International Journal for Research in Engineering Application & Management (IJREAM)
ISSN : 2454-9150 Special Issue - ICSGUPSTM 2018

Infiltration Efficiency of Permeable Pavements

Sadashiv S. Hubli
Selection Grade Lecturer and Head, Department of Civil Engineering, BVVS Polytechnic [Autonomous), Bagalkot-587101, Karnataka, India; sadashivhubli@gmail.com

ABSTRACT

The use of permeable pavements is one method that can be adopted to enhance water sustainability. The implementation of permeable pavements in place of standard impermeable asphalt would increase water infiltration into underground storage and the filtration of rainwater, while reducing runoffs. An attempt was made to measure the efficiency of permeable pavement on a table-top test model. The test model was measuring 900 mm x 600 mm x 300 mm in size. The efficiency was measured in terms of quantity of water collected at outlet against the quantity of water sprinkled over the test model, under saturated pavement condition. Test results indicate that, 0% to 100% output was observed from dry state to saturated state of the permeable pavement and for saturated permeable pavement, 100% efficiency in the form of output versus input was observed.

Key Words: Permeable, Pavements, Infiltration, Runoff.

1. INTRODUCTION

A pavement system designed to achieve water quality and quantity benefits by allowing movement of storm water through the pavement surface and into a base/sub base reservoir. Examples include pervious concrete, porous asphalt and permeable pavers/blocks.

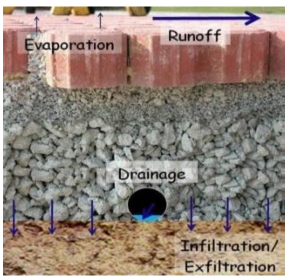
Permeable pavements can reduce volumes and improve water quality of storm water runoff by allowing water to infiltrate on its structure. As urbanization increases, the urban drainage system becomes gradually overloaded, with frequent spills to receiving water bodies of polluted water and uncontrolled flooding on critical areas. Upgrade or re-design the existing system is not an effective solution because it does not act on the causes.

Permeable pavements must allow water to infiltrate; therefore, they show a high porosity structure with open and interconnected spaces where water and air can pass through. Infiltration must be fast enough to avoid the possibility of significant ponding for most rainfall events. Although they are often referred as porous pavements in literature, it is important to notice that all pavements present some level of porosity.

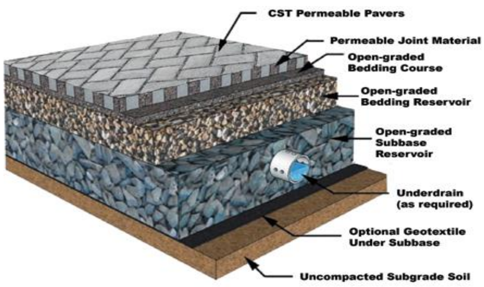
Various kinds of surfaces may be used for those pavements: concrete blocks, in placed pervious concrete, pervious asphalt, concrete grids, aggregates, grass, plastic grids, granular materials and loose decks. The ones that provide vehicular support are concrete blocks used on permeable interlocking concrete pavement, in place pervious concrete and pervious asphalt. The pavement base/sub-base is similar to the conventional one. The main difference is the aggregate void rate, which must be such that it allows the base to perform as a water reservoir

The primary role of a permeable pavement is to reduce runoff volume and promote hydrograph attenuation. Therefore, this feature was considered on the majority of researches, mainly addressing the effect of the type of surface and structure on runoff.

This practice may be applied individually or as a part of a storm water management system to promote storm water infiltration, groundwater recharge, stream base flow preservation, reduce the discharge of storm water pollutants to surface waters, reduce storm water discharge volumes and to reduce the temperature of storm water discharges. However, permeable pavement may not be used in industrial storage and loading areas or vehicle fueling and maintenance areas.



