THE EFFECTIVENESS OF DETENTION POND IN URBAN AREA

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ABSTRAK

Pembangunan yang pesat telah membawa perubahan kepada alam sekitar terutamanya topografi tanah. Hal ini berlaku kerana penebangan hutan yang tidak terkawal sehingga menyebabkan kadar penyusupan ke dalam tanah berkurang. Peningkatan kuantiti air larian akan membawa kepada banjir terutama di kawasan hilir. Manual Saliran Mesra Alam Malaysia Edisi Kedua (MSMA 2) telah mencadangkan kolam tahanan dibina untuk menyelesaikan masalah ini. Objektif utama kajian ini adalah untuk membina hidrograf dan menganggarkan pelepasan aliran puncak untuk model konseptual kolam tahanan kering dan basah. Eksperimen hubungan antara hujan dan air larian dijalankan untuk tiga kes hujan; hulu sahaja, seluruh kawasan tadahan dan hujan berganda. Eksperimen ini dijalankan dengan menggunakan Alat Hidrologi di Makmal Hidraulik & Hidrologi, Universiti Malaysia Pahang. Model konsep kolam tahanan kering dan basah diletakkan di dua lokasi; tengah dan hujung dalam Alat Hidrologi. Kolam tahanan boleh dibahagikan kepada dua jenis, kolam tahanan kering dan basah. Untuk kes ini, saiz kolam besar (50 cm x 24 cm x 10 cm) dan saiz kecil (32 cm x 24 cm x 10 cm) digunakan. Kolam tahanan dibina untuk menyimpan air larian permukaan buat sementara waktu dan mebebaskannya secara perlahan-lahan ke saluran air seperti sungai. Nilai aliran puncak dan isi padu air larian selepas pembangunan adalah lebih tinggi daripada sebelum pembangunan. Sehubungan dengan itu, kolam tahanan perlu dibina untuk menurunkan kadar aliran puncak dan isipadu air larian permukaan. Dalam eksperimen ini, kolam tahanan kering bersaiz besar dan kolam tahanan basah bersaiz besar yang terletak di hujung Alat Hidrologi mempunyai nilai aliran puncak terkecil, waktu ke puncak paling lambat dan mempunyai isipadu larian yang paling rendah. Kesimpulannya, eksperimen ini telah menunjukkan dua kolam tahanan ini merupakan kolam tahanan yang paling efektif dalam kawasan pembangunan.

ABSTRACT

Rapid urbanization has cause changes to the environment especially the topography of the land. By clearing the land and forests, the rate of infiltration into the ground will reduce. It will create a large quantity of stormwater runoff that will lead to flooding. In Urban Stormwater Management Manual for Malaysia Second Edition (MSMA 2), detention pond is applied to solve the problem regarding urban stormwater. The main objective of this study is to construct hydrograph and estimate the peak discharge for conceptual model of dry and wet detention pond. Rainfall-runoff relationship experiment is conducted for three stormwater cases; upstream, whole catchment and multiple storm whole catchments. This experiment is carried out by using Hydrology Apparatus in Hydraulic & Hydrology Laboratory, Universiti Malaysia Pahang. Conceptual model of dry and wet detention ponds were placed at the middle and end of Hydrology Apparatus. Detention can be divided into two types, dry and wet detention pond. For this case, large (50 cm x 24 cm x 10 cm) and small (32 cm x 24 cm x 10 cm) sizes of pond were used. Detention ponds are built to collect stormwater runoff temporarily and release them slowly to waterway. Peak flow and runoff volume after development must be higher than before development. Therefore, detention pond needs to be built for peak flow and volume of runoff reduction. In this experiment, large dry pond and large wet pond located at the end of Hydrology Apparatus has the smallest value of peak flow, longest time to peak and has the lowest runoff volume. This experiment proves that the two types of detention pond are effective for urban area.

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LIST OF SYMBOLS

Q	Flow rate
Q_{peak}	Peak flow rate
T_p	Time to peak
V	Volume runoff
h	Head

LIST OF ABBREVIATIONS

MSMA 2	Urban Stormwater Management Manual Second Edition
DID	Department of Irrigation and Drainage Malaysia
OSD	On-site detention pond
SuDS	Sustainable Drainage System
BMP	Best Management Practice

CHAPTER 1

INTRODUCTION

1.1 Background of Study

Urbanisation has cause great impact to the environment especially in the change of land cover. Land cover is referred as surface cover on the ground such as vegetation, urban infrastructure, water and bare soil (Ryan Coffey, 2013). In this study, urbanisation had cause changes to vegetation cover like forest to be developed as pavement and buildings. This situation happens because new developments project take place one after another to urbanized the city and increase its economic growth.

