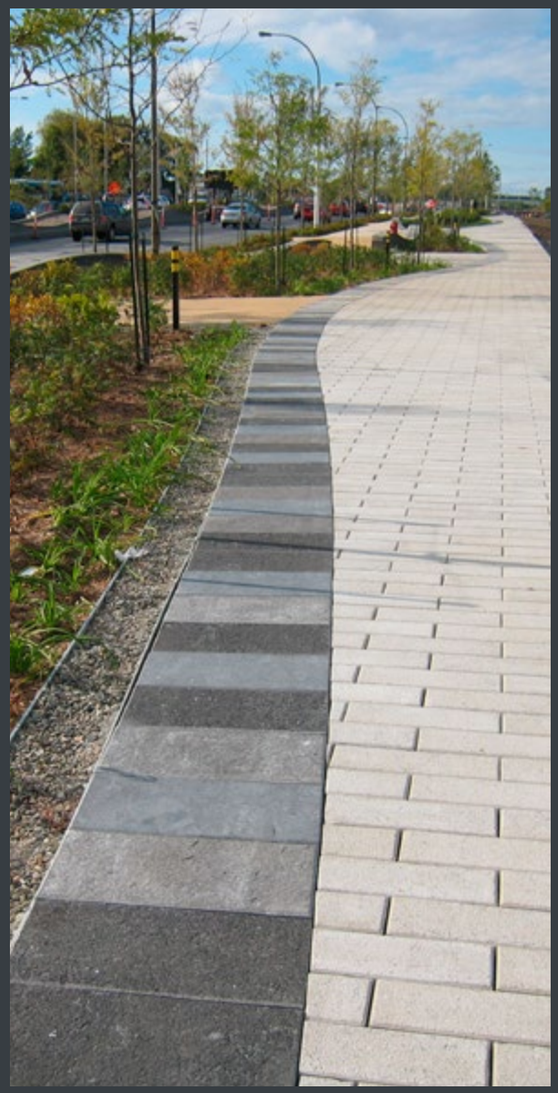
TECHNICAL MANUAL

Permacon Urban Landscaping,

2016



PERMACON

SAFE REHABILITATION RESPECTING THE BUILT ENVIRONMENT

IMPORTANT

Safety first on the jobsite...a must

Permacon is a staunch defender of the principle that, when carrying out a project, it is critical that everything be done to ensure a safe and secure working environment at all times. The use of individual protective equipment is also essential, regardless of the context in which the work is to be executed. Finally, it should be recognized that no concrete product should be sawed, drilled or milled dry on the jobsite. The emission of fine concrete dust particles in the air is harmful to workers' health has been well established. It is imperative, therefore, that this type of dust not be released in the environment when working with concrete products.

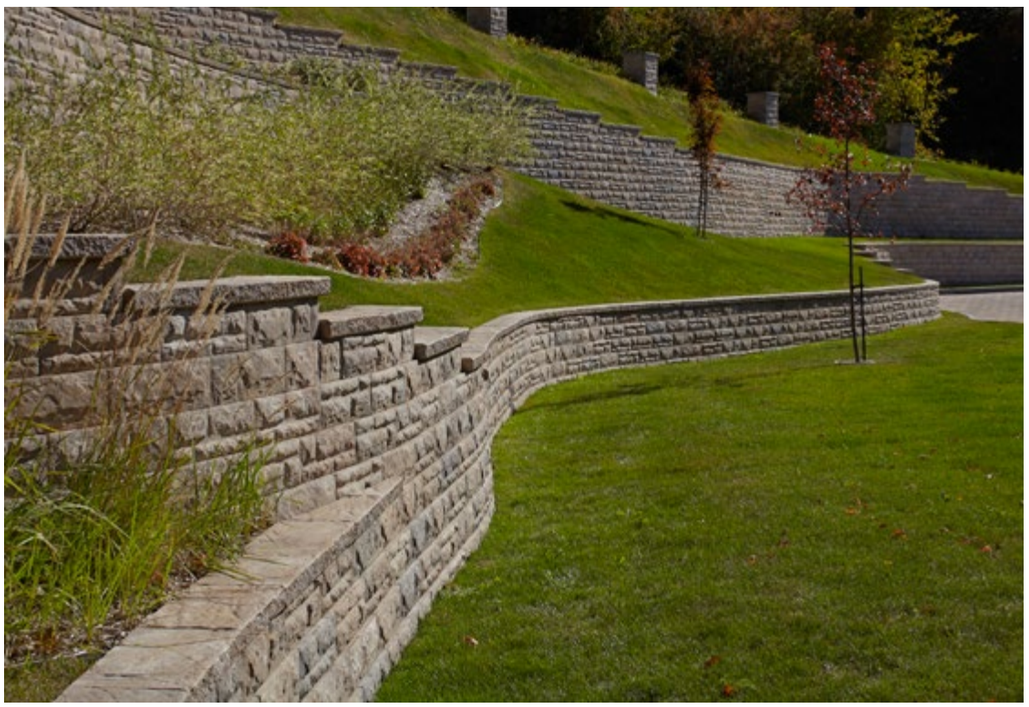
IMPORTANT NOTE TO THE END-USER

COMPLEMENTARY REFERENCE FOR CONSULTATION PRIOR TO THE EXECUTION OF A PROJECT

In this document, Permacon has made it a point to report, as accurately as possible, on the latest technologies, knowledge and the industry's best practices. It is in this specific, rapidly evolving context that Permacon identifies requirements and expectations in order to develop and market the most pertinent and effective products.

In addition, there is a North American reference active in the field of precast concrete products – the INTERLOCKING CONCRETE PAVEMENT INSTITUTE (ICPI). This professional organization, which represents manufacturers as well as the paver industry in general, plays a key technical role with landscaping professionals. It is an inexhaustible source of relevant, regularly updated information. When designing and implementing projects involving the use of its concrete products, Permacon strongly urges you to go to www.icpi.org, the website made available to you by this highly reputable organization.

Permacon's Technical Management



Consisting of facings and stabilizing blocks, the FS^2 retaining system developed by Permacon is the perfect example of a construction product that combines knowledge and recognized practices with the science behind the design of retaining walls to create a product of unlimited potential applications

FOREWORD

Every year, Permacon makes it a point to share the latest developments in the field of land use planning with its clients and industry professionals. This edition is no exception. It includes revised best industry practices, along with the most recent technological developments and a number of innovations, which will certainly rank among Permacon's significant contributions to the evolution of landscaping techniques (see SECTION I).

With regards to large urban pavers, application limits recently proposed for interlocking models, such as the family of Boulevard TLI pavers, have once again allowed Permacon to distinguish itself. New on the market, multi-length interlocking pavers will quickly grow in popularity, given their considerable installation speed and ease. Moreover, innovative new products that lend themselves to the permanent marking of urban roads or the construction of permeable pavement promise to attract the interest of designers concerned with sustainable development. On this issue, Permacon recommends measures for the ongoing maintenance of urban pavement produced from concrete pavers, in order to maximize their service life. Further to this, we refer you to the intervention plan and schedule on page 33.

With regards to best practices, Permacon's involvement has taken the form of a proposed complementary construction technique ensuring the production of more even paved surfaces incorporating slabs or pavers. Finally, in an effort to help designers select the best pavers for effectively countering the risk of flexural failure in service, Permacon recently introduced the "PAVERS' FLEXURAL CAPACITY" concept, a technical approach consistent with the one recognized by the CSA for precast concrete slabs. This approach will now make it possible to compare the flexural strength of each of the pavers in order to select the most effective product in service for a given type of application and/or traffic. In fact, in this edition, the flexural capacity of Permacon pavers will be specified. In addition, a table of reference values showing minimum flexural capacities will be provided, in order to guide designers in the selection of products.

For additional technical information and possible future updates to this document, we invite you to contact Permacon (Permacon.ca/onlinesupport. Complete the form provided and enter your message in the message box under the heading: TECHNICAL SUPPORT). Together, we can push back limits on the use of the proposed products, in the best interests of industry professionals as well as the owners of structures and consumers. In the process, we can achieve an increasingly green environment today.

The Permacon team

NOTE
This publication is intended for industry professionals capable of evaluating the meaning and limitations of the information provided. It is imperative that Permacon's recommendations be respected, within the service limitations of the products used.

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Large dimensional multi-length interlocking urban pavers, called CRESCENDO at Permacon, lend themselves to the paving of streets without a specific installation pattern; an innovative way of maximizing the service life of the structures.

[Reconstruction of Ste-Dominique Street (Lahaie Park, Montreal) using Boulevard TLI_{150}Crescendo^{320} inter-locking urban pavers.

Section I

URBAN PAVERS

URBAN PAVERS
Technical

PAVERS IN CONSTANT EVOLUTION

Prefabricated concrete products used in Ontario and Quebec landscaping projects have been around for decades. A case for the use of these construction materials no longer needs to be made. Their outstanding durability combined with their peerless aesthetics have made them materials of choice.

Precast concrete pavers are a perfect example. Used in Ontario and Quebec since the mid-1970s, many of the original structures are still in service, having effectively withstood the test of time. In fact, these achievements now allow Permacon to push back the limits in the use of concrete pavers. For example, the mechanized interlocking of some of the elements used early on remains highly pertinent, and must absolutely be part of the approach.

The revised objective now consists in extending durability by at least 50 years. Is this possible? Yes. How can we do better? This is a task that Permacon has tackled in recent years. The proposed solution involves the mechanized interlocking of large dimensional elements in terms of thickness and surface area. Larger elements reduce the number of joints in the pavement, addressing one of structure's weaknesses, and considerably reduce traffic loads transferred to the base course, the structure's other weakness. Permacon retained this approach, which calls for the mechanized interlocking of large dimensional pavers, in the development of the Boulevard TLI, its new family of large dimensional interlocking urban pavers.

URBAN PAVERS
Technical

PERIPHERAL INTERLOCKING PAVERS

Concrete pavers lend themselves to the production of flexible pavement. Installed pavers react to each other under the stress of repeated traffic, redistributing a significant part of the vertical load over the paved surface. This redistribution of vertical loads extends over several adjacent pavers simultaneously, since pavers are interdependent. This important performance factor is known as the interlocking of pavers in use. The peripheral interlocking of elements involves the use of an angular granular material (known as joint filler) applied during the construction of the structure. The interdependence of interlocking pavers then makes it possible to significantly reduce loads normally transferred directly to the underlying compacted granular base.

The use of an angular granular material as joint filler between the pavers is essential to ensure the required interlocking of concrete pavers.

URBAN PAVERS
Technical

MECHANIZED INTERLOCKING OF PAVERS

Guaranteed stability

The interlocking design of the pavers ensures their considerable horizontal as well as vertical stability in use. The standard interlocking of pavers is known to result in part from the use of granular joint filler. This interlocking force is generally proportional to the thickness of the paver. What's more, in order to increase this property, manufacturers market pavers whose peripheral shapes add to their interlocking quality; this is known as mechanized interlocking (see figure 1). However, this approach limits the possible combination of pavers when designing structures. Another way of simultaneously increasing interlocking by standard peripheral friction and the mechanized interlocking pavers consists in incorporating peripheral grooves (see figure 2). This is the option favoured by Permacon in recent years, in its development of a family of high performance interlocking urban pavers, i.e. the Boulevard TLI pavers for very heavy and intense traffic loads. As result, designers now have access to a paving material delivering great long term stability on urban structures subjected to heavy traffic.

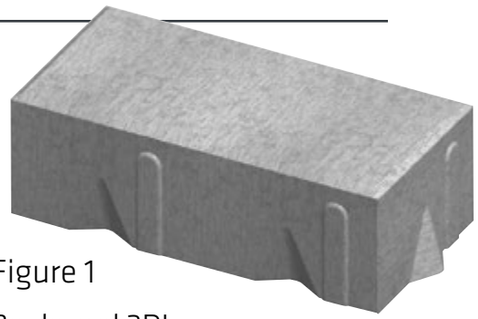


Figure 1
Boulevard 3DI,
50 mm x 300 mm module
(thickness: 100 mm)

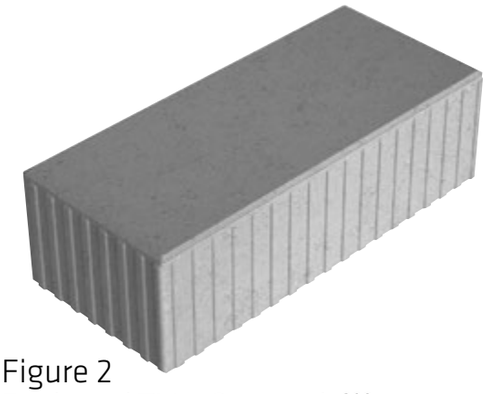


Figure 2
Boulevard TLI_{200} Crescendo^{300},
300 mm x 675 mm module
(thickness: 200 mm)

Reduction in loads applied to the base curse

The use of specialized simulation software reproducing the onsite performance of pavers in service made it possible to establish the distribution of loads and stresses exerted on the interlocking pavers and base course. A simulation* of the performance of Boulevard TLI 200_{mm} pavers in service, by finished element, concluded, for example, that vertical traffic loads usually exerted on the base course by this type of large dimensional interlocking pavers are more than 3 times less than those observed on smaller road pavers under similar conditions.

* Simulation conducted by an outside consultant at the request of Permacon. Conclusions are available upon request.

URBAN PAVERS
Technical

PAVERS' ASPECT RATIO AND FLEXURAL STRENGTH

New on the market, large dimensional pavers [whose surface area exceeds 0.090 m^2 or 1 $ft.^2$ or whose narrow length/thickness look (aspect ratio) exceeds 3.0], encourage designers to ensure that the specified elements deliver the required flexural resistance in service. It should be recalled that the CSA standard defines a paver as a precast concrete element measuring at least 60 mm thick, with a maximum surface area of 0.090 m^2 and a maximum aspect ratio (length/thickness) of 3.0 (vehicular applications). Large dimensional and elongated pavers whose surface and aspect ratios exceed these standard values, must be subjected to a structural review.

Establishing a paver's aspect ratio

More elongated than in the past, new urban pavers have a greater aspect ratio. Even if their mechanical flexural resistance has been established further to a critical analysis of their minimum performance, it is still a good idea to limit the aspect ratio of these materials, i.e., to impose a maximum aspect ratio or, in other words, limit the ratio of the paver's length divided by its thickness. This maximum aspect ratio is the approach that is, in fact, prescribed by the CSA standard.

Further to this, Permacon proposes maximum aspect ratios based on a product's field of application and specific thickness. Refer to tables on page 17 and 18.

PAVER'S ASPECT RATIO

Aspect ratio: LE/D

i.e. :

LE = paver's length (mm) D = paver's thickness (mm)

FLEXURAL STRENGTH CONCEPT APPLIED TO PAVERS

Establishing a paver's flexural strength

All of Permacon's new large dimensional and elongated pavers have been given special attention in this regard. To check the stability of pavers versus their flexural strength in service, Permacon uses a recognized, standard CSA practice, i.e. careful laboratory characterization of the minimum flexural strength determined according to the CSA-A231.1-14 standard for Precast concrete paving slabs, (see figure 1). This test subjects pavers to flexural stresses (see figure 2) and the vertical load applied when breakage is measured. Knowing the dimensions of the tested element and the load measured at the breaking point (expressed in Newtons) makes it possible to calculate the concrete's maximum flexural strength, i.e., a property common to all pavers produced from concrete of the same composition and quality. For example, a precast paver of good quality with a low rate of absorption (generally below 4.0%) has a flexural strength that can range from 6.0 MPa to 8.0 MPa.

$$R_{(MPa)} = (3P_{(N)}L_{(mm)}) / 2b_{(mm)}d^2_{(mm)}$$

i.e. :

R = maximum flexural strength (MPa)

P = vertical load measured at the breaking point (Newtons)

L = distance between two supports (mm)

b = width of the element (mm)

d = thickness of the element (mm)

Figure 1: Equation specified by the CSA-A231.1-14 standard, paragraph 7.2.4 to evaluate the flexural strength of a precast concrete slab.

Calculating a paver's flexural capacity

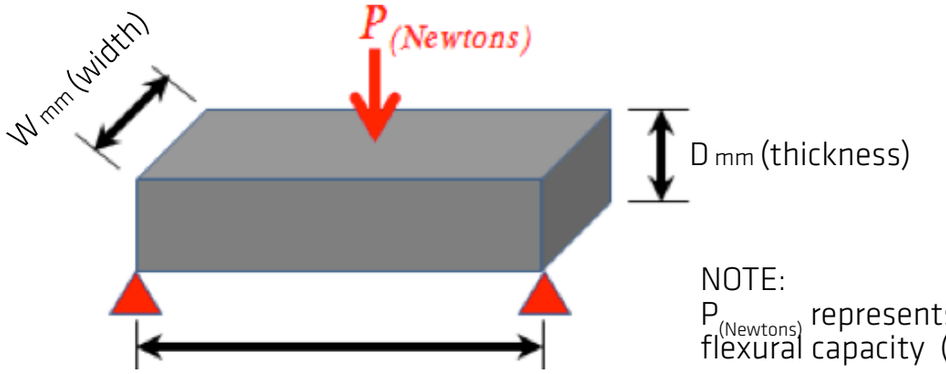
Permacon therefore used the equation specified by the CSA-A231.1-14 standard, paragraph 7.2.4 to estimate the flexural strength of a paver (C_{flex} expressed in kN) resting on two simple supports, and considering that the concrete has a safe minimum flexural strength of 4.5 MPa (see figure 2). This method allows Permacon to compare pavers to each other, knowing the paver's respective lengths, widths and thicknesses.

For several years, this method of obtaining paver's relative characterization has successfully proven its effectiveness at Permacon. It is not only used in the development of new products but has been subjected to strict experimental tracking of performances on the jobsite. Urban and residential pavers are used in a wide range of applications. Day after day, they are subjected to different types of traffic. In an effort to guide designers in the selection of a paver allowing the construction of structures that perform effectively, Permacon proposes to use the design table, see page 17 and 18.

Figure 2

Calculating the maximum vertical load ***P*** measured at the paver's breaking point

(regardless of interlocking capacity)



NOTE:
$P_{(Newtons)}$ represents the paver's flexural capacity (C_{flex})

Maximum load $P = (2\ W \times (D)^2 \times R^*) / 3\ L$

(Reformulation of the equation of Figure 1)

* R refers to the paver's flexural strength (MPa)

URBAN PAVERS
Technical

Minimum flexural load required in service

When designing a structure using precast concrete pavers, the expected performance with regards to the flexural potential of the paving elements depends mainly on the type of application, characteristic traffic and the desired performance. When selecting a paver, distinguishing between the product's urban use (road or off-road application) and residential use, where traffic frequency and loads tend to be much lower, is recommended.

To support the designer with product selection, Permacon presents minimum flexural load values required, based on specific parameters (see table on page 17 and 18). Moreover, Permacon assigns a safe value (minimum safety factor of 25%) to flexural capacity (C_{flex} expressed in kN). Therefore, when choosing a paver, the C_{flex} (flexural capacity) shown in this technical guide must exceed the minimum flexural capacity shown in the table on page 17 and 18 in order to deliver the required performance in service (see the following application example).

Application example

Predicted performance of a paver in service, based on the required flexural capacity values proposed by Permacon (interlocking effect and soil reaction not considered).

PRODUCT	SELECTION CRITERIA FOR PREDICTING THE FLEXURAL PERFORMANCE OF A PAVER IN SERVICE*				
Boulevard TLI Paver (150 mm x 500 mm x 500 mm) Thickness: 150 mm Aire 'A' : 0.250 m^2 Flexural capacity: C_{flex} : 67.5 kN	Use	Field of application	Paver area class	Minimum flexural load required	Predicted performance in service
	Urban	Road	A > 0.090 m^2	Trafic I: 40 kN Trafic II: 45 kN Trafic III: 50 kN	Good High Very high

* See Permacon table on page 17 and 18

CONCLUSION:

Based on the aforementioned application example, the Boulevard TLI 150mm (500mm x 500mm) interlocking urban paver with a flexural capacity of 67.5 kN will deliver very high flexural performance under type III urban road conditions (very heavy and intense traffic with concentrations of trucks and buses) requiring a minimum flexural load of 50 kN, according to the table.

URBAN PAVERS
Technical

FLEXURAL STRENGTH CONCEPT APPLIED TO PAVERS (cont'd)

FLEXURAL LOAD VALUES PROPOSED BY Permacon						
USE	**FIELD OF APPLICATION**	**PAVER AREA 'A' (m^2)**	**TYPE* OF TRAFFIC**	**MIN. FLEXURAL LOAD (kN)****	**RECOMMENDED THICKNESS (mm)**	**RELATIVE CHARACTERISTIC PERFORMANCE**
URBAN	**Road** MAX. ASPECT RATIO[NOTE 1] .if D = 200 mm LE/ D = 3.38 max. .if D = 150 mm LE/D = 3.33 max .if D = 100 mm LE/D = 3.00 max.	A > 0.090	Type III	**50**	150 @200	Very high
			Type II	**45**	150	High
			Type II	**40**	150	Acceptable
		A ≤ 0.090***	Type III	**30**	100	High
			Type II	**25**	100	Good
		A ≤ 0.050***	Type III	**20**	100	High
			Type II	**15**	100	Good
	Non-road MAX. ASPECT RATIO[NOTE 1] .if D = 200 mm LE/D = 3.50 max .if D = 150 mm LE/D = 5.00 max .if D = 100 mm LE/D = 7.00 max	A > 0.090	Type I	**30**	80	High
			Type I	**18**	80	Good
			Type I	**15**	80	Acceptable
			Pedestrians	**< 15**	80	Good
		A ≤ 0.090	Type I	**20**	80	Very high
			Type I	**15**	80	High
			Type I	**10**	80	Good
			Pedestrians	**< 10**	80	Good

NOTE 1: Maximum aspect ratio = LE/D and LE: length of the paver (mm), WI: width of the paver (mm), D: thickness of the paver (mm).

* Characteristic of the type of traffic involved

Type I = Mainly AUTOMOBILES with occasional LIGHT SINGLE-AXLE SERVICE TRUCKS (non-road)

Type II = Mainly LIGHT SINGLE-AXLE SERVICE TRUCKS & AUTOMOBILES with occasional BUSES (road)

Type III = Heavy and intense traffic CONCENTRATION OF HEAVY MULTI-AXLE TRUCKS & BUSES (road)

** Load calculated according to CSA-A231.1-14, paragraph 7.2.4 for 'Precast concrete slabs' with a safe flexural strength of 4.5 MPa.

NOTE : *The pavers' interlocking quality and the normal transfer of vertical loads to the base course are not taken into account when evaluating the paver's potential flexural capacity in service.*

*** To ensure the long-term sustainability and stability of the road structure, the use of an urban paver with a surface area equal to or exceeding 0.090 m^2 (1.0 $ft.^2$) is strongly recommended.

URBAN PAVERS
Technical

CHARGES MINIMALES À LA FLEXION PRESCRITES EN SERVICE (suite)

FLEXURAL LOAD VALUES PROPOSED BY PERMACON IN 2016						
USE	**FIELD OF APPLICATION**	**PAVER AREA 'A'**	**TYPE* OF TRAFFIC**	**MIN. FLEXURAL LOAD** (kN)**	**RECOMMENDED THICKNESS (mm)**	**RELATIVE CHARACTERISTIC PERFORMANCE**
RESIDENTIAL	**Driveway** That is: MAX. ASPECT RATIO[NOTE 1] .if D = 80 mm LE/D = 7.20 max. .if D = 70 mm LE/D = 6.80 max. .if D= 60 mm LE/D = 6.25 max.	A > 0.090	Type I	**15**	80	high
			Type I	**8**	60	Acceptable
			PEDESTRIANS	**< 8**	60	Good
		A ≤ 0.090	Type I	**10**	60	High
			Type I	**8**	60	Good
			Type I	**7**	60	Acceptable
			PEDESTRIANS	**< 7**	60	Good
		A ≤ 0.050	Type I, if LE/WI ≤ 3.2	**6**	80	Good
			Type I, if LE/WI≤ 2.0	**5**	60	Good
			PEDESTRIANS	**< 5**	60	Good

NOTE 1: Maximum aspect ratio = LE/D and LE: length of the paver (mm), WI: width of the paver (mm), D: thickness of the paver (mm).

* Characteristic of the type of traffic involved

Type I = Mainly CARS with occasional LIGHT SINGLE-AXLE SERVICE TRUCKS (non-road)

Type II = Mainly LIGHT SINGLE-AXLE SERVICE TRUCKS & CARS with occasional BUSES (road)

Type III = Heavy and intense traffic with CONCENTRATION OF HEAVY MULTI-AXLE TRUCKS & BUSES (road)

** Load calculated according to CSA-A231.1-14, paragraph 7.2.4 'Precast concrete slabs' for a safe flexural strength of 4.5 MPa.

NOTE: The pavers' interlocking effect and the normal transfer of vertical loads to the base course are not taken into account when evaluating the paver's potential flexural strength in service.

URBAN PAVERS
Technical

MULTI-LENGTH PAVERS

Aesthetics

On the market, there are so-called “MODULAR PAVERS”. Consisting of 3 to 4 different sizes delivered on the same pallet, these pavers lend themselves to random installation and are favoured by designers. Permacon recently innovated multi-length pavers (called “CRESCENDO”), consisting of 5 to 7 lengths with a common width. These products can be randomly installed in strip (linear pattern). Furthermore, it is necessary to ensure that the pavement’s transverse joints be sufficiently staggered (approx. 75 mm) from one strip to the other, to ensure the structure’s optimal aesthetics and performance (see figure 2).

Installation ease and speed

Pavers in each of a pallet’s row have a common width but different lengths. In fact, with a large number of different lengths, installation is not only easier but faster as well. To build in strips, use a mason’s line and ensure a minimum staggering of transversal joints by selecting the right paver length for installation (see an example of construction on page 18). This eliminates the need for aligning pavers in both directions.

Stability in service

The presence of pavers of different lengths on each of a pallet’s rows offers the landscape architect the possibility of ending each strip of pavers with a cut element whose length has been maximized thanks to the choice of elements of the right length. This avoids having small cut elements at the end of a strip and confers greater long-term stability to the pavement.

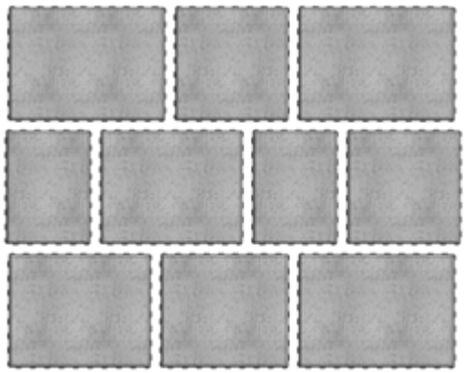


Figure 1
Typical row of multi-length pavers Boulevard TLI_{90} Crescendo^{320} consisting of 5 different lengths

Figure 2
Staggering the transversal joints when building a paved structure with strips of multi-length pavers ensures the optimal aesthetics and performance of the structure.

PAVER MODULE (or nominal dimensions at installation)

In its literature, Permacon specifies the size of its products in terms of nominal dimensions in place. These nominal dimensions are the only values used in this document. It is imperative to refer to these when designing a project, which is to say that the reference dimensions used in developing a pavement's pattern must be the nominal paver dimensions provided by Permacon. It should be recalled that the nominal dimension, or paver module, represents the size of the installed paver plus its two half-joints, i.e. the absolute distance between the half-joint on one side of the paver to the half-joint on the opposite side (see figure 1). Size tolerances specified in the production of moulds allow for a degree of variation in the size of the product being manufactured (permitted variations comply at all times with the CSA standard) without affecting installation in keeping with the nominal dimensions provided.

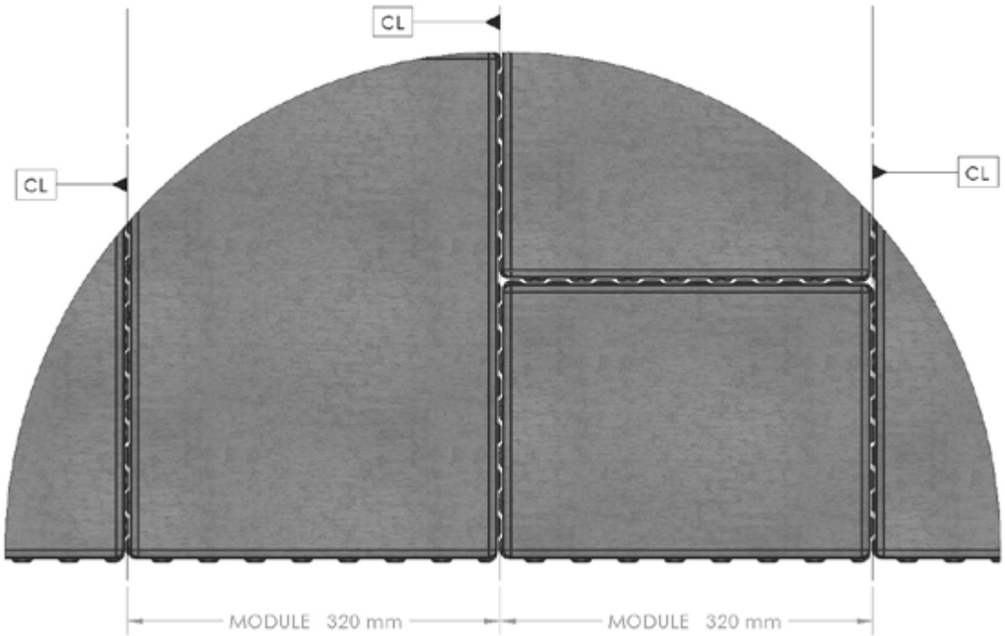


Figure 1
The nominal dimension of a paver (called MODULE) refers to the size of the installed paver plus its two half-joints (i.e. the absolute distance between the half-joint on one side of the paver to the half-joint on the opposite side).

URBAN PAVERS
Technical

Paver's descriptive parameters
In order to simplify the design of pavement, Permacon proposes 3 descriptive parameters specific to each of the pavers marketed: the paver's nominal thickness (D_n), its surface area (A) and its minimum flexural capacity (C_{flex}). These are the reference values to be used when designing structures.

Paver's nominal thickness, D_N (mm)
This parameter primarily identifies the product. This is also the reference value used in calculating the paver's minimum flexural strength. In addition, Permacon markets pavers whose absolute thickness is equal to or slightly higher than the nominal thickness specified prior to their transformation (such as the Buffed and Granitech finishes). Generally speaking, the thickness variation permitted by Permacon in production is less than that authorized by the CSA standard (CSA-A231.2-14 Precast Concrete Pavers, paragraph 6.1.3, Sizing variations permitted: height: ± 3.0 mm).

Paver's area, A (m^2)
This parameter refers to a paver's surface (or its nominal area) calculated based on its nominal dimensions. This value is used to calculate the surface area of a paver installed on the jobsite. Finally, Permacon refers to this value to characterize its products. Where the area A (m^2) is equal to or lower than 0.090 m^2 (1 $ft.^2$), the product is referred to as a STANDARD PAVER, in compliance with the CSA standard. Where the surface exceeds 0.090 m^2 (1 $ft.^2$), the product is referred to by Permacon as a LARGE DIMENSIONAL PAVER (see note). Finally, in the case of a modular product with several dimensions, the longest element (generally the one that is most critical with regards to flexural failure in service) will be retained to identify the area of the modular paver.

Paver's aspect ratio
A paver's aspect ratio refers to its length/thickness ratio. The CSA standard refers to this intrinsic paver property to distinguish between pavers for pedestrian and vehicular applications. In addition to analysing a paver's potential performance in service based on its mechanical flexural capacity, Permacon specified, at a pavement's design stage, the maximum aspect ratio that should be respected based on the paver's thickness and proposed application.

NOTE

By definition, the CSA standard considers products with an area exceeding 0.090 m^2 to be slabs. In this regard, Permacon gives special attention to the flexural performance of LARGE DIMENSIONAL PAVERS to avoid their flexural failure in service. Furthermore, while the CSA standard defines elements with an area of more than 0.090 m^2 as slabs, these products, which Permacon refers to as LARGE DIMENSIONAL PAVERS, are evaluated in the laboratory using the CSA standard for concrete pavers.

URBAN PAVERS
Technical

PAVER'S MINIMUM FLEXURAL CAPACITY, C_{flex} (kN)

This mechanical paver property is calculated based on its nominal dimensions (length, width and height (thickness), and the flexural strength of the concrete from which it is produced (Permacon uses a safe flexural strength of 4.5 MPa to calculate its pavers' minimum flexural capacity. This standardized property is calculated in a laboratory. When designing pavement, a paver's minimum flexural capacity must always exceed the minimum strength required to withstand loads to which the structure will be subjected. See tables on page 17 and 18.

Application example

(identification of a Permacon paver's descriptive parameters)

Boulevard TLI 200 Crescendo^{300} interlocking urban paver (D_n: 200 mm, A: 0.203 m^2, C_{flex}: 53.3 kN)
See product description on page 39.

Designed for linear installation, this urban paver has a nominal thickness of 200 mm (D_n: 200 mm) and comes in 7 sizes with the following dimensions (expressed in mm): module A (300 x 300), module B (300 x 412.5), module C (300 x 487.5), module D (300 x 525), module E (300 x 562.5), module F (300 x 637.7) and module G (300 x 675). Module G – the most critical in terms of flexural performance in service – is considered the module controlling the pavement's design. Therefore, the surface area retained for the Boulevard TLI 200 Crescendo^{300} paver is 0.203 m^2 while its minimum flexural capacity (C_{flex}) is 53.3 kN. These are the reference values used for design purposes.

URBAN PAVERS
Technical

NOMINAL INSTALLATION OF PAVERS

Application example:

Interlocking TLI 150 mm urban paver (500 mm x 500 mm)
The nominal installation dimension of each paver in place (half-joint to half-joint) will be 500 mm, even if the paver's absolute dimension is less. In this example, the proper nominal installation dimension of two pavers of 500 mm each will be 1,000 mm (see the following drawing).

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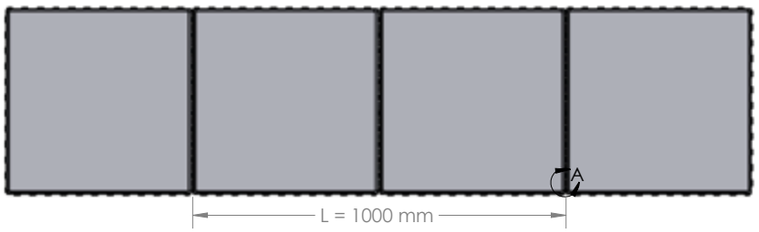
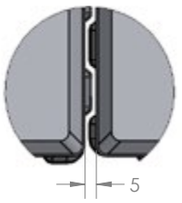
Conclusion: (see the 3 proposed drawings)

If this installation dimension is 1,000 mm on the jobsite, the installation will be correct. If this dimension is lower than 1,000 mm (example: 996 mm, the installation will be too tight) or higher than 1,000 mm (example: 1,004 mm, the installation will be too loose), the pavers' installation will be deemed non-compliant. In the midterm, this will affect the performance and integrity of the structure in service (possible breakage of elements, abnormal shifting or buckling of the pavement).

