Hydraulic Design of Permeable Interlocking Concrete Pavement (PICP)

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Project Summary: 9

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Background and Need

While PICP has structural and hydrologic design components, there is no overt design for transmittal of the stormwater across and through the pavement surface.

Top left and right: Flume containing PICP measures surface and subsurface flows and volumes. Bottom left and right: PICP surface at the flume end and cross section with jointing, bedding and No. 57 stone base.

Objectives

This research developed a hydraulic design methodology and laboratory verification to allow proper selection impervious contributing drainage area (CDA) into PICP as well as prediction of surface cleaning. This was accomplished by building a full-scale, two-layer hydraulic PICP model to measure surface and subsurface flows. PICP sections were constructed with 6, 10, and 12.5 mm joint widths using ASTM No. 8 and 9 jointing aggregate and flow tested at slopes up to 10%. 60 mm thick pavers were used. Flows were compared to water infiltrated across and through the PICP and compared to what overflowed.

Testing surface flow established rates at which the hydraulic capacity of the PICP is full and the surface generates runoff. This testing was done at various slopes. The (high) flow rates that cause incipient runoff from PICP were identified at various slopes for previously noted paver joint widths and jointing aggregate. Flow rates can be correlated to rainfall intensities depending on the CDA slope and area configuration. Also 45° herringbone pattern demonstrated a slightly lower overall infiltration rate than a 90° herringbone layout. Similar flow research was previously done at the university on pervious concrete using similar test equipment. Therefore, that data is available for comparison.

Outcomes

Vertical infiltration rates tested per ASTM C1781 Standard Test Method for Surface Infiltration Rate of Permeable Unit Pavement Systems were compared to the measured horizontal infiltration capacity. C1781 overpredicts the horizontal flow capacity of a PICP surface between 11% and 35%. In other words, the horizontal infiltration capacity of PICP is lower than the vertical rate measured with C1781. This suggest using higher infiltration rates for determining maintenance when using C1781 which have been incorporated into Tech Note PAV-TEC-023 on PICP maintenance.

The study included dosing stormwater with sediment at very high concentrations conforming to gradations used by the New Jersey Corporation for Advanced Technology (not-for-profit technology assessment center) for assessing sediment reductions on various stormwater management practices. PICP with 6 mm joints and No. 9 jointing stone clogged about three times more quickly than PICP with 10 mm joints and No. 8 jointing stone. The latter clogged about 2.3 times faster than PICP with 12.5 mm joints and No. 8 jointing stone. This exercise pointed to the need to minimize sediment sources including that from impervious CDAs. The data suggests more frequent surface cleaning intervals for PICP with smaller joints and jointing aggregate.

This tests better defined the clogging potential of PICP as a function of joint width and jointing stone gradation. The test results were incorporated into a hydraulic design Excel program to evaluate potential site designs and to predict the anticipated maintenance period assuming various sediment loads. The project funded two master's theses. A summary technical paper is found here.