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Testing the Concept of Mitigating Urban Flooding with Permeable Road: Case Study of Tong Wei Tah Street, Kuching City, Sarawak, Malaysia

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Abstract

This paper describes the investigation of permeable road as a mitigation measure for urban flooding. The study involves the reconstruction of a historical case of inundation, namely the 11 December 2019 flood event along the Tong Wei Tah Street in Greater Kuching City, Sarawak, Malaysia. The Storm Water Management Model version 5.0 was used as the platform to describe the flooding at the selected site and the functionality of permeable road to alleviate flooding. A permeable road with a dimension of 200 m long, 6 m wide and 1 m deep was simulated along the whole stretch of Tong Wei Tah Street. The model results show that flooding was caused by a backwater effect in the drainage system. Models predicted 0.1 to 0.5 m flood depths which matched the observed 0.3 m flood depth account of a local resident. The permeable road exhibited capability to absorb all the out-of-drain floodwaters, leaving no water due to the 11 December 2019 flood on the street. Modelling efforts demonstrated that the floodwater hydrographs in the drain rose and fell within 7 h, while the underground storage, filled and drained within 13 h. Moreover, the storage of permeable road was found to fill up to 75 %, reserving the unfilled 25 % for adverse weathers.

Keywords: Drain, Flash flood, Permeable road, River, Stormwater detention, Urban runoff

Introduction

Flood mitigation is human intervention that may consist of one or more measures to lessen the impacts of flooding [1,2]. The impacts usually mean losses of lives, damages to goods or properties and disturbances to daily activities. One of the ways to mitigate flood is to divert the floodwaters away so that it would not accumulate on the urban surfaces [3]. Permeable road designed with an underground water structure is an example of a flood mitigation measure. It could help divert floodwaters from above-ground surfaces to the underground structure. A permeable road could alleviate the impacts of flash flooding by providing a temporary water holding place and the waters could be released once the waterway is cleared of congested running water [4,5].

This paper intends to model the flooding processes that involve water transitioning between the waterway to permeable road. Evaluation of the flood model depends on the flood level [6], which is generated by rainfall delivered to the affected area. In this regard, the rainfall data could be in terms of statistically generated design rainfall which the authors had previously reported [7]; or alternatively using a historical rainfall event, such as the one described in the following section.

Materials and methods

Permeable road

Generally, a permeable road consists of 2 layers, namely a top layer of permeable pavement that allows floodwater to drain through; and a 2nd layer of underground storage that is equipped under the pavement to capture and hold floodwater [8]. Its general concept is illustrated in **Figure 1**. Once the