PROPER NOMINAL INSTALLATION

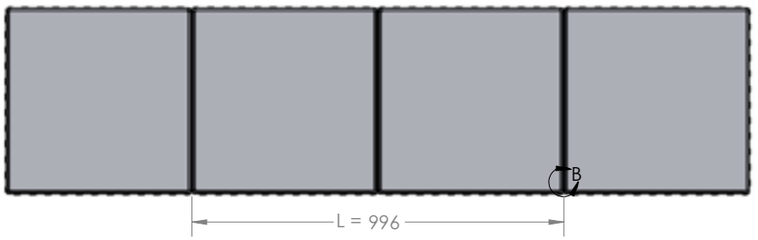


(L = 1000 mm)

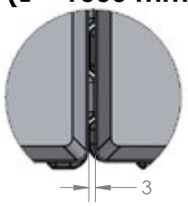


A

OVERLY TIGHT, NON-COMPLIANT INSTALLATION

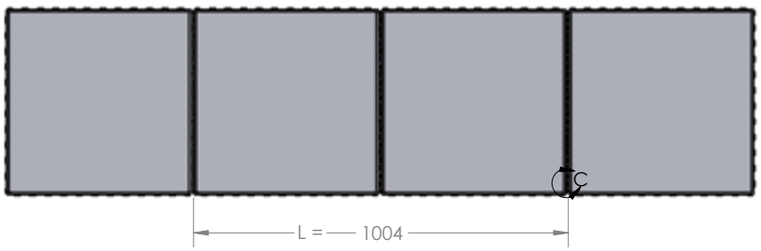


(L < 1000 mm)

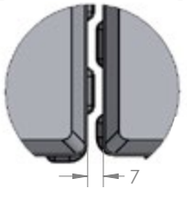


B

OVERLY LOOSE, NON-COMPLIANT INSTALLATION



(L > 1000 mm)



C

URBAN PAVERS
Technical

CSA STANDARD (reminder)

In Canada, precast concrete pavers are subjected to the Canadian CSA A231.2-14 ''Precast Concrete Pavers'' standard. Manufacturers as well as test laboratories and expert reports must refer to it. In addition to dealing with the properties of precast concrete pavers, which manufacturers are required to meet, this standard sets forth the testing protocols for evaluating products and guides professional landscapers and landscape architects by specifying the best practices for the onsite installation of pavers (optional appendix B).

The following table presents a summary of the main elements and requirements addressed in this standard.

SUMMARY A FEW OF THE ESSENTIAL ELEMENTS & REQUIREMENTS COVERED BY THE CSA A231.2-14 STANDARD*		
ELEMENTS		**REQUIREMENTS**
Definition of a paver	• Surface	Less than 0.090 m^2 (1 pi^2)
	• Minimum nominal thickness	60 mm
	• Aspect ratio	≤ 4,0 (pedestrian applications) ≤ 3.0 (vehicular applications)
Variations in size**	• Length • Width • Thickness	-1 mm @ + 2 mm - 1 mm @ + 2 mm ± 3 mm
Physical properties	• Compressive strength***	50 MPa min (28d)
	• Durability (maximum loss of weight to scaling)	225 g/m^2 (after 28 cycles) or 500 g/m^2 (after 49 cycles)

* CSA A231.2-14 “Precast concrete pavers”, go to the website of the “CSA Group'' at shop.csa.ca to obtain this standard online, (tel.: 1-800-463-6727).

** Absolute values compared to the manufacturer’s technical drawings.

***When accepting the product, no individual compressive strength result obtained in characterization testing must be under 45 MPa. Finally, the CSA standard recommends onsite compliance with a minimum maturity (minimal compressive strength of 40 MPa) before installing the pavers.

URBAN PAVERS
Technical

INSTALLATION OF A TYPICAL JOINT BETWEEN TWO PAVERS (using nominal installation)

When building a paved surface, concrete pavers must be positioned in compliance with Permacon's nominal installation dimensions. The installed elements must be neither too tight nor too loose. Generally, once the work has been completed, i.e., after the addition of the polymer jointing sand and final compacting, a 2.0 mm gap, measured between a paver's spacer and the edge of the adjacent paver, is created*. Futhermore, the space between the pavers (excluding paver spacers) will be approximately 5 mm while the space created at the surface of the paver (using nominal installation) will range from 13 mm to 27 mm, depending on the configuration of the selected bevel (see figure 2 and its caption).

* NOTE
This gap can be less than 2.0 mm depending on the wear of the mould used in production and the possible deformation of the fresh concrete when demoulding the product.

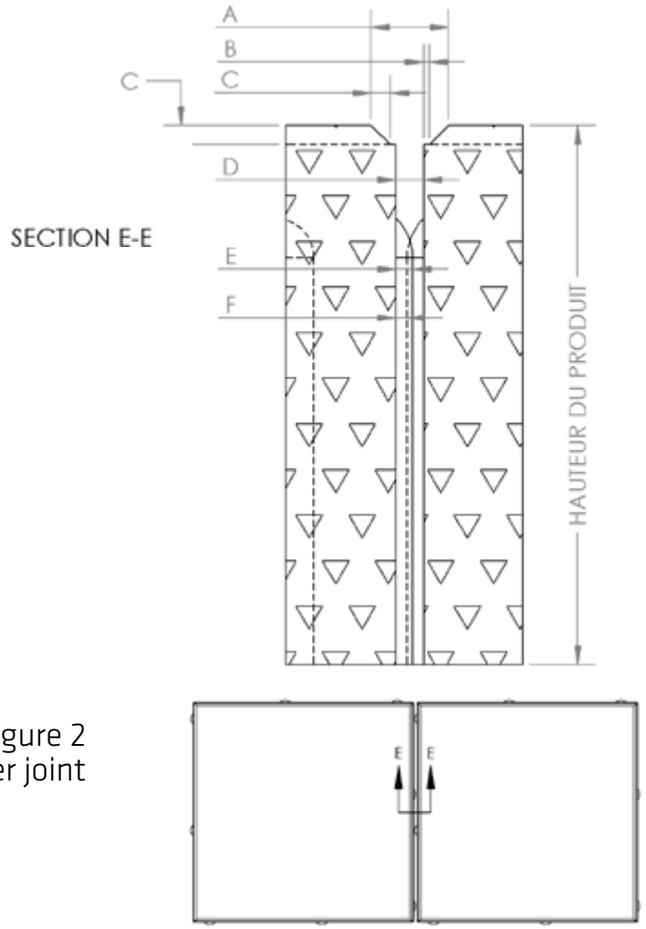


Figure 2
Cross-section of a typical paver joint

IDENTIFICATION	ELEMENTS	CARACTERISTICS
A	Joint width on the surface of the pavement (nominal installation)	Approx. 13 mm to 27 mm (depending on the type of bevel chosen)
B	Flat shoe chamfer	Minimum width of 1 mm
C	Standard bevel	Can vary from $3V_{mm}$:$3H_{mm}$ to $10V_{mm}$:$10H_{mm}$
D	Width of joint between 2 pavers (nominal installation excluding spacers)	Approx. 5 mm
E	Thickness of spacers integrated around the edge of the paver	Approx. 3 mm
F	Free space between the paver's spacer and the adjacent paver (nominal installation)	Approx. 2 mm

URBAN PAVERS
Technical

Urban development inevitably comes with a significant reduction in natural permeable ground. The construction of buildings in the residential, industrial and commercial sectors are contributing factors. Every day, large areas are covered with impermeable pavement (asphalt or Portland cement concrete) to facilitate access to new developments.

Municipalities are now required to invest more than ever in the management of their storm sewer systems, which at times can barely eliminate rainwater, especially in the wake of heavy precipitation.

One of the most innovative solutions is the use of permeable interlocking concrete pavement in areas designed to return rainwater directly to the groundwater table rather than channel it to storm sewers, particularly in urban sectors where more than 50% of the ground surface is impermeable.

Role of permeable pavement
The objective, when building a permeable pavement system, is to allow rainwater to infiltrate the underlying soil. The stormwater will be stored in the subbase of the paved area instead of running off to the sewer system. The open graded subbase material will provide storage for the runwater that is collected and will be held for a period of time.Subsequently, the natural permeability of the soil beneath the subbgrade will allow the accumulated water to gradually return to the ground table, thus pursuing its natural cycle.

Concrete pavers used in the construction of permeable pavement
Specifically designed concrete pavers can be used for the construction of a permeable pavement. The joints between the pavers, which are filled with a permeable granular material, have the required porosity to channel water into the system.

Design and construction
Before undertaking any construction work, an engineer experienced in the field of hydrology should be consulted, in order to obtain an accurate history of local precipitation and the amount of rainwater or drainage from neighbouring surfaces that will run through the permeable paved area.

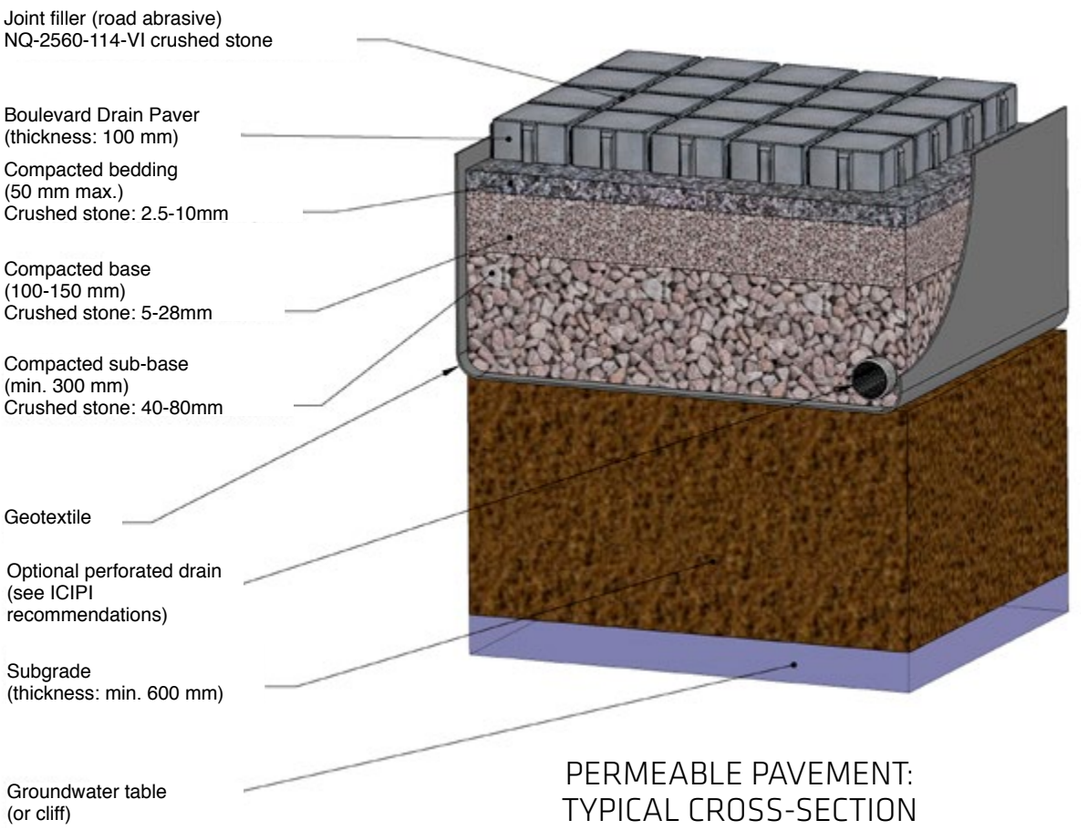
URBAN PAVERS
Technical

Design and construction

A detailed study is also required to determine the permeability of the undisturbed soil present beneath the permeable materials, as well as proximity to the groundwater table, rock bed, etc. The technical data gathered will make it possible to design effective permeable pavement**, i. e. , pavement where the volume of the subgrade's intergranular basin is sufficient to collect the projected amount of rainwater, and where the permeability of the soil is adequate (permeability coefficient exceeding 2x10-6m/sec. or 0. 27 inches/hour) to allow the water to return naturally to the groundwater table before another major rainfall. Failing this, it will be necessary to build a drainage system into the subbase , perhaps even on the surface of the pavement (which should always have a minimum 1% slope) as a complementary measure to evacuate residual rainwater and avoid any overflow or flooding of the structure in service. Melting snow and winter rains must also be taken into account.

Construction must be carried out by a competent contractor in strict compliance with plans and specifications. Moreover, materials must be selected with considerable care to obtain the required permeability.

(table 1).



PERMEABLE PAVEMENT:
TYPICAL CROSS-SECTION

* Permacon strongly recommends that you go to the website of the ICPI (Interlocking Concrete Pavement Institute) at the following address www. icpi. org (items: permeable pavers) before undertaking any studies or work on permeable pavement using concrete pavers.

** Application software has been developed for this purpose. See the ICPI.

URBAN PAVERS
Technical

Granulometric requirements of granular materials

In building a permeable pavement, it is imperative to incorporate concrete pavers complying with the granulometric limits established for this type of structure. See the table below. The grading ranges with which these granular materials must comply serve to ensure that the load-bearing capacity of the base and subbase is adequate, as well as avoid contamination between the layers and obtain the desired permeability

Sieve (mm)	Joint filler Crushed and washed road abrasive		Bedding Thickness : 50 mm max. (before compacting)		Base course Thickness: Max. 100 to 150 mm		Subgrade Min. thickness: 300 mm	
	MTQ limits AB-5[NOTE 1]	Preferred targeted value	CSA range 10-2.5 mm Groupe I	Preferred targeted value	CSA range 28-5 mm Groupe I	Preferred targeted value	CSA range 40-80 mm Groupe II	Preferred targeted value
80	---	---	---	---	---	---	90-100	100
56	---	---	---	---	---	---	25-60	55
40	---	---	---	---	100	---	0-15	15
28	---	---	---	---	95-100	100	0-10	5
20	---	---	---	---	53-85	75	0-5	0
14	---	---	100	---	30-65	50	---	---
10	100	100	85-100	100	20-40	30	---	---
5	85-99	90	10-30	25	0-10	5	---	---
2.5	1-15	15	0-10	10	0-5	0	---	---
1.25	0-5	0-5	0-5	0	---	---	---	---

NOTE 1: Ouvrages routiers du ministère des transport du Québec, Cahier des charges et devis généraux, (infrastructures routières, édition 2012), Norme 14401, tableau 14401-1 '' Abrasifs'' du tome VII, Matériaux de collection (Roadworks carried out by the Québec Department of Transport (MTQ), Specifications and General Requirements, (road infrastructures, 2012 edition) Standard 14401, table 14401- “Abrasives”, Volume VII, Collection Materials).

Additional required characteristics of granular materials

- Clean materials (1% max. passing 80 um sieve)
- Min. 90% of fractured particles
- Base course and subgrade properly compacted with a vibrating plate
- Values relating to passing %:
    - $D_{15\%}$ base course/$D_{50\%}$ bedding: ratio lower than 5.0
    - $D_{50\%}$ base course/$D_{50\%}$ bedding: ratio higher than 2.0

URBAN PAVERS
Technical

Advantages & benefits
These can be summarized as follows:

- Excellent way of avoiding the construction of new impermeable surfaces
- Significantly reduces the volume of rainwater channelled to a storm sewer
- Eliminates the need to dig catch basins for surface water
- Reduces the quantity of toxic and suspended matter in the storm system
- Improves the comfort and safety of users during rainfalls (survival of the natural environment, plants, trees, etc.)
- Actively contributes to reloading the groundwater table
- Reduces occasional risk of flooding paved areas
- Reduces the risk of soil erosion by reducing the runoff speed of surface water
- Reduces development costs in new sectors, by avoiding oversized rainwater management works
- Provides a durable concrete paver structure capable of withstanding freeze-thaw cycles and deicing salts
- Favours sustainable development [possibility of earning 2 LEED points (Leadership in Energy and Environmental Design) from the Canada Green Building Council)] in the area of ecological site development, paragraph 6. 1 Flow and Quantity and paragraph 6. 2, Water Treatment

Permeable pavement limitations
While permeable pavement provides many advantages, it should be recalled that it is not the solution for every project that comes up. It does have its shortcomings, as shown below:

- Requires greater design and construction expertise
- A solution that should be avoided in the presence of rock or a groundwater table too close to the surface [distance of less than 600 mm (24 in.)]
- A solution that should be avoided where there are steep slopes near the permeable pavement (slopes exceeding 20%)
- A solution that should be avoided when the permeable pavement's slope exceeds 5%
- High risk of contaminating the groundwater reservoir near the draining subgrade (minimum 30-metre protective strip required, in keeping with prevailing regulations)
- High risk of progressive clogging of the drainage layers over the long term, because of the significant quantity of fine particles in suspension. These result in particular from the application of road abrasives rich in fine particles, and which could, over time, reduce the structure's permeability. With a minimum of seasonal maintenance, the structure could perform effectively for more than 25 years.
- A solution that should be avoided when a road's standard base course is too close to the drainage layer (minimum 6 m protective zone required).

URBAN PAVERS
Technical

Conclusion

- The use of permeable pavement to provide adequate management of rain water is an effective and harmonious approach to sustainable development.
- In-depth technical knowledge of the pavement construction site with regards to projected rainfall and the drainage properties of the soil is needed to produce an effective structure.
- It is imperative that plans and specifications be produced exclusively by experienced professionals.
- Construction work must be carried out with great care, particularly when selecting and installing draining granular materials.
- A minimum of maintenance is required to ensure the long-term permeability of the structure in service.

Practical references

go to www. icpi. org, under the heading "permeable pavers" and look up the document entitled "Permeable Interlocking Concrete Pavements", (ICPI manual). Highly appreciated by industry professionals, this document is one of the main references on the design, construction and maintenance of permeable pavement incorporating precast concrete pavers.

URBAN PAVERS
Design

Urban pavers offer citizens wishing to appropriate their outdoor urban environment a wide range of options for rehabilitating paved public areas. With their considerable durability and contemporary geometric design, institutional pavers harmonize seamlessly with sustainable development measures. Permacon puts its know-how and the flexibility of its production equipment to work for designers intent on standing out.

Design

As noted in the introduction to this technical guide, when selecting the right pavers for a specific installation pattern (modular, herringbone, strips, etc.), it is imperative to favour the largest possible products over smaller ones. This will ensure better stability of the elements in service and maximize the lifespan of the structure. Furthermore, knowing that urban pavement is subjected to repeated heavy traffic loads, Permacon strongly recommends the use of interlocking urban pavers such as the Boulevard TLI family of pavers with peripheral interlocking grooves; a proven way of avoiding the premature creation of ruts and excessive buckling of the pavement. Finally, when designing roads, it is crucial that strips of pavers be installed perpendicular to the flow of traffic.

URBAN PAVERS
Design

QUALITY AND COMPLIANCE
All Permacon urban pavers, most of which are produced with high performance granite-based aggregates, are subject to highly stringent production standards and controls (see page 24 for information on the CSA standard). They are required to effectively withstand demanding conditions in service (abrasion, impact, freezing, deicing salts, etc.) Some of Permacon's urban pavers (family of BOULEVARD TLI, BOULEVARD 3DI, and BONSECOURS 3DI pavers) provide clearly superior peripheral interlocking ensuring greater stability to paved areas and contributing to the long term structural integrity of pavement subjected to heavy traffic.

SELECTING THE RIGHT PRODUCT
Paved urban structures are subjected to different conditions in service, including exposure to harsh winter conditions (and the presence of deicing salts). Furthermore, the intended type of traffic, whether it is pedestrian (parks and playgrounds), heavy and intense vehicular traffic or other stresses applied to the pavement, must guide the selection of the right product for the project. Permacon has made every effort, in the development of its family of interlocking Boulevard TLI pavers to maximize the stability and longevity of the structures. Special attention was given to the flexural performance of the elements in service, taking into account loads applied to the pavement. Further to this, we refer you to the table produced by Permacon on the FLEXURAL LOAD of pavers in service (page 17 and 18), an indispensable reference when selecting the product to be specified.

IMPLEMENTATION
When building structures with urban pavers, it is imperative that you comply with Permacon's recommendations and resort to the industry's best practices. Professionals can refer to advice provided by organizations recognized in North America, such as the ICPI (Interlocking Concrete Pavement Institute, www.icpi.org).

URBAN PAVERS

Design

PREVENTIVE PAVEMENT MAINTENANCE PROGRAM

Intent on promoting sustainable development, for the first time, Permacon is offering urban landscape owners and professionals a 4-step preventive maintenance schedule whose ultimate, long term objective (50-year lifespan) is to maintain the structural integrity of the pavement in service. This schedule calls for the periodic in-depth monitoring of the in situ performance of the structures along with appropriate corrective measures. The following outlines steps in the preventive maintenance approach recommended by Permacon.

URBAN PAVEMENT PREVENTIVE MAINTENANCE SCHEDULE	
PROPOSED SCHEDULE	**MAIN CHARACTERISTICS**
STEP I One year following completion of the work	The first inspection (in-situ observation of the general performance of the structure in service including: maintenance of the pavement's uniform surface, effective draining slopes, well-filled joints, etc.) with any appropriate corrective measures needed. .
STEP II 5 years following completion of the work	Inspection of paver joints (performance in service) with appropriate correctives measures, if required.
STEP III 15 to 20 years following completion of the work (depending on the condition of the structure)	First upgrading of the pavement based on observation of its performance in service (partial correction of the pavement's uniformity, replacement of defective elements, restoration of the joints, etc.).
STEP IV Every 10 years after Step III	Upgrading of the pavement based on observation of its performance in service (partial correction of the pavement's uniformity, replacement of defective elements, restoration of the joints, etc.).

URBAN PAVERS

Permacon Urban Pavers

NAMES OF AVAILABLE PRODUCTS

The recent introduction of Boulevard TLI (heavy and intense traffic) pavers on the interlocking urban paver market has made it possible to classify Permacon's urban pavers based on their mechanical performance in service or special applications. In this document, Permacon's urban pavers have been grouped according to very specific fields of application, i.e. urban road pavers (streets and boulevards) and off-road urban pavers (parks, sidewalks, courtyards, parking lots, pedestrian walkways, etc.). This approach is justified by the high level and intensity of traffic to which urban road structures are subjected, more so in the case of urban road pavement than off-road structures.
The following table was prepared to facilitate the job of professionals designing projects.

Permacon FAMILY OF URBAN PAVERS		
GROUP	**MAIN CHARACTERISTICS**	**COMMENTS**
Boulevard TLI	Interlocking urban pavers with peripheral grooves, of different thicknesses and sizes	Ensure peerless long term stability and performance in service
Boulevard 300	Traditional non-interlocking urban pavers of different sizes with a thickness of 100 mm	Contemporary aesthetics, freedom of design, and maximized applications
Boulevard Drain	Pavers designed for permeable paved areas	LEED performance
OTHERS . Boulevard 500 . Boulevard 3DI . Bonsecours 3DI	First-generation of urban pavers, which can be replaced by interlocking Boulevard TLI pavers of superior performance	Specific structures

URBAN PAVERS

Permacon Urban Pavers

FIELD OF APPLICATION

Permacon's specifications relating to the flexural capacity of pavers presented on page 17 and 18 of this guide are intended to categorize Permacon's urban pavers based on their physical and mechanical properties, as well as show their respective fields of application. The following two tables were prepared for this purpose and serve as an essential reference document for designers, in order to ensure the long term structural integrity of their project.

PAVERS						MAIN SPECIFIC APPLICATION				
PRODUCT NAME	DIMENSIONS				FLEXURAL CAPACITY	URBAN TRAFFIC				POTENTIAL PERFORMANCE AGAINST THE PRESCRIBED TRAFFIC
						Off-road traffic		Road traffic (low speed)		
	width (mm)	length (mm)	thickness (mm)	area (m^2)	C_{FLEX} (kN)**	pedestrian only*	light traffic (Type 1)	heavy traffic (Type 2)	very heavy and intensive traffic (Type 3)	
Boulevard 300, module A	100	450	100	0.045	6.7	✔***				pedestrian only
Boulevard 300, module B	150	450	100	0.068	10.0		✔			good
Boulevard 300, module C	150	300	100	0.045	15.0			✔		good
Boulevard 300, module D	300	300	100	0.090	30.0				✔	high
Boulevard 300, module E	300	600	100	0.180	15.0		✔			acceptable
Boulevard 300, module F	600	600	100	0.360	30.0		✔			high
Boulevard 500, module A to D	500	500	100	0.250	30.0		✔			high
Boulevard 3DI	150	300	100	0.045	15.0			✔		good
Bonsecours 3DI	140	220	100	0.031	19.1				✔	high
Mega Bonsecours	125	300	100	0.038	12.5		✔			good
Boulevard DRAIN	209	209	100	0.044	30.0		✔			

LEGEND:

typical example:

(*)Pedestrian only (pavements with no cars, trucks or mobile equipments anytime)..... parks
(Type I) mainly cars and occasional single-axle light service trucks..... sidewalks
(Type II) mainly cars, many single-axle light service trucks and minor bus roads..... secondary streets
(Type III) very heavy and intensive traffic ie multi-axles heavy trucks and major bus roads..... main streets and boulevards

**This calculated flexural capacity is related to the weaker module of a multi-lengths product when appplicable.
***Maximum allowable traffic level. Furthermore, the product's performance is implicitly assured under all traffic conditions lower than this category.

Specific application and potential performance of BOULEVARD and BONSECOURS pavers in service.

URBAN PAVERS

Permacon Urban Pavers

FIELD OF APPLICATION (cont'd)

PAVERS							MAIN SPECIFIC APPLICATION				
PRODUCT NAME	DIMENSIONS					FLEXURAL CAPACITY	URBAN TRAFFIC				POTENTIAL PERFORMANCE AGAINST THE PRESCRIBED TRAFFIC
							off-road traffic		road traffic (low speed)		
	width (mm)	length (mm)	thickness (mm)	area (m^2)	width of the peripheral grooves (mm)	C_{FLEX} (kN)**	pedestrian only*	light traffic (Type I)	heavy traffic (Type II)	very heavy and intensive traffic (Type III)	
TLI family pavers											
Boulevard TLI 200 Crescendo[300]	300	675	200	0.203	37.5	53.3				✔***	very high
Boulevard TLI 150, module A	125	500	150	0.063	41.6	16.9		✔			high
Boulevard TLI 150, module B	250	500	150	0.125	41.6	33.8		✔			high
Boulevard TLI 150, module C	500	500	150	0.250	41.6	67.5				✔	very high
Boulevard TLI 150, module D	500	750	150	0.375	41.6	45.0			✔		high
Boulevard TLI 150 Crescendo[320]	320	440	150	0.141	40.0	49.1				✔	very high
Boulevard TLI 150 Small Square	200	200	150	0.040	40.0	67.5				✔	very high
Boulevard TLI 150 Crescendo[125]	125	583	150	0.073	41.6	14.5		✔			high
Boulevard TLI 100, module A	150	300	100	0.045	37.5	15.0			✔		good
Boulevard TLI 100, module B	300	300	100	0.090	37.5	30.0				✔	high
Boulevard TL I 100 Crescendo[300]	300	600	100	0.180	50.0	15.0		✔			acceptable
Boulevard TLI 100 Large Rectangle	300	700	100	0.210	50.0	12.9	✔				pedestrian only
Boulevard TL I 90 Crescendo[320]	320	440	90.0	0.141	40.0	17.7		✔			good
Boulevard TLI 90 Small Rectangle	160	240	90.0	0.038	40.0	16.2			✔		high
Boulevard TLI 90 Large Rectangle	320	520	90.0	0.166	40.0	15.0		✔			acceptable
Boulevard TLI 80	120	240	80.0	0.029	40.0	9.6		✔			good

LEGEND:

typical example:

(*)Pedestrian only (pavements with no cars, trucks or mobile equipments anytime)..... parks

(Type I) mainly cars and occasional single-axle light service trucks ..... sidewalks

(Type II) mainly cars, many single-axle light service trucks and minor bus roads ..... secondary streets

(Type III) very heavy and intensive traffic ie multi-axles heavy trucks and major bus roads..... main streets and boulevards

**This calculated flexural capacity is related to the weaker module of a multi-lengths product when appplicable.

***Maximum allowable traffic level. Furthermore, the product's performance is implicitly assured under all traffic conditions lower than this category.

Specific application and potential performance of BOULEVARD and BONSECOURS pavers in service.

URBAN PAVERS

Permacon Urban Pavers

MINIMUM LEVEL OF PERFORMANCE REQUIRED BY PERMACON

In service, pavers are subjected to highly diverse traffic intensity levels, depending on the type of structure and prevailing traffic conditions. To ensure the structure's long term integrity, it is necessary to select the appropriate product based on its flexural capacity (Cflex). The element's flexural capacity must always be higher than the permissible minimum flexural load specified by Permacon for a given structure and traffic level (see table on page 17 and 18). The more this flexural capacity exceeds the minimum allowable load for a given application, the greater the performance of the element in service. For example, this performance can vary from "acceptable" to "good", to "high" or "very high". For the potential performance of Permacon's urban pavers, see the two tables presented on pages 35 and 36.

In urban environments, pavers are subjected to much heavier traffic loads than those characteristic of residential applications. Consequently, in order to ensure the structure's maximum service life, it is essential to apply stricter product selection criteria relating to minimum performance. The following table was developed to guide the designer in the selection of the appropriate product.

Type III traffic (see page 17 for definition), characterized by intensive bus and very heavy multi-axle truck traffic, requires a high minimum level of performance in service, in order to ensure the long term structural integrity of urban road pavement.

URBAN PAVERS

Permacon Urban Pavers

PRODUCT CHARACTERISTICS

BOULEVARD TLI INTERLOCKING PAVERS - GENERAL

Boulevard TLI (heavy and intense traffic) pavers are the latest family of high performance interlocking urban pavers with peripheral grooves. This particular mechanized interlocking system increases the long term stability of the paved structure in service.

The use of peripheral grooves increases the contact surface between the pavers and the joint filler, allowing a better redistribution of vertical traffic loads to adjacent pavers. What's more, this type of peripheral gear system serves as a type of mechanical lock between the elements, preventing movement between neighbouring elements or their horizontal shifting in the pavement. This improved redistribution of pavement loads reduces residual vertical loads applied directly to the base course. The following table presents an overview of different Boulevard TLI pavers offered by Permacon, to quickly guide the designer's choice of pavers to be specified for their projects. Proposed products have been grouped based on their physical and mechanical characteristics, in order to determine their specific fields of application as well as their potential performance in service (see table on page 36).

INTERLOCKING BOULEVARD TLI (Heavy and Intense Traffic) PAVERS		
THICKNESS (mm)	**NAME**	**ELEMENTS**
200	TLI 200_{mm} Crescendo^{300}	7 modules, not sold separately (A to G)
150	TLI 150_{mm} Crescendo^{320} and TLI 150_{mm} 200 mm x 200 mm (the 2 pavers are compatible)	5 modules, not sold separately (A to E) 1 accessory module, sold separately (permanent coloured pavement line)
	TLI 150_{mm} and TLI 150_{mm} Crescendo^{125} (the 2 pavers are compatible)	4 modules, sold separately (A to D) 6 modules, not sold separately (A to F)
100	TLI 100_{mm} TLI 100_{mm} Crescendo^{300} TLI 100_{mm} 300 mm x 700 mm	2 modules, sold separately (A and B) 3 modules not sold separately (A to C) 1 module sold separately (D)
90	TLI 90_{mm} Crescendo^{320} and TLI 90_{mm}	5 modules, not sold separately (A to E) 2 modules, sold separately (A and B)
80	TLI 80_{mm}	1 module

NOTE
TLI 200_{mm} Crescendo^{300}: 200 refers to the thickness in mm, Crescendo means multi-length per typical row, while 300 mm refers to the width in mm.

URBAN PAVERS

Permacon Urban Pavers

PRODUCT CHARACTERISTICS

BOULEVARD TLI 200_{mm} CRESCENDO^{300} Paver (D_n: 200 mm, A: 0.203 m^2, C_{flex}: 53.3 kN)*

NOTE: TLI: Heavy and intense traffic, 200: thickness (mm), CRESCENDO: multi-length, 300: width (mm)

Unique on the market, the TLI 200_{mm} paver consists of 7 modules of varying lengths, which lend themselves to the construction of contemporary roads whose look is reminiscent of large, natural stone pavements of bygone days. The interlocking quality of the elements ensures the required GIGA STABILITY and long term performance of the pavement in service.

System

- TLI 200_{mm} pavers have been designed and perfected using computerized simulations (finished element method) where the extremely high stresses to which they are subjected in service made it possible to determine the optimal thickness required to avoid flexural failure of the elements.
- According to simulations carried out on TLI 200_{mm} pavers, most of the usual stresses (more than 60%) imposed by heavy traffic on flexible pavement produced from interlocking 100mm-thick concrete pavers, such as the Boulevard 3DI, are more effectively distributed to adjacent pavers. This high interlocking quality is unique and reduces stresses transferred to the base course, maximizing the service life of the structure.

Advantages

The system's 7 modules lend themselves to mechanized strip installation (installation rate of 80 to 100 m^2 per day using appropriate suction equipment). The appropriate choice of paver lengths makes it possible to stagger transversal joints in the pavement during construction, without cutting the elements. The large sizes available maximize installation speed.

Applications

For all types of urban traffic, provided the module selected corresponds to the stresses to which the pavement will be subjected in service.(see page 16 for the table of potential applications recommended by Permacon based on the flexural capacity of the paver and projected traffic loads).

IMPORTANT NOTE
AVOID THE USE OF A RIGID CURB TO RETAIN PAVEMENT PRODUCED FROM CONCRETE PAVERS

Used in the production of roads, pavement incorporating concrete pavers performs like a flexible pavement. For this reason, when designing a structure, it is strongly recommended that you avoid inserting a rigid element into the pavement (concrete curb poured or moulded on site, granite curb, precast concrete curb, etc.) as a retaining element between the concrete pavers and the asphalt pavement. Instead, to contain the pavers in service, it is recommended that you increase the layer of asphalt, creating a transitional section adjacent to the pavers (see photo).

*D_n = nominal thickness, A = area, C_{flex} = flexural capacity (see page 15 for definition)

On this project, the thicker layer of asphalt (to the left of the photo) serves to retain the TLI 200_{mm} Crescendo^{320} pavers.

URBAN PAVERS

Permacon Urban Pavers

Installation (required uniformity of the paved area)

The installation of heavy TLI pavers must be consistent with their weight in order to ensure that paved roads have the required uniformity. In addition to levelling the base course (0-20 mm aggregate) with care, in compliance with the maximum thickness of the bedding, it is essential to compact the pavers using a high-capacity* vibratory plate compactor to achieve the area's required uniformity. **

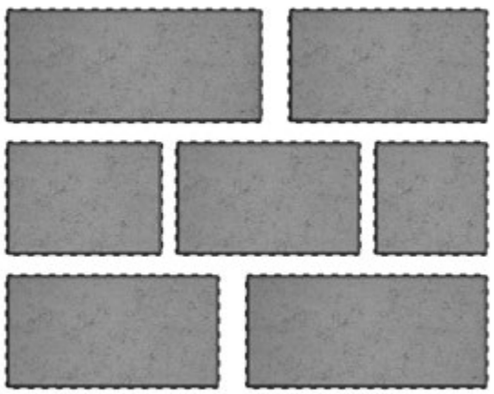
* The weight of the vibratory compactor (fitted with a neoprene base plate protecting the surface of pavers) must exceed 200 kg (440 lbs.) and develop a minimum compacting strength of 30 kN (6750 lbf).

** Snow-clearing equipment causes more rapid wear to paving elements whose surface does not have the required evenness. .

