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Model Experiment and Numerical Analysis for the Reinforcing Bar Insertion Work with Pipe

Kakuta Fujiwara[1]
[1] Dept. of Engineering/Tokai University
4-1-1 Kitakaname, Hiratsuka-shi, Kanagawa, 259-1292, Japan
fujiwara.kakuta.s@tokai.ac.jp

Extended Abstract

It is an urgent issue for preventing slope failure caused by increasingly severe earthquakes and heavy rain. We propose an easy-to-construct and inexpensive slope reinforcement structure to prevent slope failure due to earthquakes or heavy rain (e.g. [1] and [2]). Reinforcing bar insertion work, which is a conventional construction method, uses the tensile force of the reinforcing bar to integrate multiple reinforcing bars and pressure plates into the soil, which increases slope stability (e.g. [3]). Meanwhile, landslide deterrence piles are a construction method where steel or concrete piles are constructed below the slope, and the rigidity of the piles is used to resist slope sliding (e.g. [4] and [5]). These methods are effective against slope failure and are widely applied. In this study, these methods are combined to propose a reinforcing bar insertion work that uses pipes as a construction method (e.g. [6]). The pipes are not embedded in the immovable layer and are not connected to the reinforcing bar insertion work; therefore, the construction is expected to be simple.

The effectiveness of the countermeasure of the proposed construction method was examined through model tests. Soil and countermeasures (reinforcing bar and pipe) were placed inside a small stainless-steel box. A slope was created and collapsed by lifting gradually one side of the box. The angle of the box and the bending strain of the reinforcing bar were measured during the experiments. Fourteen experimental cases were conducted by varying the pipe diameter and the interval between countermeasures. The failure angle in the case of reinforcing bar insertion with a pipe was higher than that in the case of reinforcing bar insertion without a pipe. Additionally, the larger the pipe diameter and number of pipes, the more stable the slope at higher slope angles. The larger the pipe diameter, the greater the load applied to the pipe and core bar. This is because a large-diameter pipe can support a wide range of soil on the pipe. The greater the number of pipes, the lower the load applied to the pipes and core bars. This is because the load is distributed among multiple pipes.

Numerical analysis was also conducted to propose a design method for the reinforcing bar insertion work with pipe. The three-dimensional finite element method software PLAXIS3D was used in this analysis. As a result, it was confirmed that the numerical analysis successfully reproduced the results of the model experiment. Furthermore, the stress in the pipe, which could not be measured in the model experiments, has been clarified. The stress in the pipe was sufficiently small, and it is considered that even materials with low strength can be used in the proposed method for the construction.

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