltration" as in the Yabe River in Northern Kyushu in July 2012. Thus, the activity to eliminate such weak points in levees is important.

2. Levee failure by piping

In the Yabe River, there is sand layer under the levee, through which river water is likely to flow out, and sand boil occurred due to the seepage water from the river near the landside slope toe, which causes a cavity under the levee. Then, the levee subsided due to the loss of support and consequently failed (See Figure). Thus, a phenomenon where seepage water concentrates in the ground and a pipe-shape water path is created is called "piping."

There is sand stratum under the levee in many rivers. In the Kinu River above, "sand boil," a precursory phenomenon of piping, was also found at many as 23 spots. It is therefore important to clarify the mechanism of piping, i.e., under what conditions piping occurs and results in levee failure.



Based on The Report of the Yabe River Levee Investigation Committee

Figure: Progression of Levee Failure by Piping

3. Approach based on model experiment

NILIM is studying the mechanism of levee failure with model experiment and numerical analysis. In fiscal 2014, we organized the ground and water level conditions under which piping is likely to occur, using a model sampling a levee slope toe. [1] In fiscal 2015, we conducted a model experiment by reproducing an entire levee with reduced dimensions in order to grasp the performance of the entire levee when piping develops, and succeeded in reproducing a levee failure by piping. [2] From the current fiscal year, we are undertaking an experiment reproducing piping using a real-size model for the first time in Japan.

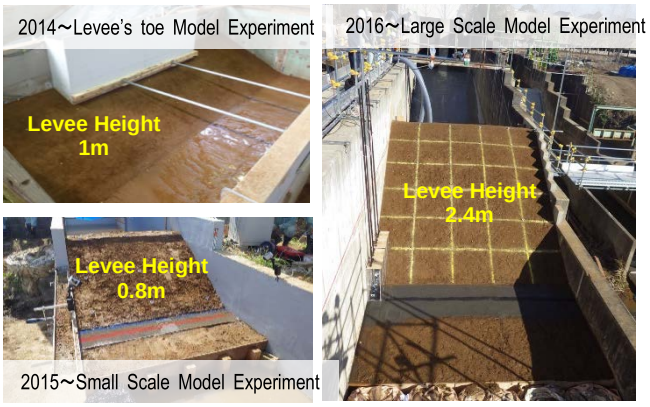


Photo: Types of Model Experiments

4 Conclusion

In the full-scale experiment, we will clarify the scale effect, which is an issue on reduced experimental model and verify the validity of the knowledge accumulated so far. Results of this experimental is to be published on the website of River Division (http://www.nilim.go.jp/lab/fbg/).

☞See the following for details.

1) Kurata et al. "A Model Experiment for the Progressive Failure of a River Levee by a Permeable Foundation Ground", The 2015 River Engineering Symposium, pp. 361-366, June 2015
2) Ueno at al, "Experiments for the Progressive Failure of a River Levee on the Permeable Foundation Ground using the Reduced Scale Embankment Model", The 4th River Engineering Symposium, pp. 1-4, Nov. 2016