A Stability Analysis of Soil Gabion Retaining Wall on Riverbank

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ABSTRACT.

This paper presents a numerical stability analysis to the failed case of a soil gabion retaining wall on the riverbank due to a heavy storm experienced. The UUU and SUU triaxial compression tests are performed first to study the influence of soils confined with woven and non-woven geotextiles at the relative density of 95%, 90%, 85%, and 80% on the strength and stiffness. Then, a series of the numerical analyses are carried out under (1) normal river condition, (2) storm river condition, and (3) drawdown condition. The results from analyses show that the soil gabion retaining walls are stable but appear a large movement outward under storm and drawdown condition. The results of the analyses are quite similar to those of failed case observed.

KEY WORDS: Soil gabion; geotextile; drawdown.

INTRODUCTION

Gabion walls have been used in the construction of erosion protection works, earthen embankment retaining walls for slope stability, and hydraulic structures. The advantages of gabion include very porous, flexible, strong, durable, reliable, easily constructed, and ecological. The gabion manufactured is usually a rectangular-shape unit which can be readily stacked into a variety of geometric configurations. The gabion unit is fabricated by the wire coated with polyvinyl chloride to prevent corrosion. The unit is available in 2, 3, and 4 meters lengths, 1 meter widths, and 1 meter heights. They are subdivided into cells, each cell being 1 square meter in size. The gabions are usually filled with stones which require qualities of weather resistance, non-friability, non-dissolution, and high stiffness. However, the stones in such requirements are of shortage gradually, and soils with gravel are used instead. A term of soil gabion is named in this paper. The difference in between is that the soil gabion requires a bag fabricated by a geotextile with highly UV resistance placing into the wire-cell unit before filling the soils. Due to advantages as mentioned above, the soil gabion retaining wall has been widely used to protect as a structure for riverbank in Taiwan. One of such retaining walls was constructed but collapsed in one year after construction by a heavy storm experienced. Generally, the design approach for soil gabion wall may refer to the conventional concept of retaining walls, which is based on limit equilibrium method and can be divided in two parts as (1) external stability analysis for sliding, overturning, and bearing capacity, and (2) overall stability analysis for shear failure of riverbank slope with soil gabion retaining wall. By applying conventional design method to the soil gabion retaining wall, the effects of soil gabions on strength is not taken into account to the stability analysis concerned. Bathurst et al. (1993) conducted a large-scale triaxial tests on sandy soil confined with a single thin walled flexible geocell. Rajagopal et al. (1998) reported the results from triaxial test on granular soil confined with single geocell and multiple geocells. The results have shown that the geocell confinement does not change the friction angle of soil whereas it induces some cohesion strength to granular soils. Chai et al. (2007) utilized PFC numerical simulation to study the influence of reinforcement on the earth stress of gabion retaining wall. It was found that the earth pressure behind the wall reached passive state at a depth of 5 m and appeared active state at a depth of 2 m which were corresponding to results of field measured. Hence, the purpose of this study presents first to investigate the mechanical behavior of soil confined with geotextiles by a series of triaxial compression tests, and second to analyze the failed case of soil gabion retaining wall by a numerical method under various conditions of river level changed.

FIELD CASE HISTORY

A-Kon-Tein River is located in Kaohsiung County of the southern Taiwan and has its origin in the Wu-Shan-Din and enters into the Taiwan Strait, after flowing for about 38 km. The upstream, about 7 km, of A-Kon-Tein River was constructed with the soil gabion retaining walls to protect from the erosion of the riverbank during the year of 2004. Two levels of the soil gabion walls were constructed; one is on the riverbank and the other is on the flood-control road of the river channel. On July 20, 2005, the Haitang typhoon brought a very heavy rainfall and resulted in a part of soil gabion retaining walls collapsed. The storm dumped nearly 874 mm of rain in five days on the area, where the normal yearly rainfall is about 1800 mm. The intensive rainfall saturated the upper portion of the slope and soil gabions and led the upper level of soil gabions sliding down on the flood-control road. The top of lower level of the soil gabions moved outward as much as 20 cm observed in the field. A photograph of the damages of the soil gabion retaining wall is shown in Fig. 1. As shown in Fig. 1, the portion A is the top of hill slope. The portion B is of 6-layer soil gabions constructed on the flood-control road which is indicated in portion C. It is of 6 meters height with slope angle of 60° from the top of slope to the top of soil gabion retaining wall of the flood-control road. The portion D is the channel of the river where a 4-layer of soil gabions constructed as a protection of riverbank. According to the design report of the river, the level of river under 50-year return period flood will not exceed the flood-control road. The site is consisted of 20 m-thick of...