Segmental Permeable Pavement Solutions

Industrial, Commercial, Institutional & Residential

ISLAND DESIGNS USVI
LANDSCAPE & STORM WATER SOLUTIONS LLC

1. Introduction

One of the direct consequences of urban development is an increase in impervious surface area. Over the years, vast areas that used to be covered by vegetation and natural permeable surfaces have been replaced by parking lots, streets and roofs, disrupting the natural process of water infiltration into the soil. One of the effects of this urbanization is increased runoff and flow during precipitation.

The higher flow and rising water levels in storm sewer pipe systems and streams can cause problems including flooding, erosion, sedimentation and pollution. In addition, with global warming, the frequency of events involving heavy rains and accelerated snowmelt is more pronounced. It is therefore important to rapidly seek new solutions.

TECHO-BLOC permeable pavement systems reduce the volume of water directed to municipal systems and, as such, are viable solutions for better stormwater management. Segmental permeable pavement systems reduce runoff and improve the quality of water returning to the environment. Water seeps through the paving stone joints and is then directed into the ground, or stored temporarily in the base/ subbase structure.

The U.S. Environmental Protection Agency (EPA) recognizes segmentable permeable pavements as a best management practice for stormwater and as a low impact development (LID) practice.

TECHO-BLOC is a company dedicated to the development and innovation of new green products to support sustainable development.

2. Operating principle

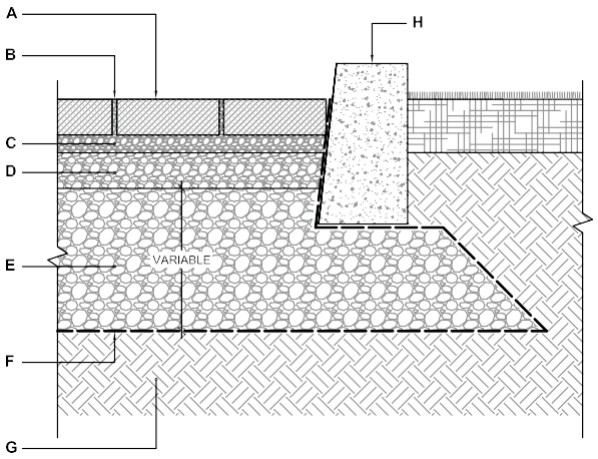
The role of a segmental permeable pavement system is to allow water from precipitation to pass through the paving stones joints and seep into the ground naturally or to be retained in the base/subbase structure rather than turning into runoff headed directly into the sewer system.

The base/subbase structure consists of a washed, angular, open-graded stone that can collect and store water for some time. The water can then seep into the ground in a more natural process.

In instances where soil permeability is insufficient, the water is intercepted by a network of perforated drain pipes before being routed to the drainage system; in this case, the system acts primarily as an underground reservoir.

The system is designed to promote water detention and infiltration. Three types of systems are used, depending on soil permeability:

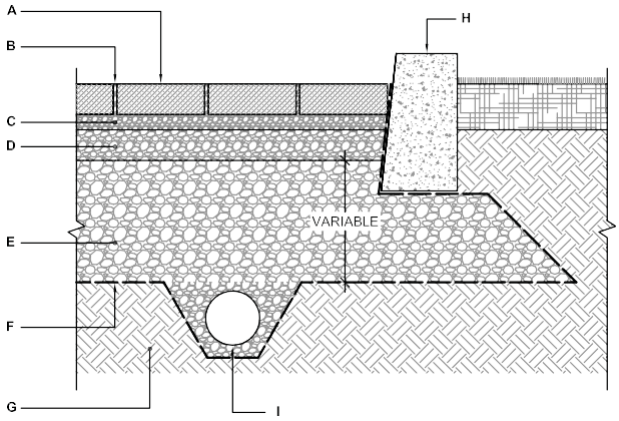
Type A - Complete infiltration



Recommended in the case of soils with an infiltration rate greater or equal to the intensity of designed precipitation

