Managing Storm Water with Hot-Mix Asphalt Pavements

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ABSTRACT: Managing storm water with porous or dense-graded hot-mix asphalt (HMA) pavements is attracting attention because of the role it can play in sustainable site design and storm water management. This technology is of interest to public works officials, consultants, engineers, land developers, contractors, environmental engineers, and others with an interest in minimizing the impact of development on the environment.

The concept is fairly new in Minnesota, however this design has been used successfully since the 1970's in the United States and Europe. This pavement structure has been used in various climate conditions and can provide many benefits including: storm water runoff control, groundwater recharge, reduction of drainage structures needed to comply with storm water regulations, reduction of right-of-way for retention ponds, reduction of curb and gutter, and increased skid resistance and safety.

The most common locations for use include parking lots and low volume roads, and in high activity recreational areas like basketball and tennis courts or playground lots. This paper discusses the general design and application of storm water HMA pavements for successful use of the concept, and recent projects in Minnesota.

1 INTRODUCTION

The concept of managing storm water with porous or dense-graded hot mix asphalt (HMA) pavements is fairly new in Minnesota, however this design has been used successfully since the 1970's in the United States and Europe to provide a solution to storm water runoff as well as groundwater table recharge. HMA pavements have been used in various climate conditions with the benefits of providing runoff control, aquifer recharge, reduction of drainage structures needed to comply with storm water regulations, and increased skid resistance and safety. The most common locations for use include parking lots and low volume roads, and in high activity recreational areas like basketball and tennis courts or playground lots.

A typical HMA pavement section consists of either a porous or a dense-graded HMA pavement over a porous, large stone aggregate base course that has sufficient void space designed for runoff detention, frost penetration, and structural capacity, Figure 1. A non-woven geotextile filter fabric is used to prevent the existing uncompacted soil or subgrade material from migrating into and clogging the voids. To provide a construction platform suitable for paving, a uniformly graded, 12.5 mm (½ inch) sized aggregate is used to slightly fill in the voids on the large stone base while maintaining porosity of the structure.