1. C/S of PP



2. C/S of PP (3D View)

 DOI : 10.18231/2454-9150.2018.0236

1. Courtesy: https://theconstructor.org/transportation/permeable-pavement-system-construction/13246/
2. Courtesy: http://renovatedsm.org/wp-content/uploads/2014/01/Permeable-Cross-Section.jpg

2. METHODOLOGY

Amongst the literatures studied, referring to Permeable Pavement (1008) Wisconsin Department of Natural Resources Conservation Practice Standard, the cross section of the test model was fixed. Accordingly, the table top test model was fabricated for testing with proper drainage arrangements incorporated in the test model.

The overall size of the test model is 900 mm x 600 mm x 300 mm. The bottom most layer was made of natural soil which was overlain by geo textile PE20XEF. Over this geo textile 150 mm thick layer of gravel, with minimum porosity of 25%, was laid. Above the gravel layer porous concrete layer of thickness 100 mm was provided which was overlain by porous bitumen layer. At the bottom of the gravel layer an arrangement of drainage system was placed which was made with perforated PVC pipes. Cross drains were made of 19 mm diameter PVC Pipes and the central main drain was of 25 mm diameter PVC Pipes. Cross drains were placed along the width of the pavement at 150 mm center to center. Main drain was placed at the middle of the pavement cross section along the length of the pavement. Proper interconnection was provided between main drain and cross drains. Outlet was taken out from the test model with main drain and cross drains joined in such a way that they all get connected to one common outlet pipe. Through this one point outlet pipe, the discharge was measured using measuring cylinder.

3. RESULTS

Water was sprinkled over the porous bitumen layer at a constant rate of 4 liters per minute, starting at the dry state of the pavement. Sprinkling of water was done for 5 minutes as by that time output almost equal to input was observed. Saturation of the pavement was observed by 1 to 1.5 minutes of sprinkling of water.

Table 1. Experimental observations

TIME IN Min.	WATER SPRINKLED IN Liters	WATER COLLECTED AT OUTLET IN Liters	PERCENTAGE COLLECTION
1	4	2	50.0
2	8	7	87.5
3	12	11	91.7
4	16	16	100.0
5	20	20	100.0