Besides, urbanisation gives impacts on the rainfall-runoff process in many ways. Firstly, it increases the quantity of runoff due to addition of impervious surface in urban area. Tree removal, surface levelling, soil flipping and surface compaction are likely to boost the runoff quantity. Secondly, the extensive network of pipes and channel that are designed into the urban environment also intensified the rate of stormwater runoff. This circumstance had shortened the long surface travel time from undeveloped area. Gutters and pipes can quickly convey stormwater to nearby streams. The increase in runoff rate and quantity can lead to downstream flooding and accelerate channel erosion (Akan & Houghtalen, 2003).

Flood happens due to heavy rainfall result in a large volume of runoff. If rain falls for a long time, the ground will become saturated and the soil will no longer be able to store water leading to increased surface runoff. Surface runoff will flow faster into river and stream. When the discharge exceeds the capacity of streams and rivers, it will cause overflow to the surrounding area known as floodplain (Jackson, 2014).

Urban stormwater management practice is applied in order to reduce stormwater discharge and solve flood problems. Department of Irrigation and Drainage (DID) Malaysia had introduced Urban Stormwater Management Manual Second Edition (MSMA 2) in 2012 as a guideline for a sustainable management. MSMA 2 suggested that building a detention pond can control the stormwater quantity impacts resulting from larger urbanising catchment. Detention pond is used to store stormwater runoff temporarily and release them back to the river to prevent downstream flooding. It can be divided into two type, dry detention pond and wet detention pond.

1.2 Problem Statement

Due to the urbanization in Malaysia, more development projects are implemented which result in the addition of impervious surface in the urban area. The permeable soil is replaced by impermeable surfaces such as roads, roofs, parking lots, and sidewalks that will reduce the infiltration rate into the ground (Konrad, 2016). Developed areas usually yield more rain; as a result, large volume of surface runoff flows more rapidly.

Konrad also stated that dense networks of ditches and culverts in cities can reduce the distance travel on overland or through subsurface flow paths to reach streams and rivers. Once water enters a drainage network, it flows faster than either overland or subsurface flow. When a river overflows and the poorly equipped structures cannot withstand its peak flow, flood will occur.

Flood can cause destruction to the property, road system, agricultural land and crops. Flood seems to occur more frequently in the recent years, especially in the cities such as Kuala Lumpur, and Penang where rapid urbanisation is taking place. The west coast of Peninsular Malaysia is commonly affected by inter-monsoon period. It brings short but intense rainfall which lead to the occurrence of flash flood (Wing, 2015).

Drainage plays an important role to reduce flood risk. Unfortunately, the main cause of flash flood in Malaysia is clogged drains. The drains were clogged with litter and debris from the construction site. Furthermore, poor supervision and inadequate budget for drain maintenance are also the major factor contribute to flash flood in Kuala Lumpur (Thye, 2017).

Department of Irrigation and Drainage Malaysia (DID) had taken various structural and non-structural flood mitigation measures as stated in the Urban Stormwater Management Manual Second Edition (MSMA 2). Structural measure is the engineering method used to solve the problem such as construction of storage pond. In MSMA, detention ponds are used for controlling stormwater quantity in urban area.

1.3 Objectives of the Study

The objectives of this study are:

1. To construct hydrograph and estimate the peak discharge for conceptual model of dry and wet detention pond.

2. To verify the effectiveness of conceptual model of detention pond by type and size.

3. To determine the suitability of detention pond's location

1.4 Scope of Study

The scopes of the study are:

1) To gather information and reference material related to rainfall runoff relationship and detention pond.

2) To focus on developed and undeveloped areas.

3) To focus on dry detention pond and wet detention pond. Dry detention pond hold runoff for a short period of time before allowing it to discharge to a nearby stream while wet detention pond retain runoff and maintain a permanent pool of water.

4) To follow the guideline and procedure in MSMA 2 to design conceptual model of detention pond.

5) To design two different sizes of detention pond. Large detention pond (50 cm x 24 cm x 10 cm) and small detention pond (32 cm x 24 cm x 10 cm) were used.

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