STORMWATER DETENTION STRUCTURES IN THE VERANDA AND PARKING LOT AT COMMERCIAL CENTRE SUBJECTED TO HISTORICAL EXTREME RAINFALL EVENTS

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Abstract
This paper reports on a specifically designed stormwater detention structures that fit in a commercial centre, namely modular-based water micro tanks in the veranda and the parking lot in front of shop buildings. This is in line with the concept of integrating detention structures into urban features as small pockets to capture urban runoff along the stormwater flow path so that the amount of stormwater flowing downstream is reduced. The two designs were simulated using Storm Water Management Model and subjected to historical rainfall data, in which the selected storms were found to span more than 10 hours and with maximum hourly rainfall depths between 40 - 70 mm. Results from the modelling efforts were stormwater characteristics of the particular type of detention system in times of extreme rainfall events. The identified stormwater characteristics provide a guide to urban planners to mitigate urban flooding. It was found that the detention structures, although with a limited storage volume, were able to sustain an accumulated rainfall up to 60 mm, a feature 3 times higher than the 23 mm design rainfall. It was found that accumulated rainfall of a particular storm was a better indicator than the maximum rainfall depth of the storm to indicate the water storing capacity of detention structures.

Keywords: *Detention; Drainage; Flood; Sustainable Development; SWMM; Urban Runoff.*

INTRODUCTION

A stormwater detention structure is made to temporarily hold stormwater on the urban land surfaces (Bilodeau, Pelletier & Duchesne, 2018). Having detention structures embedded in the veranda and parking lot in a commercial centre are in line with the trends of integrating urban runoff management with urban features (Hamouz et al., 2020; Pour, Wahab, Shahid, Asaduzzaman & Dewan, 2020). This is due to the fact that congested urban environments had caused difficulty to source empty land spaces for stormwater structures (Shams et al., 2018; Maulana, Samad & Nordin, 2022). Four examples of the integrated structures are presented in the following paragraphs.

The first example showcases a roof detention (Figure 1a). This integration method made use of the building roof surfaces, one of the prominent features of cities, to capture stormwater. Generally, a storage layer was laid on a roof and channels were equipped to deliver overflowing water to the exit points (Campisano, Modica & Gullotta, 2020; Rey-Mahía, Álvarez-Rabanal, Sañudo-Fontaneda, Hidalgo-Tostado & Menéndez Suárez-Inclán, 2022).

The second example showcases high density polyethylene pieces which were embedded within a building floor slab (Figure 1b). This method targeted the buildings covering the urban landscape. The square pieces were hollow and interconnected with pipelines. Once

completed, these pieces functioned as ground-level floor and water tanks which received water from the building itself (Rainey, Brody, Galloway & Highfield, 2021).

Retaining wall is an urban feature built as a solid wall to keep the soil behind it from sliding. The third example showcases concrete pieces which were laid as retaining wall (Figure 1c). Referring to the inlet of the figure, one could see that stones filled the gaps in between the concrete pieces instead of soil. The voids in between the stones play a role in holding the stormwater (Ostendorf, Morgan, Celik & Retzlaff, 2021).

The fourth example shows the most common integration to blend stormwater detention into roads and car parking spaces (Maurer et al., 2021; Xu, Liu & Ding, 2021). Hollow concrete pieces were replacing conventional tarred road structure (Figure 2d), in which the surfaces of the pieces supported vehicles and pedestrians alike, with service inlets to direct stormwater to the underground hollow chambers. In short, stormwater structures had been merged successfully into building roof, floor slab, retaining wall and roadway. These endeavours gave confidence to the current study to explore on veranda and parking lot in front of shops to house detention structures.

(Source: https://sustainabletechnologies.ca/)

a) Rooftop Detention

(Source: https://www.aquacomb.com.au/)

b) Building Floor Slab Detention

(Source: https://magnumstone.com)

c) Retaining Wall Detention

(Source: https://oldcastleinfrastructure.com/)

d) Road Subsurface Detention

Figure 1. Integrated Stormwater Structures

In the case study of this paper as depicted in Figure 2, manmade structures were designed with water holding capacity to replace the natural process of water infiltration to the soil layer that was depleted due to urbanization (Kaykhosravi, Khan & Jadidi, 2022; Yang, Zhang &