Resilient Structure for Coastal Dikes -- Structural Device Considering the Effect of Pressure Increase in Dike Body --

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1. Background and objective

Engineers have long sought a coastal dike structure that can be resilient even in the case of a tsunami exceeding the designed tsunami height of the dike. When tsunami waves overtop a three-face-armored concrete dike, saturated surface in the dike body increases as water penetrates the body; the force of the overtopping water results in scouring on the landward side. To protect the landward slope toe from scouring, soil improvement and other remediation methods were found to be effective [1)], and soil improvement was adopted in the disaster restoration project for the Southern Coast of Sendai Bay. This study examined a resilient structure against tsunami overtopping for coastal dikes with flat laid concrete armor, for which the pressure rise in the dike body is a concern, by conducting experiments with a large model to detect pressure rises in the dike body in the case of tsunami overtopping. [2)]

2. Results of study

First, pressure gauges were attached under the concrete armoring to measure the pressure inside the dike body during overtopping. It was found that, when the tsunami overtopped the coastal dike, pressure under the concrete armoring increased and reached a level at which the concrete armoring on the landward slope could become unstable. This would depend on conditions, since a filter layer is provided under the concrete armoring or seaward slope toe to accelerate saturation into the dike body.

Next, assuming an area where the space on the land side of the dike was limited, an experiment with a large model was conducted. The purpose of this experiment was to study the impact of the filter layer under the concrete armoring and the effect of sheet piles (e.g., sheet piles installed under the foundation of a coastal dike with concrete armoring to control scouring). Movement of the landward slope armoring was controlled when no filter layer was provided under the armoring, and movement of the foundation was controlled by combining the landward slope armoring with the embankment soil by an iron frame.

The disaster mechanism of coastal dikes with concrete armoring that was confirmed by this experiment is illustrated in Fig. 1. Considering this mechanism, as shown in Fig. 2, a filter layer that facilitates saturation in the dike body between the armor and dike body soil should be avoided. It is also effective to provide a device that controls the movement of the landward slope armoring, and thus, reduces the force with which the landward slope armoring pushes the foundation when the pressure increases inside the dike body. It is also effective to install sheet piles in the foundation to control its movement, although they are not as strong as soil improvement.

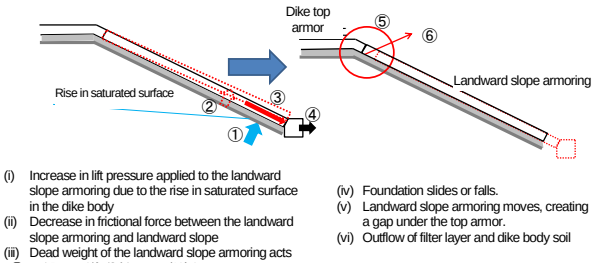

Figure 1: Disaster Mechanism of Landward Slope Armoring by Rise in Saturated Surface

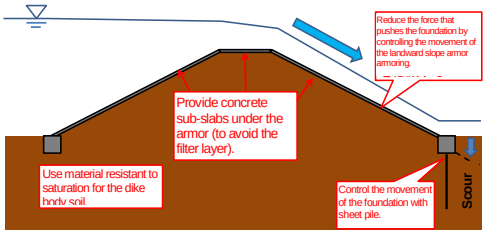

Figure 2: Structural Device for Coastal Dike with Concrete Armors in Limited Space

[Reference]
1) NILIM: A Study on Resilient Structures for Coastal Dikes, NILIM Technical Bulletin, 2012
http://www.nilim.go.jp/lab/fcg/labo/02_02.html
2) Kato, Suwa & Hatogai: Structures for Coastal Dike with Concrete Armors Resilient to Tsunami Overflow, Journal of JSCE, Series B2 (Coastal Engineering), Vol.69, No.2, pp.I_1021-I_1025, 2013.