A. SEGMENTAL PERMEABLE PAVEMENT FROM TECHO-BLOC
B. JOINT FILLING MATERIAL ASTM NO 8, 9 OR 89 (CSA 2.5-10 mm, 2.5-5.0 mm) AGGREGATE, AS SPECIFIED OR EQUIV.
C. BEDDING COURSE 1 1/2" TO 2" (40 TO 50 mm) ASTM NO 8 (CSA 2.5-10 mm) AGGREGATE OR EQUIV.
D. BASE COURSE 4" (100 mm) ASTM NO 57 (CSA 5-28 mm) AGGREGATE OR EQUIV.
E. SUBBASE COURSE ASTM NO 2 (CSA 40-80 mm) AGGREGATE OR EQUIV.
F. GEOTEXTILE
G. SUBGRADE
H. CONCRETE EDGE

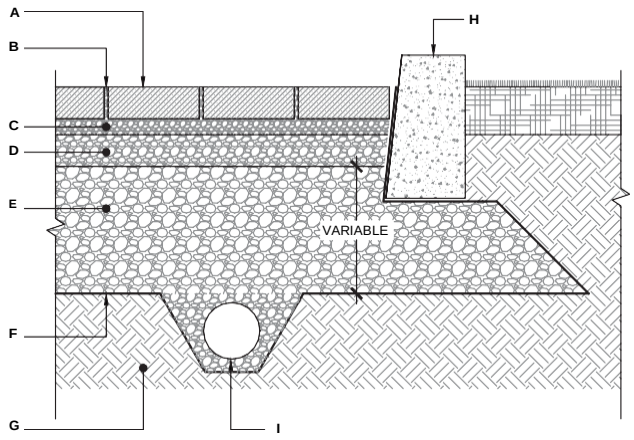
Type B - Partial infiltration



Water does not infiltrate fully. A perforated pipe system in the subbase is required to allow the residual water to be evacuated to the network.

A. SEGMENTAL PERMEABLE PAVEMENT FROM TECHO-BLOC
B. JOINT FILLING MATERIAL ASTM NO 8, 9 OR 89 (CSA 2.5-10 mm, 2.5-5. mm) AGGREGATE, AS SPECIFIED OR EQUIV.
C. BEDDING COURSE 1 1/2" TO 2" (40 TO 50 mm) ASTM NO 8 (CSA 2.5-10 mm) AGGREGATE OR EQUIV.
D. BASE COURSE 4" (100 mm) ASTM NO 57 (CSA 5-28 mm) AGGREGATE OR EQUIV.
E. SUBBASE COURSE ASTM NO 2 (CSA 40-80 mm) AGGREGATE OR EQUIV.
F. GEOTEXTILE
G. SUBGRADE
H. CONCRETE EDGE
I. PERFORATED DRAIN CONNECTED TO DRAINAGE SYSTEM

Type C - No Infiltration (infiltration near zero)



Recommended when soil infiltration capacity is too low or the water table is too high. Water is discharged through a system of perforated pipes and a flow restrictor to control the entry of water into the municipal network. The system essentially acts as an underground reservoir.

A. SEGMENTAL PERMEABLE PAVEMENT FROM TECHO-BLOC
B. JOINT FILLING MATERIAL ASTM NO 8, 9 OR 89 (CSA 2.5-10 mm, 2.5-5.0 mm) AGGREGATE, AS SPECIFIED OR EQUIV.
C. BEDDING COURSE 1 1/2" TO 2" (40 TO 50 mm) ASTM NO 8 (CSA 2.5-10 mm) AGGREGATE OR EQUIV.
D. BASE COURSE 4" (100 mm) ASTM NO 57 (CSA 5-28 mm) AGGREGATE OR EQUIV.
E. SUBBASE COURSE ASTM NO 2 (CSA 40-80 mm) AGGREGATE OR EQUIV.
F. IMPERMEABLE MEMBRANE
G. SUBGRADE
H. CONCRETE EDGE
I. PERFORATED DRAIN CONNECTED TO DRAINAGE SYSTEM

