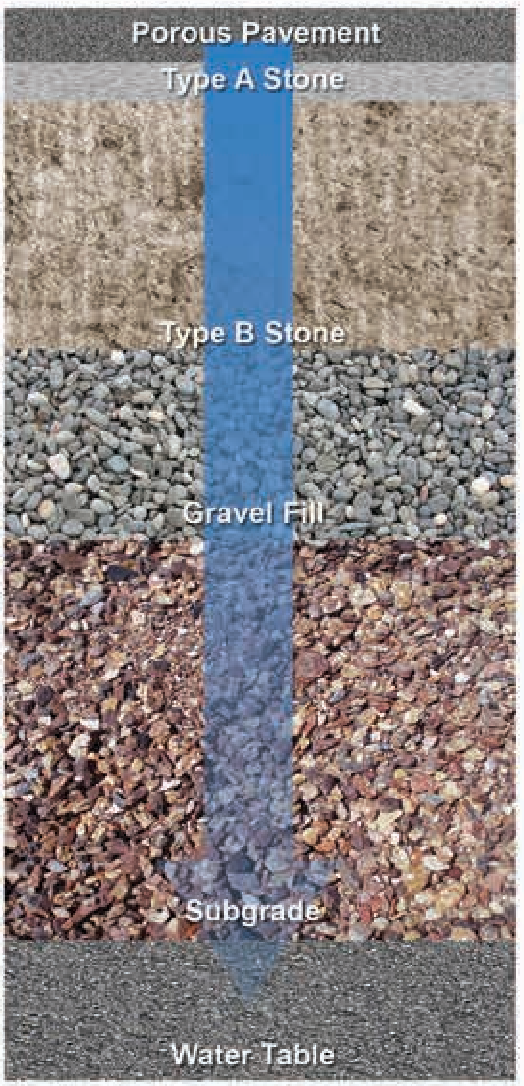
Maintenance and Restoration of Porous Pavement Surfaces

Elgin Sweeper Company



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Porous Pavement Surfaces

Porous surfaces have been growing at a double digit rate the last several years as a Best Management Practice (BMP) to deal with storm water runoff. They have been proven to be an effective tool to reduce the quantity of water and accompanying pollutants that is directed untreated to our waterways. However, major questions concerning the maintenance of these surfaces have risen as a result of the growth.

Elgin Sweeper Company has been participating in research programs with major universities and municipalities across the U.S. in order to get a better understanding of the maintenance requirements. The purpose of this paper is to give the reader a better understanding of the role of street sweepers in this application.

Porous surfaces can be divided into two broad categories:

1. Surfaces where the water seeps directly through the material pore structure. This type of surface can be made of concrete, asphalt, crumbled tire rubber and other materials.

2. Surfaces where the water seeps through pervious gaps between non-pervious blocks. This category is commonly referred to as interlocking blocks that are generally made of concrete. The gaps between the blocks are filled with a granular material that serves to maintain the relative position of the blocks and allow water to seep through.

Porous surfaces can be thought of as a rigid, load bearing area with an internal structure not unlike open cell foam. When water comes in contact with the upper surface, it flows immediately through the surface to the engineered volume under it.

The interlocking blocks are placed on an engineered surface where their spacing is precisely controlled. The gap between the blocks, where the water flows, can vary from 1/8" on the edges to 1" square in the corners to other proprietary shapes. The size of the gap will have a relationship to the tendency to plug.

Several studies have shown that either surface type will plug, to varying degrees, with silt, fine clay, cement derivatives, and decomposed plant material. In addition, most studies have shown that on non-traffic areas the plugging is limited to the top half inch or less of the surface.

The care of these surfaces is divided into two activities:

1. Maintenance :Routine debris removal primarily for aesthetic purposes.

2. Restoration: Deep cleaning to restore percolation on plugged surfaces.

A frequent question is “How long will the surface last before restoration is required?” It is dependent on the composition of the surrounding soil and the care that landscaping activities exhibit. In certain areas of the country that have very sandy soil, the surfaces will last longer. In areas where there is a high degree of clay in the soil, clogging can occur rather quickly. In fact, installation of porous surfaces in areas of high clay content may not be practical.

Since all surfaces can be plugged by non-attentive behavior, the first step to retaining the porous nature of the surfaces should be to install signs to inform the casual passersby that the surface is indeed porous and that certain activities such as depositing landscape material should be avoided.

Prior to cleaning the surfaces, an understanding of the mechanics of street sweepers is in order to get the most effective use of the equipment and prevent further clogging of the surfaces.

Street sweepers and their effects on porous surfaces can be divided into three main groups:
- Broom
- Regenerative air
- Vacuum

Broom Sweepers

Broom sweepers are the most common type of sweeper in the U.S. and account for about 60%-70% of the sweeper population. They rely on metal wire side brooms that dislodge material from the gutter and move it to a cylindrical main broom that lifts the material on to a conveyor or squeegee for loading into a debris hopper. They are good at dealing with large amounts of debris ranging in size from fine particles to large bulky objects. This range of sweeping flexibility is why this style of sweeper is so widely used. However, this type of sweeping mechanism is not capable of removing silt from the pores of the surface, and in fact, may actually leave silt in the pores and contribute to clogging. If a porous surface is covered with soil it should be understood that using a broom sweeper to clean it will not restore the percolation of that surface, but may be a good first required step in the permeability restoration process.

