EVALUATION OF HYDRAULIC CONDUCTIVITY ON PERVIOUS CONCRETE FOR URBAN DRAINAGE APPLICATION

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DEDICATION

"To my father, mom and brother, to my little family wife and daughter thanks for completing my life as a hero in your heart"

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ABSTRACT

Impervious pavement leads to depletion of groundwater recharge and generate excessive surface runoff. In order to mitigate the flash flood problem, pervious surfaces were introduced to allows the passage of water to the ground through small openings, establishing a natural hydrologic balance which minimizes or delayed peak flow rate of precipitation. The research focused on determine hydraulic conductivity of pervious concrete unit, the product of existing drainage system developed by Majlis Bandaraya Shah Alam, MBSA to overcome flash flood problem in urban area. Other than that the study also will determine the appropriates size of aggregate (proposed 8 mm and 16 mm in cube) used as variables in hydraulic conductivity in experimental work, obtain porosity value from sieve analysis and compared with 7 established empirical equations. The experimental result shows 11.41 mm/s and 20.71 mm/s of hydraulic conductivity, while Alyamani and Sen give the nearest results of 7.0948 mm/s for 8mm cube and 21.3408 mm/s 16 mm cube. These new sustainable construction initiatives believed may become the answer for best management practice to control flash flood occurrence in urban development area.

ABSTRAK

Penurapan yang telap air menyebabkan pengisian semula air bawah tanah berkurang dan menghasilkan limpahan air permukaan yang berlebihan. Untuk mengatasi masalah banjir kilat, permukaan yang telus air diperkenalkan untuk memungkinkan penyusupan air ke tanah melalui bukaan kecil, mewujudkan keseimbangan hidrologi semula jadi yang meminimumkan atau menunda halaju aliran puncak aliran hujan. Penyelidikan ini memfokuskan untuk menentukan konduksi hidraulik unit konkrit telus air, produk sistem saliran sedia ada yang dibangunkan oleh Majlis Bandaraya Shah Alam, MBSA untuk mengatasi masalah banjir kilat di kawasan bandar. Selain itu, kajian ini juga akan menentukan saiz agregat yang sesuai (dicadangkan 8 mm dan 16 mm dalam bentuk kubus) yang digunakan sebagai pemboleh ubah dalam konduksi hidraulik dalam tatakerja eksperimen, nilai keliangan diperoleh dari analisis ayak dan dibandingkan dengan 7 persamaan empirikal yang telah ditetapkan. Hasil eksperimen menunjukkan konduksi hidraulik 11.41 mm/s dan 20.71 mm/s, sementara persamaan Alyamani dan Sen memberikan hasil terdekat 7.0948 mm/s untuk kubus 8mm dan 21.3408 mm/s untuk kubus 16 mm. Inisiatif pembinaan lestari baru ini dipercayai boleh memberi jawapan bagi amalan pengurusan terbaik untuk mengawal kejadian banjir kilat di kawasan pembangunan bandar.

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LIST OF ABBREVIATIONS

ASTM	-	American Society of Testing and Material
RHA	-	Rice Husk Ash
MBSA	-	Majlis Bandaraya Shah Alam
UTM	-	Universiti Teknologi Malaysia
SKA	-	Sekolah Kejuruteraan Awam
MSMA	-	Manual Saliran Mesra Alam
EPA	-	Environment Protection Agency
BMP	-	Best Management Practice

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CHAPTER 1

INTRODUCTION

1.1 Background of The Problem

In process of urbanization, most land is rapidly being paved to create new layer of pavements and roads to support increasing demands of development and traffic loads. This action causes large amounts of land area to be developed with an impermeable surface, mostly with concrete layer which affects natural hydrological cycle balance (refer to figure 1.1). Currently, there are constructed drains to collect surface runoff at intervals along pavements for drainage system. Mostly they were designed as rapid discharge concept to divert all the water into the main drainage. Recent flash floods have proved that they are insufficient to cope with heavy rainfall event.

