Design of a Pervious Concrete – Porous Asphalt Comparison Study

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ABSTRACT

Porous asphalt and pervious concrete have been in use since the 1970’s as a method of decreasing the amount impervious surface area and increasing the amount of stormwater infiltrating back into the ground water without requiring the use of extra land for retention basins. Although research has been completed in the past on each of these mediums individually, there are no direct comparisons available in the literature. Villanova University and its partners have designed a study on the Villanova campus that contains two adjacent 30 feet by 50 feet areas separated by an impervious barrier. One area will be covered by pervious concrete while the other will be covered by porous asphalt. There is a stone bed beneath each pavement type to store stormwater while it infiltrates into the ground. The site will be heavily instrumented to monitor temperature and moisture movement. In addition, samples for water quality testing will be obtained from first flush samplers, pore water samplers below the beds, the beds, and a pipe exiting the site. This paper will discuss the key components of the physical design of the project as well as the planned monitoring effort.

INTRODUCTION

Many state departments of environmental protection and the US EPA lump all porous pavement (pervious concrete, porous asphalt, and porous pavers) into one category. Pervious concrete and porous asphalt have been the subject of a number of studies and papers (e.g. Kwiatkowski, et al. 2007, Dreelin, et al. 2006, Traver, et al. 2005, Cahill, et al. 2004, Traver, et al. 2004, Adams and Cahill 2003, Brown 2003, Dempsey and Swisher 2003, Moore, et al. 2001, and Backstrom and Bergstrom 2000). However, all of these studies evaluated pervious concrete or porous asphalt. In addition, much of the existing literature is focused on porous asphalt to the exclusion of pervious concrete.

We believe that both pervious concrete and porous asphalt are useful products for enhancing the infiltration of stormwater. In fact, we currently have both products in use at Villanova at this time. However, we hypothesize that these products may behave differently in regards to durability, maintenance requirements, ability to transmit or filter key contaminants such as hydrocarbons and heavy metals, and ability to mitigate heat island effects. Consequently, a side-by-side comparison study was initiated.
OBJECTIVES
When we construct any new BMP on Villanova’s campus we have two-pronged goals. The first is always to improve the environment by increasing the amount of stormwater infiltrated into the ground to restore the natural hydrologic cycle. The second is to study a specific BMP and transfer the knowledge we gain to the public to increase the use of BMPs nationwide. The key outcomes of this comparison are:
- heightened awareness of the use of pervious/porous materials in infiltration BMPs
- a description of the durability differences between the products
- the maintenance requirements of the two products with recommendations to keep them functional
- a description of the impact the products have on water quality and temperature.

LOCATION
The site is located on Villanova’s campus in between Mendel Hall and the greenhouse near the Villanova SEPTA station.

PAVEMENT INFORMATION
The grade of the site is sloping downwards from Mendel Hall towards the greenhouse. The thickness of the stone beds varies because a flat bottom was maintained for the beds. A geotextile was placed under both pavement types to separate the stone beds from the existing soil. A jersey barrier covered in a geomembrane separates the two pavement types and their beds. The key components of the pavement types are summarized below:

<table>
<thead>
<tr>
<th>Pervious Concrete</th>
<th>Porous Asphalt</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mix design by NRMCA</td>
<td>Mix design by Cahill Associates (same mix as Radnor Middle School)</td>
</tr>
<tr>
<td>6 in thick pavement</td>
<td>2.5 in thick pavement</td>
</tr>
<tr>
<td>#2 stone (varies in thickness from approximately 0.5 ft to 3.5 ft)</td>
<td>1 in of choker stone over #2 stone (varies in thickness from approximately 1.5 ft to 3.5 ft)</td>
</tr>
</tbody>
</table>

SUMMARY OF INSTRUMENTATION
The site is heavily instrumented. A summary of the instrumentation is presented below.

<table>
<thead>
<tr>
<th>Instrument</th>
<th>Number</th>
<th>Location</th>
<th>Use</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tipping bucket rain gauge</td>
<td>1</td>
<td>Roof of Mendel Hall</td>
<td>Measure precipitation</td>
</tr>
<tr>
<td>First flush samplers</td>
<td>4</td>
<td>Edge of new pavement</td>
<td>Obtain surface samples for water quality testing</td>
</tr>
<tr>
<td>Pressure transducers with temperature sensor</td>
<td>2</td>
<td>Inside drop inlet connected to beds</td>
<td>Depth of water in bed and amount of water exiting the site</td>
</tr>
<tr>
<td>V-notched weirs</td>
<td>2</td>
<td>Inside drop inlet connected to beds</td>
<td>Amount of water exiting the site</td>
</tr>
<tr>
<td>Soil moisture, temperature, and conductivity sensors</td>
<td>12</td>
<td>2 banks under each pavement type at depths of 3 in, 9 in, and 21 in</td>
<td>Track movement of wetting front, record temperature and conductivity</td>
</tr>
<tr>
<td>Pore water samplers</td>
<td>12</td>
<td>2 banks under each pavement type at depths of 3 in, 9 in, and 21 in</td>
<td>Obtain subsurface samples for water quality testing</td>
</tr>
<tr>
<td>Temperature sensors</td>
<td>4</td>
<td>1 in each first flush sampler</td>
<td>Monitor temperature of water entering, in, and exiting the site</td>
</tr>
</tbody>
</table>
Water quality samples will be obtained from the first flush samplers, the inlets connected to the beds, and the pore water samplers. All of these samples will be tested for pH, hydrocarbons (PAH), and dissolved and particulate metals, including chromium, copper, lead, and zinc. The samples obtained from the first flush samplers and the inlets will also be tested for conductivity, total suspended solids and total dissolved solids.

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REFERENCES