SURFACE INFILTRATION RATES OF PERMEABLE PAVEMENTS

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ABSTRACT

Impermeable surfaces have greatly increased runoff going into receiving waters. The purpose of permeable pavement is to allow water to infiltrate, reducing this effect. However, permeable pavement must be maintained to retain its permeability. This study tested the surface infiltration rates of 30 permeable pavement sites in North Carolina, Maryland, and Delaware. Seven different classifications of surfaces were tested with installation ages ranging from six months to 20 years. These included concrete block pavers with sand filled joints and pea gravel filled joints, permeable interlocking concrete pavements (PICP), grass pavers, porous concrete and porous asphalt. Twelve concrete block paver lots with sand filled joints were tested twice. The first test was under existing conditions and the second was run after the top layer 15 mm of residue was removed to simulate maintenance. The average pre-maintenance and post-maintenance infiltration rates were 9.6 cm/hr and 8.8 cm/hr, respectively. Two other final observations from this study were: (1) sites built near disturbed areas with loose fines had infiltration rates an order of magnitude or two less than sites built away from disturbed soil and 2) unless the site was constructed in a clay soil area, the infiltration rate was at least 2.0 cm/hr.

DATA

Permeable Interlocking Concrete Pavers

Two PICP sites were tested, seven in Maryland, two in North Carolina and one in Delaware. Seven of these sites were tested using the surface inundation test, due to their high permeability (infiltration rate of 2000 cm/hr). The remaining three PICP sites were located in areas containing exposed fine soil particles (infiltration rate of 4.2 cm/hr) which were found to be statistically lower or a 99% confidence than sites away from fine.

Concrete Grid Pavers

Infiltration rates were measured from 14 sites with Turfstone™. Twelve sites were tested after maintenance. Eleven of 12 sites had improved infiltration rates after maintenance. The site with the lowest infiltration rate, Town of Cary Public Works (1.6 cm/hr), could be the result of no maintenance, frequent heavy traffic, and clay soil. The median average pre-maintenance surface infiltration rate was 4.8 cm/hr, the median average post-maintenance surface infiltration rate was 3.9 cm/hr, maintaining the lots increased infiltration rates by 2/3.

Porous Asphalt and Porous Concrete

Two sites in Chapel Hill, NC, had the highest surface infiltration rates: 9000 cm/hr, and 2000 cm/hr, asphalt and concrete respectively. These lots were recently constructed in 2002. A site in Kinston, NC, had the lowest surface infiltration rate, 1.0 cm/hr. The Kinston site was constructed in 1972 and located near exposed fine soil particles (25 cm/hr) and is statistically lower than 95% confidence than others away from fine.

maintained the site increased permeability by 66%. A SAS™ analysis showed a statistically significant (97% confidence) difference between pre- and post-maintenance infiltration rates. The site with the lowest surface infiltration rate, Town of Cary Public Works (1.6 cm/hr), could be the result of no maintenance, frequent heavy traffic, and clay soil. The median average pre-maintenance surface infiltration rate was 4.8 cm/hr, the median average post-maintenance surface infiltration rate was 3.9 cm/hr.

KEY OBSERVATIONS & CONCLUSIONS

(1) Maintenance is a key factor to maintaining infiltration rates on pavements comprised of concrete block pavers filled with sand. Maintaining the site increased permeability by 66%. A SAS™ analysis showed a statistically significant (97% confidence) difference between pre- and post-maintenance infiltration rates.

(2) Locating PICP away from fines is very important to maintaining high infiltration rates. Infiltration rates of newly installed PICP filled with gravel were not limited by their surface infiltration capacity. Sites free of fine material had a infiltration rate of 2000 cm/hr (900 in/hr), while the PICP sites near disturbed soils with fines had 2.0 cm/hr (0.8 in/hr), a drop of over 99%.

(3) PICP sites away from site had rates similar in order of magnitude to those rates found for pervious concrete and pervious asphalt. However, all three surface types have a strong tendency to have a highly decreased surface infiltration rates when they are either (1) substantially older and/or (2) located near exposed fines. Due to a limited number of pervious concrete and pervious asphalt sites, it is difficult to make too many inferences from the data collected in this study.

(4) Almost all sites (77/90) had infiltration rates greater than 2.0 cm/hr (1 in/hr). These rates are equal to or greater than infiltration rates expected for grassed sandy soil.

METHODOLOGY

One of two methods were used to measure infiltration rates.

(1) The first method used double ring infiltrometers (DRI) for derived to test lower infiltration rates (110 cm/hr). A DRI placed into a ring filled with fine textured soil near the inner ring. Thus, the inner water level can be measured to determine infiltration rates. At each site, three DRI tests were run for existing conditions. Five nearly all concrete block paver sites, three DRI tests were also run, after maintenance had been performed on the surface. Maintenance involved removing the top 13-19 mm (0.5-0.75 in) of material from void spaces. Most tests ran for 45 minutes, or until the rings were empty of water.

(2) The second method used was the surface inundation test, which was used for high infiltration rates from the site, the inner ring from the DRI was sealed to the surface, while a ruler was taped inside the cylinder. Using a five gallon bucket, water was poured into the cell, and the inner ring. Infiltration rate was then determined by taking reading water levels every 30-60 s. This test is neither as accurate nor as precise as the DRI test; however, the surface inundation test was not concept horizontal position of the water.