Layout

TLI 200$_{mm}$ paver modules are installed in strips using a mason's line and staggering the transversal joints of neighbouring strips by at least 75 mm to maximize the interlocking quality of the elements while optimizing the pavement's good looks. What's more, Permacon recommends selecting the proper paver module as the next to last construction element of each strip in order to end the strip with a cut element measuring at least 300 mm. This will maximize the stability of the elements in place and ensure the long term integrity of the structure (see figure 1). This same approach, which seeks to keep the number of short pavers to a minimum, must also be taken when circumventing roads obstacles such as valves, catch basins, etc.

Typical row



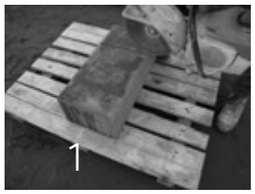
PALLET

46.5 ft.^{2} per pallet
11.6 ft.^{2} per row

Figure 1
Towards the end of a strip of pavers, it is necessary to carefully select the paver lengths required in order to ensure that the last paver cut to complete construction of the strip measures at least 300 mm in length, i.e., a length corresponding to the TLI 200 $_{mm}$ Crescendo^{300} paver's shortest element.

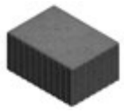
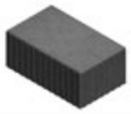
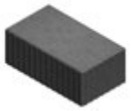
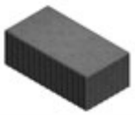
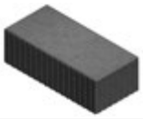
URBAN PAVERS

Permacon Urban Pavers



Photos 1, 2 and 3: The paver at one of the two extremities of the strip of pavers is marked, sawed on the surface (to a maximum depth of 25 mm) on both faces, then split with a mallet. It can also be sawed through, cutting both faces.

PHYSICAL CHARACTERISTICS

MODULES	NOMINAL DIMENSIONS	WEIGHT (kg-lb.)
A 	200 mm x 300 mm x 300 mm 7 7/8" x 11 13/16" x 11 13/16"	42 kg - 93 lbs.
B 	200 mm x 300 mm x 412.5 mm 7 7/8" x 11 13/16" x 16 1/4"	57 kg - 126 lbs.
C 	200 mm x 300 mm x 487.5 mm 7 7/8" x 11 13/16" x 19 3/16"	67 kg - 148 lbs.
D 	200 mm x 300 mm x 525 mm 7 7/8" x 11 13/16" x 20 5/8"	72 kg - 159 lbs.
E 	200 mm x 300 mm x 562.5 mm 7 7/8" x 11 13/16" x 22 1/8"	78 kg - 172 lbs.
F 	200 mm x 300 mm x 637.5 mm 7 7/8" x 11 13/16" x 25 1/8"	88 kg - 194 lbs.
G 	200 mm x 300 mm x 675 mm 7 7/8" x 11 13/16" x 26 9/16"	93 kg - 205 lbs.

(Modules not sold separately)

IMPORTANTE

CUTTING PAVERS IN PAVEMENT

Pavers must be cut with great care and precision around service openings to ensure the long term performance of the pavement. Further-more, to facilitate the installer's job, the use of deeper service cover rims is recommended as this will eliminate the need to cut the under-side of the pavers, which is a difficult task. Furthermore, rebevelling is strongly recommended, in order to avoid the premature spalling of the elements' sawed edges.

Complying with the CSA A 231.2 standard.

URBAN PAVERS

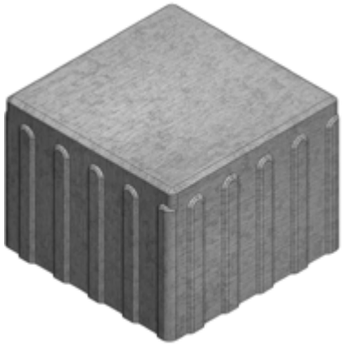
Permacon Urban Pavers

PRODUCT CHARACTERISTICS

BOULEVARD TLI 150$_{mm}$ CRESCENDO^{320} Paver (D_n: 150 mm, A: 0.141 m^2, C_{flex}: 50.0 kN)*

NOTE: A complementary accessory is available: the Boulevard TLI 150$_{mm}$ 200 mm x 200 mm (permanent pavement lines)

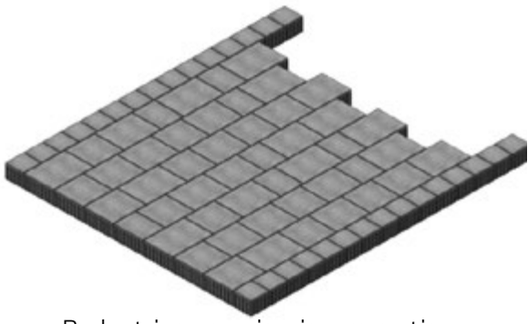
The TLI 150$_{mm}$ Crescendo^{320} is one of the first large interlocking pavers developed for paving urban roads subjected to heavy traffic. It is part of Permacon's line of multi-length pavers with interlocking peripheral grooves. It is also Permacon's product of choice for the construction of urban road pavement. Moreover, the addition of a complementary element measuring 200 mm x 200 mm makes it possible to integrate permanent colour lines (white, yellow or black) in the pavement, enhancing the security of end-users.



Accessory TLI 200 mm x 200 mm paver used for integrating permanent coloured lines in the pavement.

System

Interlocking Boulevard TLI 150$_{mm}$ Crescendo^{320} pavers come in 5 basic sizes (A-B-C-D-E), combined on each row of a pallet (not sold separately). These come in lengths ranging from 240 mm to 440 mm with a common width of 320 mm. Providing greater freedom when designing paved structures, the addition of the Boulevard TLI 150mm paver measuring 200 mm x 200 mm makes it possible to incorporate permanent coloured lines in the pavement. This complementary module is sold separately. The interlocking grooves typical of TLI pavers are incorporated around the elements to maximize the stability of the structures in service.



Pedestrian crossing incorporating 2 white safety lines. (see construction details on the following page).

*D_n = nominal thickness, A = area, C_{flex} = flexural capacity (see page 15 for definition)

** TLI 150$_{mm}$ 200 mm x 200 mm pavers can be installed alone, in a chessboard pattern or soldier course. However, the odd number of peripheral grooves does not make it possible to stagger transversal joints by half a paver length (see page 44 for layout).

URBAN PAVERS

Permacon Urban Pavers

PRODUCT CHARACTERISTICS

Advantages

These large pavers can be installed mechanically (highly recommended) or manually, with peerless speed and ease. Their sizes ensure considerable long term stability to the structure in service.

Installation

(for the required uniformity of the paved surface, see the INSTALLATION paragraph for TLI_{200}Crescendo^{300} pavers on page 40 and the note relating to the cutting of pavers around services on page 41).

Layout**

$TLI\ 150_{mm}$ Crescendo^{320} must be installed in strips only, using a mason's line. When installing, it is necessary to select appropriate module lengths in order to stagger transversal joints by at least 80 mm, representing 2 groove widths.

*D_n = nominal thickness, A = area, C_{flex} = flexural capacity (see page 15 for definition)

** $TLI\ 150_{mm}$ 200 mm x 200 mm pavers can be installed alone, in a chessboard pattern or soldier course. However, the odd number of peripheral grooves does not make it possible to stagger transversal joints by half a paver length (see page 44 for layout).

URBAN PAVERS

Permacon Urban Pavers

Applications

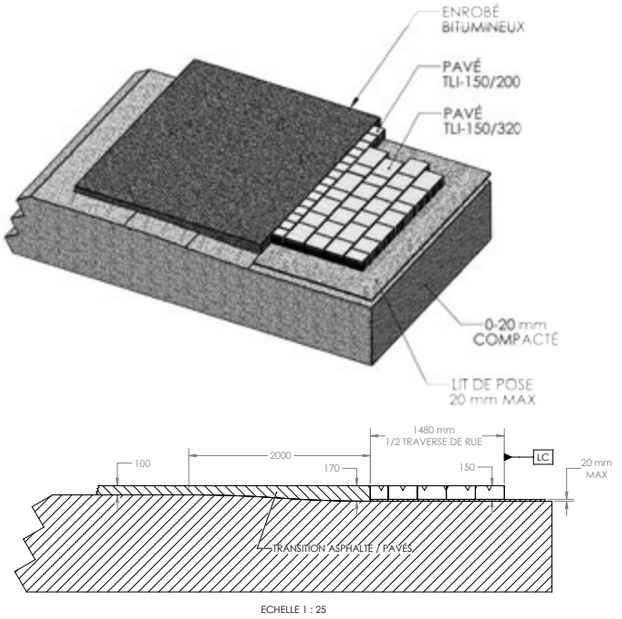
TLI 150$_{mm}$ Crescendo^{320} pavers are designed specifically for the construction of urban pavement subjected to very heavy and intense traffic. Their peerless contemporary good looks are also highly valued in densely populated urban environments when rehabilitating road-work and protecting the built heritage without compromising user safety. They are suited to all types of urban traffic, based on projected traffic loads and the module used (for prescriptions relating to the module's flexural capacity based on projected traffic, see the table of potential applications recommended by Permacon on page 17 and 18).

IMPORTANT

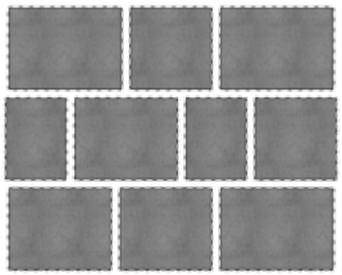
See the note relating to rigid concrete retaining elements to be avoided when designing road pavement on page 39.

Application example

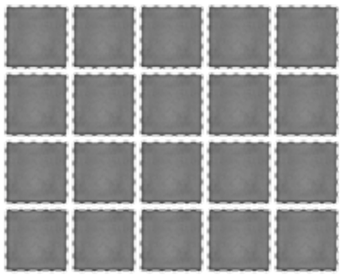
(Pedestrian crossing with transition)



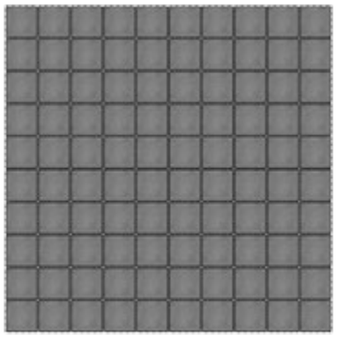
Typical row



TLI 150$_{mm}$ Crescendo^{320}



TLI 150$_{mm}$ (200 mm x 200 mm)

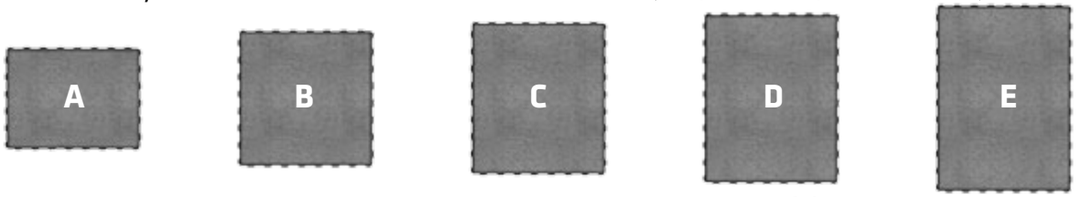


Chessboard installation of the TLI 150$_{mm}$ 200 mm x 200 mm paver

Dimensions

6 sizes available (nominal dimensions)

A: 150 mm x 320 mm x 240 mm (5 7/8" x 12 5/8" x 9 1/2")
B: 150 mm x 320 mm x 320 mm (5 7/8" x 12 5/8" x 12 5/8")
C: 150 mm x 320 mm x 360 mm (5 7/8" x 12 5/8" x 14 3/16")
D: 150 mm x 320 mm x 400 mm (5 7/8" x 12 5/8" x 15 3/4")
E: 150 mm x 320 mm x 440 mm (5 7/8" x 12 5/8" x 17 5/16")
Accessory: 150 mm x 200 mm x 200 mm (5 7/8" x 7 7/8" x 7 7/8")



Pallet

TLI 150$_{mm}$ Crescendo^{320}: 49.6 ft.^{2} per pallet (12.4 ft.^{2} per row)

TLI 150$_{mm}$ 200x200: 51.6 ft.^{2} per pallet (8.6 ft.^{2} per row)

NOTE:
Modules A to E are not sold separately

URBAN PAVERS

Permacon Urban Pavers

Construction of curved pavement (longitudinal cross-section of pavers to be respected)

When building a curved paved surface, strips of pavers must be cut in a point to allow the pavement's desired rotation (see figures 1 and 2). Compliance with the minimum specific cut (paver width to be reduced) for each of the five TLI 150_{mm} Crescendo^{320} modules is imperative in order to retain a safe minimum flexural capacity. This maximum required cut value ranges from 2 inches (50 mm) to 6 inches (150 mm) depending on the length of the module used (see figures 3 and 4). As a rule, the longer the paver, the smaller the part to be removed. The number of strips to be cut will depend on the width and rotation angle of the pavement to be built.

IMPORTANT
Using a saw, rebevel cut edges to avoid the premature spalling of the elements (see figure 5).

When preparing the final profile of the compacted granular base's top layer, it is essential for the crown's bent radius to be even along the entire length of the pavement, as shown in the specifications, in order to avoid the loss of self-locking effect between pavers (undesirable joint width greater than 2.0 mm), particularly those located in the middle of the paved area.

Figure 1
Construction of a curved section of pavement.

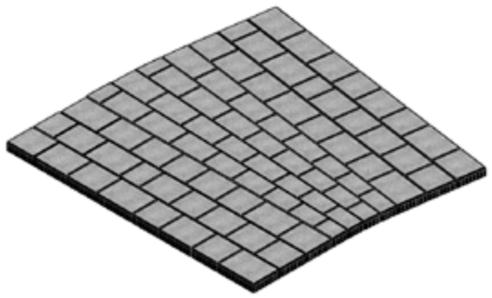


Figure 2
Sketch of paver strips cut in a point.

Length of the paver (mm)	Maximum cut width (mm)
240	150
320	125
360	100
400	75
440	50

Figure 3
Maximum allowable cuts of paver modules.

Figure 4
Preparations for cutting a strip's pavers using a mason's line.

Figure 5
Rebevelling a cut paver's sawed edges.

Figure 6
Example of an irregular transversal profile of the pavement's crown.

URBAN PAVERS

Permacon Urban Pavers

PRODUCT CHARACTERISTICS

BOULEVARD TLI 150_{mm} CRESCENDO^{125} Paver (D_n: 150 mm, A: 0.073 m^2, C_{flex}: 14.5 kN)*

Interlocking TLI 150_{mm} Crescendo^{125} pavers consist of narrow elements whose 150 mm thickness allows the design of off-road urban pavement incorporating oversized elements without compromising their flexural performance in service. These narrow pavers harmonize beautifully with Boulevard TLI 150_{mm} pavers (modules A, B, C and D), offering designers considerable latitude when creating distinctive, prestigious paved structures. Exclusivity, outstanding aesthetics and stability are the hallmarks of these high performance pavers.

System

These multi-length interlocking pavers come in 6 sizes ranging in length from 333 mm to 583 mm, with a common width of 125 mm. Their large 150 mm thickness makes it possible to offer pavers up to 583 mm in length without compromising their safe flexural strength in ser-vice. Moreover, these elements feature peripheral grooves maxi-mizing the stability of the elements in service. These pavers have been de-signed for strip installation only. When installing, it is necessary to select appropriate module lengths in order to stagger transversal joints by at least 80 mm, representing approximately 2 groove widths. (See page 19 for additional details relating to the installation of Permacon's TLI multi-length pavers).

Advantages

- Considerable installation speed and ease given the large size of the elements
- Despite their size, these pavers can be installed without the use of clamps or suction equipment
- Long term Giga stability provided by interlocking grooves
- Significant reduction in the amount of joint filler required for 150 mm pavers, minimizing installation costs

Applications

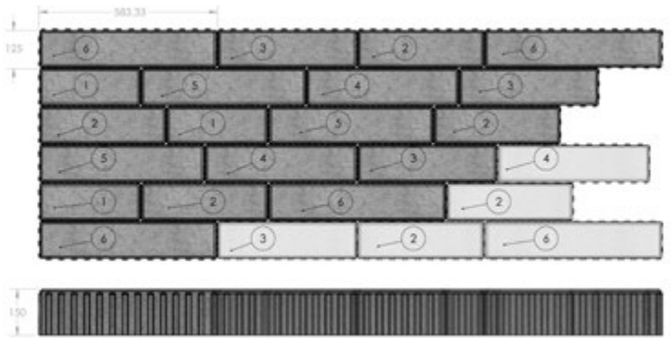
For all types of urban traffic, based on projected traffic loads and the module used (for prescriptions relating to the module's flexural capacity based on projected traffic, see the table of potential applications recommended by Permacon on page 17 and 18).

*D_n = nominal thickness, A = area, C_{flex} = flexural capacity (see page 15 for definition)

URBAN PAVERS

Permacon Urban Pavers

Layout



Typical row

Dimensions

6 sizes available (nominal dimensions)

A: 150 mm x 125 mm x 333 mm (5 7/8" x 4 15/16" x 13 1/8")

B: 150 mm x 125 mm x 417 mm (5 7/8" x 4 15/16" x 16 3/8")

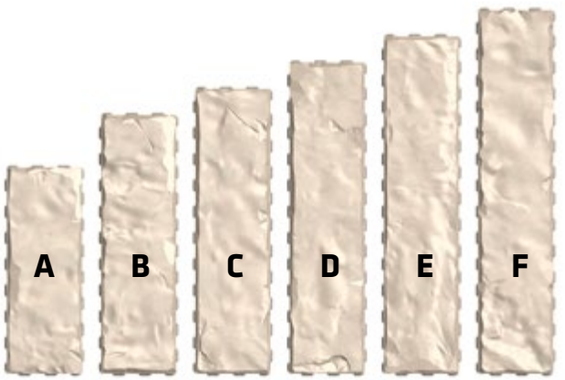
C: 150 mm x 125 mm x 458 mm (5 7/8" x 4 15/16" x 18")

D: 150 mm x 125 mm x 500 mm (5 7/8" x 4 15/16" x 19 11/16")

E: 150 mm x 125 mm x 542 mm (5 7/8" x 4 15/16" x 21 5/16")

F: 150 mm x 125 mm x 583 mm (5 7/8" x 4 15/16" x 23")

(Sizes A to F are not sold separately)



Pallet

53.8 ft.^{2} per pallet

10.76 ft.^{2} per row

URBAN PAVERS

Permacon Urban Pavers

PRODUCT CHARACTERISTICS

BOULEVARD TLI 150_{mm} Paver (D_n: 150 mm)*

Exclusive to Permacon, oversized Boulevard TLI 150_{mm} pavers lend themselves to the construction of innovative, high performance urban structures. Available in 4 sizes, these modular elements have a common thickness and width of 150 mm and 500 mm respectively.

Concept

The development of this family of pavers, whose modules are sold separately, took into account the need for mechanized installation. Its largest size was maximized, then harmonized with the 3 other smaller sizes to ensure the finished structure of optimal good looks. With their significant thickness and peripheral grooves characteristic of the family of Boulevard TLI pavers, these elements deliver peerless interlocking quality.

Advantages

- Considerable installation speed and ease given the large size of the elements
- Long term Giga stability provided by interlocking grooves
- Significant reduction in the amount of joint filler required for 150 mm pavers, minimizing installation costs
- Available in the same sizes as Giga residential slabs, these products can be harmonized to create landscaping arrangements reflecting the same aesthetic concept (sidewalks, backyards, patios, etc.)
- High flexural strength of modules B, C and D, some of which lend themselves to urban roadwork (see page 17 and 18 for recommendations on the flexural capacity to take into account when designing structures for specific projected traffic loads).

Installation (required uniformity of the paved area)

The installation of heavy TLI pavers must be consistent with their weight in order to ensure that paved roads have the required uniformity. In addition to levelling the base course (0-20 mm aggregate) with care, in compliance with the maximum thickness of the bedding, it is essential to compact the pavers using a high-capacity* vibratory plate compactor to achieve the area's required uniformity. **

* The weight of the vibratory compactor (fitted with a removable neophrene base plate protecting the surface of pavers) must exceed 200 kg (440 lbs.) and develop a minimum compacting strength of 30 kN (6750 lbs).
** Snow-clearing equipment causes more rapid wear to paving elements whose surface does not have the required evenness.

NOTE: See page 41 for note on cutting pavers around service openings.

Layout

Available sizes allow modular layouts. See pages 51 and 52 for suggested installation patterns combining modules B, C and D in different proportions.

*D_n = nominal thickness

URBAN PAVERS

Permacon Urban Pavers

Applications

For all types of urban traffic, based on the structure's projected traffic loads in service and the module used (for specifications relating to the module's flexural capacity based on projected traffic, see the table of potential applications recommended by Permacon on page 17 and 18).

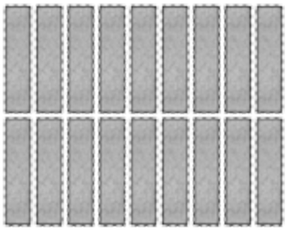
Example of application according to Permacon's specifications

The following table recaps information on the design of structures using Boulevard TLI 150$_{mm}$ pavers, taken from the table of potential applications proposed by Permacon (see table on page 17).

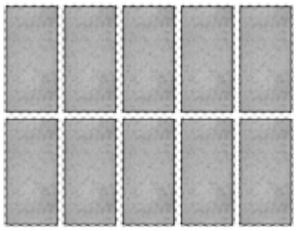
Possible urban uses* suited to Boulevard TLI 150$_{mm}$				
Module	**Paver area A (m²)**	**Min. flexural capacity C_{flex} (kN)**	**Application, Type of traffic***	**Characteristic performance**
A (125 mm x 500 mm)	0.063	16.9	Off-road, Type I	High
B (250 mm x 500 mm)	0.125	33.8	Off-road, Type I	High
C (500 mm x 500 mm)	0.250	67.5	Off-road, Type III	Very high
D (500 mm x 750 mm)	0.375	45.0	Off-road, Type II	High

* see Permacon's table of potential applications, page 17

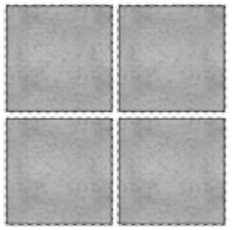
Typical row



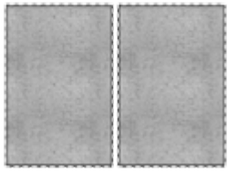
Module A



Module B



Module C



Module D

IMPORTANT

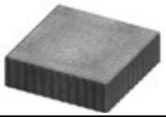
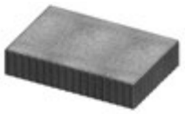
See the note relating to rigid concrete retaining elements to be avoided when designing road pavement on page 39.

URBAN PAVERS

Permacon Urban Pavers

Dimensions

PHYSICAL CHARACTERISTICS

MODULES	NOMINAL DIMENSIONS	WEIGHT (kg-lb.)	Flexural capacity C_{flex} (kN)
A 	150 mm x 500 mm x 125 mm 5 7/8" x 19 11/16" x 4 15/16"	23 kg - 51 lbs.	16.9
B 	150 mm x 500 mm x 250 mm 5 7/8" x 19 11/16" x 9 7/8"	46 kg - 101 lbs.	33.8
C 	150 mm x 500 mm x 500 mm 5 7/8" x 19 11/16" x 19 11/16"	91 kg - 200 lbs.	67.5
D 	150 mm x 500 mm x 750 mm 5 7/8" x 19 11/16" x 29 1/2"	135 kg - 297 lbs.	45.0

(A, B, C and D modules are sold separately)

Pallet

Modules	Ft.²/pallet	Ft.²/row
Module A	60.5	12.1
Module B	67.2	13.5
Module C	65.6	10.8
Module D	48.4	8.1

URBAN PAVERS

Permacon Urban Pavers

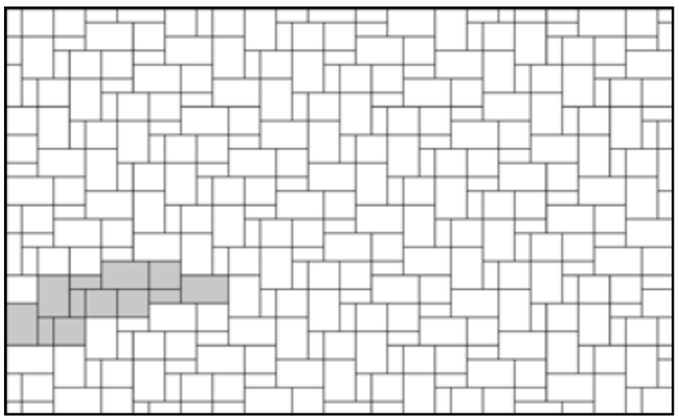
A few suggested installation patterns

The four Boulevard TLI 150$_{mm}$ paver modules lend themselves to the design of linear and strip structures. However, they were developed primarily to work together in creating a modular pavement. Permacon also offers designers a series of 7 installation layouts in varying proportions showcasing the aesthetic quality of modules B, C and D.

GIGA pavers and tiles – Pattern 1

Module proportions for this pattern

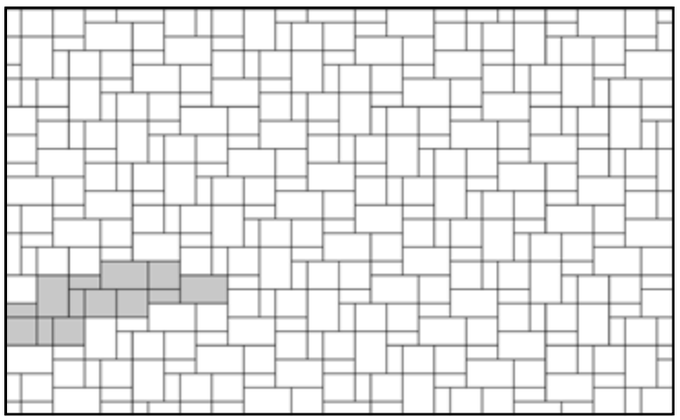
Module A	Module B	Module C
4 units 50%	4 units 33%	4 units 17%



GIGA pavers and tiles – Pattern 2

Module proportions for this pattern

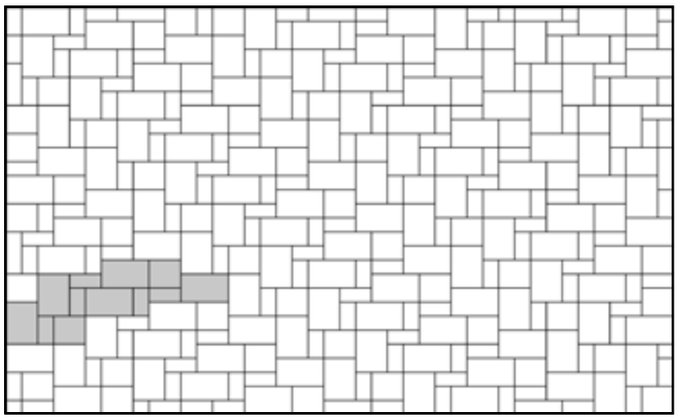
Module A	Module B	Module C
3 units 37%	5 units 42%	5 units 21%



GIGA pavers and tiles – Pattern 3

Module proportions for this pattern

Module A	Module B	Module C
5 units 62%	5 units 17%	5 units 21%



URBAN PAVERS

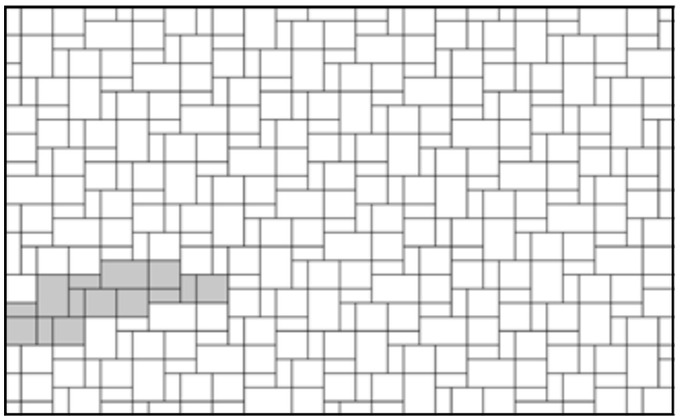
Permacon Urban Pavers

A few suggested installation patterns

GIGA pavers and tiles – Pattern 4

Module proportions for this pattern

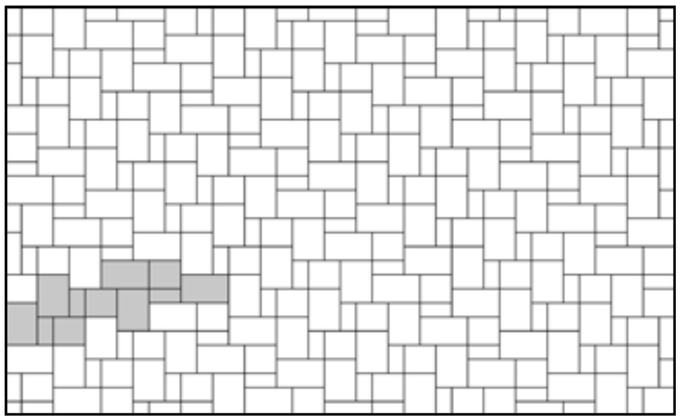
Module A	Module B	Module C
2 units 25%	6 units 50%	6 units 25%



GIGA pavers and tiles – Pattern 5

Module proportions for this pattern

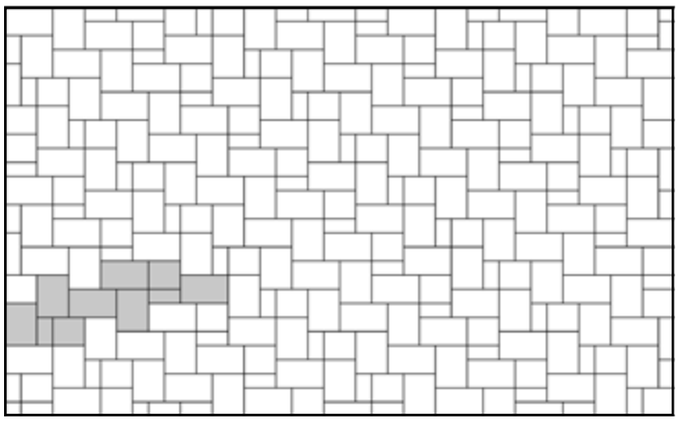
Module A	Module B	Module C
5 units 62 %	3 units 25 %	3 units 13 %



GIGA pavers and tiles – Pattern 6

Module proportions for this pattern

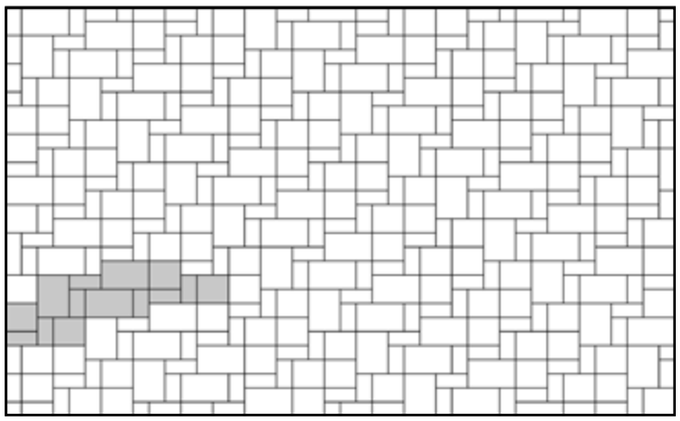
Module A	Module B	Module C
6 units 75%	2 units 17%	2 units 8%



GIGA pavers and tiles – Pattern 7

Module proportions for this pattern

Module A	Module B	Module C
3 units 38 %	4 units 33 %	7 units 29 %



URBAN PAVERS

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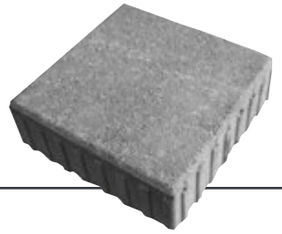


PRODUCT CHARACTERISTICS

BOULEVARD TLI 100 Paver (D_n: 100 mm)*

On the market for several years, the two models in this family of pavers have made it possible to measure the true meaning of "peripheral interlocking" by tracking their performance in service. Easy to produce in the plant, these pavers are at the source of the new family of oversized Boulevard TLI pavers.

System

These two pavers were developed to confer greater stability in service to traditional non-interlocking Boulevard 300 pavers of the same sizes, without compromising the contemporary aesthetic quality valued by designers. The four-sided interlocking system, along with the number of grooves and joint size, ensures the optimal transfer of vertical and horizontal loads.

Advantages

- Increase durability and abrasion resistance thanks to granite-based concrete
- Increase the vertical and horizontal stability of the surface
- Facilitate installation and maintenance
- Reduce the erosion of jointing sand
- Allow the strip and herringbone installation of module A.

Applications

For all types of urban traffic, based on the structure's projected traffic loads in service and the module used (for specifications relating to the module's flexural capacity based on projected traffic, see the table of potential applications recommended by Permacon on page 17 and 18).

IMPORTANT

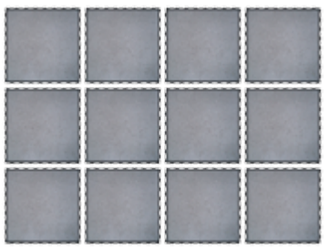
See page 39 for the note relating to rigid concrete retaining elements to be avoided when designing road pavement.

Dimensions

Boulevard TLI 100_{mm} Pavers			
Module	**Nominal dimensions**	**Paver area A (m^2)**	**Min. flexural capacity C_{flex} (kN)**
A	100 mm x 150 mm x 300 mm (4" x 5 7/8" x 11 13/16")	0.045	15.0
B	100 mm x 300 mm x 300 mm (4" x 11 13/16" x 11 13/16")	0.090	30.0

Typical row

Module A



Module B

Pallet

Modules A and B:
69.8 $ft.^2$/pallet and 11.6 $ft.^2$/row

*T_n = nominal thickness

URBAN PAVERS

Permacon Urban Pavers

PRODUCT CHARACTERISTICS

BOULEVARD TLI 100_{mm} CRESCENDO^{300} and BOULEVARD TLI 100_{mm} (300 mm x 700 mm) Interlocking Urban Pavers

PRODUCTS	PARAMETERS*				
	Modules (mm)	E_n	A	Weight	C_{flex}
TLI 100_{mm} CRESCENDO^{300}	A (100 x 300 x 400) B (100 x 300 x 500) C (100 x 300 x 600)	100 mm 100 mm 100 mm	0.12 m^2 0.15 m^2 0.18 m^2	27.6 kg 34.5 kg 41.4 kg	22.5 kN 18.0 kN 15.0 kN
TLI 100_{mm} (300 mm x 700 mm)	D (100 x 300 x 700)	100 mm	0.21 m^2	48.3 kg	12.9 kN

The new family of Boulevard TLI 100_{mm} multi-length pavers consists of high-end products including large dimensional modules. Its smooth surface finish along with slight colour variations and small bevels (3 mm x 3 mm) ensure peerless good looks. These pavers are also available in a Granitech and buffed finish in most urban colours.

System

The basic element of the Boulevard TLI 100_{mm} family of multi-length pavers is the interlocking TLI 100_{mm} Crescendo^{300} paver. With their 100 mm thickness and 300 mm width, these multi-length units make it possible to offer interlocking multi-length elements measuring up to 600 mm while maximizing the pavement's stability in service. This family of pavers consists of three sizes, A, B and C in lengths of 400 mm, 500 mm and 600 mm respectively. Not sold separately, these different paver sizes come in proportions, per pallet, representing 27% (A), 33% (B) and 40% (C) of the projected paved area.