3. Benefits of segmental permeable pavement systems

- Reduce the construction of additional impervious surfaces
- Contribute to maintaining hydrologic conditions that existed prior to development
- Reduce runoff volume
- Reduce peak flow (discharge to sewer is spread over a longer period)
- Reduce network overload
- Reduce wastewater treatment costs
- Reduce the need for expensive underground retention basins and surface retention ponds
- Use in confined spaces in existing areas requiring additional stormwater management
- Reduce potential risk of erosion and flooding associated with increased runoff rates and volumes
- Improve water quality
- Contribute to replenishing the water table
- Reduce heat island effects (light color, high solar reflectance index, cools and humidifies surrounding air)
- Gain credits for LEED certification
- Improve the aesthetic quality of urban landscape

Percentage of pollutant removal by segmental permeable pavement systems1

POLLUTANT	AVERAGE (%)
Total suspended solids	81
Total phosphorus	53
Total Kjeldahl nitrogen	53
Total copper	13
Total zinc	72

1 .Van Seters, T., Performance Evaluation of Permeable Pavement and Bioretention Swale Seneca College, King City, Ontario, Interim Report #3, Toronto and Region Conservation Authority, Downsview, Ontario, May, 2007.

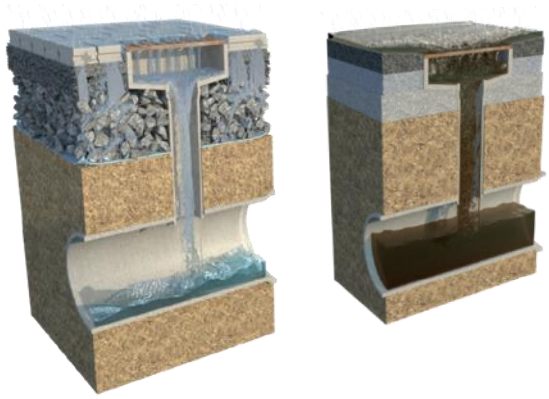
4. Improved water quality

When it rains, water runoff takes on pollutants (suspended solids, nutrients, heavy metals and other contaminants) that are then directed to the municipal network before ending up in the waterways.

Pollutants carried by runoff have a significant impact on water quality, affecting the water supply, fish and wildlife habitat, recreational usage and aesthetic aspects.

Segmental permeable pavements are known for their high pollutant removal potential, which contributes to improving water quality. Pollutants are reduced mainly by infiltration, and through several other processes. The segmental permeable pavement system is effective for removing sediment, nutrients and heavy metals. Several studies have also shown potential for bacterial treatment of oils.

The data shown in the table below was measured on King Campus at Seneca College in King City, Ontario. The Interlocking Concrete Pavement Institute presents several data from the various sites that show lower levels of pollutants where permeable pavers were used.



To better understand the differences and benefits of segmental permeable pavement when compared to other paving solutions, go to:

YOUTUBE.COM/TECHOBLOC

Search for keyword “Permeable”

5. Techo-Bloc segmental permeable pavement systems

TECHO-BLOC permeable pavements are an alternative to traditional impervious cover. They reduce stormwater runoff to sewer systems by promoting water detention and infiltration. They are an effective way to control stormwater at source on residential, commercial and industrial lots. They can also minimize the need to build larger sewer systems downstream of vacant lots being developed in an existing urbanized sector.

The segmental permeable pavement system is the type that has been the most successful among the various types of permeable paving available today. It can be used successfully in a winter climate and is less prone to clogging compared to pervious concrete or porous asphalt.

TECHO-BLOC pavers and slabs exceed the requirements of ASTM C936, CSA A231.2 and CSA A231.1 standards.

