Clogging of PICP and Its Maintenance Requirements

Colmatage des pavés en béton autobloquants perméables et exigences d'entretien

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RÉSUMÉ

Les pavés en béton autobloquants perméables (PICP) sont les types de revêtements perméables les plus largement utilisés. Des études ont montré que la performance des PICP et leur perméabilité à l'eau diminuent avec le temps en raison de l'accumulation de sédiments dans leurs joints perméables, mais que leur perméabilité peut être améliorée s'ils sont bien entretenus. Le taux de colmatage des joints des PICP dépend fortement de facteurs propres à l'emplacement géographique, notamment de la quantité de sédiments contenus dans les eaux pluviales. Pour cette raison, il est important de comprendre la vitesse à laquelle le taux d'infiltration en surface (SIR) des PICP diminue en fonction de la quantité de sédiments transportée par les eaux de ruissellement. Dans cette étude, cinq lots de PICP côte à côte ont été progressivement obstrués à l'aide de sédiments plus lourds et dont la granulométrie était connue. La vitesse de diminution de leur taux d'infiltration en surface a été surveillée jusqu'à ce qu'ils atteignent presque l'objectif de 250 mm/h. L'étude vise à établir des corrélations entre la quantité cumulée de sédiments transportés dans les eaux pluviales et le niveau de performance des PICP. Les résultats de l'étude peuvent aider les propriétaires et les exploitants de PICP à déterminer la fréquence d'entretien appropriée. Les résultats de cette étude sont limités, car ils ne tiennent pas compte de l'effet de la circulation automobile sur le processus de colmatage. Les prochaines études combinant tous les facteurs affectant le processus de colmatage des PICP pourront s'appuyer sur des prévisions plus précises concernant la fréquence d'entretien requise des PICP.

ABSTRACT

Permeable Interlocking Concrete Pavements (PICP) are the most widely used types of permeable pavements. Studies have shown that PICP performance and its ability to infiltrate water decreases over time due to accumulation of sediment into their permeable joints, but with effective maintenance their permeability can be enhanced. The rate at which clogging of PICP joints occur is highly dependent on location specific factors one of which is the amount of sediment contained in the stormwater. For this reason it is important to understand the rate at which PICP Surface Infiltration Rate (SIR) decreases based on the amount of sediment that is transported by stormwater runoff. In this study five side-by-side PICP lots were progressively clogged using weighted sediment of known gradation. The rate at which their surface infiltration rate decreased was monitored till they reached near target SIR of 250 mm/h. The study aims to draw correlations between the cumulative amount of sediment carried in the stormwater and the performance level of the PICP. The results of the study can assist the owners and operators of PICP to decide on appropriate maintenance frequencies. This study is limited in its findings as it does not account for the effect of vehicular traffic on the clogging process. Future studies combining all factors affecting the PICP clogging process can build on making more accurate predictions about the maintenance frequency requirements of PICP.

KEYWORDS

Clogging, low impact development, maintenance, permeable interlocking concrete pavement, surface infiltration rate

Clogging of permeable interlocking concrete pavement and maintenance requirements

1 INTRODUCTION

Urban water management strategies have advanced beyond sewer systems and stormwater storage facilities. Strategies that focus on infiltration of stormwater into the native soil or below grade storage have proven to be more effective at not only reducing stormwater runoff generation and flood incidents but also at improving the quality of stormwater and protecting the surrounding environments (Hunt et al. 2012). Instruments that support such strategies are called Green Infrastructure (GI) (Brown and Borst, 2013).

Permeable Pavement (PP) is a big component of GI. Retrofitting asphalt covered streets and parking lots that are impervious surfaces, contributing to runoff, to allow for infiltration of stormwater with use of PP is one of the most commonly used GI (Brown and Borst, 2013). PP is also an effective instrument that can help protect watersheds and their natural hydrology (Page et al. 2015). Among the types of PPs, Permeable Interlocking Concrete Pavement (PICP) is being increasingly common (Luke and Beecham, 2011). PICP systems consist of 60 – 80 mm concrete pavers that are layered with a bedding layer, an aggregate base reservoir and a sub-base reservoir. Stormwater can infiltrate through the permeable joints between the pavers into the storage layer and ultimately into the native soil and/or drainage pipes. PICPs have proven to reduce the amount of stormwater runoff, lower runoff peak flows and improve the quality of stormwater by lowering the suspended solids and heavy metals concentrations (Kazemi et al. 2017). PICP performance depends on factors such as construction, permeability of the native soil and characteristics of the surrounding environment. The permeability of PICP decreases over time as sediment accumulates into the joints, clogging its permeable surface (Boogaard et al. 2014). The clogging process occurs at a faster rate if the PICP acts as a source control, accepting run-on (Luck and Beecham, 2011). Studies have shown that with effective surface cleaning techniques, PICP's long-term performance can be maintained (Kazemi et al. 2017; Drake and Bradford, 2013). Understanding the PICP clogging process is key in determining its maintenance requirements. An important fact to understand with respect to clogging is that its progression will be dependent on specific location characteristics and the sediment loading from the surrounding environment (Luke and Beecham, 2011). For this reason, following one generic maintenance regime may not be adequate for all locations. Therefore investigating how PICP infiltration rate drops due to the sediment loading of the stormwater can provide guidance to the owners and operators of PICP in planning an appropriate maintenance frequency for specific locations. In this study, five (5) side by side PICP lots are artificially clogged using weighted sediment loads of known gradation. Surface Infiltration Rates (SIR)s are monitored for each lot after every round of sedimentation. The study aims to demonstrate the rate at which PICP SIR decreases when under the influence of sediment from stormwater and allow for predictions as to the maintenance needs dictated by the location specific stormwater characteristics.