There is a type of broom sweeper referred to as a “combination” sweeper that has a filtered vacuum system that captures dust that the brooms generate, however the vacuum level created at the brooms is designed to control airborne dust and is insufficient to provide any restoration of clogged surfaces.

Regenerative Air Sweepers

Regenerative air sweepers are the second most common type of street sweeper in the US. They account for about 20%-30% of the total sweeper population. The mechanics of Regenerative Air Sweepers are generally not understood. The full sized regenerative sweepers in use on streets use a blast of air the width of the sweeping head to dislodge material from the surface and lift it into an airstream that moves the material across the sweeper into a vacuum hose where it's lifted into the debris hopper. The greatest confusion is when these are referred to as vacuum sweepers. In general recirculating mode, the amount of vacuum they produce is rather low and inadequate to do restoration. However, regenerative air sweepers frequently have a device called a "Vacuum Enhancer". This is merely a valve that when activated limits the amount of air volume that is recirculated through the blast nozzle and therefore increases the vacuum level in the vacuum chamber of the sweep head. If the "Vacuum Enhancer" is operated to its maximum capability, the sweeper can become more like a vacuum sweeper. In this mode a typical regenerative sweeper is capable of producing a maximum vacuum level of approximately 40"- 50" water, however due the size and shape of a regenerative head, much of the produced airflow is drawn around the head seal and not through the permeable surface. Another downside of regenerative sweepers is that they are generally not designed to be operated in this mode for dust suppression purposes. As a result, they tend to blow excessive amounts of dust out the vacuum enhancer.

Testing has indicated that if a regenerative sweeper is operated in full regen mode, care has to be taken to prevent re-depositing fine silt into the pores of the surface with the air blast. This would tend to occur if the surface was damp. When operated in the full vacuum mode, the vacuum level is generally insufficient to restore a clogged surface, but may produce acceptable maintenance cleaning.

Pure Vacuum Sweepers

The pure vacuum sweeper is the most popular type of sweeper in Europe but the least populous in the U.S. It accounts for approximately 5% of the U.S. market. The Elgin Whirlwind is the most common pure vacuum sweeper in the United States. It can be configured with either single or dual vacuum nozzles, side brooms and a transverse "windrow" broom that moves debris into the path of the 3' wide vacuum nozzles. The sweeper operates like a giant vacuum cleaner where debris is vacuumed off the surface and deposited into the debris hopper. The fan air is then simply exhausted out of the body. It is important that this type of sweeper use water in the hopper or at the side brooms to prevent fine particles from being pulled through the vacuum fan and being exhausted into the free air.

The main advantage of the pure vacuum sweeper for use on porous pavements is the high vacuum level of 70"- 80" water they can create. Most porous pavements and many interlocking block surfaces require this degree of vacuum to restore infiltration of a clogged area.

Use of water for cleaning

The silt that plugs both types of surfaces is generally carried there by water. In a damp condition, the silt swells and has a sticky texture to it. In order to clean the silt out of the pavement, best results are obtained when it's dry enough for the silt to contract and release its grip on the surrounding material. An alternative is to add large amounts of water such that the ratio of water to dirt is very large and use a vacuum sweeper. It is difficult to create this situation outside of a heavy rainstorm.

A problem using any of the sweepers mentioned is that they are designed to dampen the surface with a water spray to reduce airborne dust as well as dust and material that is carried through the two types of air sweepers (vacuum and regenerative air). An alternative on the regenerative and vacuum sweepers is to preload the hoppers with a few hundred gallons of water. The water in the hopper effectively eliminates carryover dust through the vacuum fan of either type of sweeper. A downside is that the dumped load contains large amounts of liquid which can create its own issues.

Research indicates that unless the pressure washing is followed up with a vacuum sweeper it is not effective. In addition, the job of pressure washing tends to break up surface buildup and simply move it to another location. Some sweepers are equipped with high pressure spray bars to provide this combination cleaning system.

Cleaning Non-Traffic Areas

Studies have shown that a significant amount of interlocking pavers as well as porous surfaces are being installed in non-vehicle traffic areas. They aren't accessible for truck sweepers.

Several companies make small litter vacuum sweepers who's size would be acceptable for maintenance cleaning but don't develop adequate vacuum to restore clogged surfaces.
If clogging in these areas is limited to extremely small areas, a high powered shop vacuum might be used to restore the infiltration.

Maintenance of Interlocking Paver Block areas

When monitoring block areas, there are two methods to determine if the surface is infiltrating properly:

1. Observe the area for standing water after a major rainstorm event; or
2. Conduct surface infiltration test using a double ring infiltrometer.