Furthermore, the TLI 100_{mm} (300 mm x 700 mm) module, complementing the basic line of multi-length pavers (sold separately), adds to the design flexibility provided by this family of pavers. Combining 30% of this module with 70% of multi-length paves results in the creation of a surface area with the exceptional look of large paved structures. Used on its own, this complementary paver confirms the outstanding potential of large dimensional pavers for producing exceptional contemporary pavements.

Advantages

- Considerable installation speed and ease given the large size of the elements
- Long term Giga stability provided by interlocking grooves
- Possibility of using the complementary paver to produce innovative new layouts
- Significant reduction in the amount of joint filler required for 100 mm pavers, minimizing installation costs.

URBAN PAVERS

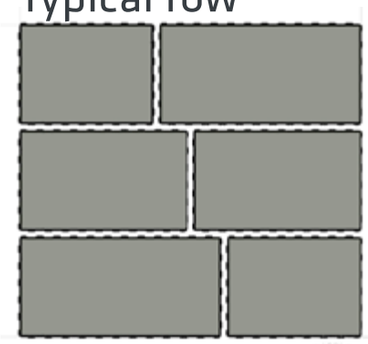
Permacon Urban Pavers

Layout

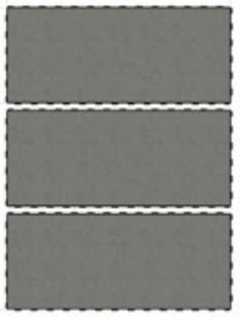
TLI 100$_{mm}$ Crescendo^{300} pavers and the complementary TLI 100$_{mm}$ (300 mm x 700 mm) module are designed for strip installation only, using a mason's line. The transversal joints of adjacent strips must be staggered by at least 100 mm or two groove widths. For additional construction details, see page 19 for this guide's paragraph on the installation of multi-length pavers.

TLI 100$_{mm}$ Crescendo^{300} multi-length pavers are designed to be installed in strips, with transversal joints stag-gered by at least 100 mm.

Typical row

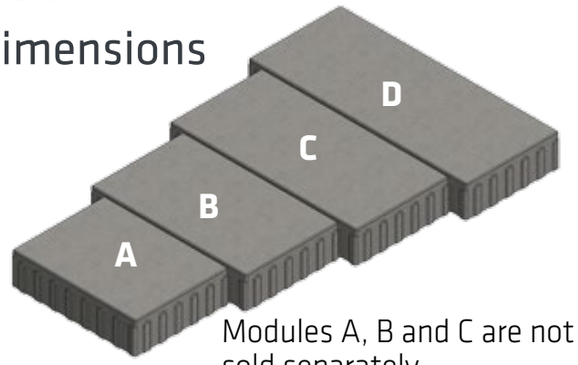


TLI 100$_{mm}$ Crescendo^{300}



TLI 100$_{mm}$ (300 mm x 700 mm)

Dimensions



Modules A, B and C are not sold separately

A : 100 mm x 300 mm x 400 mm (4" x 11 13/16" x 15 3/4")

B : 100 mm x 300 mm x 500 mm (4" x 11 13/16" x 19 11/16")

C : 100 mm x 300 mm x 600 mm (4" x 11 13/16" x 23 5/8")

D : 100 mm x 300 mm x 700 mm (4" x 11 13/16" x 27 9/16")

Pallet

Cassara multi-length pavers
77.52 ft.i^2 per pallet
9.69 ft.^{2} per row

Cassara Large Rectangle paver
54.24 ft.^{2} per pallet
6.78 ft.^{2} per row

Recommandations

When installing pavers (particularly modules C and D), the use of suction equipment is strongly recommended, given the significant weight of these elements.

Demonstration of the installation of Cassara pavers.

*D_n = nominal thickness, A= area, C_{flex} = Flexural capacity

URBAN PAVERS

Permacon Urban Pavers

PRODUCT CHARACTERISTICS

BOULEVARD TLI 90_{mm} CRESCENDO^{320} Paver (D_n: 90 mm, A: 0.141 m^2, C_{flex}: 18.0 kN)*

NOTE : Two accessory elements are available: Boulevard TLI 90_{mm}, modules A and B

The Boulevard TLI 90_{mm} Crescendo^{320} is the second multi-length interlocking urban paver offered by Permacon since the Boulevard TLI 200_{mm} Crescendo^{300}. Because of its 90 mm thickness and a common width of 320 mm, this model can be offered in lengths of up to 520 mm while maximizing the pavers' stability in service. Installed in strips, these pavers lend themselves to the construction of aesthetic struc-tures.

System

The line of Boulevard TLI 90_{mm} Crescendo^{320} pavers consists of 5 basic sizes (A-B-C-D-E), combined on each row of a pallet. Available in lengths ranging from 240 mm to 440 mm, these pavers have a common width of 320 mm. Further increasing design possibilities, this line also features two additional models available in the same colours and surface finishes, i.e. the Boulevard TLI 90_{mm}, modules A (160 mm x 240 mm) and B (320 mm x 520 mm). Sold separately, these two complementary elements can be combined with the 5 basic sizes (which are not sold sepa-rately), to create a more prestigious paved area. The two complementary elements can also be used on their own. Peripheral interlocking grooves maximize the stability of the structure in service. These pavers are designed for strip installation only. When installing, it is necessary to select appropriate module lengths in order to stagger transversal joints by at least 80 mm, representing 2 groove widths. (See page 19 for additional details relating to the installation of Permacon's TLI multi-length pavers).

Advantages

- Considerable installation speed and ease given the large size of the elements
- Long term Giga stability provided by interlocking grooves
- Possibility of inserting permanent coloured lines to mark the pavement, using module A (see page 59 for installation patterns)
- Possibility of using the 2 complementary pavers to produce innovative new patterns (see page 80 for installation patterns)
- Significant reduction in the amount of joint filler required for 90 mm pavers, minimizing installation costs

*D_n = nominal thickness, A = area, Cflex = flexural capacity (see page 15 for definition)

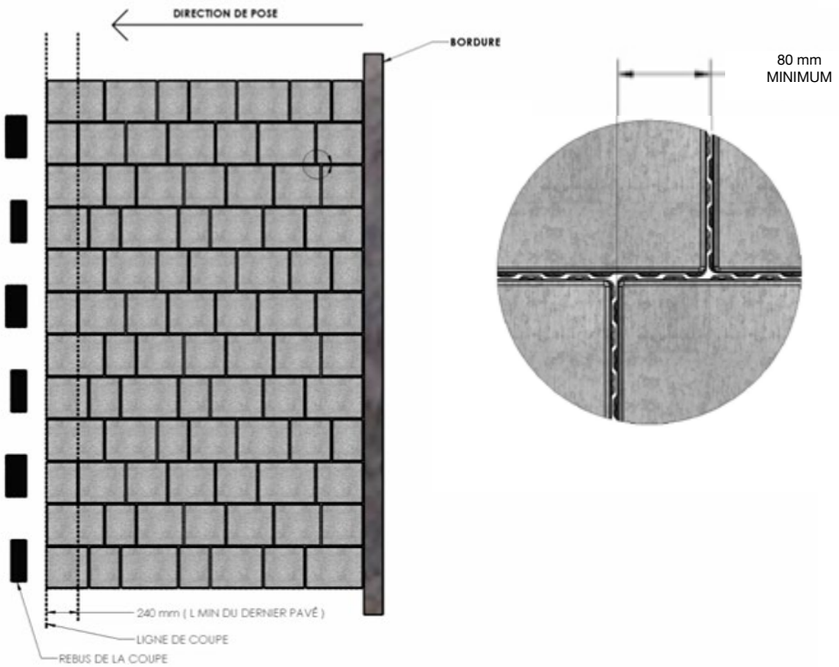
URBAN PAVERS

Permacon Urban Pavers

Applications

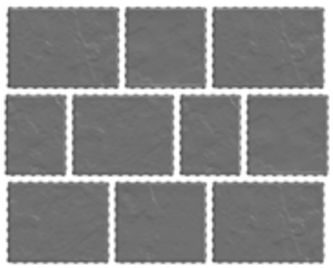
For all types of urban traffic, based on the structure's projected traffic loads in service and the module used (for specifications relating to the module's flexural capacity based on projected traffic, see the table of potential applications recommended by Permacon on pages 16 and 17).

Layout (see page 59 for other suggested patterns)

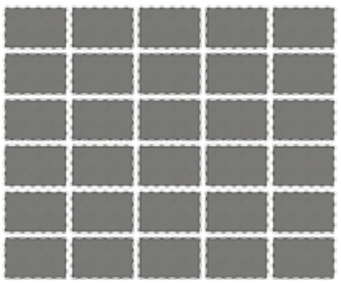


TLI 90$_{mm}$ Crescendo^{320} pavers are designed for strip installation with transversal joints staggered from adjacent pavers by 80 mm to optimize the pavement's performance and aesthetics.

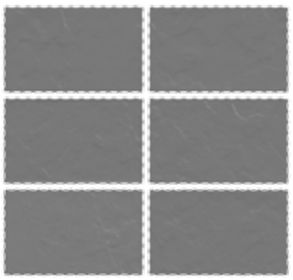
Typical row



TLI 90$_{mm}$ Crescendo^{320}



TLI 90$_{mm}$ module A
(160 mm x 240 mm)



TLI 90$_{mm}$ module B
(320 mm x 520 mm)

Sizes A to E of Boulevard TLI 90$_{mm}$ Crescendo^{320} pavers are not sold separately
Sizes A and B of Boulevard TLI 90$_{mm}$ pavers are sold separately

URBAN PAVERS

Permacon Urban Pavers

Dimensions

Boulevard TLI 90$_{mm}$ Crescendo^{320} Paver		
Module	**Nominal dimensions**	**Flexural capacity C_{flex} (kN)**
Boulevard TLI 90$_{mm}$ Crescendo^{320}		
A	90 mm x 320 mm x 240 mm 3 1/2" x 12 5/8" x 9 1/2"	18.0 (Area A:0.141 m^2)
B	90 mm x 320 mm x 320 mm 3 1/2" x 12 5/8" x 12 5/8"	
C	90 mm x 320 mm x 360 mm 3 1/2" x 12 5/8" x 14 3/16"	
D	90 mm x 320 mm x 400 mm 3 1/2" x 12 5/8" x 15 3/4"	
E	90 mm x 320 mm x 440 mm 3 1/2" x 12 5/8" x 17 5/16"	
Boulevard TLI 90$_{mm}$ (accessories)		
A	90 mm x 160 mm x 240 mm (3 1/2'' x 6 5/16'' x 9 1/2'')	16.2 (Area A:0.038 m^2)
B	90 mm x 320 mm x 520 mm (3 1/2'' x 12 5/8'' x 20 1/2'')	15.0 (Area A:0.166 m^2)

Pallet

Boulevard TLI 90$_{mm}$ Crescendo^{320}
86.8 ft.^{2} per pallet
12.4 ft.^{2} per row

Boulevard TLI 90$_{mm}$, module A
86.8 ft.^{2} per pallet
12.4 ft.^{2} per row

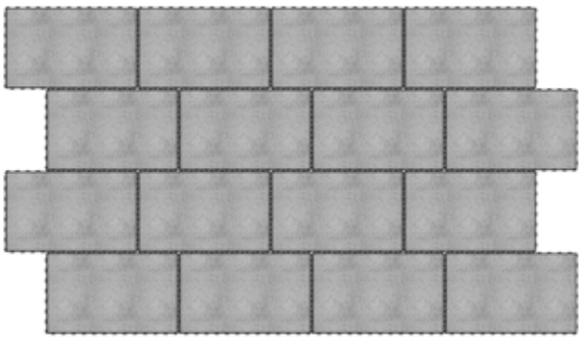
Boulevard TLI 90$_{mm}$, module B
86.0 ft.^{2} per pallet
10.75 ft.^{2} per row

URBAN PAVERS

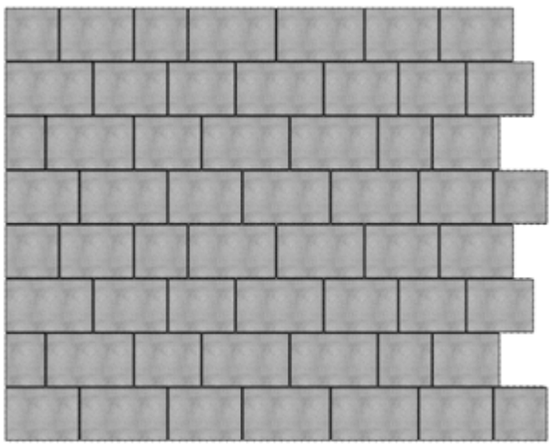
Permacon Urban Pavers

Other suggested installation patterns

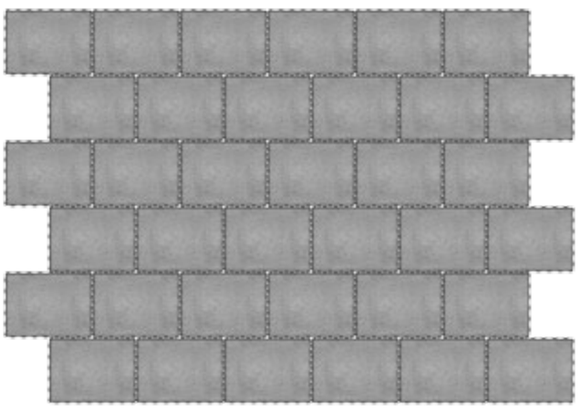
TLI 90$_{mm}$ paver, module B
(installed alone)



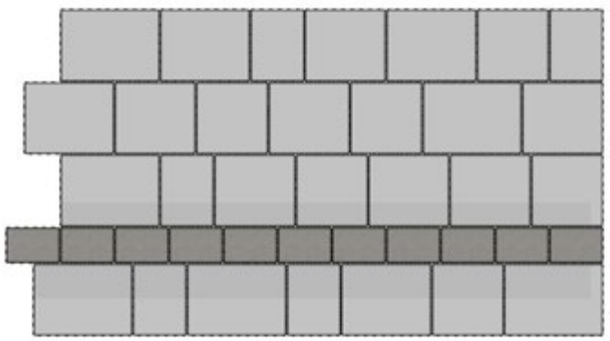
50% TLI 90$_{mm}$ module B pavers combined with
50% BOULEVARD TLI 90$_{mm}$ CRESCENDO^{320} pavers



Note: Module B cannot be installed with a mid-length transversal joint (staggering by half a paver length is prevented by the peripheral groove. In the example presented above, the paver has been staggered by 160 mm to optimize the aesthetic quality of the construction).



TLI 90$_{mm}$ paver, module B (installed alone)



Lines (TLI 90mm, module A) inserted
in pavement of BOULEVARD TLI 90$_{mm}$
CRESCENDO^{320} pavers

URBAN PAVERS

Permacon Urban Pavers

PRODUCT CHARACTERISTICS

BOULEVARD TLI 80^{mm} Paver (D_n: 80 mm, A: 0.029 m^2, C_{flex}: 9.6 kN)*

The smallest member of the family of Boulevard TLI pavers, this product was designed for the mechanized paving of large residential areas as quickly and economically as possible while ensuring considerable stability of the structure in service.

System

TLI 80$_{mm}$ pavers were developed for fast mechanized installation, particularly where very large surfaces are to be paved. Their outstanding peripheral interlocking quality ensures considerable stability in service while their specific dimensions have been optimized to maximize their cost/performance ratio. These are the most economical Boulevard TLI pavers.

Advantages

Highly valued in the industrial and commercial sectors for paving large, high-traffic areas at the best possible price, these pavers are available in a variety of finishes and colours, making them ideal for residential applications and manual installation. Cost savings, installation speed, and stability in service rank among their key advantages.

Applications

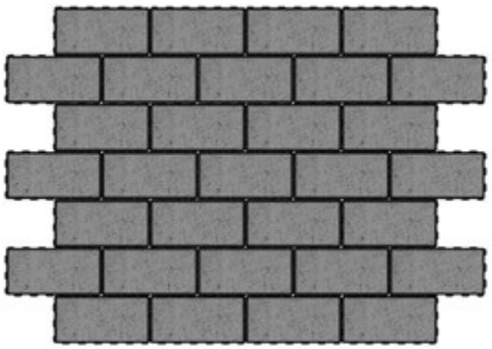
For all types of urban traffic, based on the structure's projected traffic loads in service and the module used (for specifications relating to the module's flexural capacity based on projected traffic, see the table of potential applications recommended by Permacon on page 17 and 18). Paved industrial areas, parking lots, sidewalks and parks, public squares and driveways are some of the potential applications of these economical pavers.

*D_n = nominal thickness, A = area, Cflex = flexural capacity (see page 15 for definition)

URBAN PAVERS

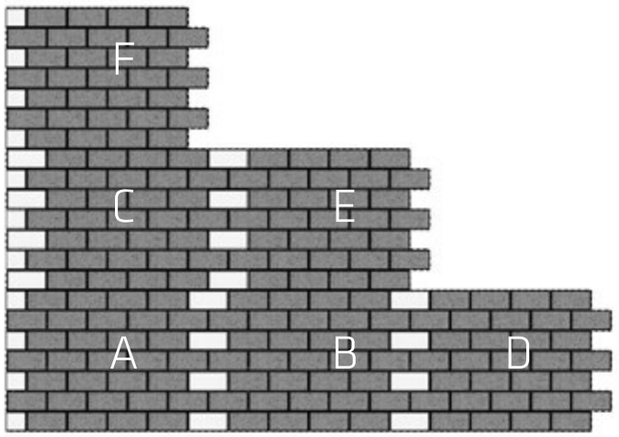
Permacon Urban Pavers

Typical row



Dimensions

1 size available
Nominal dimensions:
80 mm x 120 mm x 240 mm
(3 1/8" x 4 3/4" x 9 1/2")



Mechanized installation

Pallet

115.3 ft.^{2} per pallet
9.61 ft.^{2} per row

URBAN PAVERS

Permacon Urban Pavers

PRODUCT CHARACTERISTICS

BOULEVARD 300 Paver (D_n: 100 mm)*

The most popular Boulevard paver, this model allows the production of prestigious public areas where the wide range of colours and finishes allow designers to give free rein to their imagination.

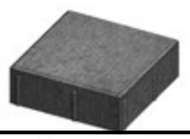
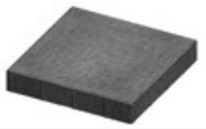
System

The 6 paver sizes available (pavers standardized to 300 mm) make it possible to design projects distinguished by their beauty and originality.

Advantages

Considerable design flexibility (sizes, finishes and colours), along with peerless durability in service.

Dimensions, flexural capacity and pallet

Modules	Nominal dimensions (thickness x width x length)	Minimal flexural capacity, C_{flex} (kN)	Content: ft.²/pallet (ft.2/row)
A 	100 mm x 100 mm x 450 mm 4" x 4" x 17 3/4"	6.7 (Area A:0.045 m²)	85.3 (10.7)
B 	100 mm x 150 mm x 450 mm 4" x 5 7/8" x 17 3/4"	10.0 (Area A:0.068 m²)	81.3 (10.2)
C 	100 mm x 150 mm x 300 mm 4" x 5 7/8" x 11 13/16"	15.0 (Area A:0.045 m²)	69.8 (11.6)
D 	100 mm x 300 mm x 300 mm 4" x 11 13/16" x 11 13/16"	30,0 (Area A:0.090 m²)	69.8 (11.6)
E 	100 mm x 300 mm x 600 mm 4" x 11 13/16" x 23 5/8"	15.0 (Area A:0.180 m²)	69,8 (11.6)
F 	100 mm x 600 mm x 600 mm 4" x 23 5/8" x 23 5/8"	30.0 (Area A:0.360 m²)	46.5 (7.8)

*D_n = nominal thickness

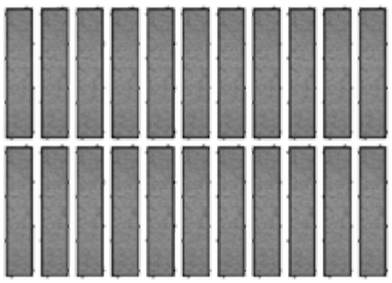
URBAN PAVERS

Permacon Urban Pavers

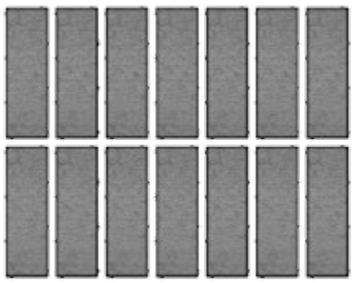
Applications

For all types of urban traffic, based on the structure's projected traffic loads in service and the module used (for specifications relating to the module's flexural capacity based on projected traffic, see the table of potential applications recommended by Permacon on page 17 and 18). Proposed products are grouped based on their physical and mechanical characteristics in order to determine their specific fields of application as well as their potential performance in service (see table on page 35).

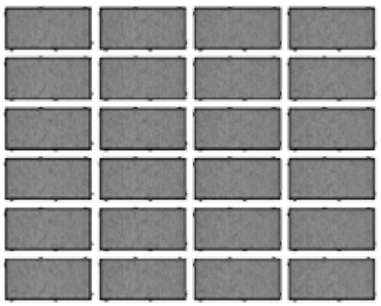
Typical rows



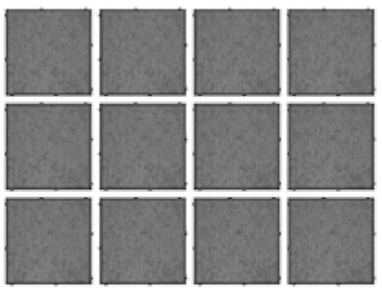
Module A (100 mm x 450 mm)



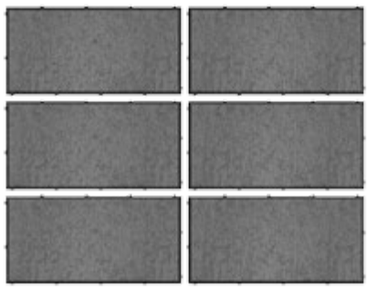
Module B (150 mm x 450 mm)



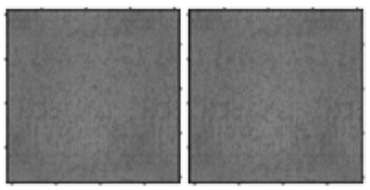
Module C (150 mm x 300 mm)



Module D (300 mm x 300 mm)



Module E (300 mm x 600 mm)



Module F (600 mm x 600 mm)

IMPORTANT

See page 39 for the note relating to rigid concrete retaining elements to be avoided when designing road pavement.

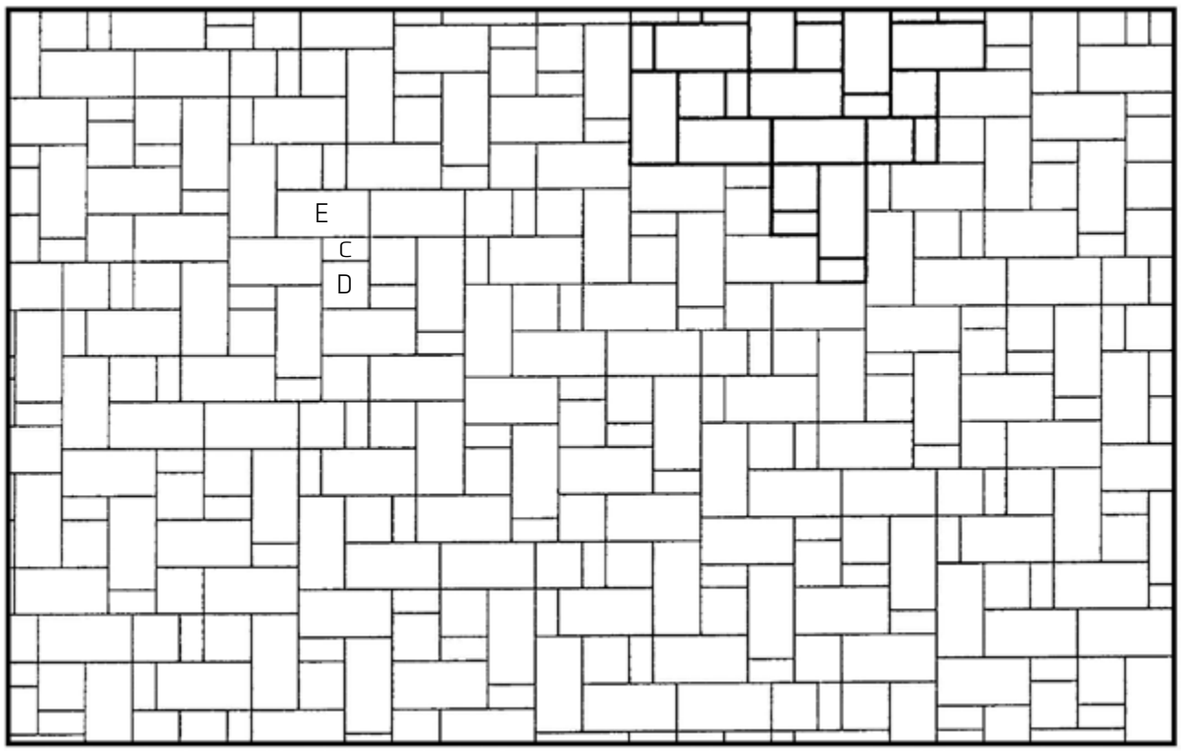
URBAN PAVERS

Permacon Urban Pavers

A few suggested installation patterns

Pattern 1

(Module proportions: E: 67%, D: 21%, C: 12%)



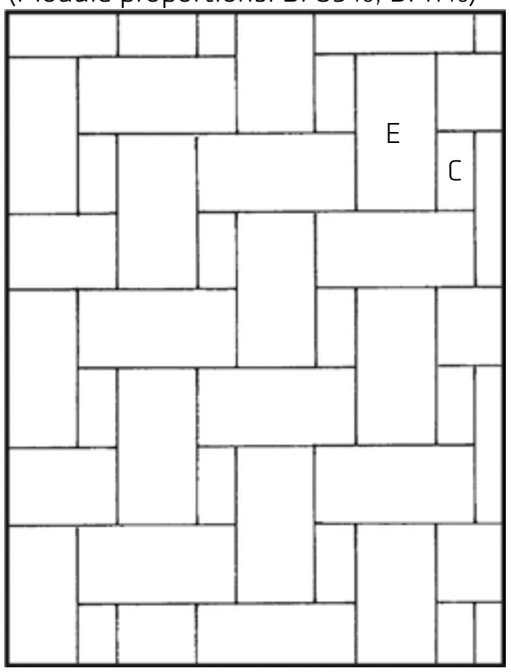
URBAN PAVERS

Permacon Urban Pavers

A few suggested installation patterns (cont'd)

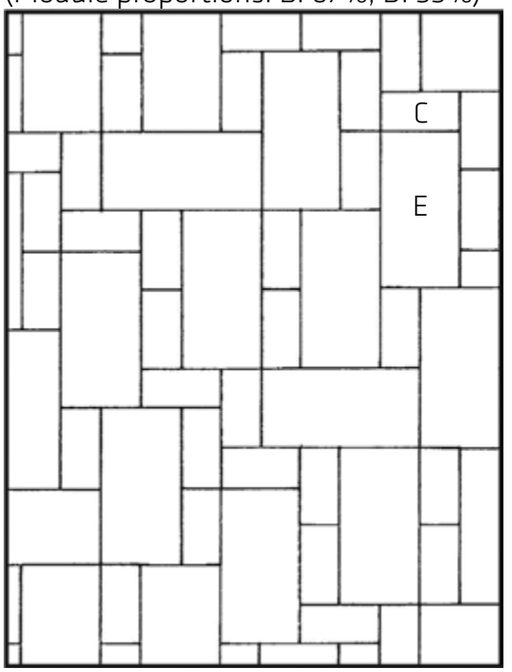
Pattern 2

(Module proportions: B: 89%, D: 11%)



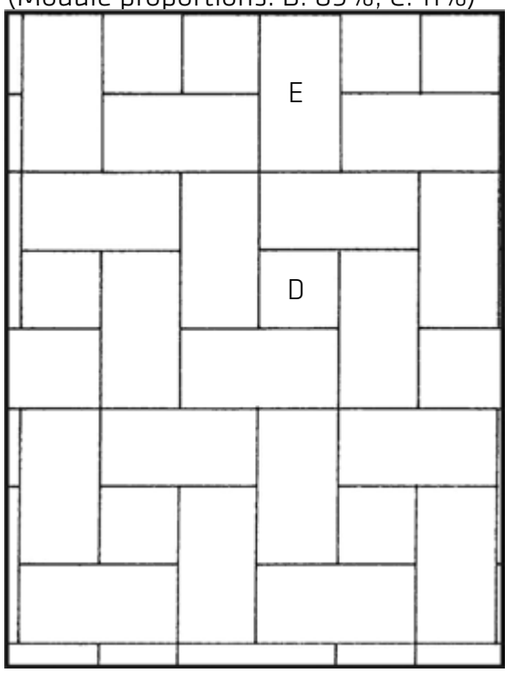
Pattern 3

(Module proportions: B: 67%, D: 33%)



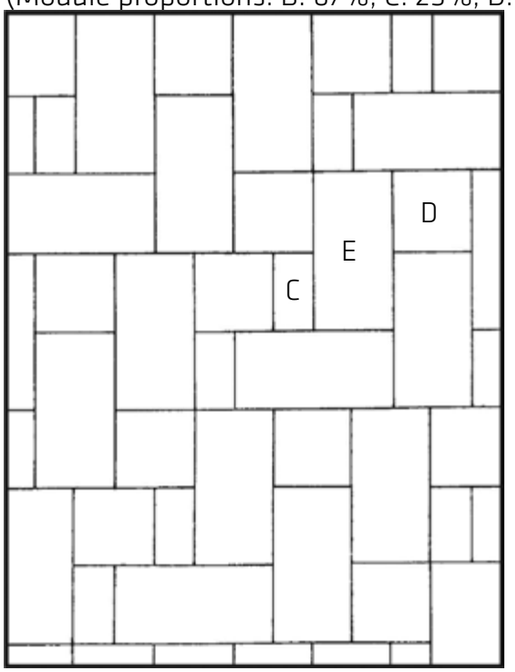
Pattern 4

(Module proportions: B: 89%, C: 11%)



Pattern 5

(Module proportions: B: 67%, C: 25%, D: 8%)



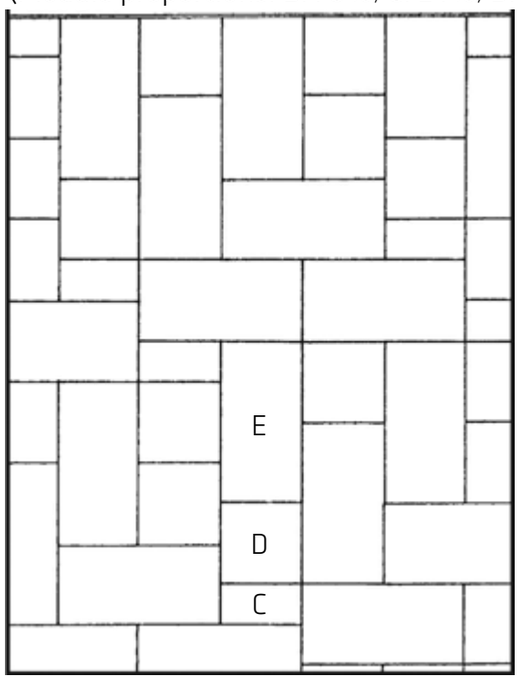
URBAN PAVERS

Permacon Urban Pavers

A few suggested installation patterns (cont'd)

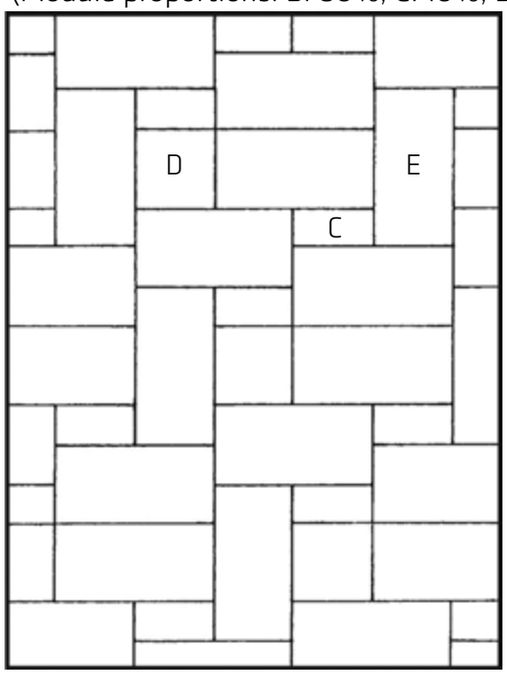
Pattern 6

(Module proportions: B: 70%, C: 24%, D: 6%)



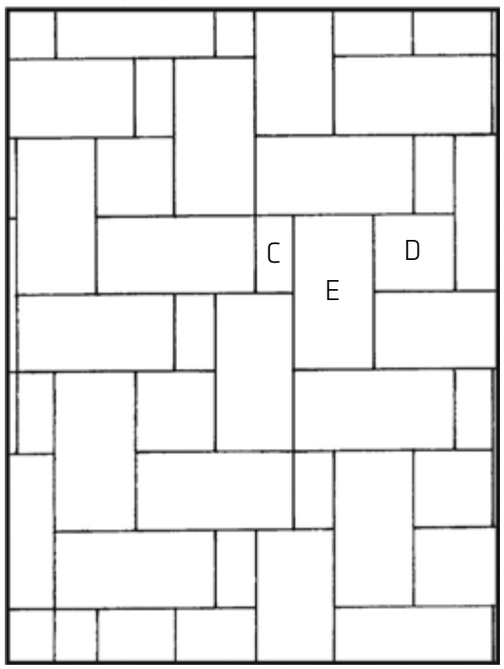
Pattern 7

(Module proportions: B: 80%, C: 10%, D: 10%)



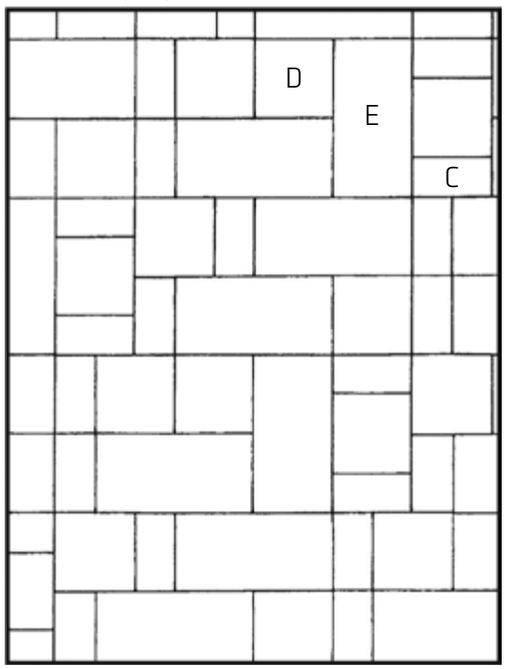
Pattern 8

(Module proportions: B: 80%, C: 10%, D: 10%)



Pattern 9

(Module proportions: B: 50%, C: 31%, D: 19%)

