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Sediment deposition characteristics of urban concrete drains in Kuching City, Sarawak, Malaysia

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ABSTRACT
Sediment deposition in drains has been found to be one of the major causes of flooding in urban areas. In order to design an effective removal mechanism, an understanding of the characteristics of the sediment deposition is needed. This paper highlights the results of sediment size characteristics analysis done on sediment samples collected from concrete drains in Kuching city, Sarawak, Malaysia. A total of 30 sediment samples from 10 urban locations (4 residential areas, 5 commercial areas and 1 industrial area) were collected and subjected to sieve analysis. Results from sieve analysis had shown that the major component of the sediment is sand with an average percentage of 68.8%, followed by gravel with average percentage of 30.4% and silt and clay as the minor component with an average percentage of 0.8%. Of the 30 samples, 7 samples show bimodal characteristics while 23 samples show unimodal characteristics. 14 out of the 23 unimodal samples had shown a non uniform distribution with the tendency to skew to the coarser grain size. Due to this, the conventional use of median grain size d_{50} as the effective size for the sediment samples might not be a good representation for the sediment distribution. Further statistical analysis in this paper had suggested that the mode grain size is a much better representative grain size due to its stability when compared to median and mean size. Thus, a much better representative size for the sediment samples from Kuching urban areas would be the mode size (in this case is d_{45}). An analysis on drain characteristics had shown that trapezoidal shape drain tends to have higher blockage percentage due to sediment deposition when compared to rectangular shape drain.

Keywords: Kuching city; Representative sediment size; Sediment deposition; Urban concrete drains.

1 Introduction

Most of the major urban areas in Malaysia use open storm drain systems to convey surface runoff. Though open storm drain system might be effective in rapid removal of surface runoff; sediment deposition in the drain over a period of time would reduce the hydraulic capacity and thus causing flash flood. Besides causing flash flood, sediment deposition might have adverse effects on the environment due to the high pollutants concentration that might be released during the erosion of these depositions (Ashley et al. 1992).

To reduce sediment deposition, a constant minimum velocity of 0.9 m/s is recommended by the Department of Irrigation and Drainage (DID), Malaysia (Ab. Ghani *et al*, 2008). Various equations for incipient motion have also being developed for the design of self-cleansing open drain/channel. However, in applying these equations at fields, the results were not satisfactory due to the different conditions compared to the controlled condition in the laboratory where the equations were developed. The conditions or factors affecting the application of incipient motion equations at fields could be categorized in terms of sediment characteristics (size and concentration) and drain characteristics (size, slopes and roughness) (Ab. Ghani *et al*, 2008).

Sediment commonly found in urban drains consists of differing size, shape and specific gravity. Due to this, it is difficult to choose an effective grain size that is the most representative of the average particle size in the sediment distribution. Conventionally, the median diameter d_{50} has been assumed as the size that represents the sediment mixtures. The median diameter d_{50} has been used in the development of incipient motion equations (Novak and Nalluri, 1975; Ojo, 1978; El-Zaemey, 1991; Ab. Ghani et al., 1999). The sediment distribution used in the development of these equations were of uniform material and well-sorted with almost lognormal distribution; thus the median diameter d_{50} is a suitable representation of the sediment since it coincide with the mode and geometric means of the distribution.