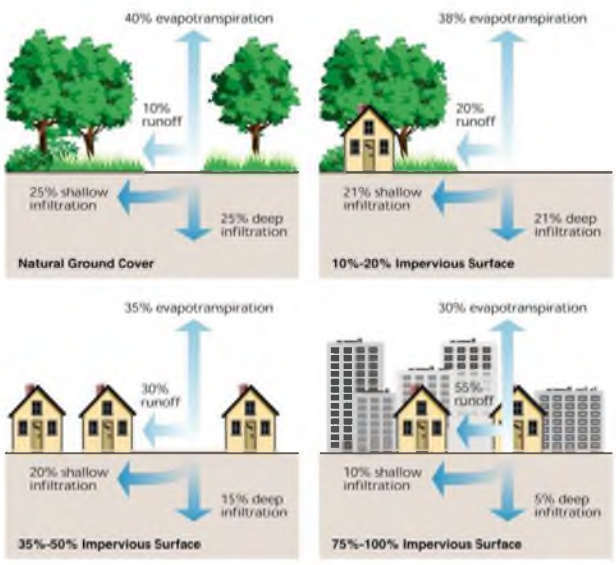

Figure 1.1: Hydrologic cycle before and after urbanization (source: https://megamanual.geosyntec.com)

Therefore, invention like pervious concrete for pavements, roads and drains introduced to allow surface runoff to penetrate into the ground soil and rather than accumulate on the surface of impervious materials. Pervious concrete is recognized among the best management practice (BMP) by Environmental Protection Board (ACI, 2010). This technology provides a solid structure for allowing rainwater to infiltrate naturally into the ground, recharging aquifers and reducing storm water runoff (Zhong, Leng, & Poon, 2018).This would not only relieve the excessive construction of drainage system, but also help increase the infiltration rate that rainwater is drained away through the soil, reducing flash floods occurrences. For many years, pervious pavements have been able to reduce the annual runoff volume by at least 60% as most of the rainwater infiltrated into the sub-soil, hence the amount of rainwater on the surface was significantly reduced during rainfall. (William F. Hunt and Laura L. Szplr, 2006).

In Putrajaya, Malaysia, porous pavements are commonly used throughout the state, especially in parking lot areas. These conceptual design emphasized to attenuate, an alternative way to providing more permeable surfaces, and in some cases infiltrate runoff volume to generate groundwater level. For less steep slope situations, reduced surface runoff velocity for further enhance attenuation and infiltration opportunities. Rapid development in an urban area is placing strain on towns, developers and academics to consider new approaches to minimize impervious surfaces and treat storm water in a safe and environmentally responsible manner (Gupta & Kim, 2013).

1.2 Problem Statement

One of the biggest innovation in human urbanization history is the creation of concrete technology, concrete used widely in every means of today's construction material. It is known that concrete characteristic was water proof thus leave modern city pervious surface fewer. Conventional drainage system nowadays also made of concrete. The concept with this old system was surface runoff collection and rapid discharge thus creating problems such as flash flood, higher velocity discharge means more erosion occur. This will lead to produce of faster peak flow rate, excessive water ponding situation and flash floods. Therefore, pervious concrete design is an

alternative way to provide as infiltration medium for the water to penetrate into the soil and recharging ground water level was proposed in this study. Pervious concrete is used instead of steel grating due to high possibility of stolen cases as scrap iron. Other than that pervious concrete easier to construct, available with local supplier and low cost in material compared to steel structure.

1.3 Objective of Research

The research mainly focused on hydraulic and concrete structure part, for more precise the objectives are as follows:

(a) To obtain hydraulic conductivity of pervious concrete material.

(b) To analyse the hydraulics conductivity and compressive strength of pervious concrete under various size of aggregate used.

(c) To evaluate the hydraulic conductivity obtained from experiment and compared with established empirical equations.

1.4 Scope of Research

In general, the focus of this research is related to the following main area:

(a) The different size of aggregate used of pervious concrete.

(b) Laboratory experimental only.

(c) Only cube and drain cover design of available product are presented in the discussion of hydraulic conductivity and design guidance.

(d) The maintenance of pervious concrete consideration is neglected in this research.

1.5 Significance of The Research

From this research, it will give an alternative way to create more permeable surface for a better flash flood control solution and reorganizing urban water drainage system. Providing approach for sustainable urban storm water management in term of quantity and public safety value in urban area.

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