Design Considerations for Plantable Permeable Pavement

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LEED BD+C, SITES AP, LEED Green Associate

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June 2, 2021

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Purpose and Learning Objectives

Purpose:

Plantable permeable paving systems continue to grow in scope and practicality as we search for ways to reduce our carbon footprint, improve water quality, diminish flooding and erosion, reduce the urban heat island from reradiated heat in our cities and environment, and add attractive open space to building sites and neighborhoods. This course looks at plantable permeable pavement system types, their use, and how they can help achieve sustainability goals.

Learning Objectives:

At the end of this program, participants will be able to:

- define plantable permeable pavement types, including applicable government regulations and best management practices for their use
- recognize the environmentally friendly attributes of plantable permeable pavement systems including how they can be part of a project team's strategy for achieving building certification in LEED BD+C v4 and v4.1 and SITES v2
- identify basic design considerations for plantable permeable pavement
- contrast the attributes of the four main types of plantable permeable pavements, and
- apply sustainable design considerations for plantable permeable pavements to project types.

Contents

Introduction

Permeable paving is a replacement for traditional hard surfaces. These systems use a range of sustainable materials and techniques that allow the movement of stormwater through the surface down into the underlying base and subbase. Currently, there are four varieties of permeable pavements:

- permeable asphalt
- permeable concrete
- permeable interlocking concrete pavers
- plantable permeable pavements

A 2007 study at the North Carolina State University (NCSU) Permeable Pavement Research Lab showed that “all permeable pavements significantly and substantially reduced surface runoff volumes and peak flow rates when compared to asphalt.”

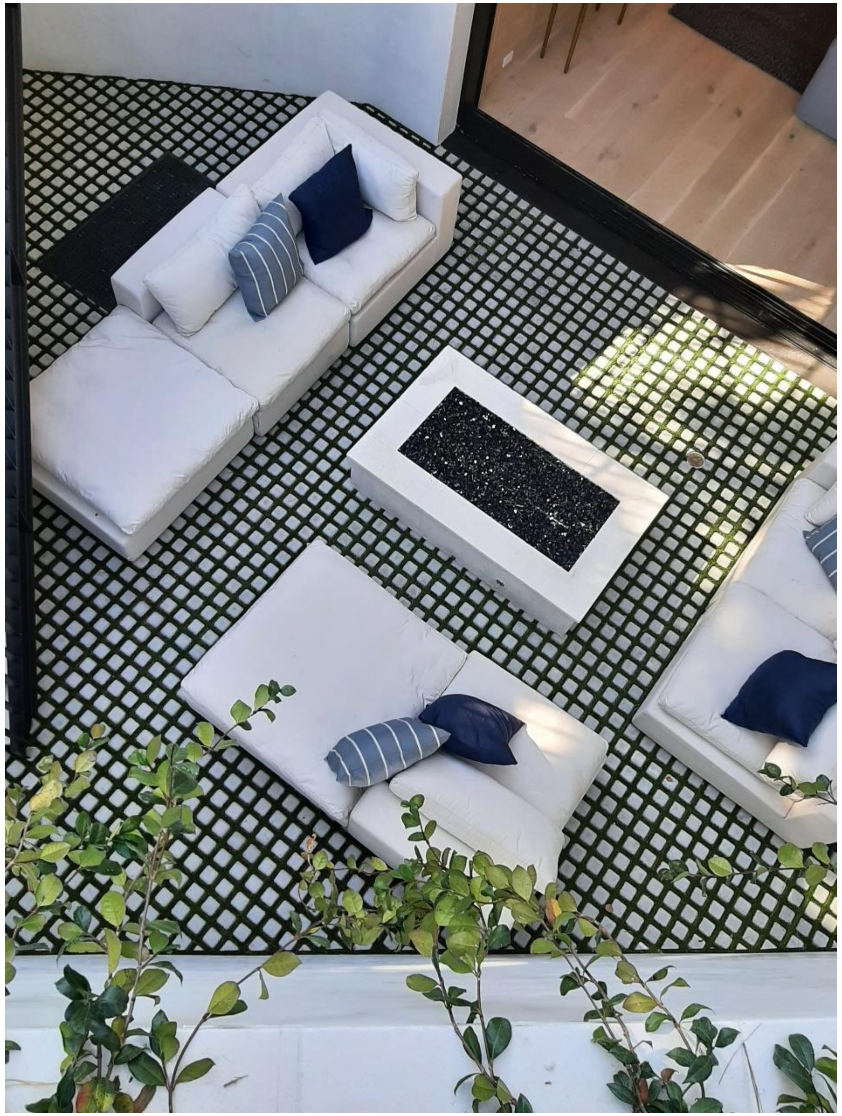
Introduction

Using permeable pavement, whether planted or not, is one of several strategies within a comprehensive site design and green infrastructure approach to creating more functional and sustainable landscapes.

The Environmental Protection Agency (EPA) considers “stormwater runoff in urban and developing areas to be one of the leading causes of water pollution in the United States.”

Since 2007, using Section 438 of the Energy Independence and Security Act, EPA has required federal agencies to reduce stormwater runoff from federal projects, compelling agencies to lead by example to clean up water resources by using green infrastructure and low-impact development techniques.

Introduction



In 2011, the EPA compiled a list of green infrastructure case studies nationwide. As part of a national rule-making process to create an EPA program to reduce stormwater runoff, 47.3 percent of the 479 case studies used some type of permeable pavement system, with just over half of the projects being retrofits of existing properties. Various applications are represented, from commercial and institutional/education to open space/parks and transportation. The EPA's website Green Infrastructure provides information on each case study, its location by region, and research associated with infrastructure types. (Link accessed May 2021.)

"The primary motivation for using permeable pavement," according to Neil Weinstein, executive director of the nonprofit Low Impact Development (LID) Center in Washington, D.C., "is that it doesn't eat up the land [like surface retention basins, bioswales, and filtration basins do]. This is especially important in urban areas where sites are smaller and must meet stormwater regulations."