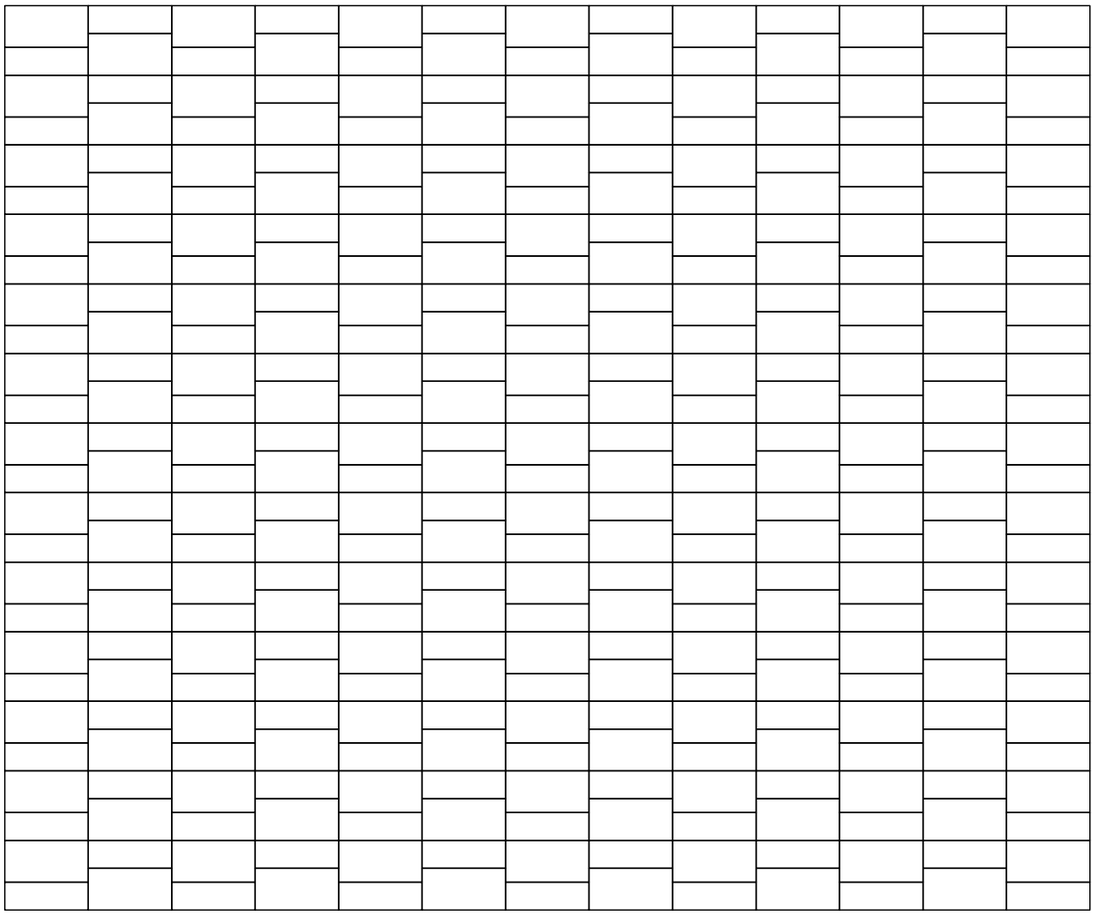


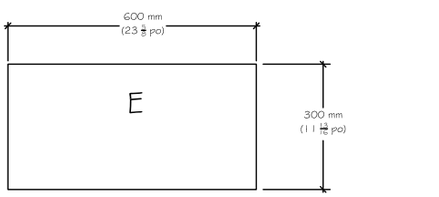
URBAN PAVERS

Permacon Urban Pavers

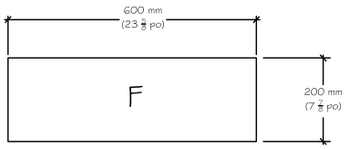
A few suggested installation patterns (cont'd)

Pattern 10





(100 mm x 200 mm x 600 mm)



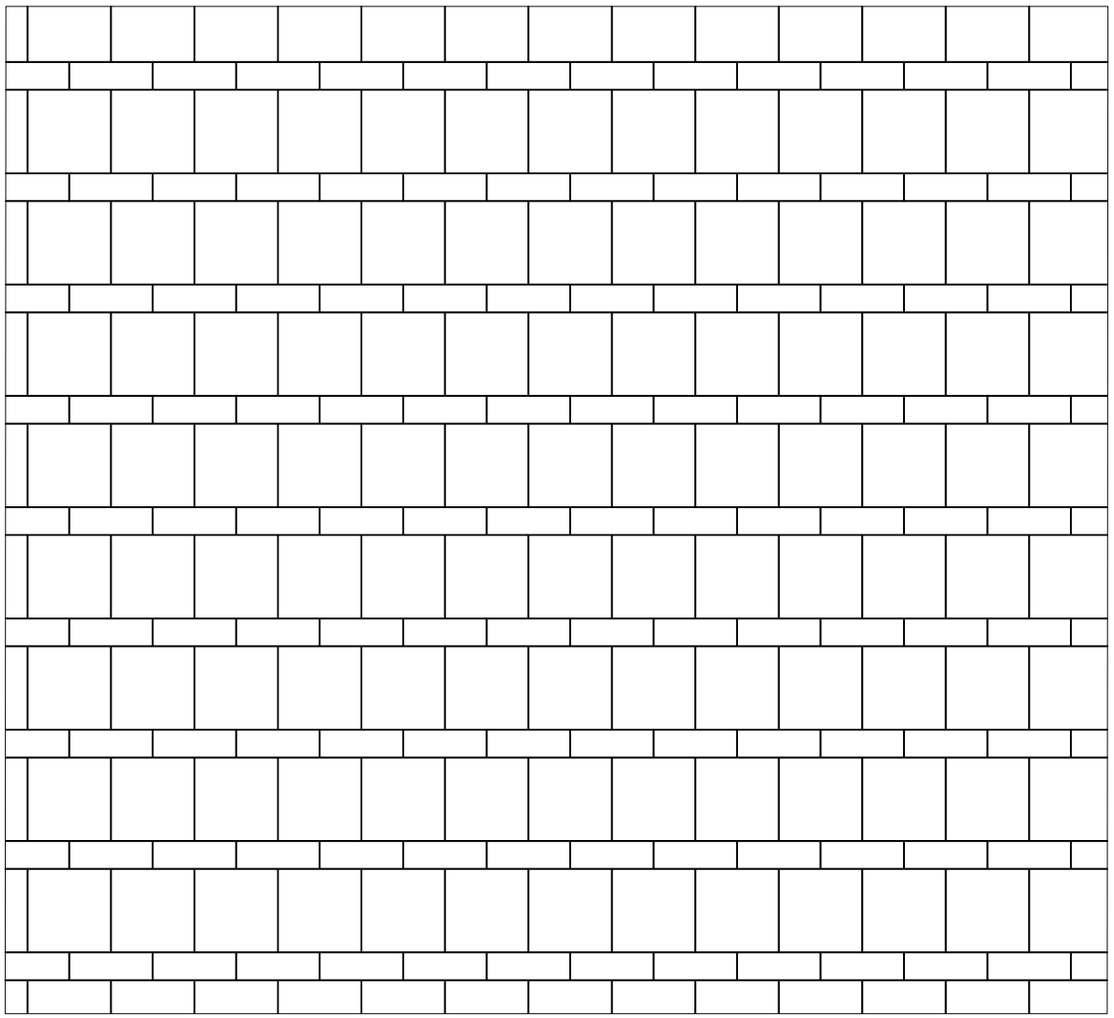
(100 mm x 300 mm x 600 mm)

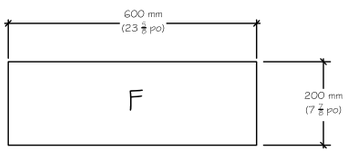
URBAN PAVERS

Permacon Urban Pavers

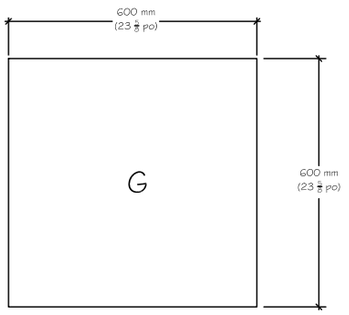
A few suggested installation patterns (cont'd)

Pattern 11





(100 mm x 200 mm x 600 mm)



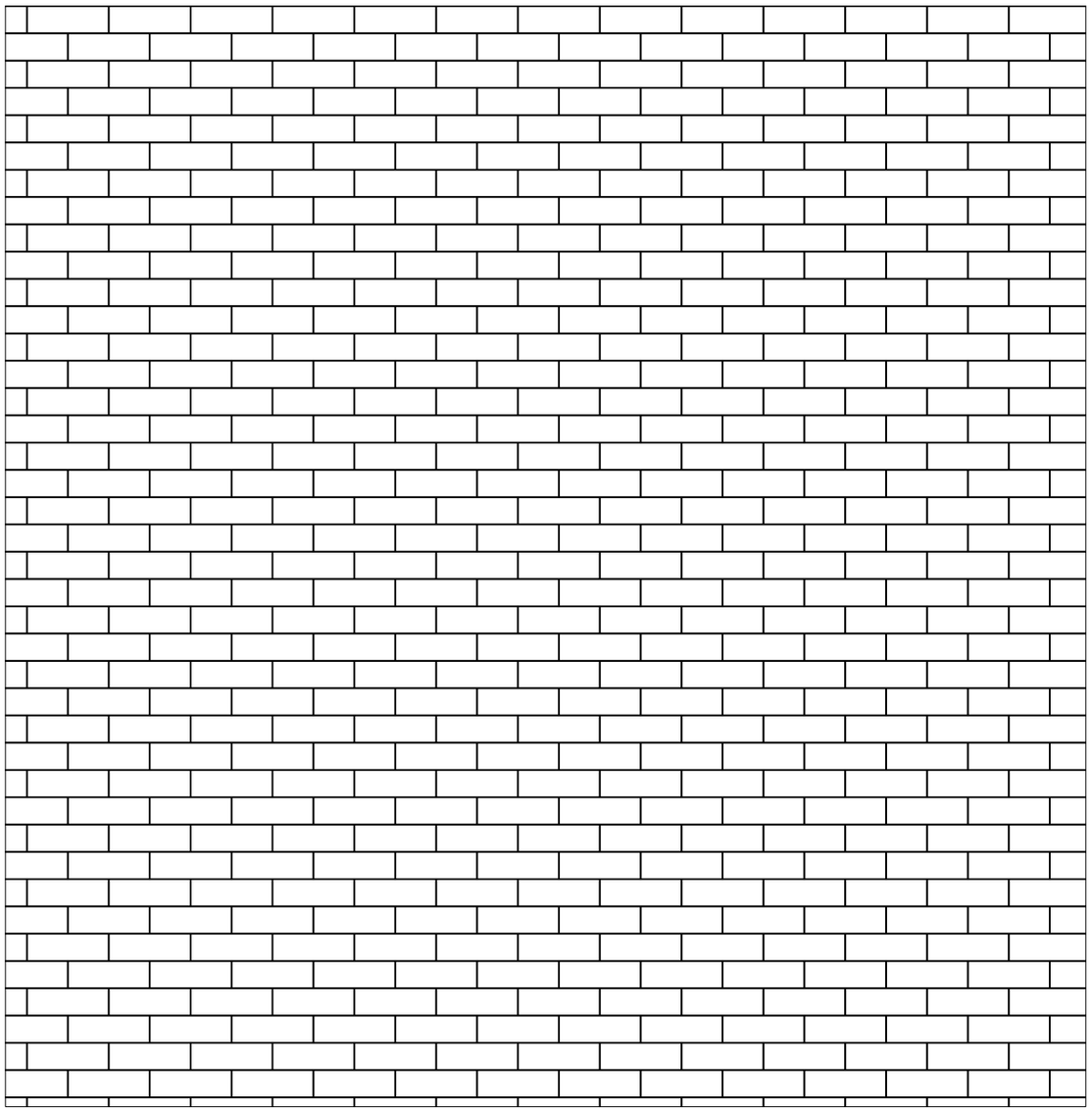
(100 mm x 600 mm x 600 mm)

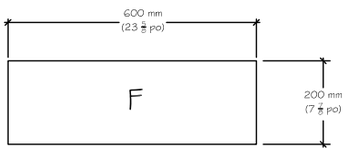
URBAN PAVERS

Permacon Urban Pavers

A few suggested installation patterns (cont'd)

Pattern 12





(100 mm x 200 mm x 600 mm)

URBAN PAVERS

Permacon Urban Pavers

PRODUCT CHARACTERISTICS

BOULEVARD 500 Paver (D_n: 100 mm, A: 0.250 m^2, C_{flex}: 30.0 kN)*

The classic design of this paver makes them ideally suited to urban off-road applications such as large paved public areas.

System

Reminiscent of slabs, these single-unit pavers' simulated surface joints create the look of multiple elements (standardized to 500 mm).

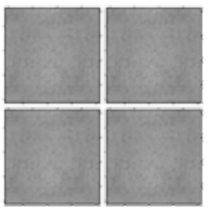
Advantages

Pavers consist of a single element, facilitating their mechanized installation and making it possible to carry out projects quickly.

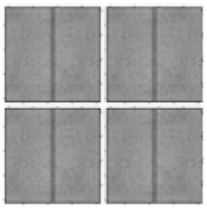
Applications

For all types of urban traffic, based on the structure's projected traffic loads in service and the module used (for specifications relating to the module's flexural capacity based on projected traffic, see the table of potential applications recommended by Permacon on page 16).

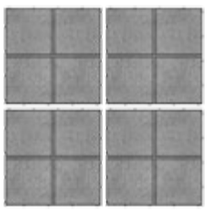
Typical row



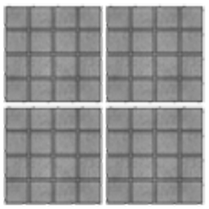
Module A



Module B

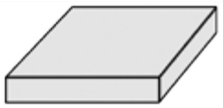
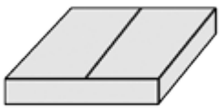
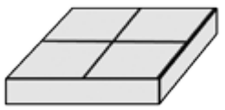
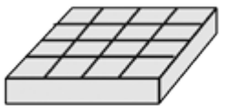


Module C



Module D

Dimensions :

Modules	Modules
A 	100 mm x 500 mm x 500 mm (4" x 19 11/16" x 19 11/16")
B 	Motif 1/2 100 mm x 500 mm x 500 mm (4" x 19 11/16" x 19 11/16")
C 	Motif 1/4 100 mm x 500 mm x 500 mm (4" x 19 11/16" x 19 11/16")
D 	Motif 1/16 100 mm x 500 mm x 500 mm (4" x 19 11/16" x 19 11/16")

Pallet

64.5 $ft.^2$ per pallet

10.75 $ft.^2$ per row

*D_n = nominal thickness, A = area, Cflex = flexural capacity (see page 15 for definition)

URBAN PAVERS

Permacon Urban Pavers

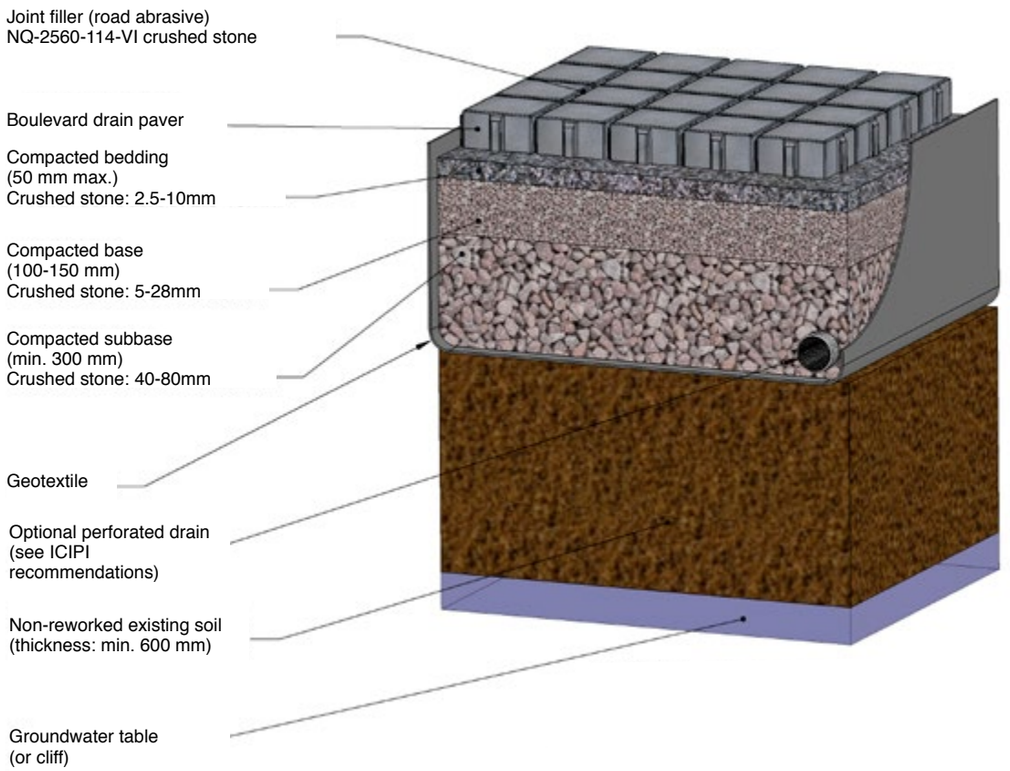
PRODUCT CHARACTERISTICS

BOULEVARD DRAIN Paver (D_n: 100 mm, A: 0.044 m^2, C_{flex}: 30.0 kN)**

NOTE :

Before designing permeable pavement, it is imperative that you refer to page 26, regarding information about best practices related to this particular type of structure

In a context of sustainable development, the management of rainwater remains a major challenge for urban planners. The Boulevard Drain paver emerges as the solution to this challenge. Not only does this product provide pavement of great stability, it allows the construction of permeable pavement, an effective solution for all large areas where the instant runoff of surface water can be a problem during heavy rains.



*D_n = nominal thickness, A = area, Cflex = flexural capacity (see page 15 for definition)

URBAN PAVERS

Permacon Urban Pavers

System

When installing Boulevard Drain pavers, a wide permeable joint is created between the elements by the addition of a permeable joint filler. This permeable joint, in turn, is set on a base course consisting of aggregate materials of different sizes, serving as a catch basin for surface runoff.

Finally, a detailed study of local history of precipitation and surface runoff in the area where the structure is to be built, is carried out by an engineer experienced in hydrology, in order to design a complementary underground drainage system to remove water that has not infiltrated the underlying soil following rainfalls, thereby ensuring the safety of users at all times. The size of this complementary system will depend on the amount of surface runoff and the permeability of the soil beneath the structure to be built.

Advantages

- Rapid elimination of surface runoff (minimum long term permeability of 2.7x10-5 m/sec.)

  (3.8 in./hr.) is possible 20 years after commissioning, in normal use and with minimum maintenance)
- Significant reduction in the volume of water quickly channelled to the storm system during a rainfall
- Reduction in the volume of water at the treatment plant
- Safer pavement during rainfalls
- Reduction in infrastructure investment costs when starting urban development projects
- Foster sustainable development (attribution of LEED points)
- Paving technique, which has already proven its effectiveness in the United States, Canada and Europe
- Strong road surface with the advantages of a flexible pavement adapted to winter conditions

URBAN PAVERS

Permacon Urban Pavers

Applications

Boulevard Drain pavers allow the construction of off-road pavement with narrow joints (9% of the total paved surface) or wider ones (22% of the total paved surface) depending on the pavement's required permeability or projected applications (see photos).

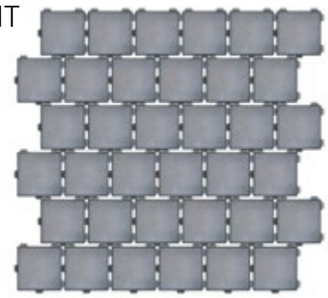
For all large off-road areas, based on the structure's projected traffic loads in service and the module used (for specifications relating to the module's flexural capacity based on projected traffic, see the table of potential applications recommended by Permacon on page 17 and 18).

Layout

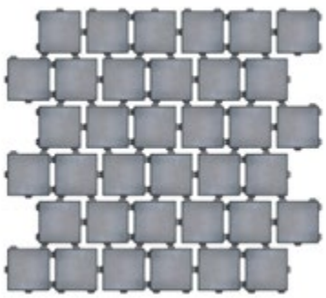
NARROW JOINT
CHESSBOARD

WIDE JOINT
CHESSBOARD

NARROW JOINT
STAGGERED
(50%-50%)



WIDE JOINT
STAGGERED
(35%-65%)

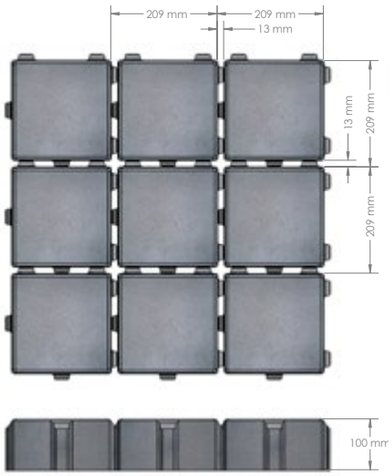


URBAN PAVERS

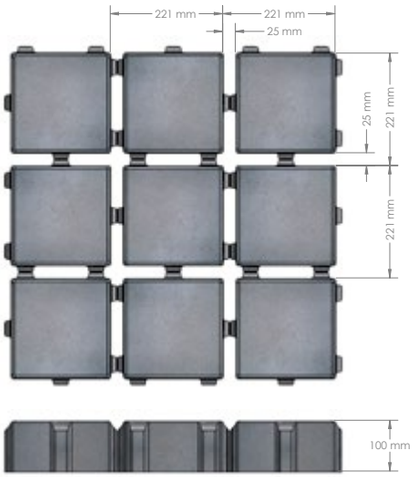
Permacon Urban Pavers

Layout (cont'd)

NARROW JOINT



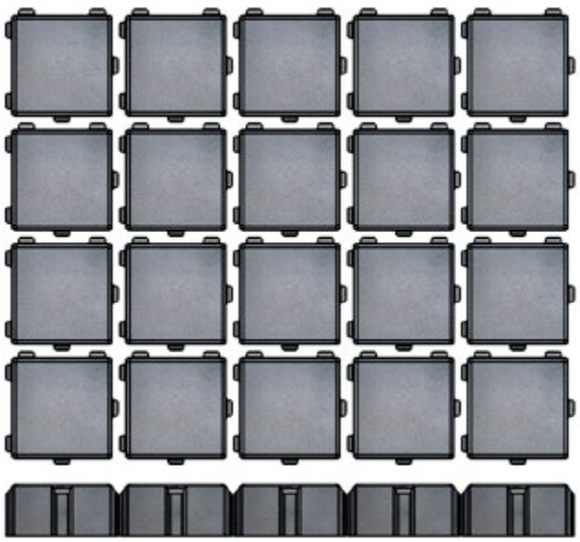
WIDE JOINT



Dimensions

BOULEVARD DRAIN PAVER (100 mm THICKNESS)			
TYPE OF JOINT (% of the surface covered)	**NOMINAL DIMENSIONS**	**Width of the joint**	**Paver coverage/m² (pavers/ft.²)**
Narrow joint (9 %)	209 mm x 209 mm 8 1/4'' x 8 1/4''	13 mm ½ in.	22.9 (2.13)
Wide joint (22 %)	221 mm x 221 mm 8 11/16'' x 8 11/16''	25 mm 1 in.	20.5 (1.90)

Typical row



Construction of permeable pavement using Boulevard Drain pavers in a chessboard layout with narrow joints.

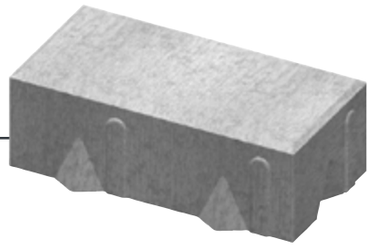
PALLET

56.4 ft.^{2} per pallet

9.4 ft.^{2} per row

URBAN PAVERS

Permacon Urban Pavers



PRODUCT CHARACTERISTICS

BOULEVARD 3DI Paver (D_n: 100 mm, A: 0.045 m^2, C_{flex}: 15.0 kN)*

Boulevard 3DI pavers combine the outstanding durability of their elements with remarkable overall stability (three dimensional interlocking system).

System

Thanks to their semi-pyramidal (male-female) interlocking system, Boulevard 3DI pavers deliver unmatched stability in all directions, both horizontally and vertically.

Advantages

Interlocking urban road pavers providing outstanding stability. Given their smaller size, they also lend themselves to manual strip installation.

NOTE : These pavers cannot be installed in a herringbone pattern as their specific interlocking system prevents this option.

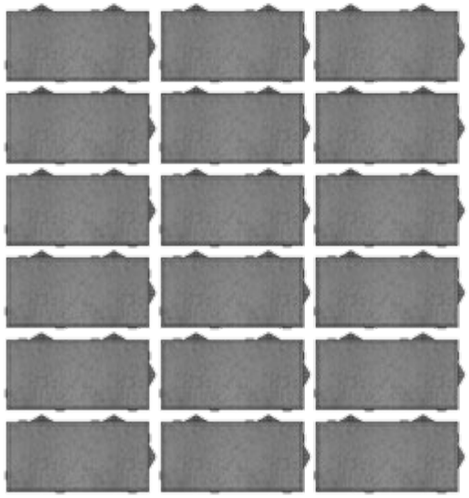
Applications

For all types of urban traffic, based on the structure's projected traffic loads in service and the module used (for specifications relating to the module's flexural capacity based on projected traffic, see the table of potential applications recommended by Permacon on page 17, 18 and 35).

Layout

Strip installation is the general rule.

Typical row



Dimensions :

(nominal dimensions)
100 mm x 150 mm x 300 mm
(4" x 5 7/8" x 11 13/16")

Pallet

69.8 $ft.^2$ per pallet
8.7 $ft.^2$ per row

*D_n = nominal thickness, A = area, Cflex = flexural capacity (see page 15 for definition)

URBAN PAVERS

Permacon Urban Pavers

PRODUCT CHARACTERISTICS

BONSECOURS 3DI Paver (D_n: 100 mm, A: 0,031 m^2, C_{flex}: 19.1 kN)*

(Three dimensional interlocking system)
The look of antique pavers with high interlocking performance.

System

With its specific mechanized interlocking system, this product provides effective blocking of elements in 2 directions, i.e. both horizontally and vertically.

Advantages

These pavers confer considerable stability to structures in service.

Applications

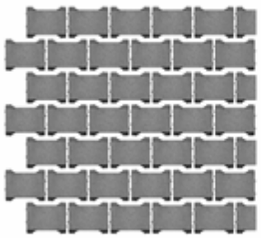
For all types of urban traffic, based on the structure's projected traffic loads in service and the module used (for specifications relating to the module's flexural capacity based on projected traffic, see the table of potential applications recommended by Permacon on page 17, 18 and 35).

Layout

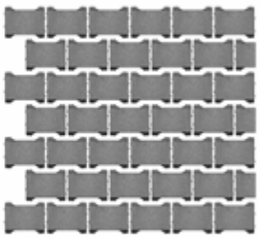
These pavers are designed for strip installation only, using a mason's line.

Typical row

Rang no. 1



Rang no. 2



A pallet consists of 6 rows including
3 rows of No. 1 and 3 of No. 2.
(pavers not sold separately)

Pallet

80.0 $ft.^2$ per pallet
13.3 $ft.^2$ per row

Dimensions :

(Nominal dimensions)
100 mm x 140 mm x 220 mm
(4" x 5" 1/2 x 8 11/16")

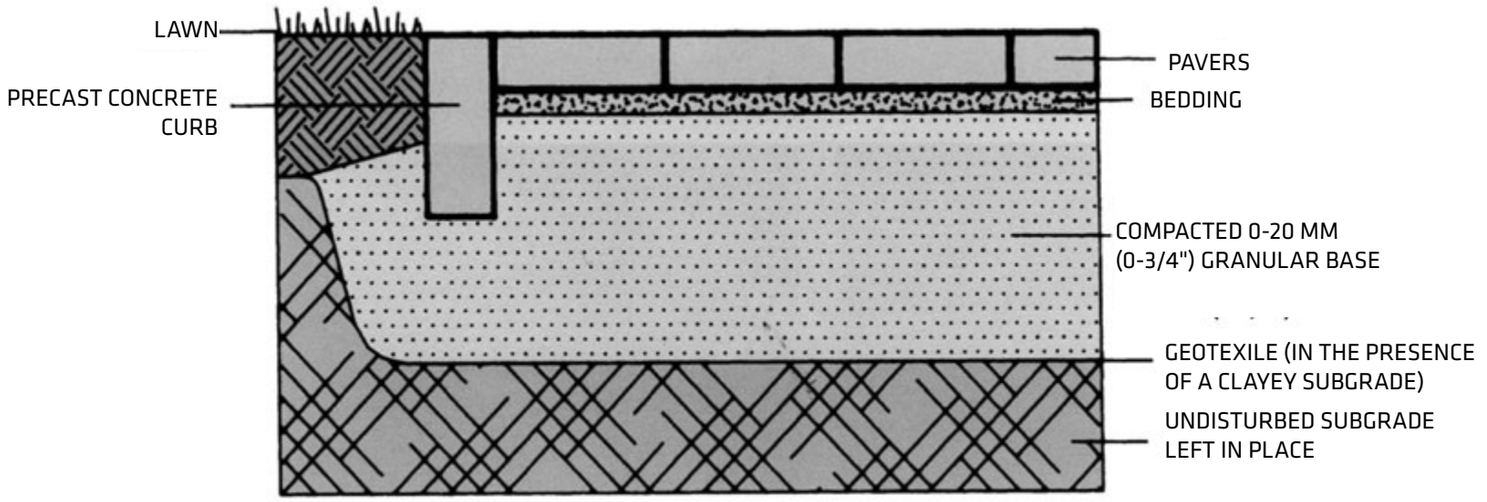
*D_n = nominal thickness, A = area, Cflex = flexural capacity (see page 15 for definition)

URBAN PAVERS

Permacon Urban Pavers

INSTALLATION OF CONCRETE PAVERS

Concrete pavers must be installed with great care to ensure the required aesthetics and long-term performance of the structure. To this end, it is necessary to apply the industry's best practices and comply with the manufacturer's recommendations.



URBAN PAVERS
Paver Installation Guide

(Summary of the key installation practices recommended* by Permacon)

1.IDENTIFICATION OF THE SITE

- Build the structure (**1**) in keeping with the dimensions and levels stipulated in the plans and specifications (Note: obstacles to be avoided: gas and electrical power lines, pipes, roots) (**2**).
- Determine the minimum required thickness of the compacted 0-20 mm (0-¾ in.) granular base, i. e. minimum 200 mm (8 in.) for granular soil or 300 mm (12 in.) for clayey soil**.
- Ensure proper drainage of the structure. If need be, install a perforated drain around the base of the compacted granular base. The finished paved surface should have a slight 1% to 1. 5% slope to ensure adequate surface drainage. The presence of a poorly drained base course or pavement will have a negative impact on a structure's service life. Consult an expert if required.

2.EXCAVATION

- Plan to excavate an additional strip of land around the area to be paved. Its width should be at least equal to one and a half (1 ½) times the thickness of the compacted granular base to be laid.
- Disturb the natural soil beneath the subgrade (**3**) as little as possible during excavation work.
- Level and compact the subgrade using a vibrating plate in the case of a granular subgrade. In the case of a clayey soil, level and install a geotextile over the subgrade, without compacting (**4**).
- To avoid the accumulation of water on the subgrade, excavation work should produce a subgrade with a slight slope of approximately 1. 0%.

1

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* Some of the practices presented here may differ from those of the ICPI (Interlocking Concrete Pavement Institute).

** In the case of highly clayey soil with a low loadbearing capacity, this thickness could be as high as 600 mm (24 in.).

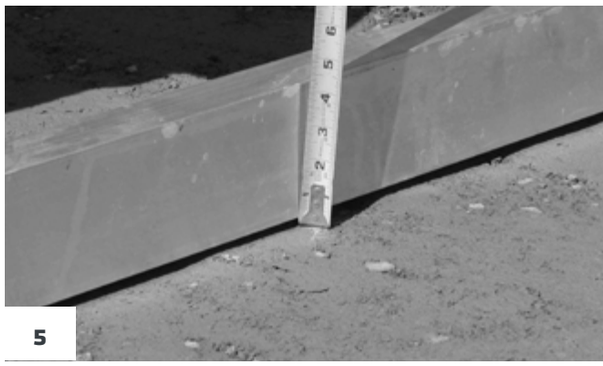
*** This maximum thickness can be increased to 150 mm (6 in.) if a powerful vibratory plate compactor is used.

**** A vibrating plate with a compacting capacity of 18 to 22 kN is usually sufficient to ensure an even surface whose variations do not exceed 3 mm/10 m (3/8 in. /10 ft.). For pavers more than 100 mm thick, the use of a more powerful vibrating plate is highly recommended, in order to produce the required uniformity. A removable neoprene baseplate must be installed under the vibrating plate when working with pavers with a fine surface finish. Consult the manufacturer.

URBAN PAVERS
Paver Installation Guide

3. COMPACTED GRANULAR BASE

- Place the specified granular base using 0-20 mm (0-¾ in.) aggregate in even, successive layers no more than 100*** mm (4 in.) thick (**5**). Compact to 98% of Modified Proctor using a vibrating plate. First, ensure that the water content of the 0-20 mm (0-¾ in.) granular material is sufficient to provide the required fill density, otherwise wet it.
- Ensure adequate levelling of the compacted surface of the next-to-last layer of the granular base course [free of bumps or depres-sions exceeding 25 mm (1 in.) in height measured over a 3 m (10 ft.) length]. It is imperative for the maximum level of this surface to be at least 40 mm (1 ½") below the final layer underlying the installed slabs.



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- Prior to placing the last layer of the compacted granular base, place 2 rigid metal pipes with an outer diameter of 40 mm (1 ½") parallel to each other and a few meters apart, then secure in place by adding 0-20 mm (0-¾ in.) aggregate on each side of the pipes. The top of the pipes in place must be absolutely even with the underside of the slabs to be installed. If not, adjust the granular base course manually with 0-20 mm (0-¾ in.) aggregate [maximum 25 mm (1 in.) correction] and compact. Next, spread the last layer of the 0-20 mm (0-¾ in.) aggregate base course between the pipes, sliding a levelling bar over the pipes (**6**). Then compact the layer of 0-20 mm (0-¾ in.) aggregate between the pipes using a vibrating plate, without touching the pipes, which have remained in place at the required level (**7**).

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4. BEDDING

- Between the pipes in place, spread the first layer of granular bedding [screening (10% max. passing through an 80-micron sieve) or coarse concrete sand) on top of the 0-20 mm (0-¾ in.) compacted granular base course, then compact using a vibrating plate, without touching the pipes.
- Next, spread the second layer of bedding without compacting, to fill the space created by running the vibrating plate over the first layer of bedding (8). This makes it possible to build a base course with a very even surface topped by compacted bedding with a final thickness of less than 20 mm (¾ in.) at all times.

NOTE :

If desired, for a paved structure with a more even surface, the second layer of non-compacted bedding can be compacted with a third and final layer of non-compacted bedding added using the same construction method and without displacing the pipes.

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* Some of the practices presented here may differ from those of the ICPI (Interlocking Concrete Pavement Institute).

** In the case of highly clayey soil with a low loadbearing capacity, this thickness could be as high as 600 mm (24 in.).