			ASTM C936	CSA 231.2
PAVERS	Compressive strength		8000 psi (55 MPa) min.	50 MPa (min)
	Resistance to freezing and thawing	Loss of mass after 28 cycles, or	225 g/m²	225 g/m² (max)
		Loss of mass after 49 cycles	500 g/m²	500 g/m² (max)
	Water absorption		Max. 5 %	-
	Dimensional tolerances	Length and width	± 1/16" (1.6 mm)	-1 mm à +2 mm
		Height	± 1/8" (3.2 mm)	± 3 mm
			ASTM C1782	CSA A231.1
SLABS	Modulus of rupture		725 psi [5 MPa]	4.5 MPa (min)
	Resistance to freezing and thawing	Loss of mass after 28 cycles, or	225 g/m²	225 g/m² (max)
		Loss of mass after 49 cycles	500 g/m²	500 g/m² (max)
	Dimensional tolerances	Units up to and including 24 in. [610 mm]	Length & Width: -0.04 in. [1 mm] to +0.08 [2 mm]	Length and width: -1 mm à +2 mm Height: ± 3 mm
			Thickness: ± 0.12 in. [3 mm]	
		Units over 24 in. [610 mm]	Length & Width: -0.06 in. [1.5 mm] to +0.12 [3 mm]	
			Thickness: ± 0.12 in. [3 mm]	
	Warpage		+ 0.08 in. [2 mm] Dimension of 17.75 in. [450 mm] and less + 0.12 in. [3 mm] Dimension over 17.75 in. [450 mm]	Dimension up to and including 450 mm : ± 2 mm Dimension Over 450 mm: ± 3 mm

On a path with no obstacles, walkways should not have any gaps allowing the passage of a sphere greater than 1/2" (13 mm) in diameter. The openings of the permeable paver joints are filled with clean stone and thus comply with ADA Standard for Accessible Design.

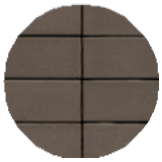
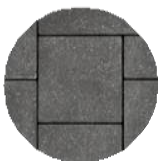
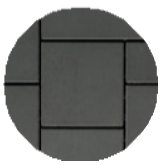
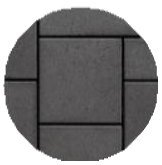
PERMEABLE PAVERS	PERCENT OF SURFACE OPENING (%)	JOINT WIDTH (mm)	INFILTRATION RATE[1] (mm/h)	JOINT FILL MATERIAL
ANTIKA[2]	Variable	Variable	993 in./hr (25 227 mm/hr)	ASTM No. 8 (CSA 2.5 - 10) (1/4")
AQUASTORM[2]	38.4	1 5/8" (41 mm)	2,395 in/hr (60,833 mm/hr)	ASTM No. 8 (CSA 2.5 - 10) (1/4")
			1,418.7 in/hr (36,035 mm/hr)	ASTM No. 9 (CSA 2.5 - 5) (1/8")
			1,647.1 in/hr (41,836 mm/hr)	Synthetic Turf
			1,535.2 in/hr (38,994 mm/hr)	Natural Turf (Sod/Grass)
BLU 80 mm[2]	3.0	9/32" (7 mm)	570 in./hr (14 475 mm/hr)	ASTM No. 9 (CSA 2.5 - 5) (1/8"'')
BLU 80 mm (6x13)[2]	4.6	9/32" (7 mm)	570 in./hr (14 475 mm/hr)	ASTM No. 9 (CSA 2.5 - 5) (1/8")
HYDRA[1]	8.3	1/2" (13 mm)	837 in./hr (21 267 mm/hr)	ASTM No. 8 (CSA 2.5 - 10) (1/4")
MIKA[2]	7.8	5/8" (15 mm)	909 in./hr (23 094 mm/hr)	ASTM No. 8 (CSA 2.5 - 10) (1/4")
MISTA random[1]	6.3	3/16" (4 mm) to 9/16" (14 mm)	610 in./hr (15 505 mm/hr)	ASTM No. 9 (CSA 2.5 - 5) (1/8")
PURE[2]	5.0	3/8" (10 mm)	726 in./hr (18 440 mm/hr)	ASTM No. 9 (CSA 2.5 - 5) (1/8")
TRAVERTINA RAW[2]	7.8	5/8" (15 mm)	793 in./hr (20 150 mm/hr)	ASTM No. 8 (CSA 2.5 - 10) (1/4")
VALET[2]	5.9	9/32" (7 mm)	400 in./hr (10 160 mm/hr)	ASTM No. 9 (CSA 2.5 - 5) (1/8")
VICTORIEN PERMEABLE 60 mm[1]	9.6	3/8" (10 mm)	909 in./hr (23 085 mm/hr)	ASTM No. 9 (CSA 2.5 - 5) (1/8")
VILLAGIO[1]	8.0	3/8" (9 mm) to 9/16" (15 mm)	896 in./hr (22 750 mm/hr)	ASTM No. 8 (CSA 2.5 - 10) (1/4")
PERMEABLE SLABS	**PERCENT OF SURFACE OPENING (%)**	**JOINT WIDTH (mm)**	**INFILTRATION RATE[1] (mm/h)**	**JOINT FILL MATERIAL**
BLU 60 mm[2]	3.0	9/32" (7 mm)	570 in./hr (14 475 mm/hr)	ASTM No. 9 (CSA 2.5 - 5) (1/8")
BLU 60 mm (6 × 13)[2]	4.6	9/32" (7 mm)	570 in./hr (14 475 mm/hr)	ASTM No. 9 (CSA 2.5 - 5) (1/8")

