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RESEARCH ARTICLE

Sediment size and deposition characteristics in Malaysian urban concrete drains – a case study of Kuching City

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This paper highlights the results of sediment size characteristics and deposition analysis on 24 sediment samples from urban concrete drains in Kuching City. Further sampling from surrounding urban towns outside Kuching City and Penang were done for comparison. Samples were collected randomly from three land-use types (residential, commercial and industrial). Sieve analysis results had shown that most of the total samples collected (51 out of 57) were predominantly sand, followed by gravel; while silt and clay were the minor components. Unimodal characteristics were observed in 46 samples while 11 samples showed bimodal characteristics. Of the total 46 unimodal samples, 39 showed non-uniform distribution with tendency to skew to the right. Due to this, the mode grain size with characteristic diameter d_{45} is suggested as a much better representative size than the conventional median size d_{50}. Factors affecting sediment deposition characteristics in urban drains are also discussed.

Keywords: characteristic diameter; deposition; sediment; urban areas; urban drainage

1. Introduction

Sediment deposits in sewers had been known to have an adverse effect on the sewer system and the environment. The nature of sewer sediments was first defined systematically by Crabtree (1989). Sediments that enter sewer systems originate from rooftops, streets and highways, construction sites, commercial and industrial parking lots and runoff (Fan *et al.* 2003). Sediments in storm sewers are mainly inorganic and non-cohesive (Butler *et al.* 2003). As for combined sewers, it is widely accepted to have cohesive properties due to the presence of organic substances (Campisano *et al.* 2008). Studies on urban litter (Armitage and Rooseboom, 2000, Marais *et al.* 2004, Armitage, 2007) had classified sediment as secondary pollution and is of great concern as they could contain potentially dangerous concentrations of heavy metals, nutrients or pesticides of human origin. This high concentration of pollutants could be released during the erosion of sediment depositions (Ashley *et al.* 1992a). Losses of hydraulic capacity due to sediment deposition have been identified as one of the factors of flash flooding in urban areas (Ab. Ghani *et al.* 2008, Liew *et al.* 2012, Rodríguez *et al.* 2012). Under given conditions, a substantial increase in sediment depth (from 2% to 10%) resulted in a 10% to 20% reduction of full sewer discharge capacity relative to a clean sewer (Banasiak, 2008). While structured best management practices (BMPs) provide some level of control, many of the devices rely on settling of sediment and their effectiveness is largely dependent on the range of particle sizes in storm water runoff (Selbig and Fienen, 2012).

In Malaysia, separate networks of storm water and sanitary sewer are used. The design of urban storm water drains in Malaysia follows a manual known as "Urban Storm Water Management Manual for Malaysia" (DID, 2000, 2012). To reduce sediment deposition in an urban open storm concrete drain, a minimum constant self-cleansing velocity of 0.9 m/s had been recommended by the Department of Irrigation and Drainage (DID), Malaysia (Ab. Ghani *et al.* 2000). The adoption of a constant minimum value however does not take into account the characteristics of the sediment and the hydraulic aspect of the channel (Butler *et al.* 2003). Vongvisessomjai *et al.* (2010) provides a review on the minimum value for velocity and shear stress adopted by various countries for a self-cleansing design for sewers.

Various approaches and suggestions exist in the literature to choose the characteristic diameter to be the representative particle size for a sediment distribution (Tranckner *et al.* 2008). However, choosing a robust characteristic diameter for a given sediment sample distribution still remains an issue. A robust characteristic

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