*** This maximum thickness can be increased to 150 mm (6 in.) if a powerful vibratory plate compactor is used.

**** A vibrating plate with a compacting capacity of 18 to 22 kN is usually sufficient to ensure an even surface whose variations do not exceed 3 mm/10 m (3/8 in. /10 ft.). For pavers more than 100 mm thick, the use of a more powerful vibrating plate is highly recommended, in order to produce the required uniformity. A removable neoprene baseplate must be installed under the vibrating plate when working with pavers with a fine surface finish. Consult the manufacturer.

URBAN PAVERS
Paver Installation Guide

5.INSTALLATION OF PAVERS

- When preparing and installing pavers, avoid all unfavourable conditions such as rain, snow, frozen bedding and base course.
- When installing the pavers, remove the metal pipes left in place as you go (see step 4), taking care to fill the gaps created with screening, compacted and levelled manually to obtain a granular surface with the required uniformity.
- Place the pavers according to the pattern shown on the plan and the manufacturer's recommendations while leaving a minimum space between the elements (**9**). When placing the pavers, complying at all times with the pavers' nominal installation dimensions, as specified by the manufacturer (distance between one half joint to the other half joint) is essential. These dimensions correspond to those shown on the design plans.
- For optimal good looks, selecting pavers from several pallets at a time is recommended, as this will help ensure a more even surface and better harmonization of the pavers' shades.
- A saw (**10**) or paver splitter should be used to cut some of the elements to the required sizes.
- Plastic edging placed directly on the compacted 0-20 mm (0-¾ in.) granular base and nailed at least every 300 mm (12 in.) or a concrete curb (comply with manufacturer's instructions) must be installed around the paved area (**11**) to properly secure the structure's elements to the ground.

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6.JOINT FILLER

- Finally, a proven commercial polymer sand with the required granulometry will serve as a joint filler to stabilize the installed elements (**12**).
- Every step of the work should be carried out as specified by the manufacturer of the polymer sand.
- Once the installation of the pavers has been completed, spread part of the polymer sand over the pavement and sweep in all directions in order to fill the joints. Avoid any significant accumulation of sand on the pavers' surface. Run a vibrating plate**** twice over the surface, in both directions, to even it out. Next, finish spreading the sand to fill the joints, and run the vibrating plate over the structure again, to ensure that all joints are well filled.
- Sweep the paved surface clean, first with a broom, then with a leaf blower, to remove all remnants of polymer sand stuck to the pavers. Finally, moisten the surface of the pavement as recommended by the manufacturer.
- Avoid all unfavourable conditions when carrying out the work: humid pavement, rain (avoid all rain for at least 24 hours following the application of the joint filler), cold weather, etc.
- Carry out annual joint maintenance.
- Store a few pavers for possible future repairs (stains, breakage, etc.).

* Some of the practices presented here may differ from those of the ICPI (Interlocking Concrete Pavement Institute).

** This thickness could be as high as 600 mm (24 in.) (based on projected traffic) in the case of highly clayey soil with a low loadbearing capacity or frost (likely to swell as it freezes). In the aforementioned cases, it would be advisable to consult a geotechnical expert.

*** This maximum thickness can be increased to 150 mm (6 in.) if a powerful vibratory plate compacter is used.

**** A vibrating plate with a compacting capacity of 18 to 22 kN is usually sufficient to ensure an even surface whose variations do not exceed 3 mm/10 m (3/8 in. /10 ft.). For pavers more than 100 mm thick, the use of a more powerful vibrating plate is highly recommended, in order to produce the r equired uniformity. A removable neoprene baseplate must be installed under the vibrating plate when working with pavers with a fine surface finish. Consult the manufacturer.

URBAN PAVERS

Paver Installation Guide

7. QUANTITES OF JOINT FILLER

Permacon URBAN PAVERS				
POLYMER SAND (NOTE) USED FOR FILLING JOINTS				
Description			Area covered	
Family of pavers		thickness (mm)	pi²/30 kg bag	m²/sac de 30 kg
Boulevard TLI-200 mm	(multi-length)	200	61	5.7
Boulevard TLI-150 mm	MODULES			
	500 mm x 750 mm	150	124	11.6
	500 mm x 500 mm	150	103	9.6
	500 mm x 250 mm	150	69	6.4
	500 mm x 125 mm	150	41	3.8
Boulevard TLI_{150}Crescendo^{320}	(multi-length)	150	63	5.9
Boulevard TLI-150 mm	200 mm x 200 mm	150	36	3.4
Boulevard TLI_{150}Crescendo^{125}	(multi-length)	150	38	3.5
Boulevard TLI-100 mm	MODULES			
	300 mm x 300 mm	100	121	11.3
	150 mm x 300 mm	100	80	7.4
Boulevard TLI_{100}Crescendo^{300}	(multi-length)	100	160	14.9
Boulevard TLI-100 mm	300 mm x 700 mm		229	21.3
Boulevard TLI_{90}Crescendo^{320}	(multi-longueurs)	90	94	8.8
Boulevard TLI-90 mm	160 mm x 240 mm	90	54	5.0
Boulevard TLI-90 mm	320 mm x 520 mm	90	111	10.3
Boulevard TLI-80 mm	120 mm x 240 mm	80	65	6.0
Boulevard 300	MODULES			
	600 mm x 600 mm	100	104	9.7
	200 mm x 600 mm	100	45	4.2
	300 mm x 600 mm	100	69	6.5
	300 mm x 300 mm	100	52	4.9
	150 mm x 300 mm	100	36	3.4
	150 mm x 450 mm	100	39	3.6
	100 mm x 450 mm	100	29	2.7
Boulevard 500	500 mm x 500 mm	100	88	8.2
Boulevard 3DI	150 mm x 300 mm	100	62	5.8
Bonsecours 3DI	140 mm x 220 mm	100	24	2.2
Méga Bonsecours	(multi-longueurs)	100	61	5.7

NOTE: A bulk density of 2 kg/litre was used to calculate the required quantities of the polymer sand.

Section II

URBAN SLABS

URBAN SLABS
Technical

URBAN PEDESTRIAN PAVEMENT

This section deals with urban slabs and, in particular, precast slabs used in the construction of rooftop terraces. It should be recalled that, unlike residential applications where precast concrete slabs are installed on the ground, over a conventional granular base, in the field of urban landscaping, they tend to be replaced by precast concrete pavers. This approach is justified by significant and sometimes unpredictable live loads in service, where only concrete pavers with much greater flexural capacity can ensure the integrity of pavement on the ground.

CSA STANDARD

Slabs are very narrow elements with a high length-to-thickess product ratio, which can vary from 8 to 15. It should be noted, however, that the CSA A231.1-14 'Precast Concrete Paving Slabs' standard defines precast concrete slabs as elements with a surface area exceeding 0.09 m^2 (1 $ft.^2$), a minimum thickness of 30 mm (1.18 in.), a maximum length or width of 1.0 m (3.28 ft.) and an aspect ratio of more than 4.0. According to this standard, these precast elements must be tested in a laboratory to ensure a flexural strength of more than 4.5 MPa (653 $lbs./in.^2$). Dimensional tolerances that must be met compared to the manufacturers technical drawings are -1 mm @ + 2 mm for the product's length and width, and plus or minus 3 mm for its thickness. Finally, in terms of durability, freeze-thaw testing in salt water limits volume loss from scaling to 300 g/m^2 (or 500 g/m^2 for architectural slabs) at 28 cycles or 800 g/m^2 (or 1,200 g/m^2 for architectural slabs) at 49 cycles.

MECHANICAL RESISTANCE OF SLABS

Although none of the slabs are designed for vehicular applications, slabs offered by Permacon always take into account application's minimum standard flexural resistance. In addition, their specific thickness is determined based on their width and length, to ensure minimum bending capacity and stability in service. It is worth mentioning that the majority of pedestrian slabs used in the construction of rooftop terraces and presented in this section can be installed on pedestals or granular bases. In all instances, their flexural capacity allows them to withstand, in service, a minimum live load that is safe for end-users.

URBAN SLABS
Design

IMPLEMENTATION

When building rooftop terraces, compliance with the designer's plans and specifications is imperative. The selection of materials and construction protocol must be carried out with care in order to achieve the desired performance. The structure's watertightness and drainage are, unquestionably, two of the most important elements to take into account in order to maximize service life. This also applies to slabs on pedestals (strict compliance with the specifications set forth by the pedestals' manufactuer is essential) as well as slab structures built on a granular subbase over a waterproofing membrane.

URBAN SLABS

Permacon Urban Slabs

NAMES OF AVAILABLE PRODUCTS

For the construction of rooftop terraces, Permacon offers 4 products with various characteristics and applications. The following table provides, for each of these products, a brief description of their field of application. It should be noted that these precast slabs are designed for pedestrian applications only.

FIELD OF APPLICATION

PRODUCT NAME	BRAND	APPLICATIONS SLABS (PEDESTRIAN ONLY)				
		GRANULAR BASE	PEDESTAL (ROOF DECK)	EROSION CONTROL	PERMEABLE	HIGH REFLECTANCE
SLABS						
SmartCast Reflect/Clean	Permacon	✓	✓			✓
SmartCast Diamond Roof	Permacon	✓	✓			
Turfstone	Permacon	✓		✓	✓	
Versailles	Permacon	✓	✓			
Giga	Permacon	✓	✓			

URBAN SLABS

Permacon Urban Slabs

PRODUCT CHARACTERISTICS

Smartcast Reflect/Clean Slab

URBAN SLABS

Permacon Urban Slabs

PRODUCT CHARACTERISTICS
Smartcast Reflect/Clean Slab

SmartCast Reflect slabs, due to their very high solar reflectance qualities, are the rooftop terrace paving material of choice when it comes to reducing the negative environmental impacts of heat islands.

Features and typical applications

The pristine white colour of SmartCast Reflect slabs achieves a laboratory-calculated solar reflectance index (SRI*) greater than 86. This slab is ideal for all rooftop terrace paving projects that aim to reduce ambient temperature (urban heat islands). It also complies with LEED requirements** for this purpose.

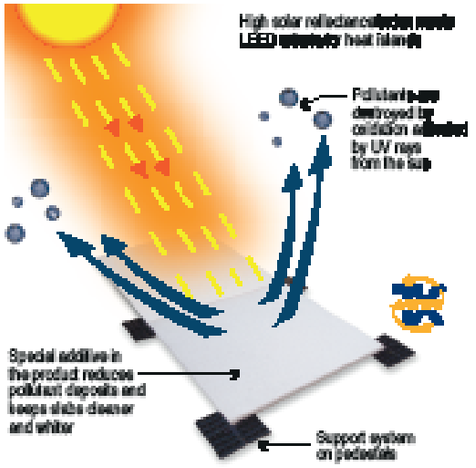
SmartCast Reflect slabs come in a 600 mm x 600 mm format with a thickness of 50 mm. They are highly durable and also have a slip-resistant surface to ensure pedestrian safety. The high quality concrete of the slab achieves a superior flexural strength exceeding 4.5 MPa. Slabs can be safely installed on pedestals and withstand live loads of 300 kg (660 lb).

SmartCast Reflect slabs have a slightly granular, slip-resistant finish with the look of cut stone. Available in white only.

Benefits

SmartCast Reflect slabs can also be manufactured with a special additive*** in the concrete mix for a new slab called SmartCast Clean that reduces urban pollution. Organic and inorganic pollutants that settle on the paving are literally eliminated by an oxidation process activated by the sun's UV rays making the surface of the concrete cleaner and whiter for longer.

SMARTCAST CLEAN SLAB
600 mm x 600 mm x 50 mm
(23.62 in x 23.62 in x 1.97 in)
42.2 kg (93.0 lb)



* SRI = Solar Reflectance Index. This is obtained by a test on the material to measure the ability of the surface to reflect sunlight. The lighter the material, the higher the reflectance. Lighter material better reflects sunlight and is therefore cooler. A surface covered with white slabs like SmartCast Reflect contributes significantly to reducing the ambient temperature.

** LEED (Leadership in Energy and Environmental Design) is a program that essentially aims to promote sound environmental practices and sustainable development in building construction or renovation. It is governed in the United States by the US Green Building Council (USGBC) and in Canada by the Canada Green Building Council (CaGBC).

*** A special concrete additive called "TX Active cement" is responsible for an accelerated oxidation process using light energy in a photocatalytic reaction.

URBAN SLABS

Permacon Urban Slabs

PRODUCT CHARACTERISTICS

Smartcast Diamond Roof Slab

URBAN SLABS

Permacon Urban Slabs

PRODUCT CHARACTERISTICS

Smartcast Diamond Roof Slab

SmartCast Diamond general-purpose rooftop paving slabs are an economical solution for paving projects of all kinds.

Features and typical applications

The high flexural strength of SmartCast Diamond Roof slabs enables the production of large-format, 600 mm x 600 mm modules. Slabs are diagonally grooved with a non-skid finish and are available in a single colour–Natural Grey concrete. Their optimal 50 mm thickness serves to minimize loads on buildings. They are specifically designed to be installed safely on pedestals and to withstand a live load of 300 kg (660 lb). They minimize the number of pedestals required. In addition, SmartCast Diamond Roof slabs may also be used in any applications on a granular base, such as sidewalks, outdoor facilities, pedestrian walkways, etc.

Benefits

- Reduction of loads transmitted to the building
- Non-skid for safe use
- Economical paving slab
- Can be used on granular base or pedestals

SMARTCAST DIAMOND ROOF SLAB
600 mm x 600 mm x 50 mm
(23.62 in x 23.62 in x 1.97 in)
42.2 kg (93.0 lb)

URBAN SLABS

Permacon Urban Slabs

PRODUCT CHARACTERISTICS

Versailles Slab

URBAN SLABS

Permacon Urban Slabs

PRODUCT CHARACTERISTICS

Versailles Slab

Versailles slabs create a contemporary look in non-skid paving designed for prestigious rooftop terrace projects.

Features and typical applications

The high flexural strength of Versailles slabs enables the production of large-format, 610 mm x 610 mm modules. Versailles slabs have a slightly granular, non-skid finish with the look of cut stone and are available in four colours—Alpine grey, Indiana beige, Trenton grey and Luxor beige. Their optimal 50 mm thickness serves to minimize loads on buildings. They are specifically designed to be installed safely on pedestals and to withstand a live load of 300 kg (660 lb). They minimize the number of pedestals required. In addition, Versailles slabs may also be used in applications on a granular base, such as sidewalks, outdoor facilities, pedestrian walkways, etc.

Benefits

- Optimization of product dimensions enabling a reduction in loads transmitted to the building
- Non-skid, safe performance
- Fashionable, contemporary aesthetics
- Can be used on granular base or pedestals

VERSAILLES SLAB
610 mm x 610 mm x 50 mm
(24.0 in x 24.0 in x 2.0 in)
45 kg (98.80 lb)

URBAN SLABS

Permacon Urban Slabs

PRODUCT CHARACTERISTICS

Giga Slab

URBAN SLABS

Permacon Urban Slabs

PRODUCT CHARACTERISTICS

Giga Slab

The GIGA interlocking slab is a high-end product used for landscaping and rooftop terraces. It is renowned for its exceptional stability in service, made possible by the interlocking grooves around the periphery of each slab.

Features and typical applications

The Permacon GIGA slab is a manufactured product made from premium quality concrete having a high compressive strength and very low rate of water absorption. The GIGA slab's flexural strength delivers outstanding longevity for all types of pedestrian non-vehicular uses. In addition, the interlocking grooves around the periphery of each slab provide unparalleled, long-term stability. A range of modules measuring up to 750 mm in length can be used to build solid structures set on a compacted granular foundation (patios, courtyards, play areas, public spaces, etc.). The GIGA slab is available in a variety of colours. In addition, slabs in formats of 500 mm x 500 mm and 500 mm x 750 mm, installed on adjustable pedestals, are particularly well-suited for the construction of rooftop terraces. For structures such as these, the outstanding flexural resistance of the GIGA slab enables it to safely support a live load of 300 kg.

Benefits

- Exceptional stability in service, due to interlocking grooves around the periphery of each slab
- Modularity of the slabs delivers excellent design flexibility
- Possibility of incorporating larger slabs into coverage
- Possibility of installation on a granular foundation or adjustable pedestals
- Slabs with a buffed finish incorporating very narrow construction joints

Section III

RETAINING WALLS

RETAINING WALLS
Technical

RETAINING WALLS - GENERAL

Safe design and construction
A retaining wall is considered a structural work. Its design and construction must be carried out in compliance with prevailing construction codes, using the best practices recognized in the industry.

SURCHARGES AND STABILITY IN SERVICE
All retaining walls must withstand lateral soil pressure and other stresses exerted on the structure in service.
The engineer designing a retaining wall must ensure its safety and stability in service by providing, in the plans and specifications, typical cross-sections of the wall in order to avoid any buckling, toppling, settling or shifting at the base of the structure.

All retaining walls must withstand lateral soil pressure and other stresses exerted on the structure in service.It's manadory to follow plans and engineer's specifications.

RETAINING WALLS

Design

GENERAL DESIGN RULE

At the design stage, before any work is undertaken, it is necessary to conduct a detailed analysis of the conditions to which the retaining wall will be subjected in service (type of surrounding soil, surcharges above the wall, presence and depth of the groundwater table, types of materials in the subgrade, presence of an abutment downstream from the base of the wall, etc.). All other stresses to which the structure is likely to be subjected (seismic loads, pressure from the frozen soil, soil's loss of load-bearing capacity during thaw periods or fluctuations in the height of the groundwater table, pool, parking lots, vehicular traffic areas, fences, garden sheds, etc.) must also be taken into account by the engineer in designing the structure. This design approach is essential for ensuring that the wall will hold up safely and retain its long-term structural integrity.

REMINDER OF BEST PRACTICES

Retaining walls incorporating Permacon blocks have several points in common. When designing a structure and planning its construction phases, the characteristics listed in the proposed table must be analyzed with care to produce a structure that meets your highest expectations in terms of performance, and complies with prevailing codes.

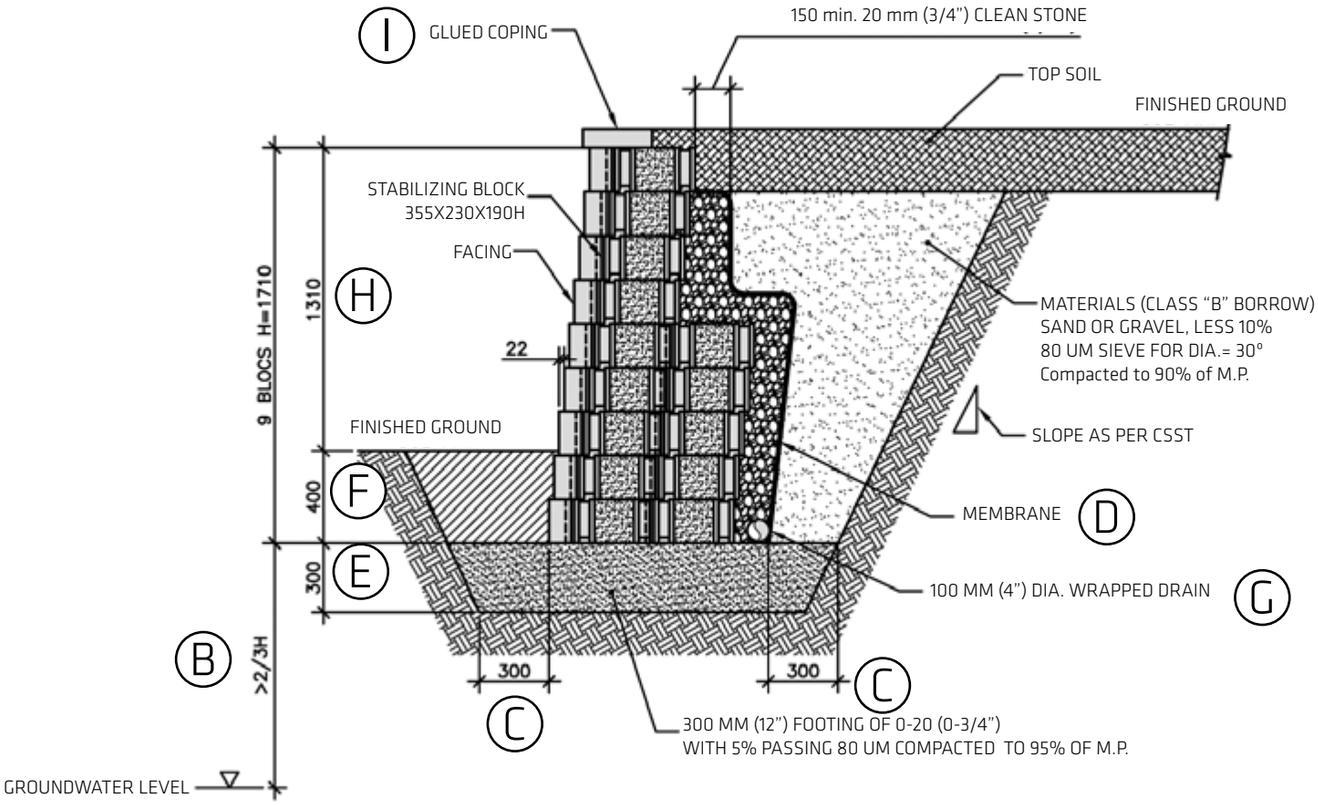
IDENTIFICATION	RECOGNIZED PRACTICES	PERMACON RECOMMENDATION
A	Minimum load-bearing capacity of the excavated soil beneath the 0-20 mm compacted granular base	100 kPa
B	Adequate depth of the groundwater table	. 2/3 of the total height of the wall
C	Excavation sufficiently deep and wide	. minimum excess of 300 mm
D	Adequate protection of the granular base against contamination in clayey environments	. use of a geotextile
E	Adequate load-bearing capacity of the granular base	. minimum thickness of 200 mm to 300 mm . compacting to a minimum of 95% of Modified Proctor
F	Minimum height of the wall's buried section (min-imum requirement sheet) ensuring additional protection against the wall's sliding	. minimum 10% of the total height of the wall built and . 200 mm to 400 mm depending on the above-ground height of the wall
G	Adequate drainage behind the wall	. 100 mm-diameter wrapped drain placed on the granular base and . minimum 150-mm layer of clean stone behind the wall, placed along the entire height of the wall
H	Wall's adequate resistance to toppling	. respecting the maximum above-ground height based on the typical wall cross-section proposed and . taking into consideration all possible loads and stresses encountered in service (one-off extra loads, wall inclination, ground slope, etc.)
I	Complementary integrity of the structure in service	. gluing the coping

NOTE 2: SOME PROPOSED QUEBEC'S SPECIFICATIONS AND REQUIREMENTS OF THIS FIGURE AND THE TABLE OF THE FOLLOWING PAGE MAY BE DIFFERENT IN ONTARIO AS PER NCMA (NATIONAL CONCRETE MASONRY ASSOCIATION).

RETAINING WALLS

Design

KEY CRITERIA AT THE DESIGN STAGE



A NOTE 1:
MINIMUM GROUND LOAD-BEARING CAPACITY: 100 kPa
BLOCK/BLOCK CONNECTION – 670 daN/m (450 lbs./ft.)

RETAINING WALLS

Permacon Retaining Walls

NAMES OF AVAILABLE PRODUCTS

For the construction of retaining walls, Permacon offers 3 wall systems distinguished by their aesthetics, materials and characteristics in service. They provide a wide range of construction possibilities and have resulted in the production of a variety of structures. They are the Grande, FS^2 and Keystone wall systems. The following table presents a brief description of the field of application for which each has been developed. They fall into the Gravity Wall type, characterized by massive concrete elements or the Geogrid Reinforced Wall characterized by relatively thin concrete elements secured to geogrids buried laterally in the granular fill.

It should be mentioned that the walls of these systems can have different inclination angles or be vertical. In carrying out any of these structures, complying with the maximum construction height specified by Permacon is imperative in order to ensure the structure's long-term integrity and stability in service.

FIELD OF APPLICATION

PRODUCT NAME		BRAND	APPLICATIONS							
			RETAINING WALLS (MAXIMUM ALLOWABLE ABOVE-GROUND HEIGHTS)							
			GRAVITY WALLS				REINFORCED WALLS			
				WITH SURCHARGE				WITH SURCHARGE		
			WITHOUT SURCHARGE	SLOPE 1V:3H	PARKINGS 5 kN/m^2 (100 lb/ft^2)	ROADS 12 kN/m^2 (250 lb/ft^2)	WITHOUT SURCHARGE	SLOPE 1V:3H	PARKINGS 5 kN/m^2 (100 lb/ft^2)	ROADS 12 kN/m^2 (250 lb/ft^2)
RETAINING WALLS										
	Setback angle									
Grande	0 degrees	Permacon	7.55 ft (2.3 m)	5.25 ft (1.6 m)	6.56 ft (2.0 m)	4.59 ft (1.4 m)	30.00 ft (9.0 m)	30.00 ft (9.0 m)	30.00 ft (9.0 m)	30.00 ft (9.0 m)
	9 degrees		9.51 ft (2.9 m)	6.56 ft (2.0 m)	8.53 ft (2.6 m)	6.56 ft (2.0 m)	30.00 ft (9.0 m)	30.00 ft (9.0 m)	30.00 ft (9.0 m)	30.00 ft (9.0 m)
	17 degrees		11.81 ft (3.6 m)	8.36 ft (2.7 m)	10.50 ft (3.2 m)	8.53 ft (2.6 m)	30.00 ft (9.0 m)	30.00 ft (9.0 m)	30.00 ft (9.0 m)	30.00 ft (9.0 m)
FS^2	0 degrees	Transpavé	8.25 ft (2.5 m)	6.42 ft (1.9 m)	(note 1)	N/A	N/A	N/A	N/A	N/A
	7 degrees		9.58 ft (2.9 m)	7.67 ft (2.3 m)	(note 1)	N/A	N/A	N/A	N/A	N/A
Keystone	2 degrees	Permacon	1.67 ft (0.5 m)	N/A	N/A	N/A	30.00 ft (9.0 m)	30.00 ft (9.0 m)	30.00 ft (9.0 m)	30.00 ft (9.0 m)
	9 degrees		2.33 ft (0.7 m)	N/A	N/A	N/A	30.00 ft (9.0 m)	30.00 ft (9.0 m)	30.00 ft (9.0 m)	30.00 ft (9.0 m)

N/A = Not applicable
Note 1: See Permacon for specific design

RETAINING WALLS

Permacon Retaining Walls

PRODUCT CHARACTERISTICS
GRANDE WALL SYSTEM

RETAINING WALLS

Permacon Retaining Walls

PRODUCT CHARACTERISTICS
GRANDE WALL SYSTEM

The Grande wall system is designed for building retaining walls that are highly stable, durable and aesthetic. The system replaces reinforced concrete walls cast in place. The solid concrete units of the Grande system permit the construction of gravity walls of up to 3.6 m (11.81 ft) aboveground height. In addition, they may be used with geogrid-type soil reinforcement for purposes of economy or for the construction of extra-high retaining structures of up to 9.0 m (30 ft).

Using geogrid lets you increase wall height and minimize construction costs.

RETAINING WALLS

Permacon Retaining Walls

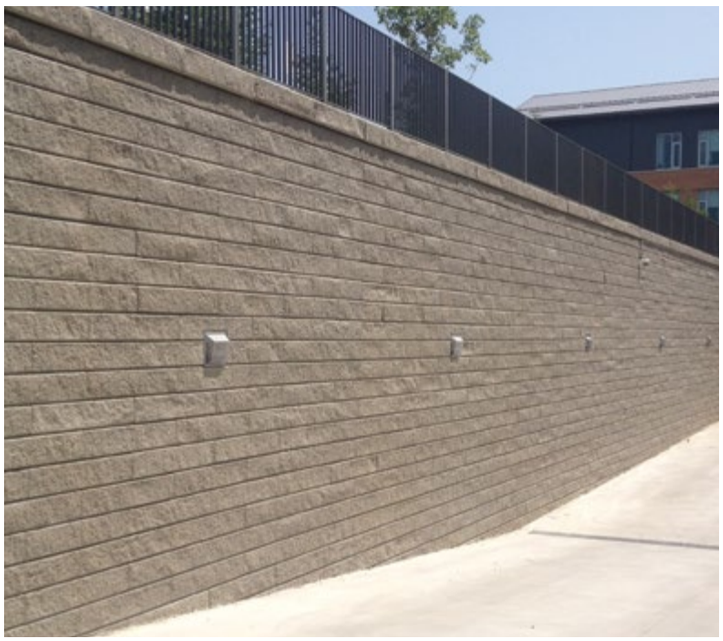
PRODUCT CHARACTERISTICS
GRANDE WALL SYSTEM

DESCRIPTION AND TYPICAL APPLICATIONS

The Grande wall system comprised of three distinct large-format modules. The unique connection system of grooves and ridges on each Grande block provides outstanding performance and greater load resistance compared to conventional retaining walls. It also allows for the construction of walls with three possible setbacks for greater stability.

The visible surface of the wall has a split finish. Units are available in natural grey colour.

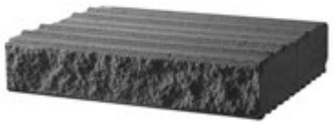
This type of wall is designed for commercial and industrial applications. It is ideal for constructing parking areas, loading bays, driveways for trucks or to ensure the stability of a slope. It can also be used as a separator wall (double-faced) or even as a noise-reduction screen.



The Grande wall system allows for the construction of highly stable retaining walls in commercial and industrial applications.

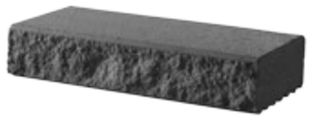
GRANDE MODULES

GRANDE MODULE 375 mm
200 mm x 375 mm x 1000 mm
(7.87 in x 14.76 in x 39.37 in)
161 kg (355 lb)



GRANDE MODULE 750 mm
200 mm x 750 mm x 1000 mm
(7.87 in x 29.52 in x 39.37 in)
322 kg (710 lb)

GRANDE MODULE 1125 mm
200 mm x 1125 mm x 1000 mm
(7.87 in x 44.29 in x 39.37 in)
483 kg (1065 lb)



GRANDE COPING MODULE 438 mm
200 mm x 438 mm x 1000 mm
(7.87 in x 17.24 in x 39.37 in)
173 kg (380 lb)

RETAINING WALLS

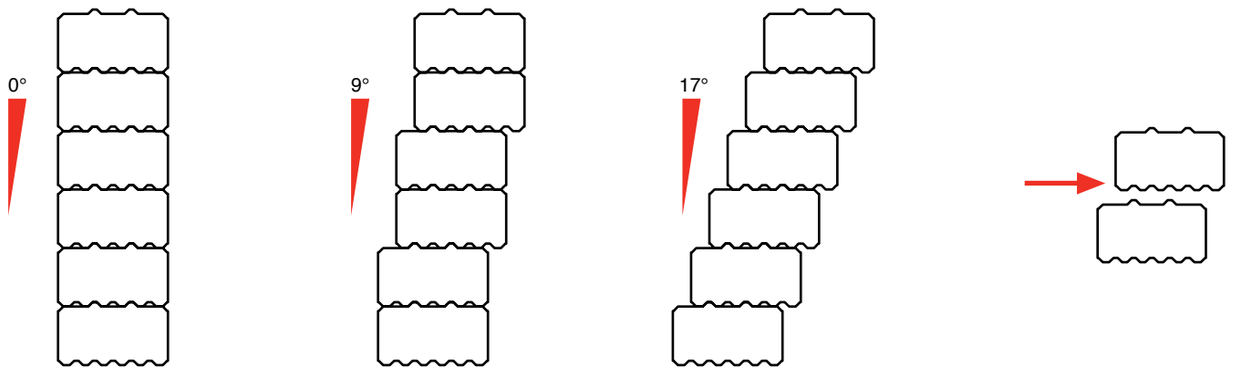
Permacon Retaining Walls

PRODUCT CHARACTERISTICS
GRANDE WALL SYSTEM

FEATURES AND BENEFITS

VARIABLE SETBACKS

The system of grooves and ridges on Grande blocks allows for the construction of walls with three possible setbacks (0 degrees, 9 degrees and 17 degrees) for greater stability.

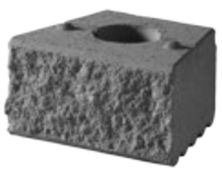


The efficient, self-locking system of Grande blocks also permits the use of geogrids for building extra-high walls, thereby reducing costs.

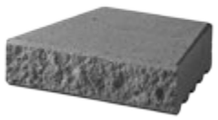
STRAIGHT OR CURVED WALLS

Grande walls can be built straight or curved using bevelled Wedge units designed for the purpose. A curved gravity wall can be erected to a height of 1.0 m (3.3 ft) and a curved wall with geogrid reinforcement can reach a height of 9.0 m (30.0 ft).

The system allows for internal and external 90° corners using corner units.