Introduction

The LID Center works with many government agencies including the EPA, various universities, and the National Academy of Sciences to set standards of practice for use of permeable pavement of all types. Weinstein goes on to point out, “Since stormwater regulation is so prevalent, use of permeable pavement is becoming much more known and used more often as a matter of course [to meet national pollution and stormwater requirements]. It’s available and has become more attractive.”

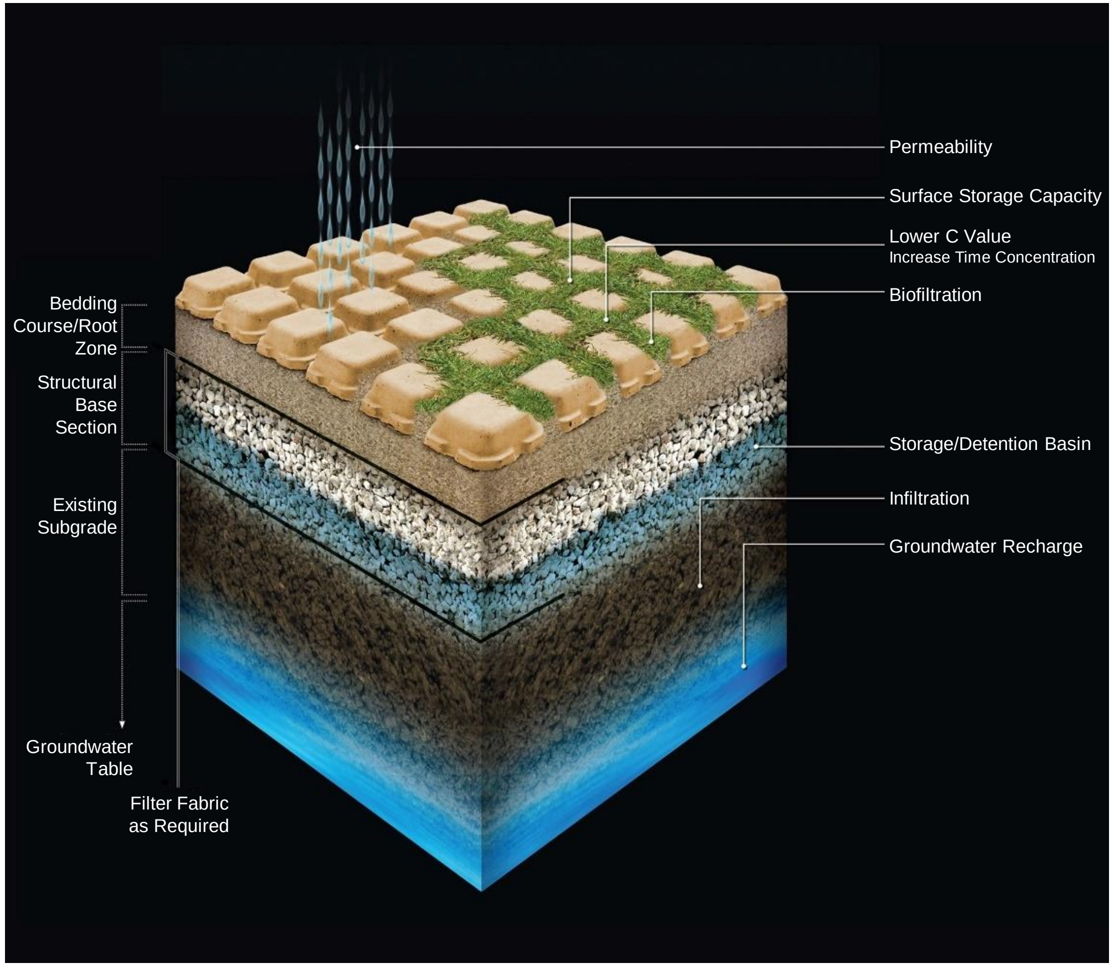
LID finds the largest users are commercial properties such as offices and shopping centers with large parking areas. However, transportation and residential applications are also becoming more commonplace.

Reducing Flooding and Erosion While Cleaning Our Water

Reducing Flooding and Erosion While Cleaning Our Water

All permeable pavements have shown their ability to clean polluted urban runoff water before it reaches local streams and rivers by filtering out heavy metal contaminants such as lead, zinc, cadmium, and copper as well as acid rain and phosphorus. As mentioned, the water moves through a variety of layers including sand, which is a natural filter.

Individual projects, whether public or private, can potentially use permeable pavements to meet local and federal flood control and stormwater pollution regulations under the Clean Water Act's National Pollutant Discharge Elimination System (NPDES). According to EPA's website, "the NPDES permit program controls water pollution by regulating point sources (pipes and ditches) that discharge pollutants into waters of the United States. Industrial, municipal, and other facilities must obtain permits if their discharges go directly to surface waters."



Reducing Flooding and Erosion While Cleaning Our Water

Cities with separate stormwater systems, known as MS4s (Municipal Separate Storm Sewer Systems), are now required to control the quality of what flows off parking lots and other sites into their storm drains. The value of permeable pavement systems to mitigate the flow of this type of pollution has increased its role in green infrastructure design, helping cities and private landowners alike to comply with these regulations. These pavements are strong enough to carry the loads from vehicles yet allow for rainfall infiltration through the pavement surface. This infiltration capacity cleans stormwater and lessens the potential for flooding and erosion as well.

Following EPA's leadership in green infrastructure, many of the most recently developed handbooks for best management practices (BMPs) and stormwater regulations are at the municipal level in locations near bodies of water—streams, rivers, lakes, and coastal areas. This is where permeable pavement has seen its greatest public benefit: the cleaning of urban runoff into fisheries and water supplies. Areas with BMPs, guidelines, and regulations include the East Coast seaboard around Chesapeake Bay, Virginia; North Carolina; Washington, D.C.; Maryland; the Great Lakes region especially around Lake Michigan; the City of Chicago; and the West Coast cities of Seattle, Portland, San Francisco, and San Diego, to list a few.

Reducing Flooding and Erosion While Cleaning Our Water

Research on the use of permeable pavement for stormwater and erosion control is extensive and compelling. Nonprofit organizations such as LID Center and American Rivers tout permeable pavement and green infrastructure investment as important to the rebuilding of our aging national infrastructure. Several examples exist in the United States where local and state governments have adopted regulations, codes, BMPs, and guidelines specifying the use of permeable pavements.