[1] Measurements were taken at various sites in conformity to the standard ASTM C 1701-09.

[2] Measurements were taken at various sites in conformity to the standard ASTM C 1781.

Blu 60 / 80 mm

Various sizes - Champlain Grey - Slate with 6 × 13 - Onyx Black - Smooth

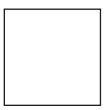
Slate	HD² Slate only in USA		Polished On order only Not available in 6 ×13	HD² Smooth	Smooth	
		Chocolate Brown only available in 6 × 13				Chocolate Brown only available in 6 × 13
		Chestnut Brown				Chestnut Brown
		Mojave Beige *80 mm only available in Various sizes				Champlain Grey
		Sandlewood *HD² only available in Eastern USA				Beige Cream
		Champlain Grey				Greyed Nickel HD² Smooth only available in Canada
		Shale Grey				Shale Grey
		Onyx Black only available in 6 × 13				Onyx Black

60 mm Various sizes

*Height: 2 3/8 in 60 mm

13 × 6 1/2
330 × 165

13 × 13
330 × 330



13 × 19 1/2
330 × 495

60 mm 6 × 13

*Height: 2 3/8 in 60 mm

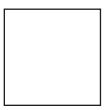
13 × 6 1/2
330 × 165

80 mm Various sizes

*Height: 3 1/8 in 80 mm

13 × 6 1/2
330 × 165

13 × 13
330 × 330



13 × 19 1/2
330 × 495

80 mm 6 × 13

*Height: 3 1/8 in 80 mm

13 × 6 1/2
330 × 165

*60 mm: Polished are 2 5/16 in (58 mm) height / 80 mm: Polished are 3 1/16 in (78 mm) height

