ICUD-0567 Long term infiltration capacity of permeable pavement determined with new full scale test method

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Summary

Permeable pavements are a type of SUDS that are becoming more common to allow infiltration, to minimize runoff volumes and to treat urban stormwater by soil filtration. However, urban stormwater runoff contains significant concentrations of suspended sediments that can cause clogging and reduce the infiltration capacity and effectiveness of permeable pavements. This study used a full-scale infiltration test procedure to evaluate the infiltration performance of 20 permeable pavements that had been in service for over 2 to 9 years in the Netherlands. The observed infiltration capacities range between 20 and 342 mm/h.

Keywords

suds, BMPS, permeable pavement, infiltration capacity, clogging, urban resilience

Introduction

Permeable (or porous) pavements are a type of sustainable urban drainage system (SUDS) treatment device that are used around the world to infiltrate and treat stormwater runoff. Clogging is a result of fines, organic matter and traffic-caused abraded particles, blocking the gaps and surfaces of permeable pavement systems due to physical, biological and chemical processes [Siriwardene et al., 2007]. This clogging decreases the porosity/permeability of the paving surface and hence the infiltration rate of a system [Borgwardt, 2006]. It is important for stormwater managers to be able to determine when the level of clogging has reached an unacceptable level so that they can schedule maintenance or replacement activities. Therefor the overall objective of this research is to review the performance of SUDS. Several 'worse case' locations are selected in the Netherlands with high groundwater tables and low permeable soils.

Methods and Materials

In order to evaluate the performance of permeable pavement a new full-scale infiltration testing method is applied. Traditional permeable pavement infiltration testing methods generally base results on the infiltration rates obtained through a very small area of the pavement, which is then used to represent the total pavement area infiltration. This approach of using small areas for testing could potentially lead to erroneous results being obtained. The new method floods a wider part of the permeable pavement area of approximately 50m^2 (Fig. 1) and the infiltration capacity is measured by three different measurement methods in conjunction with the pressure transducers in order to calibrate and verify the transducer readings. The three methods were: hand Measurements, calibrated Underwater Camera, time-Lapse Photography. The results of the initial testing were successful [Boogaard et al., 2014] and showed that the new method could be used to accurately measure infiltration rates of permeable pavements in-situ. The new testing method was therefore used on the 20 existing pavements evaluated in this study. All pavements were sealed, inundated and monitored as described above. The pressure transducer readings were then plotted against time to generate precise infiltration curves for each of the test sites. Simple linear regression analysis was used to generate lines of best fit for the transducer readings from each site. The equations of the linear regression lines were then used to calculate the average infiltration rate in

mm/h for each test site.

Results and Discussion

This study used a full-scale infiltration test procedure to evaluate the infiltration performance of 20 permeable pavements that had been in service for over 2 to 9 years in the Netherlands. Newly installed permeable pavements in the Netherlands easily demonstrate a minimum infiltration capacity of 194 mm/h (540 l/s/ha). Permeable pavement maintenance guidelines in the Netherlands recommend that maintenance is undertaken on permeable pavements when the infiltration capacity falls below 0.50 m/d (20.8 mm/h). The observed infiltration capacities range between 20 and 342 mm/h (table 1). Five of the 20 pavements showed an infiltration capacity higher than 194 mm/h and one of the pavements would require maintenance after seven years according to the Dutch guideline. Note that infiltration measurements on conventional pavement could also meet 5 to 20 mm/h.

Tab. 1.

test no	location	age	infiltration capacity [mm/h]
1	Beverwijk	2	51
2	Beverwijk	2	63
3	Alkmaar	2	177
4	Meppel	5	93
5	Almere	5	30
6	Groningen	6	103
7	Utrecht 1	7	29
8	Almere	7	20
9	Utrecht 2	7	71
10	werkendam 1	8	69
11	Breda Effen	8	109
12	Zwolle 1	8	284
13	Zwolle 2	8	186
14	Zwolle 3	8	342

test no	location	age	infiltration capacity [mm/h]
15	Zwolle 4	8	212
16	werkendam 2	8	132
17	Delft	8	124
18	Goirle	8	308
19	Goirle	8	300
20	Zwolle 5	9	40

Discussion

There are a number of potential reasons for the observed variations in surface infiltration rates between the test pavements including: age. construction type, maintenance, variations in hydraulic ground conditions, pavement usage and environmental site conditions (eg trees are known to affect the infiltration rate of permeable pavements [Fassman, 2010].

Conclusions

Infiltration rates of newly installed permeable pavement systems are generally very high, although they have been shown to decrease significantly over time. The observed infiltration capacities range between 20 and 342 mm/h. The performance of SUDS in delta areas such as the Netherlands has been viewed with skepticism. However, this research undertaken on Dutch SUDS field installations in urban areas has demonstrated that most of the permeable pavements tested in the study have met the required hydraulic performance levels even after years in operation and without maintenance.

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