GRANDE WEDGE MODULE
200 mm x 312 mm x 380 mm / 250 mm
(7.87 in x 12.30 in x 14.96 in/9.84 in)
37.6 kg (83 lb)



GRANDE WEDGE COPING MODULE
100 mm x 312 mm x 380 mm / 250 mm
(3.93 in x 12.30 in x 14.96 in/9.84 in)
21 kg (46.5 lb)

GRANDE CORNER MODULE
200 mm x 500 mm x 1000 mm
(7.87 in x 19.69 in x 39.37 in)
213 kg (469 lb)

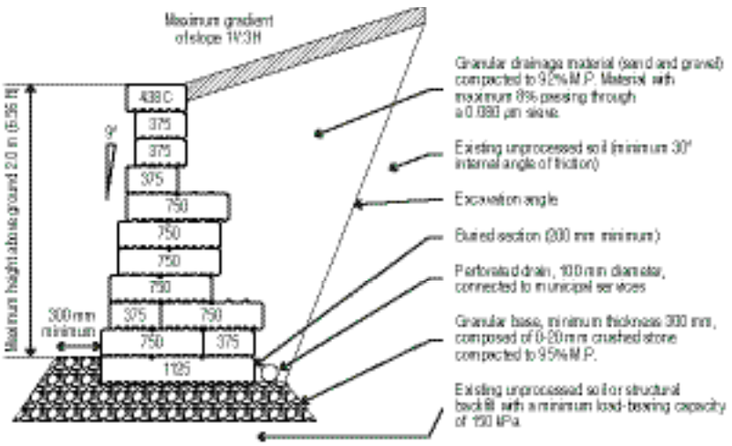
RETAINING WALLS

Permacon Retaining Walls

PRODUCT CHARACTERISTICS
GRANDE WALL SYSTEM

FEATURES AND BENEFITS

GRANDE WALL
CONSTRUCTION DETAILS FOR STANDARD 9° SETBACK



- Grande blocks are manufactured to high quality standards to withstand the harsh northern climate and de-icing salts
- The Grande wall system is particularly economical compared to reinforced concrete retaining walls poured on site
- Does not require deep foundations to protect against freezing
- Does not require steel reinforcement or formwork
- Does not require anchors or mortar
- Installation is fast and easy because Grande units are put in place with the lifting device (clamp) supplied and are moved around with a backhoe, thereby reducing labour and other costs
- The large format of the blocks enables guardrails to be directly attached
- Coping units can be used for rapid construction of solid steps
- Grande modules are highly impact-resistant
- The Grande system has been used across the USA for over 25 years and hundreds of walls have been constructed in Quebec and Ontario

Grande walls are strong, durable and aesthetic

Grande walls allow for curved designs

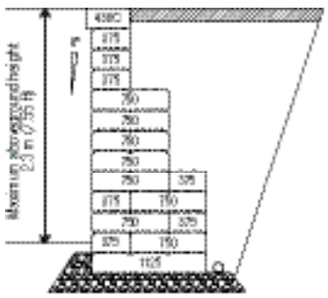
RETAINING WALLS

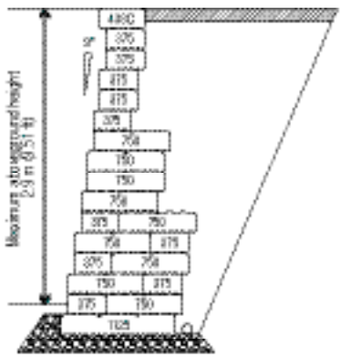
Permacon Retaining Walls

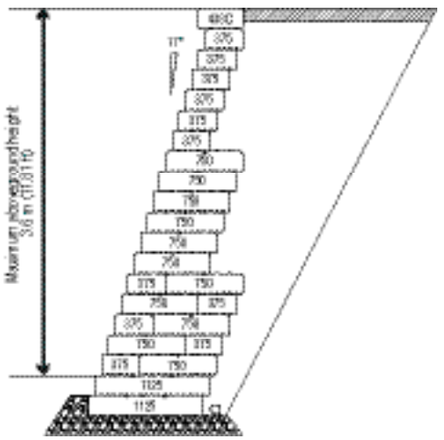
PRODUCT CHARACTERISTICS
GRANDE WALL SYSTEM

GRANDE WALL DESIGN CHARTS

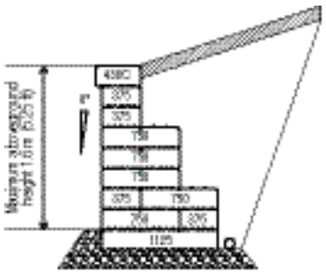
WALLS WITHOUT SURCHARGE AT VARYING ANGLES

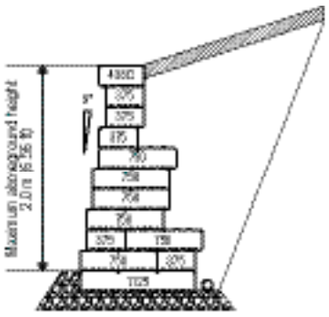


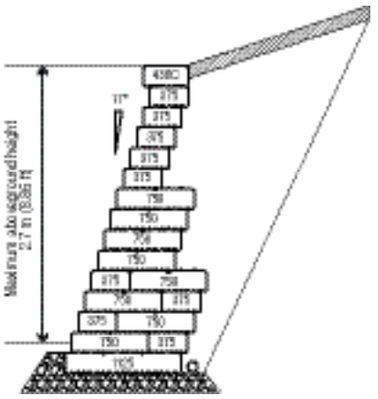




WALLS WITH SURCHARGES AT VARYING ANGLES
(Maximum gradient of slope–1 vertical: 3 horizontal)







LIMITATIONS OF USE

The design charts reflect the following assumptions:

The backfill material at the rear of the wall and the existing soil to be retained must have an internal angle of friction of at least 30°. The bearing capacity of the soil under the granular base must be at least 150 kPa (3150 lb/ft²).

These charts have been developed using 1125 mm units as the depth of the base, limiting the maximum aboveground height to 3.6 m (11.81 ft). However, the wall height can be extended by adding additional units to build broader bases. Grande walls can then be built to heights of up to 6.0 m (19.7 ft) in a gravity structure.

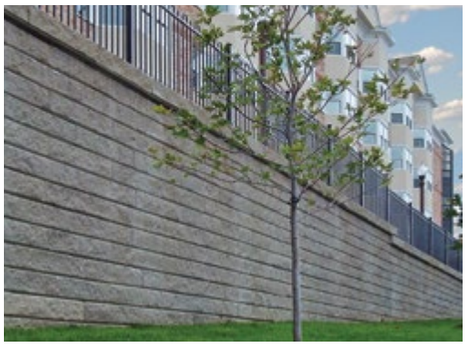
RETAINING WALLS

Permacon Retaining Walls

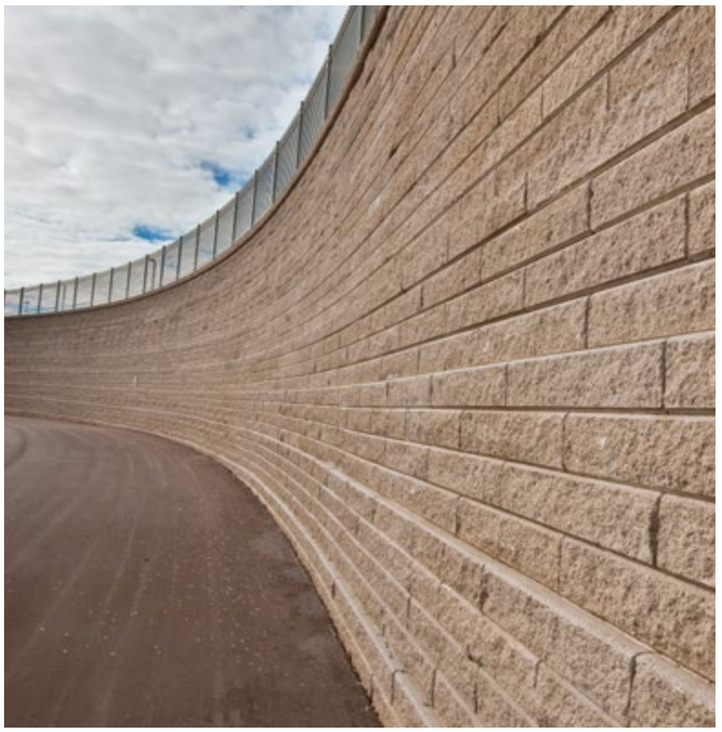
PRODUCT CHARACTERISTICS
GRANDE WALL SYSTEM

FEATURES AND BENEFITS

Aesthetics enhanced by contrasting angles and textures



Fence incorporated directly above wall



Large-scale walls may be straight or curved

CONSULT US FOR A CUSTOM-DESIGNED WALL CROSS-SECTION

Cross-sections of walls illustrated in the design chart above available for the majority of popular uses.
For more complex applications, please consult our engineering department.

Since the design of a Grande wall varies from project to project depending on individual specific parameters (gravity or reinforced wall, slope of wall, type of soil, live load, height of wall, etc.), Permacon's technical department will provide you with customized cross-sections. Just fill out the "Data sheet for design of retaining wall"* with the specific parameters of your project, and we will prepare the cross-section you need.

*Available on our website in the section "Professionals", tab "Support", submenu "Technical", item "Engineering Support"

RETAINING WALLS

Permacon Retaining Walls

PRODUCT CHARACTERISTICS

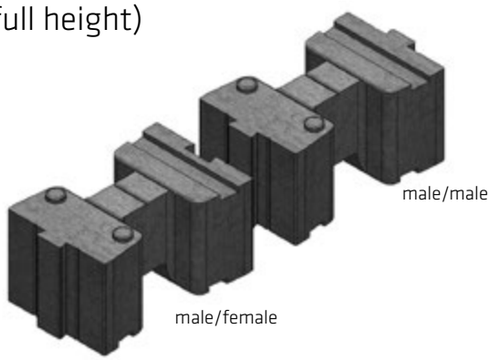
FS² SYSTEM – KEY COMPONENTS

The FS² retaining wall system combines two elements: a stabilizing block and a facing attached to it. The facing contributes to the aesthetic appeal of the outer wall. The stabilizing block ensures the stability of the wall subjected to soil stresses. In fact, the greater the pressure exerted by the soil, the greater the number of stabilizing blocks that must be fitted behind each other. Designed for optimal construction ease and speed, the FS² system allows the construction of walls of varying heights and forms.

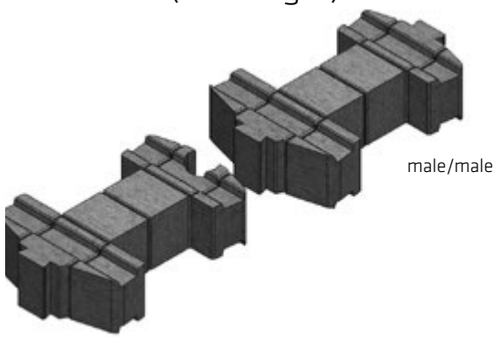
- Retaining wall
- Privacy wall
- Column
- Step

Stabilizers

Stabilizers (2 blocks)
(full height)



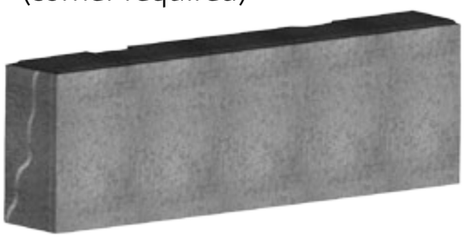
Stabilizers (half height)



Facings

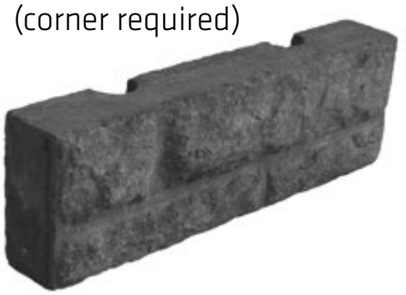
Seigneurial
(corner not required)

City
(corner required)



and Cassara Facing (smooth finish)
no corner required

Prague
(corner required)



Metropol
(corner not required)

RETAINING WALLS

Permacon Retaining Walls

PRODUCT CHARACTERISTICS

FS² SYSTEM – PRAGUE FACING

Inspired by the thousand-year-old architecture of Prague and its Charles Bridge.

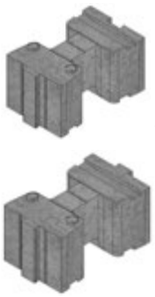
Two-component modular system (facing and stabilizing block)

- The Prague block facing is a single-size module with 4 different imprints (A, B, C, D), creating the illusion of stones of varying sizes once the installation has been completed.

  Dimensions are: 190 mm x 110 mm x 590 mm

  (7 1/2" x 4 5/16" x 23 1/4").

- The 190 mm stabilizing block comes in 2 models.
  - Male-female model for most retaining walls, and male-male for most freestanding walls (finished on both sides).



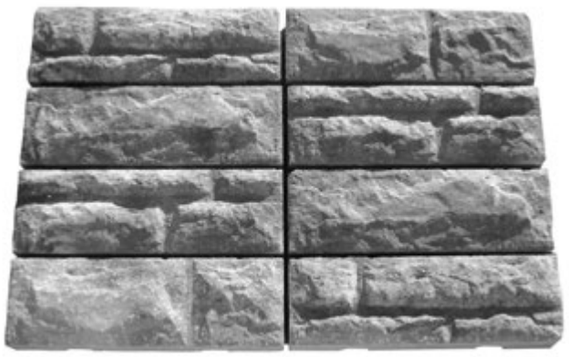
Dimensions

190 mm x 230 mm x 355 mm
(7 1/2" x 9" x 14")

Pallet

48 elements per pallet
8 elements per row

Typical row (facing)



Corner blocks are not included and are sold separately.

Facing installation sequence

The objective is to distribute elements from the left and right sides of the pallet in order to produce uniform shades and combinations of the 4 imprints, which are provided in equal quantities. Work from more than one pallet at a time.

RETAINING WALLS

Permacon Retaining Walls

PRODUCT CHARACTERISTICS

FS² SYSTEM – SEIGNEURIAL FACING

Classic good looks harmonizing with both country and urban settings.

Two-component modular system
(facing and stabilizing block)

- The Seigneurial block facing is a single-size module with 8 different imprints, creating the illusion of stones of different sizes once the installation has been completed.

  Dimensions: 190 mm x 100 mm x 590 mm (7 1/2" x 4" x 23 1/4"). All blocks can serve as corners.

- The 190 mm stabilizing block comes in 2 models

  - Male-female model for most retaining walls and male-male for most freestanding walls (finished on both sides)

Dimensions

Nominal dimensions:
190 mm x 230 mm x 355 mm
(7 1/2" x 9" x 14")

Pallet

48 elements per pallet
8 elements per row

Typical row (facing)

1 integrated corner per facing included.

Facing installation sequence

The objective is to distribute elements from the left and right sides of the pallet in order to produce uniform shades and combinations of the 8 imprints. Work from more than one pallet at a time.

RETAINING WALLS

Permacon Retaining Walls

PRODUCT CHARACTERISTICS

FS² SYSTEM –CITY FACING (buffed finish)

Reproducting the look of a natural buffed stone when a contempory style finish is sought.

Two-component modular system
(facing and stabilizing block)

- The City block facing is a single-size module distinguished by a buffed visible face and a deep joint around the perimeter. A corner block is needed to complete the installation (sold separately).

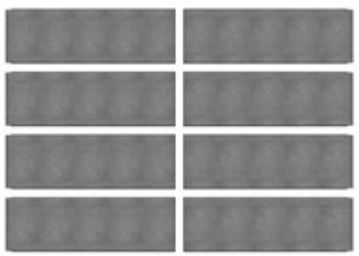
  Dimensions: 190 mm x 100 mm x 590 mm (7 1/2" x 4" x 23 1/4").

- The 190-mm stabilizing block comes in 2 models
  - Male-female model for most retaining walls and male-male for most freestanding walls (finished on both sides).
  - Male-female model for retaining walls with significant limitations.

Dimensions

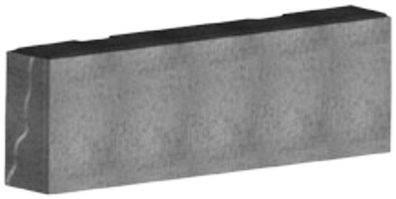
Nominal dimensions:
190 mm x 230 mm x 355 mm
(7 1/2" x 9" x 14")

Typical row (facing)



Corner not included
and sold separately

City
(corner required)



Pallet

48 elements per pallet
8 elements per row

Facing installation sequence

The objective is to distribute elements from the left and right sides of each pallet in order to produce uniform shades. Work from more than one pallet at a time.

RETAINING WALLS

Permacon Retaining Walls

PRODUCT CHARACTERISTICS

FS² SYSTEM –CASSARA FACING (smooth finish)

Reproducting the look of a natural stone when a contempory style finish is sought.

Two-component modular system
(facing and stabilizing block)

- The Cassara block facing is a single-size module distinguished by a smooth visible face and a deep joint around the perimeter.

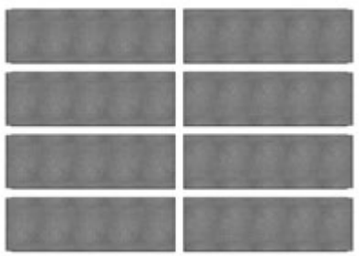
  Dimensions: 190 mm x 100 mm x 590 mm (7 1/2" x 4" x 23 1/4").

- The 190-mm stabilizing block comes in 2 models
  - Male-female model for most retaining walls and male-male for most freestanding walls (finished on both sides).
  - Male-female model for retaining walls with significant limitations.

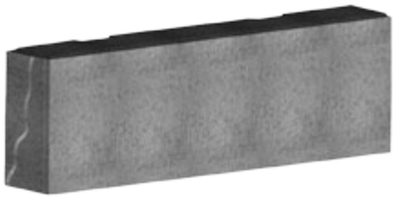
Dimensions

Nominal dimensions:
190 mm x 230 mm x 355 mm
(7 1/2" x 9" x 14")

Typical row (facing)



Cassara
(corner not required)



Pallet

48 elements per pallet
8 elements per row

Facing installation sequence

The objective is to distribute elements from the left and right sides of each pallet in order to produce uniform shades. Work from more than one pallet at a time.

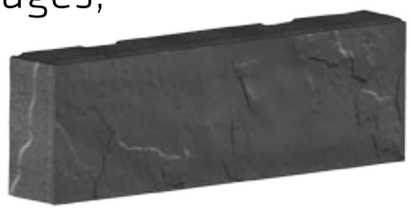
RETAINING WALLS

Permacon Retaining Walls

PRODUCT CHARACTERISTICS

FS² SYSTEM – METROPOL FACING

Reproducing the look of finely textured slate. These blocks are distinguished by subtle shading enhanced by a deep joint around the edges, which is characteristic of noble masonry detailing.



Two-component modular system
(facing and stabilizing block)

- The Metropol block facing is a single-size module with a finely textured slate surface and deep joints around the perimeter.

  Dimensions: 190 mm x 100 mm x 590 mm (7 1/2" x 4" x 23 1/4"). All blocks can serve as corners.

- The 190-mm stabilizing block comes in 2 models

.

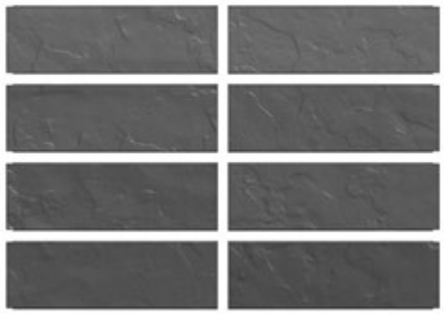
Dimensions

Nominal dimensions:
190 mm x 230 mm x 355 mm
(7 1/2" x 9" x 14")

Pallet

48 elements per pallet
8 elements per row

Typical row (facing)



1 integrated corner per facing included.

Facing installation sequence

The objective is to distribute elements from the left and right sides of the pallet in order to produce uniform shades and slate textures. Work from more than one pallet at a time.

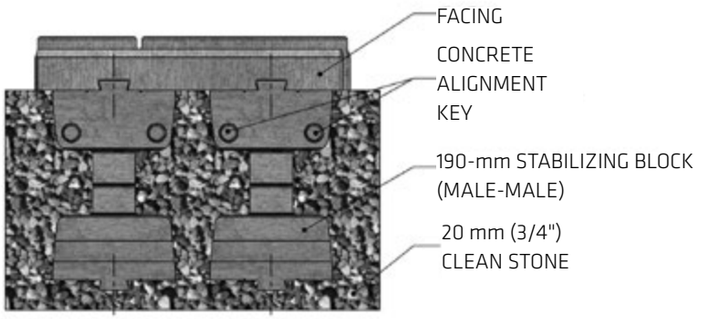
RETAINING WALLS

Permacon Retaining Walls

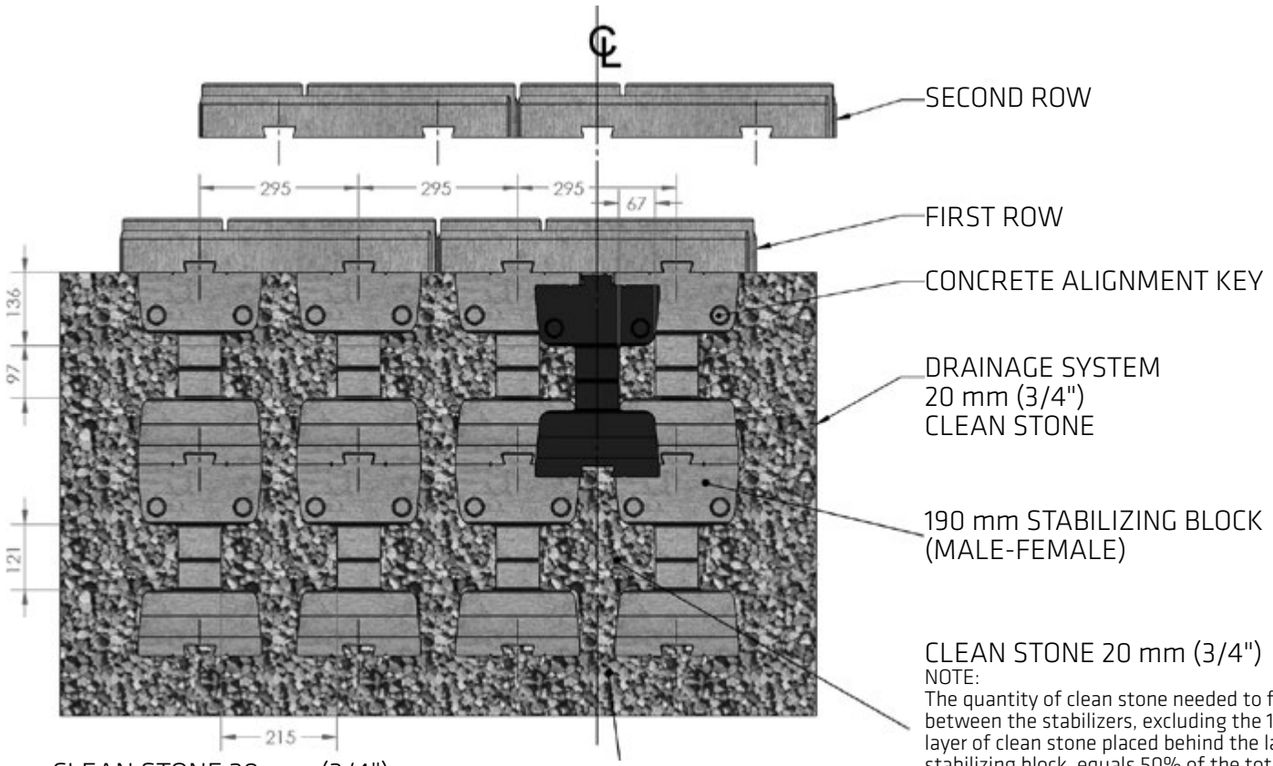
PRODUCT CHARACTERISTICS

FS² SYSTEM – ASSEMBLY

Construction sketch of a retaining wall assembled with 1 stabilizing block



Construction sketch of a high inclined retaining wall assembled with 2 stabilizing blocks staggered and secured behind each other.



CLEAN STONE 20 mm (3/4")
A minimum layer of 150 mm of 20 mm clean stone is required as a drainage material behind the last stabilizer.

NOTE:
The quantity of clean stone needed to fill spaces between the stabilizers, excluding the 150-mm layer of clean stone placed behind the last stabilizing block, equals 50% of the total weight of the stabilizing blocks installed.
(1 stabilizer weighs 26.3 kg).

RETAINING WALLS

Permacon Retaining Walls

PRODUCT CHARACTERISTICS

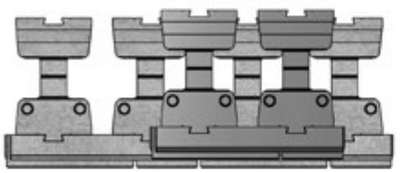
FS² SYSTEM – ASSEMBLY (cont'd)

Generally speaking, full-height 190-mm male/female stabilizers are used to build most FS² retaining walls, (except for non-inclined and privacy walls, which may occasionally require male/male stabilizers).

When using the FS² system to build the second row of a retaining wall, stabilizing blocks can be assembled by either staggering or overlaying them on the bottom row. Opting to stagger the stabilizers will result in the construction of a wall whose facings will have vertical joints offset 25% lengthwise. On the other hand, overlaying stabilizers on the bottom row will yield vertical stabilizer joints representing 50% of their length.

STAGGERED STABILIZING BLOCKS (wall with 7° slope)

Plan

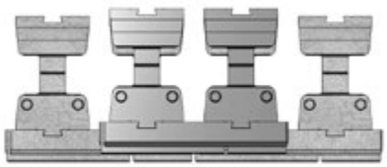


Elevation

Profile

OVERLAID STABILIZING BLOCKS (wall with 7° slope)

Plan



Elevation

Profile

RETAINING WALLS

Permacon Retaining Walls

PRODUCT CHARACTERISTICS

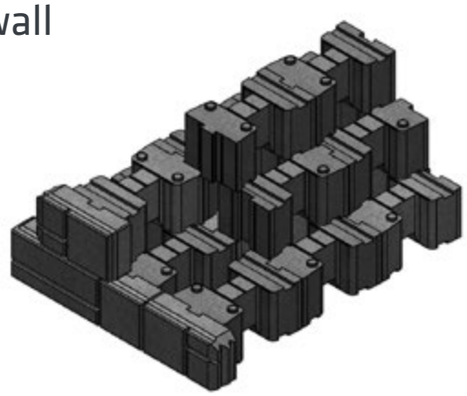
FS² SYSTEM – ASSEMBLY (cont'd)

FS² stabilizing blocks allow the construction of retaining walls whose visible face is vertical or slightly inclined by 7 degrees (i.e. 22 mm setback per row built).

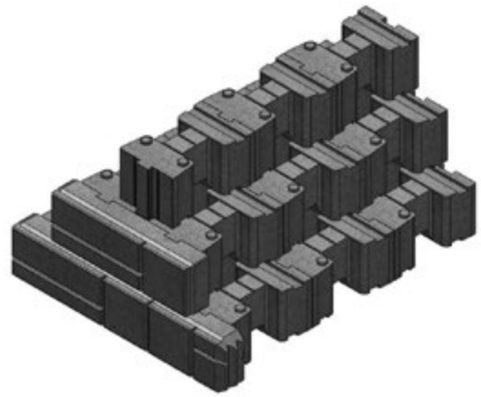
To build the façade of an inclined wall, stabilizers must be positioned in such a way that the alignment keys of the male-female stabilizing blocks are directly behind the facing. They retain this position throughout the wall's construction.

To build the façade of a vertical wall, all odd-numbered rows from the base course up will be built like those of an inclined wall. However, all even-numbered rows will have male-female stabilizers positioned at 180 degrees from the previous row, and the first stabilizer attached to the facing of even-numbered rows will be male-male type, also positioned at 180 degrees.

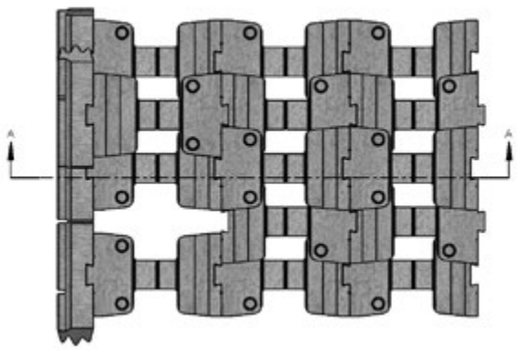
Vertical wall



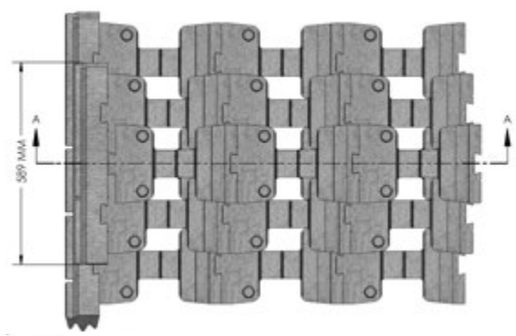
Inclined wall (7°)



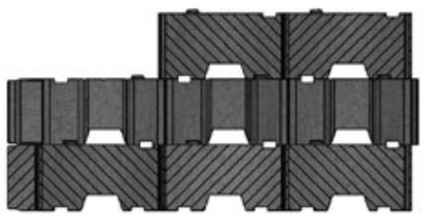
Plan view



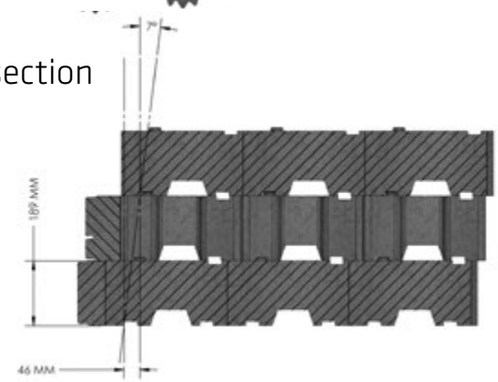
Plan view



Cross-section



Cross-section



RETAINING WALLS

Permacon Retaining Walls

PRODUCT CHARACTERISTICS

FS² SYSTEM – CONSTRUCTION OF A STRAIGHT WALL

Carefully level and compact the 0-20 mm granular base course.

Spread loose granular bedding with a maximum thickness of 20 mm

Place the first stabilizers and facings, perfectly aligned using a mason's line

Check the horizontality of the stabilizing blocks installed

Continue the installation of stabilizing blocks. A level base course and well-aligned blocks allow rapid installation of subsequent rows with no significant repositioning of elements already in place

End rows with cascading finished returns to confer excellent stability to the backfill

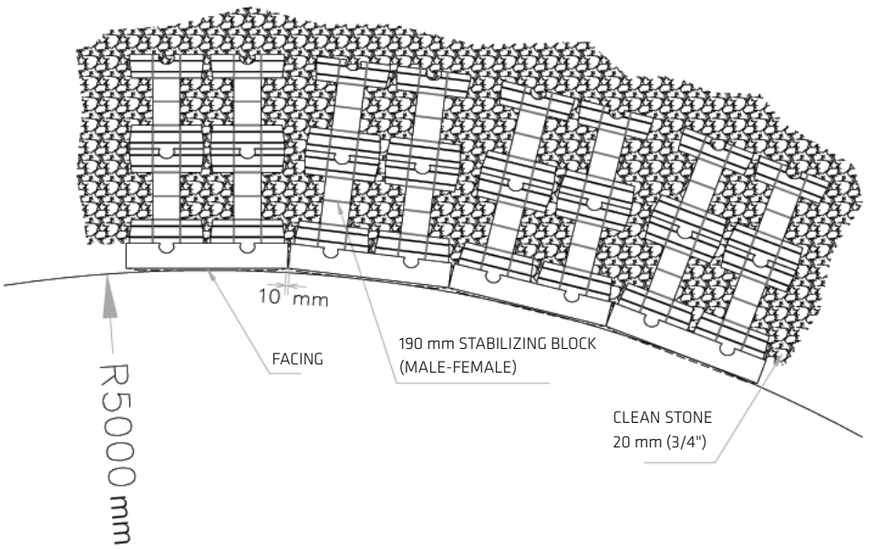
RETAINING WALLS

Permacon Retaining Walls

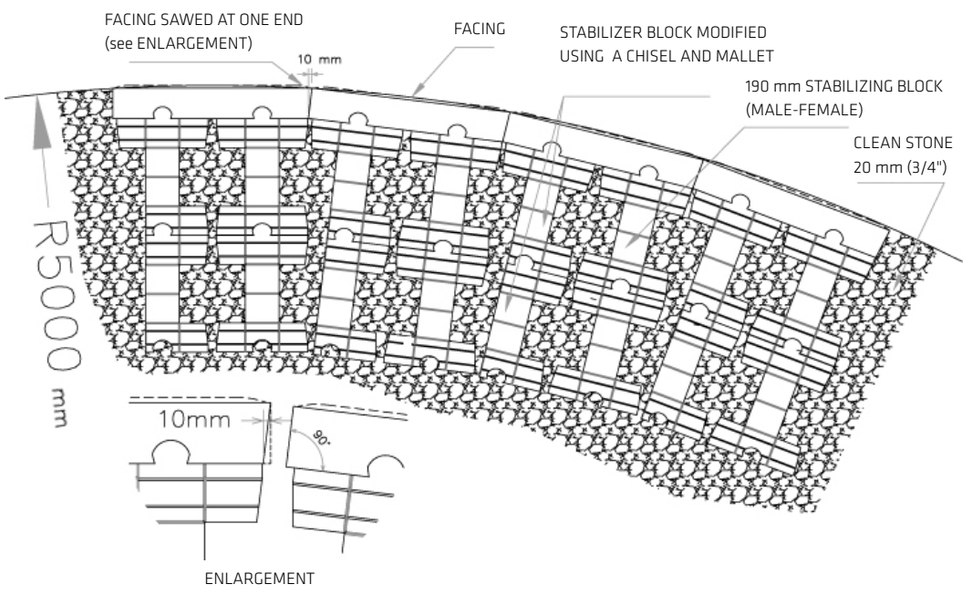
PRODUCT CHARACTERISTICS

FS² SYSTEM – CONSTRUCTION OF A CURVED WALL

CONCAVE CURVED RETAINING WALL WITH 2 STABILIZERS



CONVEX CURVED RETAINING WALL WITH 2 STABILIZERS



RETAINING WALLS

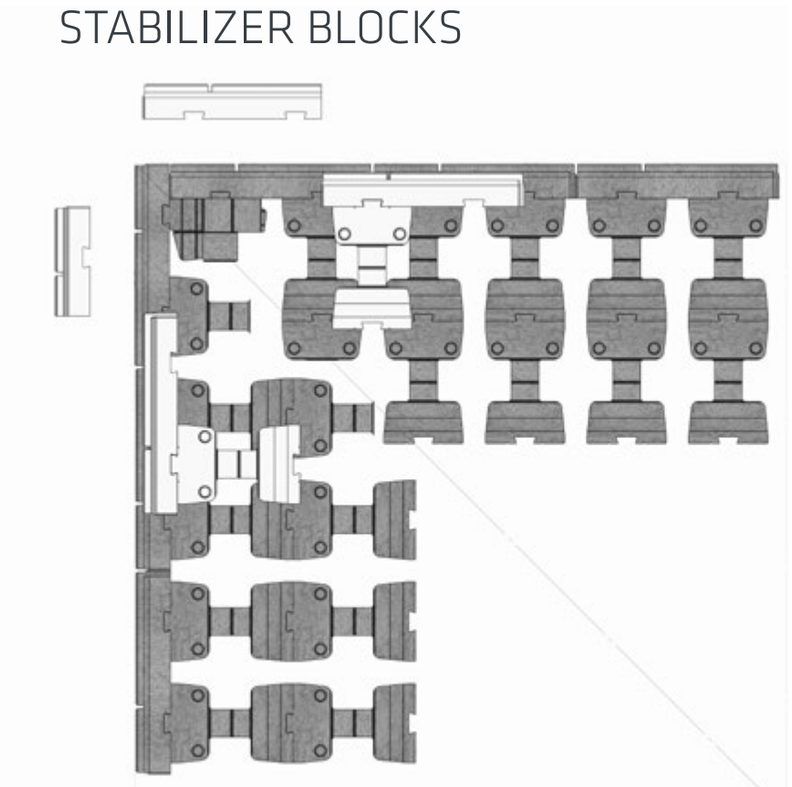
Permacon Retaining Walls

PRODUCT CHARACTERISTICS

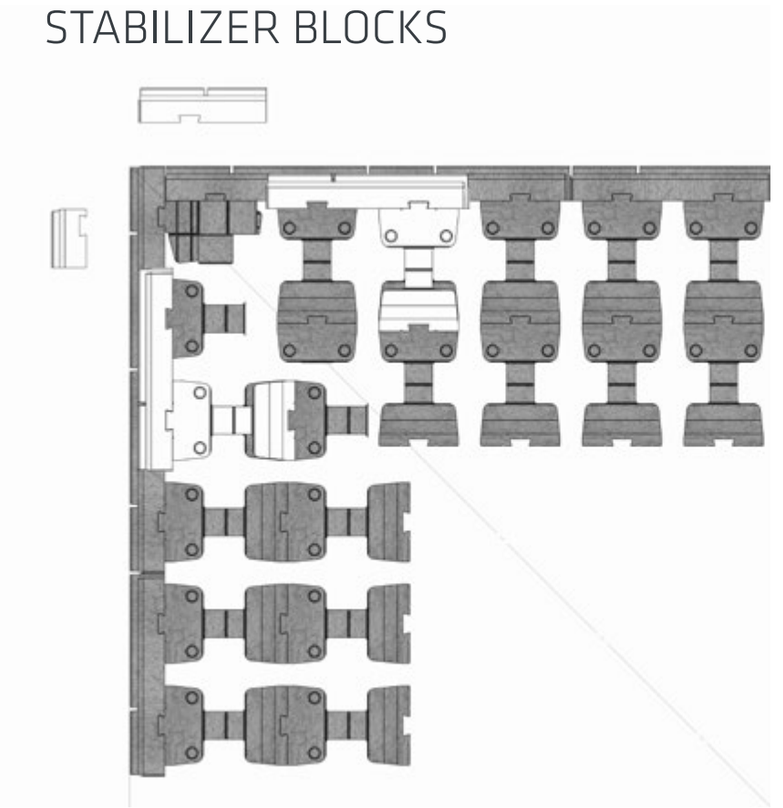
FS² SYSTEM – CONSTRUCTION OF A 90° OUTSIDE CORNER (7° SLOPE)

During the course of the work, stabilizing blocks must be positioned to create the required aesthetic effect (staggered vertical joint and inclination or lack of inclination of the wall's façade). To start the construction of the first row of a 90° outside corner over the bedding, install two mason's lines, as shown on the plan, to form a 90-degree angle. From the corner created by the two lines, install two full-length facings. Then continue the installation of facings in both directions along the lines, and complete by installing stabilizers in keeping with the wall cross-section shown on the plan. To start the construction of a second row and subsequent rows from a 90-degree outside corner, the first stabilizer must be properly positioned very close to the corner (staggered or overlaid), before installing the first full-length facing. This will then make it possible to deduce the required cut to the corner stabilizer.