*60 mm - 6 × 13 only

ICI / 80 mm - 6 × 13 only

Antika

Shale Grey

Chocolate Brown

Chestnut Brown

Sandlewood

Shale Grey

Onyx Black

Various sizes

Height: 2 3/8 in 60 mm

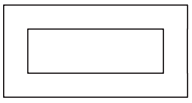
Aquastorm

Grey
with stone

Grey
with grass

Height: 3 15⁄16 in 100 mm

10 1/16 × 20 1/16
255 × 510



Grey

Hydra

Chestnut Brown

Grey

Shale Grey

Height: 3 15/16 in 100 mm

7 7/8 x 11 13/16
200 × 300

Grey

Mista Random

Champlain Grey & Chestnut Brown

Chocolate Brown
only available
in Grande

Chestnut Brown

Mojave Beige
not available
in Grande -
only available in
Midwestern USA

Sandlewood
not available
in Grande

Champlain Grey

Shale Grey

Onyx Black
only available
in Grande

Mista Random Permeable

Height: 2 9⁄16 in 65 mm

7 7/8 × 3 15/16	7 7/8 × 7 7/8	7 7/8 × 11 13/16
200 × 100	200 × 200	200 × 300

Mika

Burgundy

Rock Garden Brown

Carbon

Height: 2 3/4 in 70 mm

4 7/16 × 11
112 × 279

Burgundy

Pure

Chestnut Brown

Sandlewood

Champlain Grey

Shale Grey

Various sizes

Height: 3 1/8 in 80 mm

9 × 9
229 × 229

9 × 12
229 × 305

9 × 15
229 × 381

Grey

Valet

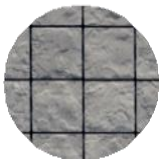
Shale Grey & Onyx Black

Chestnut Brown

Mojave Beige
*only available in Midwestern USA

Sandlewood

Champlain Grey



Shale Grey

Onyx Black

Height: 2 3/8 in 60 mm

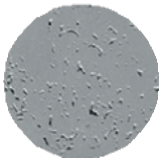
6 1/2 × 6 1/2
165 × 165

Travertina Raw

Rock Garden Brown

Ivory

Riviera



Height: 2 3/4 in 70 mm

4 7⁄16 × 11
112 × 279

Ivory

Victorien Permeable

Chestnut Brown

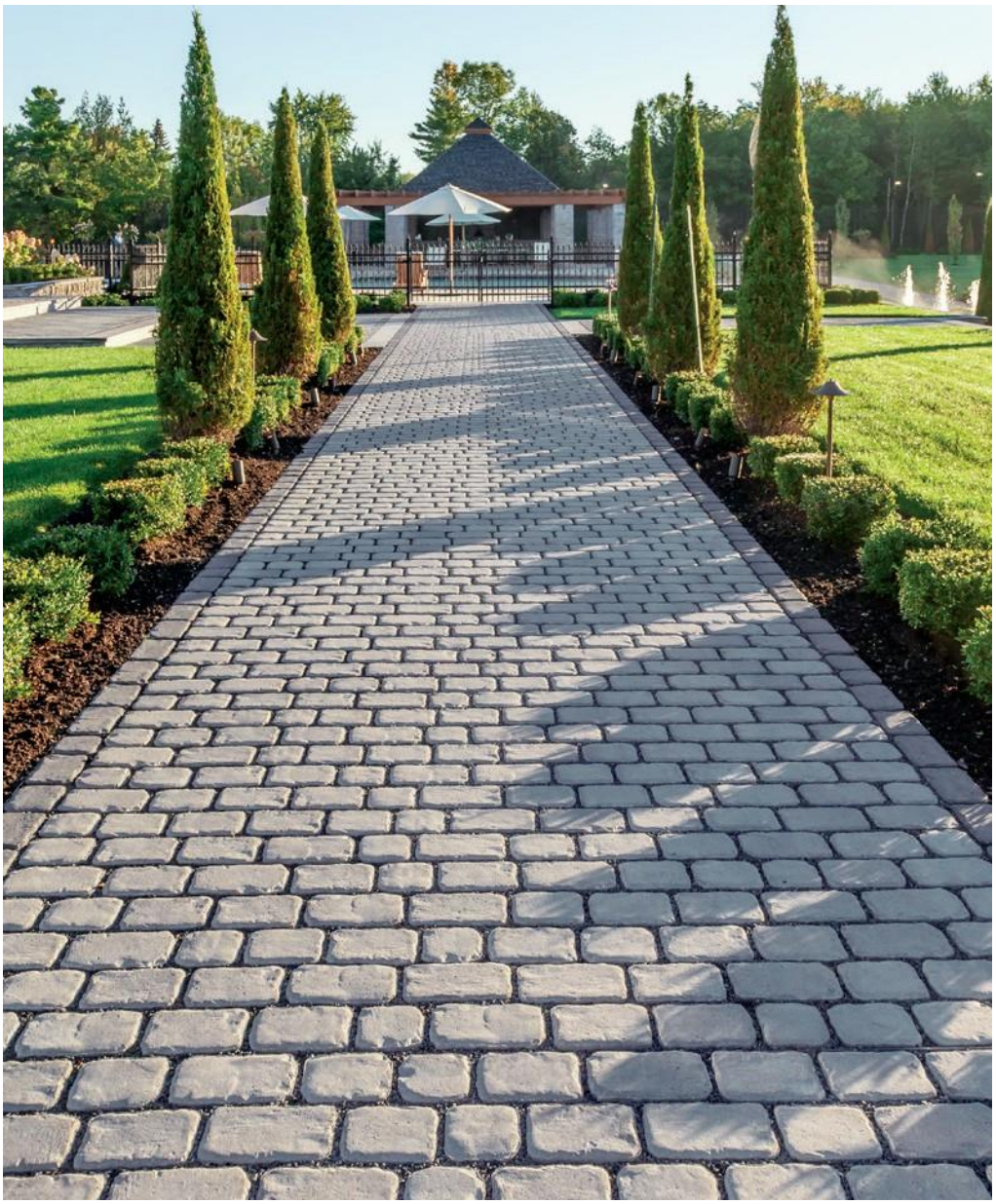
Shale Grey

Height: 2 3/8 in 60 mm

4 1/4 × 8 1/2
108 × 216

Shale Grey