The North Carolina Department of Environment and Natural Resources (NCDENR) guidelines adopted in 2008 consider permeable pavement to be a stormwater design feature credited with pollution prevention through runoff reduction. Per NCDENR, permeable pavement is now considered equal to the permeability of turf; state law requires 20 percent of parking lots be permeable pavement (or a suitable, environmentally friendly, alternative stormwater management practice).

Reducing Flooding and Erosion While Cleaning Our Water

The EPA's National Pollutant Discharge Elimination System (NPDES) has a "National Menu of Best Management Practices (BMPs) for Stormwater." The list of practices is representative of the types of practices that can successfully achieve the minimum control measures. (Link accessed May 2021.)

The City of Santa Monica, like most of Southern California, requires the hydromodification control (alteration of the natural flow of water through a landscape) of the first ¾ inch of rain falling on impervious areas. This is often achieved by increasing permeable areas such as parking lots and driveways. These large surfaces also provide a great opportunity to increase the percentage of green space with the use of plantable permeable pavement.

Plantable Permeable Pavement

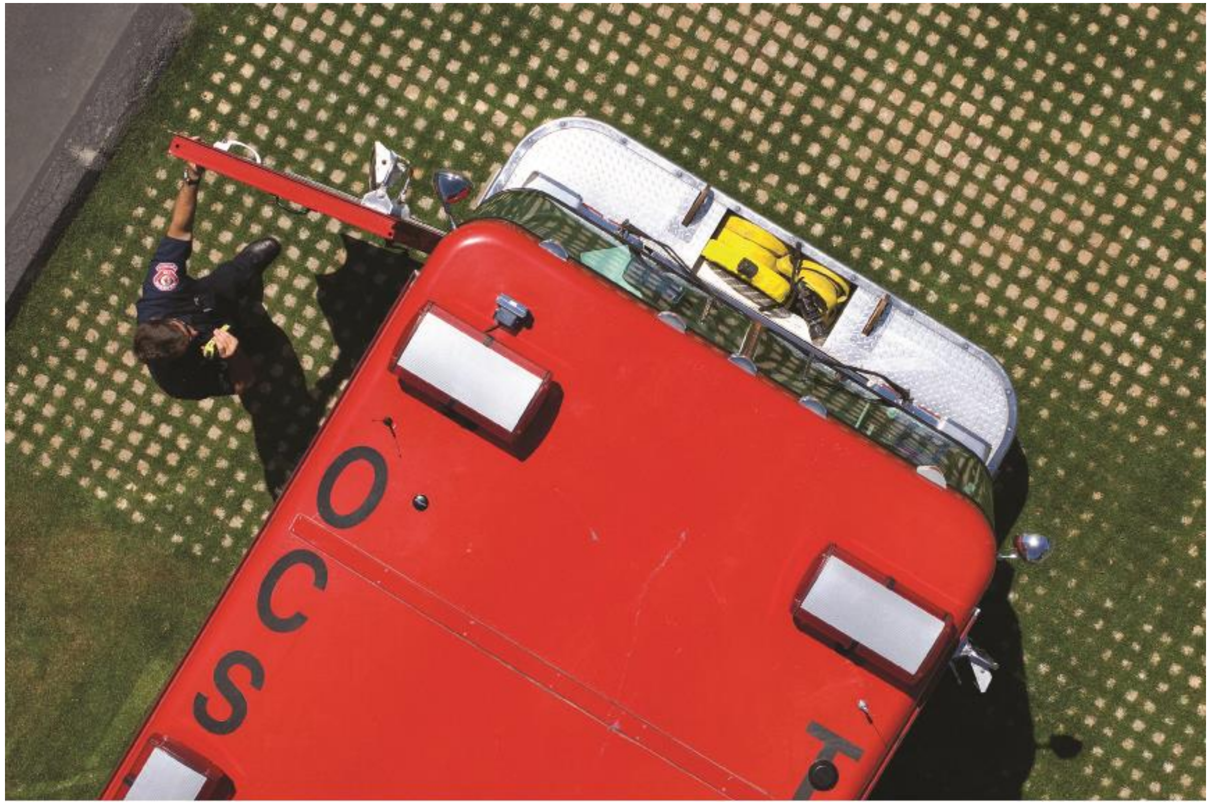
When permeable pavement is planted with turfgrass or groundcover, the overall effect can be stunning and can serve to integrate a project into its environment. Vegetation over pavement has the ability to absorb carbon dioxide, emit oxygen, and biodegrade pollutants. As a living plant material, its evapotranspiration naturally makes it cooler than inert surfaces such as concrete, reducing albedo and the urban heat island (UHI) effect. The turfgrass surface reduces glare and absorbs noise, while adding to green open space on a developed site.

Using vegetation or “soft” materials such as sand, gravel, or decomposed granite, the otherwise overwhelming effect of parking lot concrete or asphalt can be mitigated. Another advantage is that valuable space can now be considered multifunctional, creating a better aesthetic appeal often without sacrificing buildable land.

Suitable for a variety of scales, plantable permeable pavement is typically not used for major streets, except perhaps for areas with limited traffic like turnarounds in freeway medians. Many applications are perfect for site areas infrequently used, such as fire lanes, utility easements, and drainageways. Areas like these that require large amounts of space but are seldom used leave an underutilized vacant area in a project. In these cases, plantable permeable pavement can be especially helpful to the designer and developer as it can meet the requirements of these utility spaces while also providing useful and aesthetically pleasing green spaces.

Case Study: Oceanside, California, Fire Station

An Oceanside, California, fire station tested the viability of washing fire trucks parked on a plantable permeable pavement. The fire station is near one of the most polluted beach outlets in Southern California. The test was prompted by a mandate of the San Diego Regional Water Quality Control Board to clean runoff from the washing of fire trucks several times a day. Previously, the trucks were washed in front of the station on the asphalt driveway, which drained directly into the San Luis Rey River just upstream. The installation of a plantable flexible concrete mat was used both to resolve polluted runoff and to sustain daily truck loads. Placed over a bed of granular infill and base material, the plantable permeable pavement experiences no runoff, storing up to 0.40 inch of water at the surface and infiltrating at a rate of more than 3.0 inches per hour.