If the block areas are not trapping sediment in the jointing aggregate, infiltration will remain adequate, therefore only requiring annual routine maintenance cleaning of the area. Maintenance cleaning of block areas can be accomplished with a regenerative air sweeper or a high power vacuum sweeper. Both types of sweepers should be operated at low power levels to remove the loose surface material without disturbing the granular filler.

If designed infiltration is no longer occurring, surface restoration will be required. During restoration, the top layer of granular material containing the silt plug will have to be removed with a high power vacuum sweeper. In most cases, the granular material is inexpensive and easily replaced. This is not always the situation, so the cost and availability of replacement filler needs to be determined ahead of time before a complete restoration is attempted.

Maintenance of Porous Surfaces

Monitoring of porous surfaces is similar to the methods used to determine the infiltration of paver block areas. If the porous surface is demonstrating adequate infiltration, then only annual routine maintenance cleaning of the porous surface is required. Maintenance cleaning of porous surfaces can be accomplished with a regenerative air sweeper or a high power vacuum sweeper. As previously mentioned; when operating a regenerative sweeper in full regenerative mode, care has to be taken to prevent depositing fine silt back into the pores of the surface with the air blast.

If designed infiltration is no longer occurring, surface restoration will be required. During restoration, the top layer of sand, silt or clay will need to be removed using a high power vacuum sweeper in order to restore proper infiltration.

All permeable surfaces can remain unclogged if annual routine maintenance using either a regenerative air or high power vacuum sweeper is properly conducted. In the event that such maintenance is neglected, proper restoration of the surface is necessary and requires the use of a high power vacuum sweeper.

Case Study; Cost Estimate, City of Denver

Testing conducted at City of Denver – The Lakewood Maintenance Facility
Using the Elgin Megawind, a pure vacuum sweeper, to establish a baseline cost per square foot to maintain and restore permeable pavement.

The research indicates the below cost estimates:

- Maintenance = 15¢ per square foot
- Restoration = 60¢ per square foot

Measurements

Adequate measurements of infiltration can be obtained with a single ring infiltrometer.

Many people use a double ring infiltrometer that is recognized by the EPA.

Both methods will provide a good indication of the condition of the surfaces. In general, most new surfaces have an infiltration rate that exceeds the requirement for a one hundred year storm. Therefore, absolute accuracy may be more than is needed to establish the need to restore a surface.

Winter Maintenance

A common question relating to porous pavements is “How do I care for it in the winter?”

Recent testing has resulted in a few recommendations

- Don’t apply traction material.
- If salt has to be applied, use a liquid material that’s been filtered. Common de-icing salt has up to 10% dirt content in it that will plug the surfaces.
- Don’t plow snow into piles on the surfaces. The piles will contain greater than average dirt that will plug the area it’ piled on. Move the snow off the surface if possible.

Maintenance and Restoration Cleaning

To the casual observer; the infiltration of a permeable surface is unknown until the surface becomes impaired and the flow rate is visibly noticeable when it approaches zero. At this time the customer decides it’s time to do some maintenance, using a low vacuum regenerative air sweeper, and because they get some minor degree of cleaning they think they’re successful. What they don’t realize or openly admit is that they’ll have to clean the same surface afterwards in very short period of time. In the event of “Normal” usage of a permeable surface, with no maintenance until the surface is noticeably plugged, a low vacuum regenerative cleaner or pressure washer was used. The immediate “visible” result illustrates some degree of permeability has been restored, but the absolute value will generally get less until the low vacuum regenerative cleaner is inadequate.

In the event of “Normal” usage of a porous surface or interlocking paver block area, with no maintenance until the surface is noticeably plugged, a high power vacuum sweeper can be used to restore the permeability of the surface back to proper infiltration.

Doing routine, biyearly cleaning with a regenerative air sweeper or high power vacuum sweeper is a practical approach to maintenance a permeable surface. By not allowing the surface to degrade much before maintenance cleaning the full capacity should be retained.

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Summary

The progress towards urban adaption of this BMP approved paving technology and the recognition of the benefits of permeable pavement continues to increase domestically over a three-year trend. Although recognition of permeable pavement benefits are growing, and the integration into urban environments is becoming more common place, there are still challenges to overcome before the benefits of permeable pavement will outweigh the cost of its construction. Permeable pavement is a growing market; independent testing supports that both a regenerative air and high power vacuum sweepers can be used as a practical means to maintenance this pavement technology, as well as using high power vacuum sweepers for restoration projects. Communicating and establishing these practices is crucial to the future growth and market adoption of this BMP approved paving technology.

Credits

The job of maintaining porous pavements is in its infancy in the US. As a result, the library of studies and papers is limited. That is changing and in a year or so several detailed research papers will probably be published.

The material presented here is the result of different informal testing situations across the U.S. Many people have been involved in the work leading up to this paper. However we would like to acknowledge the special contribution a few people have made:

- Jim Schwaller, President of Environmental Products of Florida
- Dr. Bill Hunt, NCSU, research graduate student at the University of Central Florida
- David Smith, Technical Editor of Interlocking Concrete Paver magazine
- Chuck Taylor, Owner Advanced Pavement Technology
- Alan Gussarson, Sales Product Specialist, Elgin Sweeper Company