2 METHOD AND PROCEDURE

2.1 Clogging Sediment Gradation

Three PICP sites within The Great Toronto Area (GTA) were sampled. Sampling was conducted by manually loosening the sediment within the joints with a screwdriver and collecting the sediment with use of a bagged canister vacuum cleaner. Vacuum bags were weighed and labeled prior to use. Particle Size Distribution (PSD) analysis was conducted on all samples. All PSD analysis results were used to calculate an average. The average obtained from the PSD analysis was then used to make up the gradation of the sediment used for clogging of the lots.

2.2 Clogging Procedure

Joints within each lot were divided into rows and columns. The length of all rows and columns were measured for each lot. Sediment was weighed and placed in small jars for each row and column. The weight of the sediment was measured per joint length to ensure that all joints received the same amount of sediment. The sediment was then applied directly over the joints. Figure 1 below is an image of the lot and sediment jars prepared for clogging. Each round of clogging was followed by several wet and dry period to allow for downward movement of sediment into the joints. Compaction using a vibrating plate compactor was applied to the lots after the third round of clogging to facilitate farther movement of sediment deeper into the joints.

Figure 1: Weighted sediment in jar ready to be applied over the joint.

2.3 Surface Infiltration Rate

SIR of the lots were tested following the single ring infiltration rate test method as per ASTM C1781 Standard. SIRs were measured each round, prior to application of the next round of clogging sediment. SIRs were also measured after compaction. Figure 2 below shows the SIRs for each lot over the progressive accelerated clogging procedure.

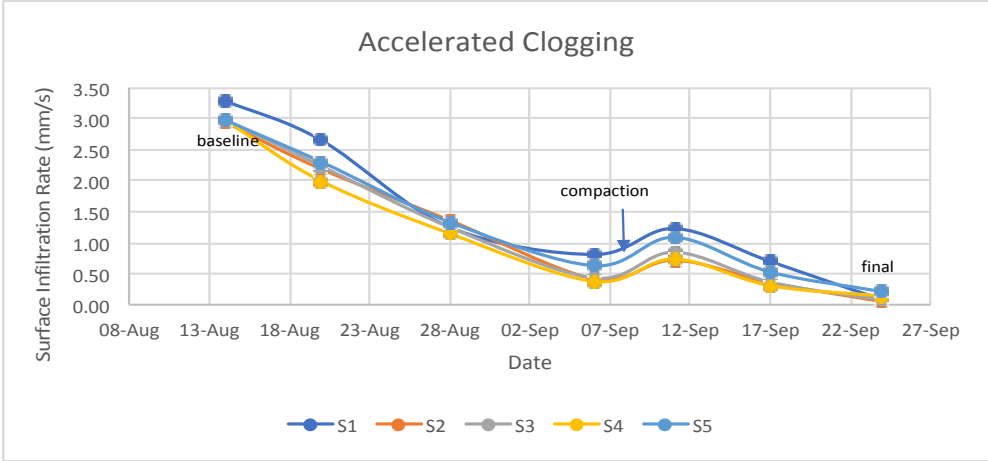

Figure 2: Surface infiltration of the each lot after each round of sedimentation.

3 RESULTS AND DISCUSSION

The goal of the project was to explore and monitor the clogging process in PICP under the influence of sedimentation. Comparison analysis was conducted between the amount of sediment applied in this experiment and other studies on the amount of sediment and suspended solids in the stormwater runoff. The results aim to draw correlations between local stormwater runoff characteristics and clogging of the PICP areas, suggesting maintenance frequencies necessary to maintain long-term performance of PICP. This study is limited in its findings as the affects of vehicular and pedestrian traffic on clogging of PICP were not included. Future studies combining all factors contributing to the clogging of PICP can help make more accurate predictions on how fast clogging occurs and therefore what maintenance frequencies should be adopted to ensure quality performance.

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