Review Question

Which areas are appropriate for the use of plantable permeable pavement?

Answer

Suitable for a variety of scales, plantable permeable pavement is typically not used for major streets, except perhaps for areas with limited traffic like turnarounds in freeway medians. Many applications are perfect for site areas infrequently used, such as fire lanes, utility easements, and drainageways. Areas like these that require large amounts of space but are seldom used leave an underutilized vacant area in a project.

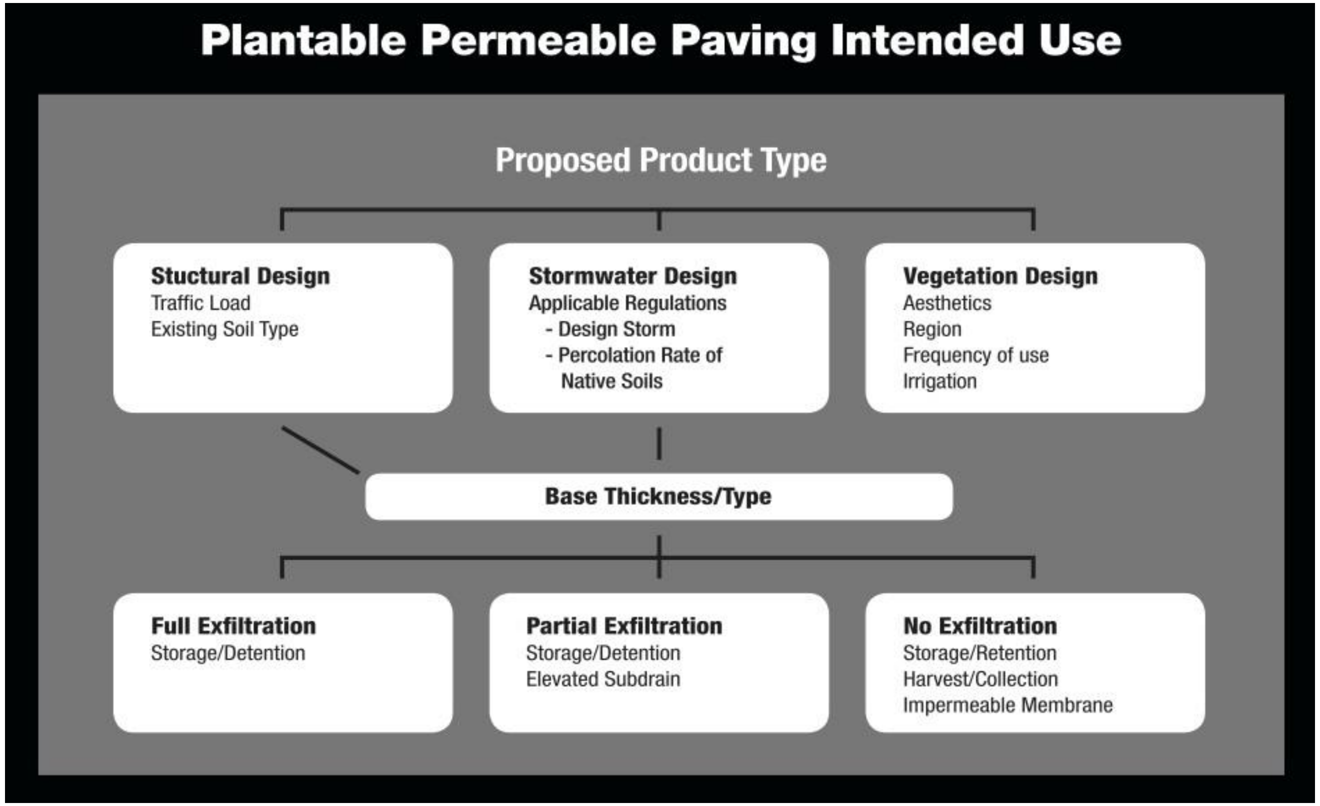
Design Considerations for Plantable Permeable Pavement

Design Considerations for Plantable Permeable Pavement

Design of a plantable permeable pavement system for any site is a multidisciplinary effort. Once a project is envisioned, important site planning factors must be considered for building layout, access, circulation, and parking, not to mention federal, state, and local code requirement compliance. Plantable permeable pavements can satisfy several objectives for stormwater management, while adding value and aesthetics to the project.

In one of the most concise summaries to date, a 2006 conference paper by Dr. Brian Shakel, a visiting engineering professor at the University of New South Wales lays out several distinct objectives to ask early on: “Flood mitigation/stormwater retention or detention? Water quality improvement, whether filtration or retention? Water conservation for collection and reuse? And ability to carry the intended site traffic.”

Design Considerations for Plantable Permeable Pavement



The design decision flowchart to the left clearly illustrates the process for designing a plantable permeable pavement system. A key design consideration is the composition of the subgrade (native soils below the paving section) and their infiltration rates. Depending on the composition of the subbase (structural base material), in some cases enough rainfall can be collected to offset and store a percentage of the increased runoff from site development. For some projects, this may eliminate an expensive and separate “hard” drainage system. For other projects with native soils with low infiltration, excess water could be detained and stored. Use of this excess stored water may have to be considered.

Design Considerations for Plantable Permeable Pavement

For example, this excess water could be harvested for reuse or alternatively piped away with an elevated underdrain. The paper points out another key design question in addition to pavement system design life, rainfall absorption, infiltration, and retention: how thick the aggregate base section should be to carry the intended traffic. Aggregate thickness may be slightly thicker for managing stormwater than for load bearing, but there is usually an associated economic benefit for its use.

A pavement system can be designed to capture rainwater and collect the runoff for reuse as irrigation. If the plantable permeable pavement also serves to enhance stormwater regulation, this may be considered an appropriate application of water in an arid environment.

