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Research Article

Evaluation of Critical Parameters to Improve Slope Drainage System

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This study focuses on identifying and evaluating critical parameters of various drainage configurations, arrangement, and filter which affect the efficiency of water draining system in slopes. There are a total of seven experiments with different types of homogeneous soil, drainage envelope, filter material, and quantity of pipes performed utilizing a model box with a dimension of 0.8 m × 0.8 m × 0.6 m. The pipes were orientated at 5 degrees from the horizontal. Rainfall event was introduced via a rainfall simulator with rainfall intensity of 434.1 mm/h. From the experiments performed, the expected outcomes when utilizing double pipes and geotextile as envelope filter were verified in this study. The results obtained from these experiments were reviewed and compared with Chapter 14 "Subsurface Drainage Systems" of DID's *Irrigation and Agricultural Drainage Manual* of Malaysia and the European standard. It is recommended that the pipe installed in the slope could be wrapped with geotextile and in tandem with application of granular filter to minimize clogging without affecting the water discharge rate. Terzaghi's filter criteria could be followed closely when deciding on new materials to act as aggregate filter. A caging system could be introduced as it could maintain the integrity of the drainage system and could ease installation.

1. Introduction

Malaysia is located in the tropics where heavy rainfall and thorough in situ chemical and mechanical weathering result in the development of deep residual soil profiles. Slope failures are affected rapidly by rising groundwater level and rainfall infiltration due to the frequent high-intensity tropical rainfalls. Installation of horizontal drains in slope is one of the common methods used by engineers to lower the amount of excess water in slopes. Horizontal drains could be defined as holes drilled into a slope and cased with perforated metal or slotted plastic linearly to drain out groundwater [1, 2]. Horizontal drains have been used successfully to improve slope stability [2–7]. However, Martin et al. [8] stated that the prescriptive drainage systems are not critical in achieving a specified factor of safety.

According to Ahmed et al. [2], the earliest usage of horizontal drains was recorded in 1843 in Great Britain to stabilize railway slopes which involved very deep cuts, while in the USA, its usage was first reported in 1939, but the method only gained acceptance within the continent in the early 1970s. Stanton [9] reported the successful use of horizontal drains to numerous landslides by the California Division of Highways. In Australia, its usage was first reported in the mid-1960s, while in France it was first used in 1954. Craig and Gray [10] found that, in Hong Kong, horizontal drains have been used at shallow depths, rarely more than 20 m in length since 1973.

However, it is observed that a number of slope drainage systems utilizing horizontal drains in Malaysia did not function properly in the long term and drained the water inefficiently from slopes. Clogging of drainage pipes by soil sediments which leads to reduced efficiency in draining water is a typical condition that inevitably could cause slope failures. Hence, there is a need to understand the influence of these technical parameters to help improve the existing prescriptive design. In Malaysia, manuals available for designing the pipe drains are *Urban Stormwater Management Manual for Malaysia* (MSMA) and *Irrigation*