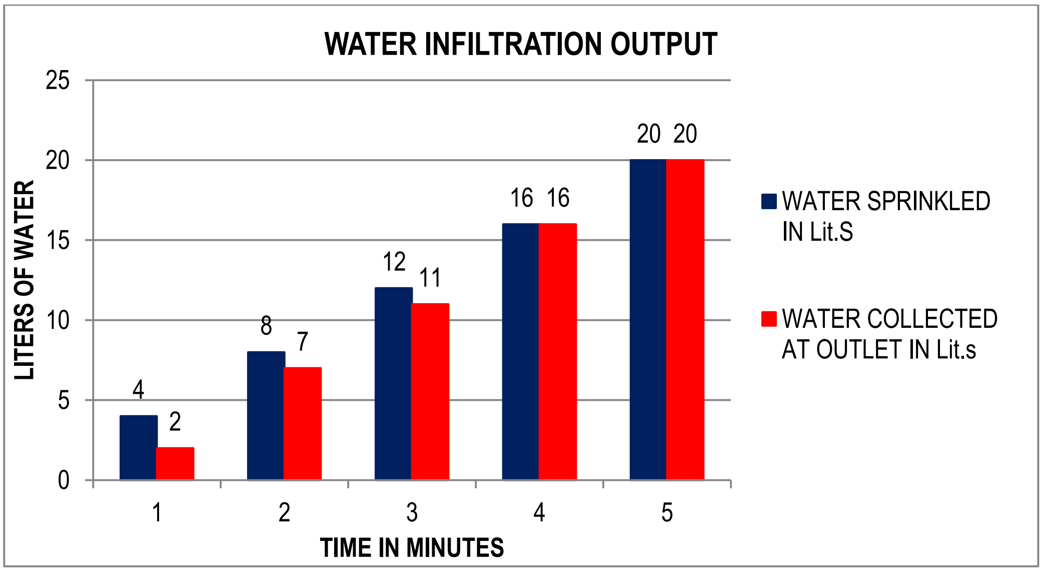


Fig. 1 Water Sprinkling Input and Infiltration Output

DOI : 10.18231/2454-9150.2018.0236

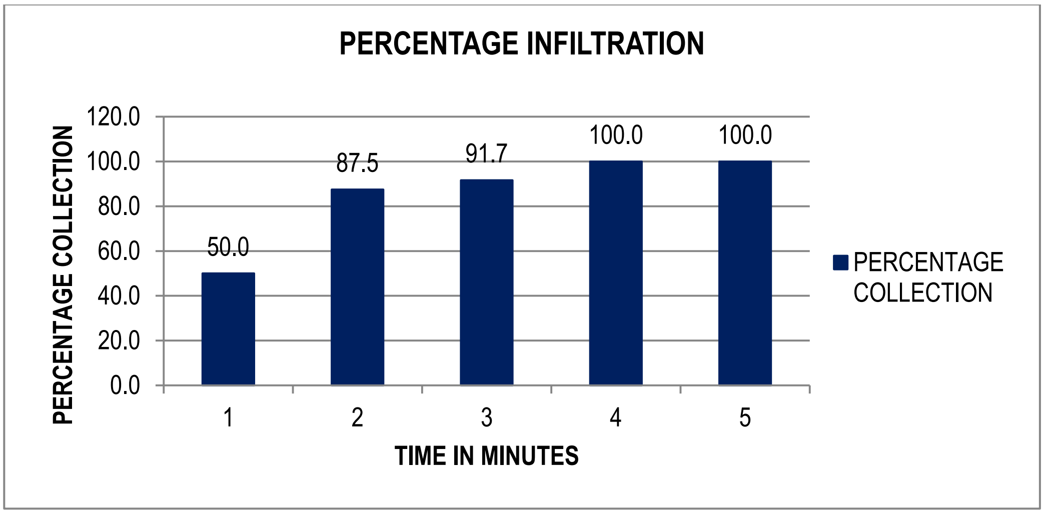


Fig. 2 Percentage Infiltration

4. CONCLUSION

Permeable pavements can be a major contributor to the effective management of storm-water. They provide the opportunity of transforming a traditional source of storm-water runoff into a best management practice for capturing, storing and infiltrating storm-water into the natural surroundings. Benefits achieved include reduced storm-water discharges as well as improvements to water quality including reduced suspended solids and reduction of chemical contaminants.

The results of the experimentation depict convincingly that from dry state to saturation state the output in terms of water infiltrating through permeable pavement increases from 0% onwards and after the saturation of the permeable pavement, 100% output in form of water infiltrating from the permeable pavement is observed.

However, there could be many more possible design considerations, parameters and logical conditions to measure the output efficiency of the permeable pavements.

5. REFERENCES

1. Carmen T. Agouridis, Jonathan A. Villines, and Joe D. Luck, Permeable Pavement for Storm-water Management, Cooperative Extension Service • University Of Kentucky College Of Agriculture, Lexington, Ky, 40546, AEN-108
2. Permeable Pavement (1008), Wisconsin Department of Natural Resources Conservation Practice Standard
3. Porous Asphalt Pavement for Storm-water Management, The UNH Storm-water Center Web: www.unh.edu/erg/cstev/
4. David J. Sample, Lia Doumar, College of Agriculture and Life Sciences, Virginia Polytechnic Institute and State University, 2013, Publication 426-126
5. David K. Hein, PERMEABLE PAVEMENT DESIGN AND CONSTRUCTION CASE STUDIES IN NORTH AMERICA, https://www.researchgate.net/publication/290946871
6. Masoud Kayhanian, Davis Peter T. Weiss, Indiana John S. Gulliver and Lev Khazanovich, The Application of Permeable Pavement with Emphasis on Successful Design, Water Quality Benefits, and Identification of Knowledge and Data Gaps June 2015, A summary report from the National Center for Sustainable Transportation.
7. http://renovatedsm.org/wp-content/uploads/2014/01/

DOI : 10.18231/2454-9150.2018.0236