Turfgrass Considerations

Vegetation, specifically turf, is commonly used as a surface for applications with light pedestrian traffic, such as parks or ballfields. For it to be a viable cover under vehicle traffic, the pavement design fundamentally needs to prevent soil compaction so that the living root zone for these plants is both porous and permeable to air and water. Plantable permeable pavement has void spaces between a load-bearing pavement material, which distributes the imposed load to the underlying base and/or bedding materials. Bruce K. Ferguson, in his book *Porous Pavements* (2005), writes, “A reinforced turf surface bears traffic equally directly…[and] assists the turf in resisting wear and compaction.” This support condition allows the plants the ability to stand up to increased traffic weight and volume. Root zone areas for plantable permeable pavements vary by type of pavement, but the more access to root space, the more likely the turf grass will survive.

The soil area between cells in addition to the root zone (as described above) is also an important factor in turfgrass health. Vehicle tires are flexible, so when void spaces are too large and overfilled, soil compaction will occur, which cuts off the air and water needed for plant growth. For example, choosing sod to top the permeable pavement for a fire lane (hopefully never used) may be an appropriate design choice. However, if the use is daily parking, applying turf by seed and not overfilling the void space will give greater protection to the emerging root system. Choosing the appropriate method of turf establishment for the intended use can be especially critical when the pavement is saturated. With heavy and/or constant traffic, significant compaction in the void space can occur along with turf damage.

Turfgrass Considerations

Another aspect of turf establishment and maintenance is to realize that the width of the load-bearing portion of any plantable permeable pavement system is important to retaining turfgrass as well as carrying the traffic load. The greater the area of contact between the pavement and the vehicle tire, the better the pressure is distributed and the root zone is protected. A relevant ingredient for healthy turfgrass is a bedding course (defined as the underlying sandy material between the pavement and its often heavily compacted base), which allows for a continuous symbiotic root zone and moisture for the plants. The thickness of the paver, along with similar-sized materials for the infill and bedding course, can also have an impact on the ability of roots and moisture to spread. That is because root zones are complex systems with physical, chemical, and biological components. Each of these components determines the health of the turfgrass.

Turfgrass Considerations

Specifying the type of grass species or groundcover and whether to seed or sod turfgrass over the pavement surface depends greatly on the location and intended use. Many geographic locations receive sufficient moisture to support turf without irrigation. Choosing the appropriate vegetation for the site conditions and anticipating cold climate factors such as freeze/thaw cycles are also important design considerations.

Selection of a turf species must take into consideration microclimates such as shade, slope, temperature variations, and seasonal conditions. Parking can create a microclimate that casts shade for a portion of the day over the turfgrass. This may affect the density and growth of some turfgrasses; therefore, specifying the correct species can be an important long-term maintenance decision.

Turfgrass Considerations

Whether to use a warm-season grass or cool-season grass, a bunchgrass or spreading grass type, or one that is tolerant to deicing salts or is shade tolerant, are all design considerations that are site and project specific. According to Ferguson, he states that a warm-season grass such as Bermuda stands up well to traffic as does tall fescue (cool-season). However, some grasses may be considered an invasive species to native ecosystems. Local cooperative extension agents, state agricultural offices, nurseries, and landscape architects can offer advice on which species are best.

Grass Seed

Ground Cover

Review Question

How do the void spaces in plantable permeable pavement facilitate plant growth?

Answer

For it to be a viable cover under vehicle traffic, the pavement design fundamentally needs to prevent soil compaction so that the living root zone is both porous and permeable to air and water.

Plantable permeable pavement has void spaces between a load-bearing pavement material, which distributes the imposed load to the underlying base and/or bedding materials.

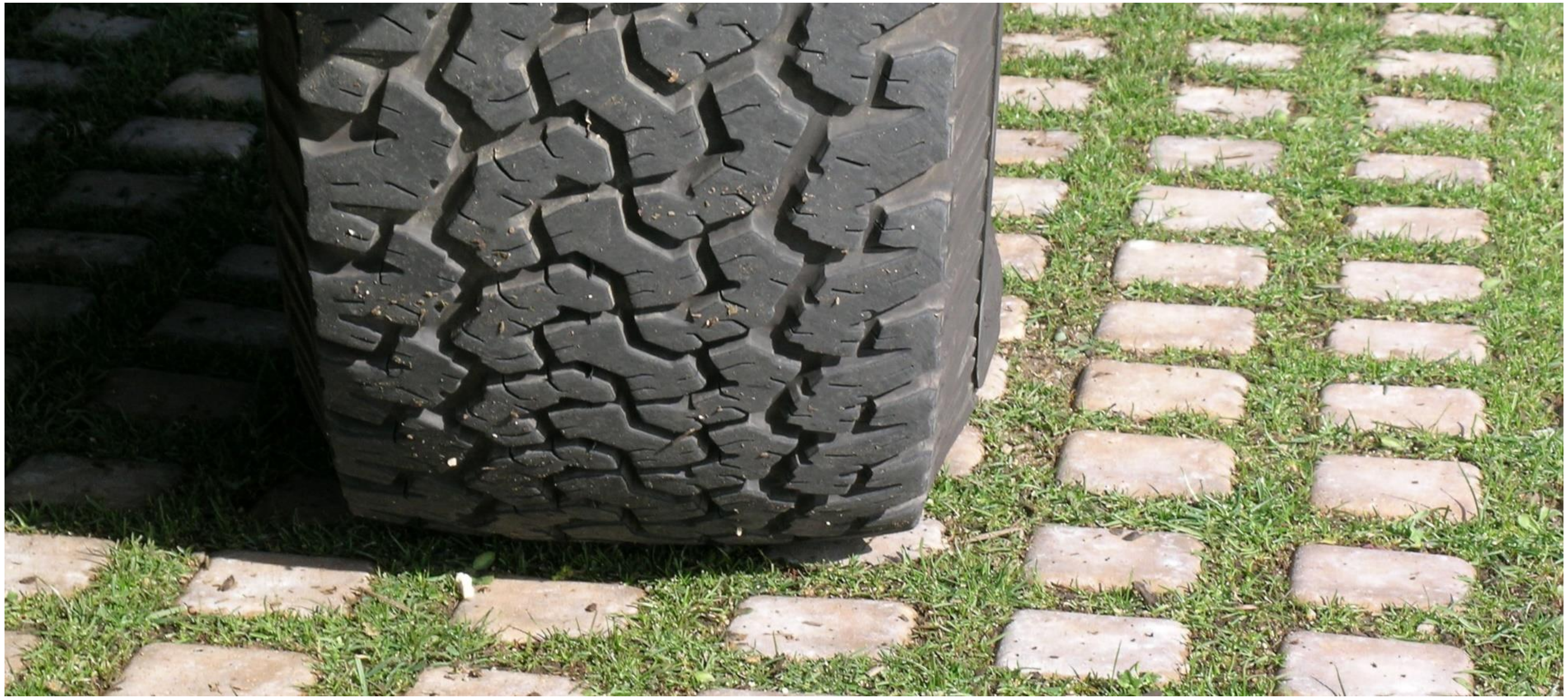
Maintenance Considerations for Permeable Pavement Systems