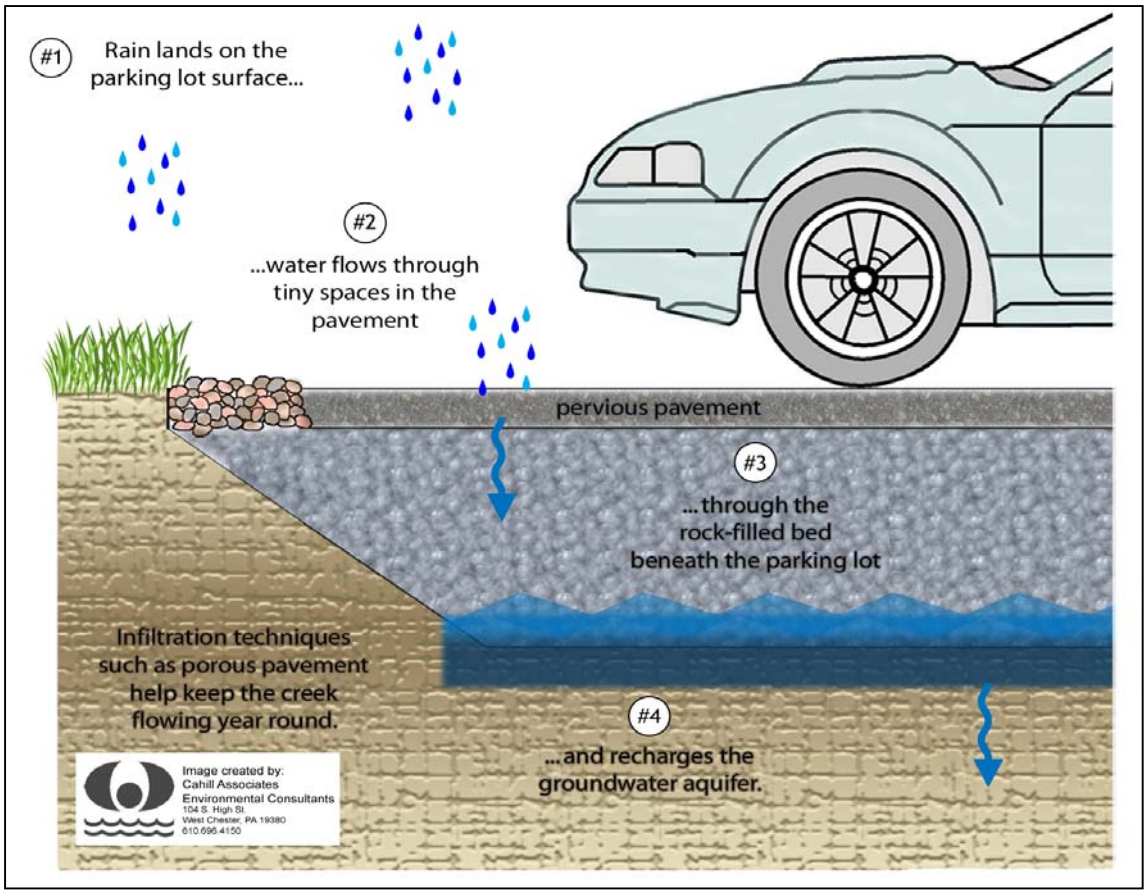

Figure 1. Managing Storm Water with Hot-Mix Asphalt Pavement Schematic (courtesy of Cahill Associates, www.thcahill.com).

The proper design and application of the pavement structure is important for successful use of the concept. It is a tool in the toolbox for pavement design, and every site should be treated as unique when designing the facility. Soil characteristics, local topography, and climate conditions are physical factors that will be used in the planning and design processes. Other considerations include traffic loading, use of the facility, and agency regulations (i.e. storm water regulations), contact the Minnesota Asphalt Pavement Association (MAPA) for design guidance at www.asphaltisbest.com.

Special consideration is needed in the design relative to soil type, topography, and climate conditions. It is recommended that sites with a relatively deep water table be used. Areas with gentle sloping topography are ideal to allow the water to percolate through the system, although terracing the parking lot and using dense-graded HMA in steeper areas has worked successfully in hilly terrain. Several climate factors should be considered in the design including precipitation rate, depth of frost penetration, and excessive dust in the area. The design should be free of frost susceptible materials (depth as needed).

The depth of the HMA course is typically 50 to 100 mm (2 to 4-inches), depending upon the facility type. A porous HMA course contains little sand or dust, with an interconnected air void space of approximately 16 percent or more as compared to the dense-graded HMA [Mn/DOT, Plant Mix hot-mix asphalt Combined 2360/2350 Specification located at the following web site:

www.mrr.dot.state.mn.us/pavement/bituminous/bituminous.asp] that traditionally has 3 to 4 percent air voids. Also, using a dense-graded rather than porous HMA course would require a piping system to distribute water in the reservoir layer.

The top filter course is typically 25 to 50 mm (1 to 2-inches) thick and is typically a 12.5 mm (½ inch) crushed stone aggregate. The filter course also protects the reservoir course from disturbance during placement of the HMA mix. The reservoir course is a base course comprised of crushed stone of a depth determined by the storage volume, structural capacity, or frost depth, whichever requires the greater thickness (typically 40 percent voids). Below the optional filter course or reservoir course, a filter fabric must be placed to prevent fines from migrating into the reservoir.

Inspections should be conducted to check for surface ponding that might indicate possible clogging. The surface can be flushed or jet washed to assist in the maintenance of the pavement surface porosity. A liquid de-icer or fine salt material should be used in place of sand that will clog the system. The surface of the porous HMA pavement should not be sealed with a surface treatment at the risk of clogging the surface.

The costs for managing storm water with HMA pavement will vary and an economic analysis should be considered. Increased costs for the required high quality materials in the large stone base may be offset by reduced piping, curb and gutter, and right-of-way costs a for retention water pond.

2 MINNESOTA PROJECTS USING HMA PAVEMENT FOR STORM WATER MANAGEMENT

Since 2004, several sites in Minnesota have used HMA pavements to help facilitate storm water management. One of the first sites constructed was the Ramsey-Washington Metro Watershed District office building (www.rwmwd.org), which employed several best management practices from typical raingardens to the new porous HMA pavement, photo 1. A commercial project in the Baxter/Brainerd area used a typical dense-graded HMA pavement and base layer material however collected and stored the water under the pavement surface for treatment and release to the groundwater rather than constructing a storm water retention pond. Another option has been to use porous HMA in the parking stall areas and dense-graded HMA in driving lanes if heavy traffic is expected. Other projects in Minnesota include a Unitarian Church in Mahtomedi, photo 2, Iven's on the Bay (restaurant) in Baxter/Brainerd area, the Maplewood Public Works building, see www.ci.maplewood.mn.us, and several bike Trails in Woodbury and in Stillwater. A future letting is scheduled for Century College (1700 stalls) in Maplewood area.

Photo 1. Porous HMA Pavement at the Ramsey Ramsey-Washington Metro Watershed District office building in Little Canada, MN.

Photos 2 & 3. Porous HMA Pavement at the Unitarian Church in Mahtomedi, MN.

3 REFERENCES

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