Villagio



Shale Grey

Merlot

Chocolate Brown

Chestnut Brown

Mojave Beige
*only available in Midwestern USA

Sandlewood

Champlain Grey

Shale Grey

Onyx Black

Height: 2 3/8 in 60 mm

5 1/8 × 5 1/8	5 1/8 × 6 5/16	5 1/8 × 7 5/16	5 1/8 × 8 7/16
130 x 130	130 x 160	130 x 185	130 x 215

6. Design criteria

The design of a permeable paving system is based on site conditions, including, without limitation, rainfall data, topography, soil characteristics, the height of the water table and bedrock surface, tributary runoff surface and proximity to water supply wells.
The main factors to be considered are:

- Soil infiltration rate should be at least 0.49 in./hr (12.5 mm/hr) where the system is designed for complete infiltration.
- The underside of the system must be at least 2' (0.6 m) above the water table and bedrock.
- The permeable pavement system should be located at a distance of at least 98' (30 m) from water supply wells.
- The paved surface must have a grade of at least 1% and most preferably not more than 5%. The slope of tributary runoff area should not be greater than 20%.
- The ratio between the tributary runoff area and the permeable pavement area should not exceed 5 to 1.
- The void space of the clean stone composing the base and subbase should be no less than 32%, but preferably 40%.
- The percolation rate measured in situ should be understated by at least 2 to account for the long-term reduction of the soil's absorption capacity.
- A maximum drain time of 48 hours is recommended. In situations where rainfall is greater than the design flow rate, an overflow system directs runoff to the drainage network.