Maintenance Concerns

As with anything new, there can be concern for long-term product maintenance and durability. The LID Center has found that as with all the pavement systems—permeable concrete, permeable asphalt, permeable interlocking concrete pavers, and plantable permeable pavements—"maintenance is low and has been shown to be quite resilient over time, as long as the openings remain permeable." The pollution-trapping benefit of plantable permeable pavements is apparent, but there may be some concern about this diminishing over time. With maintenance, these systems can reasonably last up to 20 years, according to several sources, which meets or exceeds the lifespan of asphalt.

Here are some tips on keeping these systems functioning:

- Make sure drainage from other areas with sediment loads does not flow over the pavement, clogging the voids.
- Perform periodic inspections following rainfall greater than ½ inch in depth to observe any standing water.
- Consider choosing salt-tolerant grasses where deicing is common and adding Teflon™ runners to snowplow blades to prevent damage.
- Monitor the turfgrass for diseases, fungi, and insect infestations using biological controls such as ladybugs and organic controls.
- Consider implementing resting periods that vary access points and parking stall use to reduce wear on turf and give it time to recover from heavy use, and
- Consider the benefits of overseeding and removing excess soil and thatch buildup to promote healthy living turf.



Differentiating between Plantable Permeable Pavements

Differentiating between Plantable Permeable Pavements

Each type of plantable permeable pavement system is designed to promote infiltration of rain and snowmelt. Each system contains openings to be filled with sand, soil, or a sand/soil mixture that in combination with the bedding layer becomes a rooting zone for vegetation such as turf or groundcover. Note that comparison of the four types of plantable permeable pavements is very difficult based on their diversity and different properties.

As Ferguson states, “Many manufacturers supply guidelines for installation of their products. However, the reinforced plastic/geocell-producing industry does not have the benefit of an industrial association to set uniform standards of comparison or to educate potential users about appropriate applications. Manufacturers’ reports of strength and other characteristics are too often based on tests that are inconsistent between one manufacturer and another, and between geocells and other types of paving materials. In the absence of uniform measures of performance, potential users are left to rely on experience with specific models in specific types of settings.” He goes on to suggest that “[a]n impartial industrial association would give guidance to users and credibility to suppliers. The formation of an industrial association or ASTM (American Society for Testing and Materials) committee to formulate uniform standards of plastic paving geocells is called for.”

Differentiating between Plantable Permeable Pavements

It is important to understand that compressive strength is often used when comparing plastic and concrete products.

Concrete products, by nature of their material, have compressive strength for load bearing while plastic products derive their compressive strength from the sand infill within their void space.

Concrete products' unit dimension and resistance to wear ultimately determine their overall performance. With plastic products, the sand infill takes the compressive loads and increases the compaction of the material in the voids. The sand infill often determines overall performance.

Differentiating between Plantable Permeable Pavements

Flexible Concrete Mat

A precast mat unit with a network of concrete pads cast around a polymer grid can flex and conform to irregular ground surface contours.

Basic Product Composition: Wet-cast concrete mat with an engineered grid cast inside. Individual pads are intended to crack at the joints and grid is designed to allow for long-term settlement. Individual mats are butted up similarly to conventional pavers. The concrete can use recycled material such as fly ash or slag.

Flexible or Rigid: Flexible

Typical Infill and Bedding Course: Specifies 75% sand and 25% fine ground compost infill. Bedding course is typically 2 inches thick; if nonplantable, 0.5 inches of bedding sand.

Typical Exposed Plantable Area: 1.5 inches

Typical Unit Load-Bearing Surface Area: 40%

Typical Dimensions: 24 inches x 24 inches x 1.5 inches

Testing: Varies by manufacturer. Check with manufacturer for specific reports.

Limitations: Varies by manufacturer; check with manufacturer for specific limitations.

Flexible Concrete Mat

Differentiating between Plantable Permeable Pavements

Concrete Grid Slab

Concrete grid slabs are a cast-in-place, monolithic pavement with voids from forms, with steel reinforcement.

Basic Product Composition: Cast-in-place, monolithic, pervious concrete pavement that is continuously reinforced with steel. The concrete can use recycled material such as fly ash or slag.

Flexible or Rigid: Rigid

Typical Infill and Bedding Course: Infill not specified; typically set on 1 inch of bedding sand.

Typical Void Width: 4 inches

Typical Unit Load-Bearing Surface Area: Not available

Typical Dimensions: Continuous slab, 5.5 inches thick

Testing: Typically uses common concrete strength testing and reinforcement per ASTM. Varies by manufacturer. Check with manufacturer for specific test reports.

Limitations: Varies by manufacturer; check with manufacturer for specific limitations.

Concrete Grid Slab

Differentiating between Plantable Permeable Pavements

Concrete Grid Paving Units

Most people know these as the waffle-like, commonly available individual concrete block pavers with voids.

Basic Product Composition: Dry-cast modular concrete blocks. Some products include steel reinforcement to allow for heavier vehicles (typical spec for any modular block is the length / thickness <= 4). The concrete can use recycled material such as fly ash or slag.

Flexible or Rigid: Individual units are rigid.

