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DURATION OF HYDRAULIC FLUSHING AND ITS EFFECT ON SEDIMENT BED MOVEMENT

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ABSTRACT

Hydraulic flushing is the most widely used method for sediment removal in sewer. However, open storm sewer tend to have longer flushing duration as compared to closed conduit sewer. This is due to storm water could enter more directly and rapidly into open storm sewer especially during rain events. The current study aims to determine the effect of flushing duration on the efficiency of sediment removal which is lacking in the literature. Flushing experiment was conducted in a rectangular flume for varying flushing durations namely approximately 3 seconds, 30 minutes and 60 minutes. Changes of the sediment bed profile were observed after each flush. Findings from the experiment has shown that short duration flushing is more efficient in terms of more sediment volume being removed as compared to long flushing duration. In terms of mean sediment bed front advancement, long flushing duration will moved the sediment bed front further than short duration flushing. The knowledge from the current study can be used to design a more efficient flushing devices for the management and active control of sediment in sewer system.

Keywords: Flushing devices; flushing duration; flush efficiency; hydraulic flushing; sedimentation.

1 INTRODUCTION

The control and cleaning of sediment deposited in sewer system has been a crucial aspect of sewer maintenance and operation (Bertrand-Krajewski et al., 2005). Of the various methods developed to clean sediments, hydraulic flushing is the oldest and most widely applied method in sediment removal (Bertrand-Krajewski, 2008). Flushing device such as the Hydrass gate used in Lyon, France (Bertrand-Krajewski et al., 2006; Bertrand-Krajewski et al., 2003) has proven to be successful in sediment removal for closed conduit sewer. An on-site observation at Nibong Tebal, Penang, Malaysia has shown that a tipping flush gate has the potential to be used for sedimentation management of open storm water sewer (Bong et al., 2016).

From available literature, the factors that have effect on flush cleaning efficiency are: i) height of water stored upstream of flushing device prior to flushing (Shafai-Bejestan et al., 2012; Guo et al., 2004); ii) partial exposure of deposit downstream or initial water depth downstream (Guo et al., 2004; Gendreau et al., 1993); iii) number or frequency of flushes (Ristenpart, 1998; Gendreau et al., 1993); distance of sediment deposit from flushing device (Guo et al., 2004; Ristenpart, 1998); v) sediment cohesiveness and void ratio (Shafai-Bejestan et al., 2012; Campisano et al., 2008) and vi) sediment deposits thickness (Bong et al., 2013). Another factor that might have effect on the flushing efficiency is the flushing duration but it is lacking in the literature. Flushing duration can be defined as the time between the opening of the flushing device to discharge a volume of water and the closing of the device. Flushing duration is dependent on the volume of water or water level needed for the operation (opening and closing) of the flushing device.

The flush duration for the Hydrass gate installed in a closed conduit sewer in Lyon, France under wet weather conditions was observed to be approximately equal to 3.5 minutes (Bertrand-Krajewski et al., 2003). As for the open storm water sewer in Nibong Tebal, Penang, Malaysia, the flushing duration could range between 22.8 minutes to 179.5 minutes and were dependent on the rainfall duration and intensity (Bong et al., 2016). Since surface runoff could enter open storm water sewer system more directly and rapidly during rainfall event as compared to closed conduit sewer system, the volume of water upstream of the device installed in open storm water sewer system could be maintained longer leading to longer flush duration.

The current study aims to determine the effect of flushing duration on the efficiency of sediment removal. Flushing experiment was conducted by varying the duration of flushing. Changes of the sediment bed profile were observed after each flush. The results from this study could be used in designing a more effective flushing device as well as filling the gap in the literature on flushing duration.