7. LEED credits

The U.S. Green Building Council (USGBC) is a non-profit organization promoting the implementation of sustainable projects through the Leadership in Energy and Environmental Design (LEED®) certification program. TECHO-BLOC permeable pavement solutions can directly contribute to obtaining LEED credits in the following categories:

SUSTAINABLE SITES			
CREDIT 6.1	STORMWATER MANAGEMENT	Quantity Control	1 POINT
CREDIT 6.2	STORMWATER MANAGEMENT	Quantity Control	1 POINT
CREDIT 7.1	HEAT ISLAND EFFECT	Non-roof	1 POINT
MATERIALS AND RESOURCES			
CREDIT 5.1	REGIONAL MATERIALS	10% Extracted, Processed and Manufactured Regionally	1 POINT
CREDIT 5.2	REGIONAL MATERIALS	20% Extracted, Processed and Manufactured Regionally	1 POINT (in addition to Credit 5.1)

TECHO-BLOC permeable pavements can contribute to obtaining up to 3 points in the Sustainable Sites category and up to 2 points in the Materials & Resources category.

8. FAQ

1. For what type of traffic can segmental permeable pavement be used?
In general, segmental permeable pavements are suitable for use in low-speed areas not exposed to heavy vehicles, such as parking areas, driveways, bike paths, walking paths, patios and playgrounds.
However, TECHO-BLOC's Inflo system is designed for applications in larger areas with higher traffic, such as residential streets, parking lanes, storage areas and sidewalks.

2. How much water can be absorbed by a permeable pavement system?
The absorption capacity of the system is based on the infiltration rate of the soil on the site and the clean stone materials (joints, bedding, base and subbase). The soil infiltration rate is an indicator of potential water infiltration directly into the soil and determines the type of system design (complete or partial infiltration). The materials used in the construction of permeable pavements have higher infiltration rates than natural soil. The initial surface infiltration rate of the segmental permeable pavements is very high. The system allows the infiltration of precipitation with intensity lower than the surface infiltration rate or until the water storage capacity in the clean stone reservoir is reached. In a well-designed system, water storage capacity is rarely reached.

3. Can the segmental permeable pavement system perform well in a winter climate?
Yes, in order to ensure their performance in winter weather, TECHO-BLOC permeable pavement products are manufactured to meet, in addition to ASTM C936, CSA A231.2-06 requirements for withstanding freezing and thawing with de-icing salt. Experience with segmental permeable pavements in cold climates has demonstrated the absence of heaving. A maximum drain time of 48 hours is recommended and the water that may have accumulated in the clean stone reservoir should be evacuated within this time frame. The insulating factor of the air found in the system greatly reduces the frequency of freezing. However, in the event that water freezes before it is evacuated, the space between reservoir aggregates allows sufficient room to accommodate the expansion caused by freezing water and the risk of heaving is thereby minimized. Ultimately, the segmental permeable pavement system is flexible enough to tolerate minor movements.

4. What kind of maintenance is recommended for the segmental permeable pavement?
Regular cleaning will help maintain a high enough surface infiltration rate to allow rainwater to soak through the joints. At least one inspection and cleaning should be performed during the first year of service and thereafter as required. Cleaning is recommended when the surface infiltration rate is less than 9.8 in./hr (250 mm/hr), or 99%. Cleaning can be done with a vacuum adjusted to minimize the removal of joint filling material. In winter, snow removal can be done as for any other type of paving, but it is still recommended that snow removal blades be covered with a protective coating and raised 1" (25 mm). Segmental permeable pavements require less de-icing material than conventional pavement. Since melted water does not accumulate, it will not re-freeze on the surface. It is not recommended to spread sand for traction, as this may clog the joints; instead, spread the same aggregate used for filling joints.

LEGEND

T TECHO-BLOC COLLECTION PRODUCTS
S STONEDGE COLLECTION PRODUCTS
PERMEABLE PAVERS
HD² HIGH DEFINITION & DENSITY
DE-ICING RESISTANT
ROAD TRAFFIC
LIGHT TRAFFIC
PEDESTRIAN

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NATIONAL NCMA CONCRETE MASONRY ASSOCIATION
u.s.virgin islands HOTEL & TOURISM ASSOCIATION
Association of Professional Landscape Designers APLD

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