Typical Infill and Bedding Course: Topsoil infill, ½ inch to 1 inch of bedding sand; if nonplantable, ½ inch to 1 inch of bedding sand.

Typical Void Width: 3 inches

Typical Unit Load-Bearing Surface Area: 61%

Typical Dimensions: 24 inches x 24 inches (L x W) or less. Minimum thickness of 3.125 inches.

Testing: Typically uses common concrete strength testing and reinforcement per ASTM. Varies by manufacturer. Check with manufacturer for specific reports.

Limitations: Varies by manufacturer; check with manufacturer for specific limitations.

Concrete Grid Paving Units

Differentiating between Plantable Permeable Pavements

Plastic Geocells

Reinforced plastic cells are made of a recycled plastic—high-density polyethylene (HDPE)—the #2 category for recycling.

Basic Product Composition: Plastic. Most commonly HDPE plastic in modular tray units or standard roll sizes covering 108 to 538 square feet. Rings connected by tensile members or a network of square or hexagonal cells.

Flexible or Rigid: Flexible and rigid

Typical Infill and Bedding Course: Infill varies between topsoil and sand. No bedding course is typically specified due to the lack of bearing capacity on the bottom of the product. Rolled units require staking into the base or subbase material.

Typical Void Width: 2 to 3 inches

Typical Unit Load-Bearing Surface Area: 5 to 13%

Typical Dimensions: 1 to 1.5 inches thick. Varying dimensions for trays and roll sizes.

Testing: Varies by manufacturer. Check with manufacturer for specific reports.

Limitations: Varies by manufacturer; check with manufacturer for specific limitations.

Plastic Geocells

Differentiating between Plantable Permeable Pavements

In arid regions with water restrictions, there are recent product developments using artificial turf in lieu of living vegetation. Interest and demand in this product rose during the drought conditions in California from 2013 to 2017. These products use precut artificial turf mats that are installed within the plantable recesses of the paver system to provide a green look, but without the watering and maintenance requirements. These systems provide the same infiltration performance levels as plantable pavements.

Green Infrastructure and Rating Systems

Green Infrastructure and Rating Systems

There are many design considerations that need to be made as part of the initial design process.

One major consideration is whether the project is pursuing any green building/infrastructure rating system certifications; the goals of reducing stormwater runoff and improving stream health are inherent in both green building/green infrastructure rating systems such as LEED® and SITES®. If a project is pursuing certification under one of these systems, the design team will need to ensure that the solution being proposed will help the project team achieve the criteria that is set out along with other project objectives.

Other pavement design factors that might be important for your project include what the potential first and life-cycle costs will be and the level of commitment that the client plans for maintenance.

Cities and regional planning agencies often provide BMPs with details and specifications within their green building/green infrastructure development standards and/or guidelines. Plantable permeable pavement can be used in bioswales, bioretention areas, or rain gardens, and can add to the site's biomass index (BMI), help prevent erosion, recharge the groundwater, or reduce the UHI effect.

Green Infrastructure and Rating Systems

In New York's *Green Infrastructure Plan: A Sustainable Strategy for Clean Waterways* (2011), the goal is to reduce by 10 percent its combined sewer overflow through the use of retention and infiltration by 2020. Within nearly every land use type in this large metropolitan area, from streets and sidewalks to parks and parking lots, there are opportunities to use permeable pavement to achieve that 10 percent goal. (Link accessed May 2021.)

Green Infrastructure and Rating Systems

The City of Chicago, through its "Green Alley Handbook" and extensive green infrastructure design efforts, lists permeable paving as one of its preferred materials, being "most effective in areas closer to Lake Michigan that are underlain with sandy, permeable soils…Permeable paving may have aesthetic and marketing advantages over conventional paving, depending on the materials selected. Vegetated pavers, in particular, could substantially improve the aesthetic appeal of paved areas...[and] can be effective in reducing the urban heat island effect." To this city, permeable pavement is particularly appropriate for "…overflow and special event parking, driveways, utility and access roads, emergency access lanes, fire lanes, and alleys."

The City of Seattle Public Utilities (SPU) Department and Office of Sustainability recommends use of permeable pavement for their Stormwater Facility Credit Program. The SPU program grants discounts on drainage bills for private stormwater systems that "reduce stormwater flow and/or provide water quality treatment…" Permeable pavement is among the stormwater structures that qualify for up to a 50 percent credit. In the State of Virginia's "Stormwater Design Specification #7: Permeable Pavement" (Version 2.0, 1/1/13), BMPs are enumerated at length primarily for permeable pavements. The specification details the properties for each type of pavement, material specifications, maintenance recommendations, and construction installation sequence. This type of BMP information is common among those cities and regions leading the way in the use of permeable pavements.

(Links accessed May 2021.)

LEED® and SITES®


Coronado, California, sewer pump station: sod over flexible concrete mat

To set a green building leadership example, the U.S. General Services Administration (GSA) increased its stipulation for LEED certification for its facilities in 2010. The GSA now requires all new federal buildings and major renovation projects to achieve at least a LEED Gold® certification, up from the previous LEED Silver® rating. “Sustainable, better-performing federal buildings can significantly contribute to reducing the government’s environmental footprint,” former GSA Commissioner of Public Buildings Robert A. Peck has said. “This new requirement is just one of the many ways we’re greening the federal real estate inventory to help deliver on President Obama’s commitment to increase sustainability and energy efficiency across government.” The GSA’s portfolio includes more than 361 million square feet of space in 9,600 federally owned and leased facilities occupied by more than 1.2 million federal employees.

LEED

As a quick refresher, LEED is a green building rating system that stands for Leadership in Energy and Environmental Design. It is available for virtually all building, community, and home project types. It provides a framework to create healthy, highly efficient and cost-saving green buildings. It is a program of the US Green Building Council (USGBC).

The current versions of LEED are LEED v4 and LEED v4.1, and there are several areas where plantable permeable pavement can be part of a project team’s strategy for achieving building certification.

SITES

SITES is the most comprehensive system for developing sustainable land and is aimed primarily at landscape architects, engineers, and others involved in sustainable land development. Certified landscapes help reduce water demand, filter and reduce stormwater runoff, provide wildlife habitat, reduce energy consumption, improve air quality, improve human health, and increase outdoor recreation opportunities.

The current version of SITES is v2; its site-specific performance benchmarks are based on the concept of ecosystem services; understanding of natural processes; best practices in landscape architecture, ecological restoration, and related fields; and knowledge gained through peer-reviewed literature, case-study precedents, and SITES pilot projects.

Because of its focus, there are lots of opportunities to use plantable permeable pavement as a strategy to help achieve certification.

THE Sustainable SITES Initiative®

LEED

The following are some stormwater-related credits where permeable pavement systems can help with credit achievement.

Sustainable Sites (SS) Credit: Rainwater Management

LEED BD+C v4 and 4.1

Intent: To reduce runoff volume and improve water quality by replicating the natural hydrology and water balance of the site, based on historical conditions and undeveloped ecosystems in the region.

Option 1: Percentile of Rainfall Events. This option looks for projects to best replicate natural site hydrology processes by retaining on site the runoff from regional or local rainfall events using low-impact development (LID) and green infrastructure.

LEED

Sustainable Sites (SS) Credit: Heat Island Reduction

LEED BD+C v4 and 4.1

Intent: To minimize effects on microclimates and human and wildlife habitats by reducing heat islands.

Option 1: Nonroof and Roof. This option looks for projects to reduce the heat absorption in both nonroof and roof surfaces through a variety of strategies that include the use of open-grid pavement systems.

LEED

Sustainable Sites (SS) Credit: Protect or Restore Habitat
LEED BD+C v4 and 4.1

Intent: To conserve existing natural areas and restore damaged areas to provide habitat and promote biodiversity.

Option 1: On-site Restoration. This option looks for projects to use native or adapted vegetation to restore previously disturbed portions of the site.

In LEED v4 only, plantable landscape areas that are used to accommodate rainwater infiltration can be excluded from the vegetation and soils requirements, provided all such rainwater infiltration areas are treated consistently with SS Credit: Rainwater Management.

LEED

Sustainable Sites (SS) Credit: Open Space
LEED BD+C v4 and 4.1

Intent: To create exterior open space that encourages interaction with the environment, social interaction, passive recreation, and physical activities.

Requirements: In LEED v4, provide outdoor space greater than or equal to 30% of the total site area (including building footprint). A minimum of 25% of that outdoor space must be vegetated (turf grass does not count as vegetation) or have overhead vegetated canopy. In LEED v4.1, the vegetated area must contain two or more types of vegetation.

In LEED v4, the space can be a pedestrian-oriented paving or turf area with physical site elements that accommodate outdoor social activities or a recreation-oriented paving or turf area with physical site elements that encourage physical activity. Both these strategies could use plantable paving as a solution. In LEED v4.1, the mention of physical site elements has been removed.

★ Please remember the **test password PERMEABLE**. You will be required to enter it in order to proceed with the online test.

Review Question

What are some of the functions performed by SITES-certified landscapes?

Answer

Certified landscapes help reduce water demand, filter and reduce stormwater runoff, provide wildlife habitat, reduce energy consumption, improve air quality, improve human health, and increase outdoor recreation opportunities.

SITES

The following credits from SITES v2 are areas where permeable pavement systems can be used as a strategy for compliance.

Section 3: Site Design – Water: Prerequisite 3.1: Manage precipitation on site and Credit 3.3: Manage precipitation beyond baseline

Intent: To reduce negative impacts to aquatic ecosystems, channel morphology, and dry weather base flow by replicating natural hydrologic conditions and retaining precipitation on site.

Recommended strategies: Could include designing to minimize impervious surfaces by specifying permeable materials for hard surfaces.

SITES

Section 3: Site Design – Water: Credit 3.5: Design functional stormwater features as amenities

Intent: To provide a connection to the local climate and hydrology by integrating aesthetically pleasing stormwater features that are visually and physically accessible and manage on-site stormwater.

Recommended strategies: Could include employing low-impact development strategies that emphasize site design and planning techniques to mimic the natural infiltration-based, groundwater-driven hydrology of historic landscapes.

SITES

Section 4: Site Design – Soil + Vegetation: Credit 4.9: Reduce urban heat island effects

Intent: To minimize effects on microclimate and human and wildlife habitat by using vegetation and reflective materials to reduce heat island effects.

Recommended strategies: Could include using paving materials with an SR of at least 0.33 at installation or a three-year aged SR value of at least 0.28 or using open-grid pavement systems.

Section 7: Construction: Prerequisite 7.2: Control and retain construction pollutants

Intent: To protect receiving waters (including surface water, groundwater, and combined sewers or stormwater systems), air quality, and public safety by preventing and minimizing the discharge of construction site pollutants and materials.

Recommended strategies: Could include implementing postconstruction stormwater management with construction sequencing, which could include infiltration systems.

SITES

Section 7: Construction: Prerequisite 7.3 and Credit 7.4: Restore soils disturbed during construction

Intent: To support healthy plants, biological communities, water storage, and infiltration by restoring soils disturbed during construction.

Recommended strategies: Could include using plantable permeable pavement to support the infiltration requirements for things like vehicle easements, constructed wetlands, bioswales, or rain gardens. If this is the case, these can be exempt from the criteria for soil restoration.

Summary

Summary

The use of plantable permeable pavement systems is becoming very popular in urbanized areas near coastal and riparian environments, and those adjacent to lakes and rivers, essentially where the bulk of all our cities are located. Use of these green infrastructure techniques can have huge significance to efforts to be more sustainable and to lessen our impact on the environment. Infiltration of water through plantable permeable pavement, with its ability to slow and clear runoff full of pollutants such as motor oil, salts, and urban detritus, is but one reason to use plantable permeable pavements.

The applications for plantable permeable pavements will continue to grow, as noted in the green infrastructure plans for Chicago, New York, and other major metropolitan areas. All elements of site design can benefit from permeable pavement. Whether used in a large-scale or small-scale project, plantable permeable pavements increase valuable space for the site designer and developer and offer stormwater management benefits. Site landscapes can become more multifunctional, creating more usable open space and a sustainable landscape.

Resources

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Conclusion

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