STAGGERED
STABILIZER BLOCKS



OVERLAID
STABILIZER BLOCKS



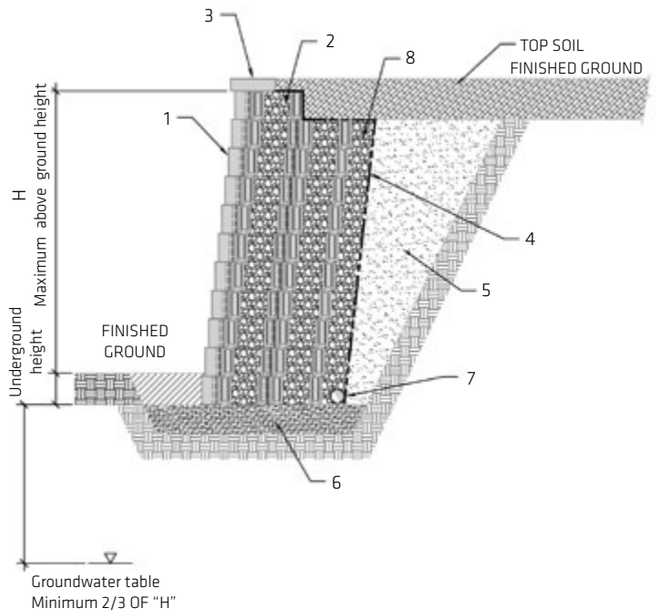
RETAINING WALLS

Permacon Retaining Walls

PRODUCT CHARACTERISTICS

FS² SYSTEM – DESIGNING STRUCTURES

FS² SYSTEM – TYPICAL CROSS-SECTION (non-optimized)



COMPONENTS

1) Facing
2) Stabilizing block (filled with 20 mm clean stone)
3) Glued coping
4) Membrane
5) Compacted backfill
6) Well-compacted footing (0-20 mm)
7) Wrapped drain
8) 20 mm of packed clean stone backfill (minimum thickness of 150 mm)

FS² SYSTEM - DESIGN

NOTE

Before designing and building a retaining wall, it is imperative that you read the introduction to design and construction presented at the start of Section IV.

Typical design views

The FS² system consists of 4 typical design cross-sections presented as a reference for the design of the final section of each of the retaining walls to be built, in keeping with site conditions. Free, easy-to-use application software is available from Permacon to help calculate the total number of rows required to produce the final view of the wall, based on the 4 typical cross-sections.

Various wall cross-sections

To help you with the design phase of a retaining wall incorporating the FS² SYSTEM, Permacon also proposes a few typical wall cross-sections adapted to various site conditions, which could be encountered on your project. They were produced from one of the 4 general cross-sections presented as reference.

NOTE:
TYPICAL CROSS-SECTIONS OF VARIOUS WALLS PROPOSED BY Permacon
These typical wall cross-sections are presented for illustrative purposes and integrate hypotheses and specific calculation parameters, which were used to produce these designs. Furthermore, all structures require final design verification based on the environment where they are to be used.

NOTE: For residential applications, if the above-ground height of the FS² wall to be built is less than 800 mm, the 400 mm penetration height (footing) shown on the drawing can be reduced to at least 200 mm without compromising the stability of the structure. For above-ground heights exceeding 800 mm but below 1,000 mm, a minimum penetration of 300 mm is required. In all other instances, a minimum penetration of 400 mm is required to prevent sliding of the wall in service. See also NOTE 2 on page 102.

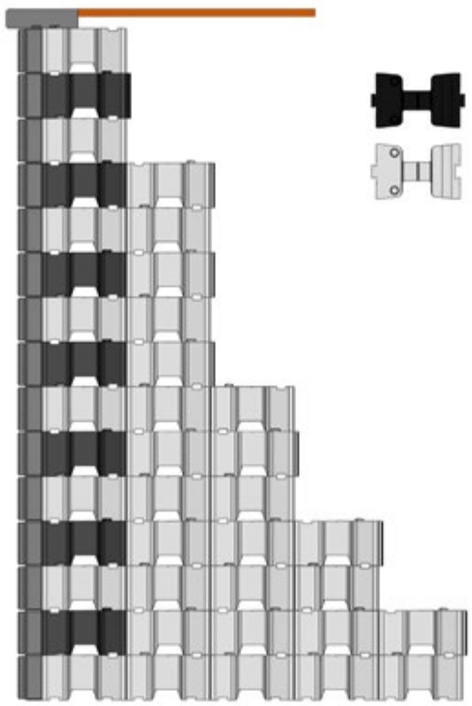
RETAINING WALLS

Permacon Retaining Walls

PRODUCT CHARACTERISTICS

FS² SYSTEM – GENERAL DESIGN CROSS-SECTIONS (composition* of wall rows)

FS² SYSTEM – 0° SLOPE



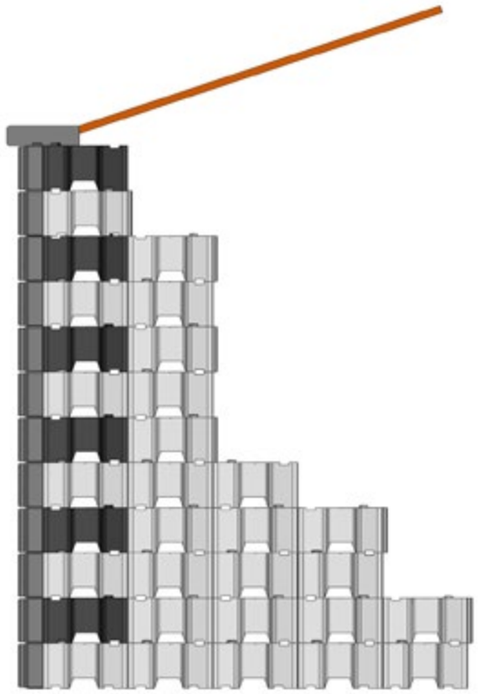
male/male stabilizer

male/female stabilizer

CHOICE OF STABILIZERS
For the first stabilizers connected directly to the facings, from one row to the next, alternate male/female and male/male stabilizers starting with the wall's bottom row. For stabilizers in all other rows, use male/female stabilizers.

N.B.:
Stabilizers must be used along the full depth of the wall for each of the rows before starting work on the next row up.

* Stabilizers: see note and indication



* Stabilizers: see note and indication

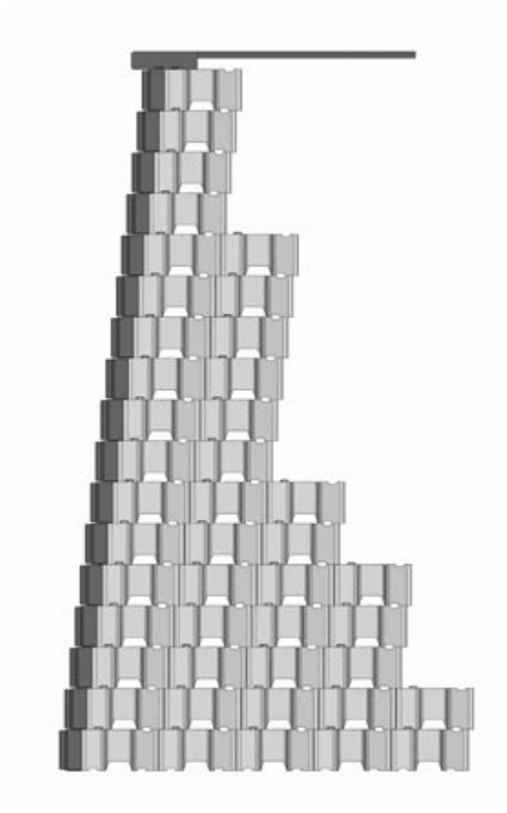
RETAINING WALLS

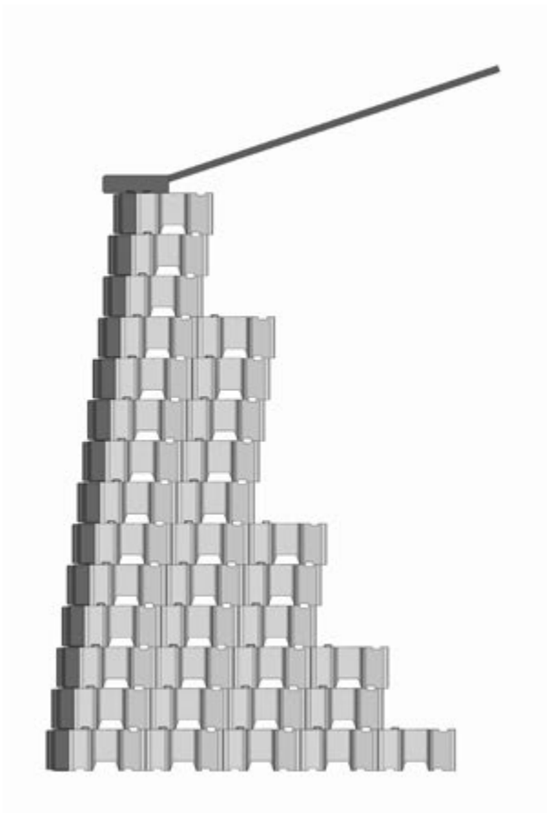
Permacon Retaining Walls

PRODUCT CHARACTERISTICS

FS² SYSTEM – GENERAL DESIGN CROSS-SECTIONS (composition* of wall rows)

FS² SYSTEM – 7° SLOPE





* For inclined walls, use male/female stabilizers

NOTE: Free, easy-to-use application software is available from Permacon to help calculate the total number of rows required to produce the final view of the wall, based on the 4 typical cross-sections.

RETAINING WALLS

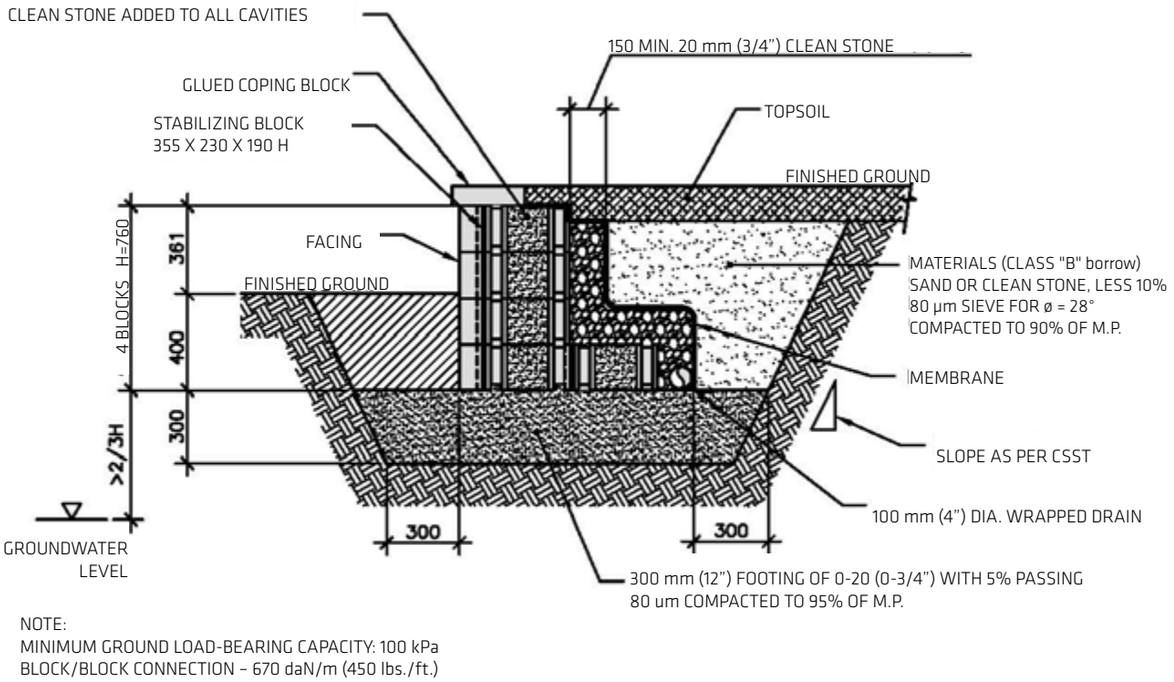
Permacon Retaining Walls

PRODUCT CHARACTERISTICS

FS² SYSTEM – TYPICAL WALL CROSS-SECTION

190 mm STABILIZING BLOCKS WITH FACING, 0°
Maximum above-ground height* of 442 mm (1'5")
WITHOUT SURCHARGE

REMARK
SOME PROPOSED QUEBEC'S SPECIFICATIONS AND REQUIREMENTS OF THIS FIGURE MAY BE DIFFERENT IN ONTARIO AS PER NCMA (NATIONAL CONCRETE MASONRY ASSOCIATION).



NOTE:
MINIMUM GROUND LOAD-BEARING CAPACITY: 100 kPa
BLOCK/BLOCK CONNECTION – 670 daN/m (450 lbs./ft.)

NOTE:
These typical wall cross-sections are presented for illustrative purposes and integrate hypotheses and specific calculation parameters, which were used to produce these designs. Furthermore, all structures require final design verification based on the environment where they are to be used.

* COPING INCLUDED

NOTE: For residential applications, if the above-ground height of the FS² wall to be built is less than 800 mm, the 400 mm penetration height (footing) shown on the drawing can be reduced to at least 200 mm without compromising the stability of the structure. For above-ground heights exceeding 800 mm but below 1000 mm, a minimum penetration of 300 mm is required. In all other instances, a minimum penetration of 400 mm is required to prevent sliding of the wall in service.

For different heights or special conditions, please contact us.

RETAINING WALLS

Permacon Retaining Walls

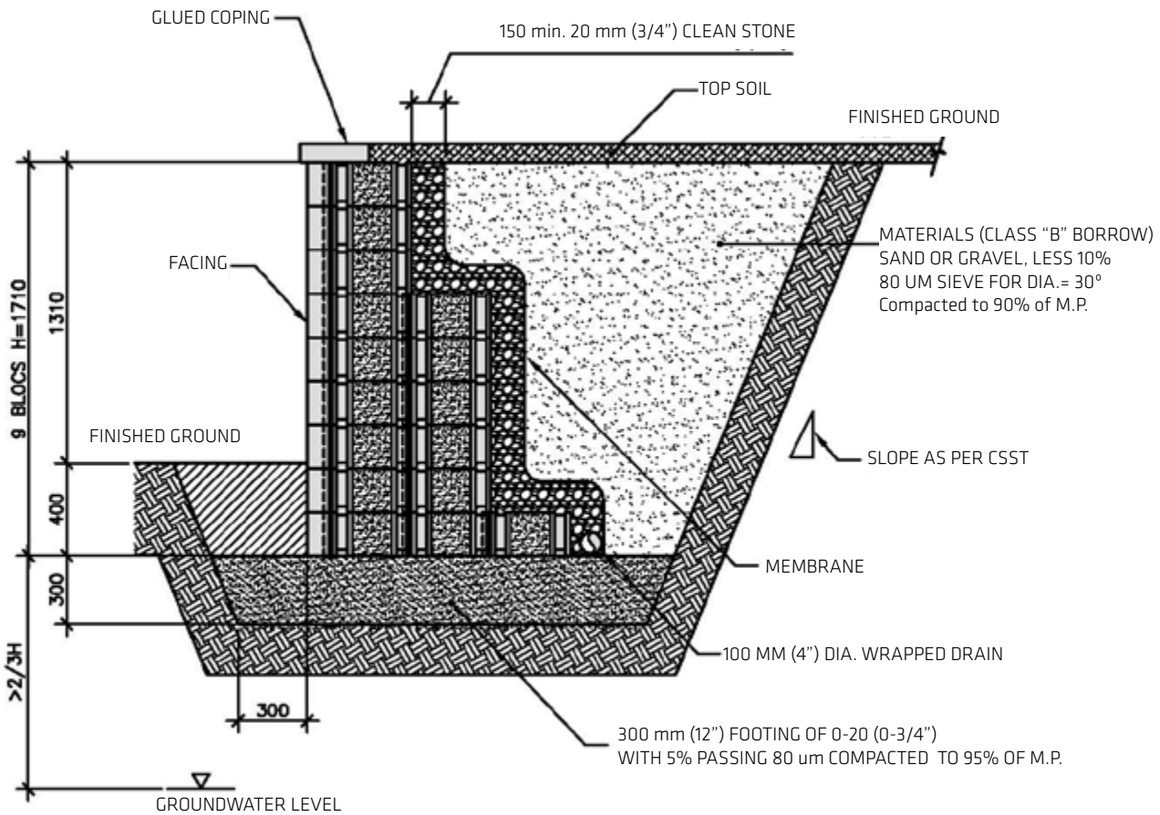
PRODUCT CHARACTERISTICS

FS² SYSTEM – TYPICAL WALL CROSS-SECTION

190 mm STABILIZING BLOCKS WITH FACING, 0°

Maximum above-ground height* of 1,392 mm (4'7")

WITHOUT SURCHARGE



NOTE:
MINIMUM 00 kPa
HOR. SHEAR KEY CAPACITY = 1,340 daN/m (900 lbs./ft.)
MALE-FEMALE KEY CAPACITY = 1,100 daN/m (740 lbs./ft.)

NOTE:
These typical wall cross-sections are presented for illustrative purposes and integrate hypotheses and specific calculation parameters, which were used to produce these designs. Furthermore, all structures require final design verification based on the environment where they are to be used.

* COPING INCLUDED

NOTE: For residential applications, if the above-ground height of the FS² wall to be built is less than 800 mm, the 400 mm penetration height (footing) shown on the drawing can be reduced to at least 200 mm without compromising the stability of the structure. For above-ground heights exceeding 800 mm but below 1000 mm, a minimum penetration of 300 mm is required. In all other instances, a minimum penetration of 400 mm is required to prevent sliding of the wall in service.

For different heights or special conditions, please contact us.

RETAINING WALLS

Permacon Retaining Walls

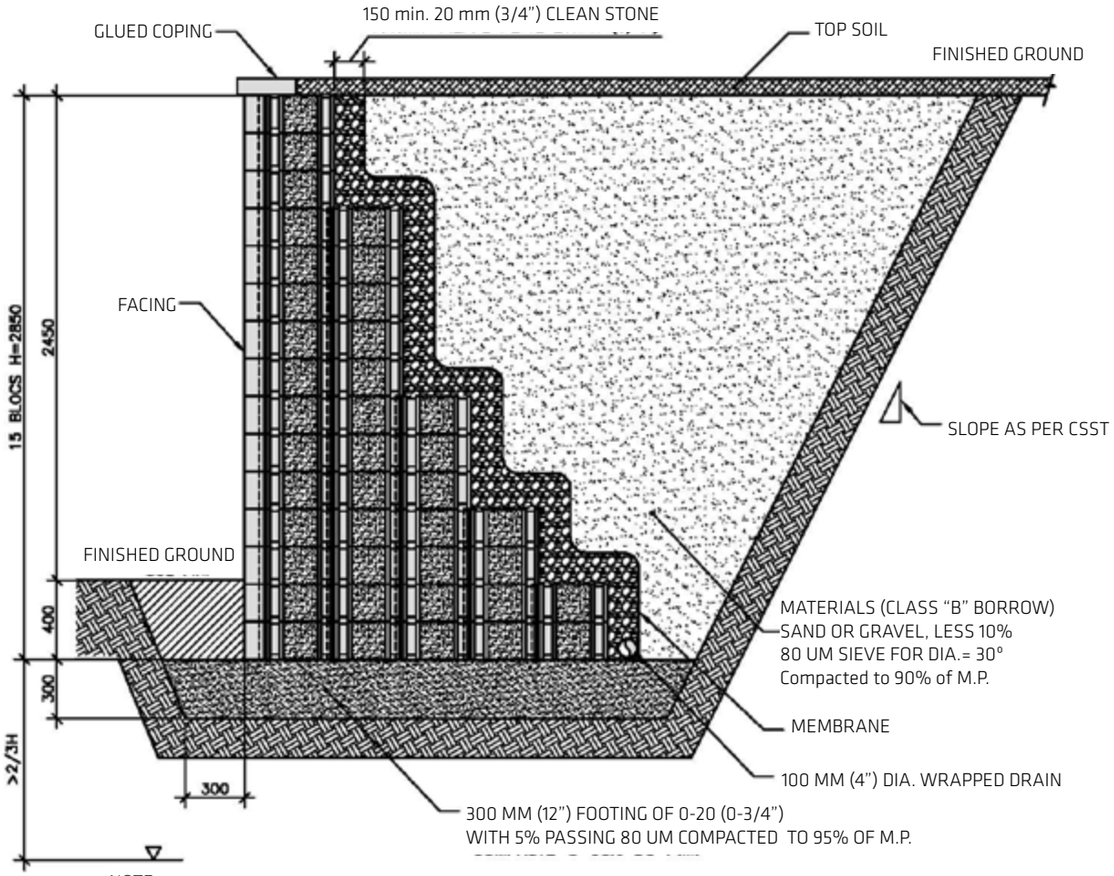
PRODUCT CHARACTERISTICS

FS² SYSTEM – TYPICAL WALL CROSS-SECTION

190 mm STABILIZING BLOCKS WITH FACING, 0°

Maximum above-ground height* of 2,532 mm (8'3")

WITHOUT SURCHARGE



NOTE:
MINIMUM GROUND LOAD-BEARING CAPACITY: 100 kPa
HOR. SHEAR KEY CAPACITY = 1,340 daN/m (900 lbs./ft.)
MALE-FEMALE KEY CAPACITY = 1,100 daN/m (740 lbs./ft.)

NOTE:
These typical wall cross-sections are presented for illustrative purposes and integrate hypotheses and specific calculation parameters, which were used to produce these designs. Furthermore, all structures require final design verification based on the environment where they are to be used.

* COPING INCLUDED

NOTE: For residential applications, if the above-ground height of the FS² wall to be built is less than 800 mm, the 400 mm penetration height (footing) shown on the drawing can be reduced to at least 200 mm without compromising the stability of the structure. For above-ground heights exceeding 800 mm but below 1000 mm, a minimum penetration of 300 mm is required. In all other instances, a minimum penetration of 400 mm is required to prevent sliding of the wall in service.

For different heights or special conditions, please contact us.

RETAINING WALLS

Permacon Retaining Walls

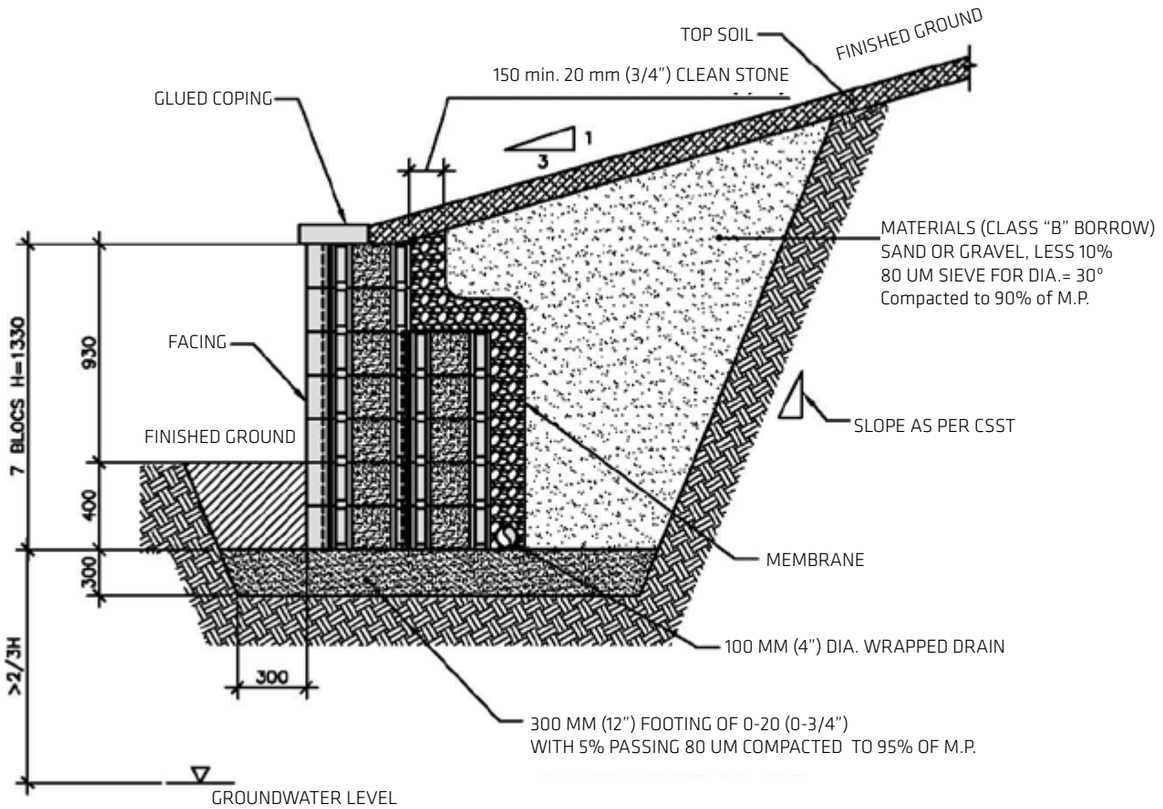
PRODUCT CHARACTERISTICS

FS² SYSTEM – TYPICAL WALL CROSS-SECTION

190 mm STABILIZING BLOCKS WITH FACING, 0°

Maximum above-ground height* of 1,012 mm (3'4")

WITH SURCHARGE



NOTE:
MINIMUM GROUND LOAD-BEARING CAPACITY: 100 kPa
HOR. SHEAR KEY CAPACITY = 1,340 daN/m (900 lbs./ft.)
MALE-FEMALE KEY CAPACITY = 1,100 daN/m (740 lbs./ft.)

NOTE:
These typical wall cross-sections are presented for illustrative purposes and integrate hypotheses and specific calculation parameters, which were used to produce these designs. Furthermore, all structures require final design verification based on the environment where they are to be used.

* COPING INCLUDED

NOTE: For residential applications, if the above-ground height of the FS² wall to be built is less than 800 mm, the 400 mm penetration height (footing) shown on the drawing can be reduced to at least 200 mm without compromising the stability of the structure. For above-ground heights exceeding 800 mm but below 1000 mm, a minimum penetration of 300 mm is required. In all other instances, a minimum penetration of 400 mm is required to prevent sliding of the wall in service.

For different heights or special conditions, please contact us.

RETAINING WALLS

Permacon Retaining Walls

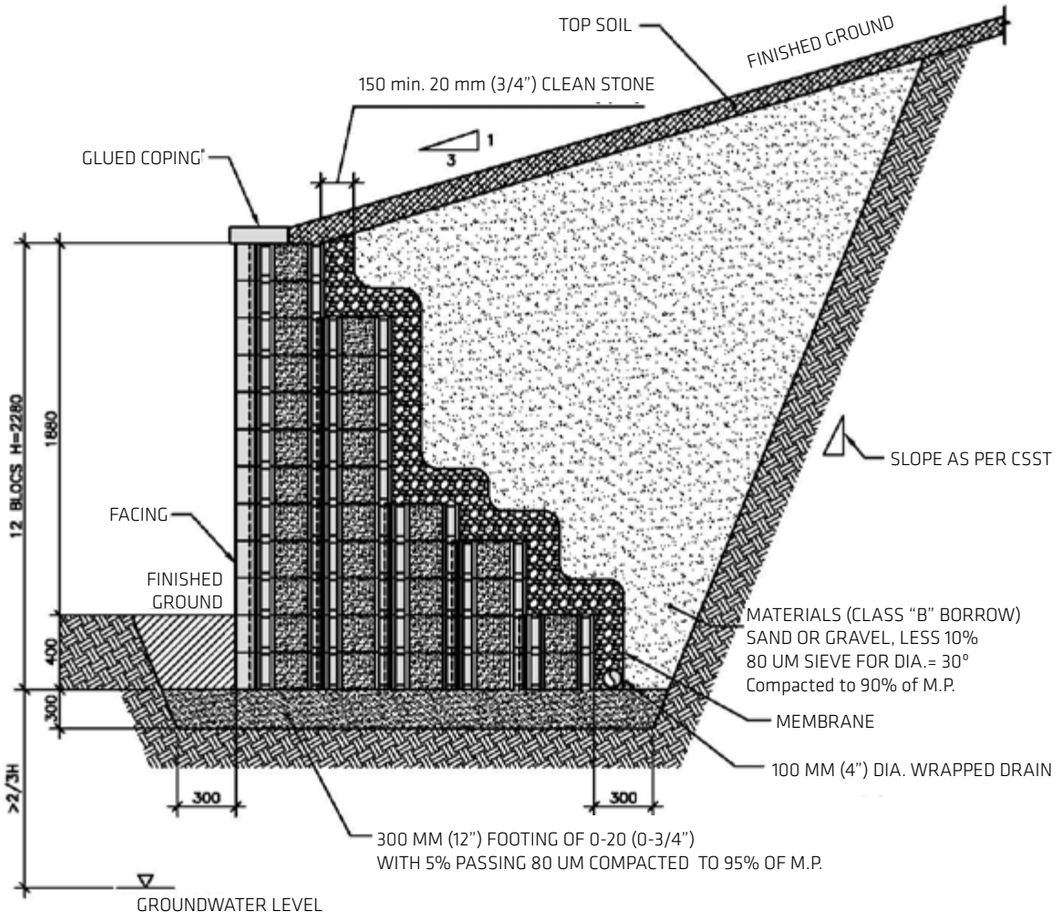
PRODUCT CHARACTERISTICS

FS² SYSTEM – TYPICAL WALL CROSS-SECTION

190 mm STABILIZING BLOCKS WITH FACING, 0°

Maximum above-ground height* of 1,962 mm (6'5")

WITH SURCHARGE



NOTE:
MINIMUM GROUND LOAD-BEARING CAPACITY: 100 kPa
HOR. SHEAR KEY CAPACITY = 1,340 daN/m (900 lbs./ft.)
MALE-FEMALE KEY CAPACITY = 1,100 daN/m (740 lbs./ft.)

NOTE:
These typical wall cross-sections are presented for illustrative purposes and integrate hypotheses and specific calculation parameters, which were used to produce these designs. Furthermore, all structures require final design verification based on the environment where they are to be used.

* COPING INCLUDED

For different heights or special conditions, please contact us.

RETAINING WALLS

Permacon Retaining Walls

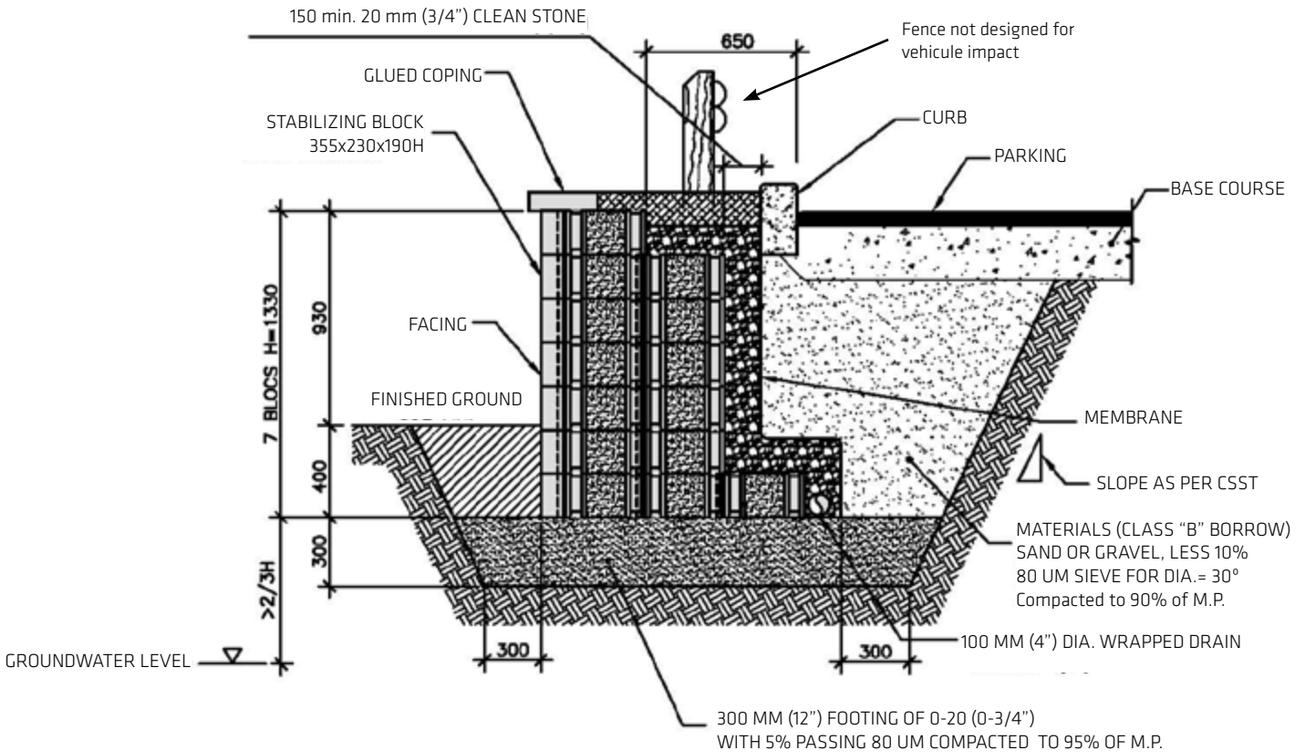
PRODUCT CHARACTERISTICS

FS² SYSTEM – TYPICAL WALL CROSS-SECTION

190 mm STABILIZING BLOCKS WITH FACING, 0° or 7°

Maximum above-ground height* of 1,012 mm (3'4")

WITH RESIDENTIAL PARKING ON TOP



NOTE:
MINIMUM GROUND LOAD-BEARING CAPACITY: 100 kPa
HOR. SHEAR KEY CAPACITY = 1,340 daN/m (900 lbs./ft.)
MALE-FEMALE KEY CAPACITY = 1,100 daN/m (740 lbs./ft.)

NOTE:
These typical wall cross-sections are presented for illustrative purposes and integrate hypotheses and specific calculation parameters, which were used to produce these designs. Furthermore, all structures require final design verification based on the environment where they are to be used.

* COPING INCLUDED

For different heights or special conditions, please contact us.

RETAINING WALLS

Permacon Retaining Walls

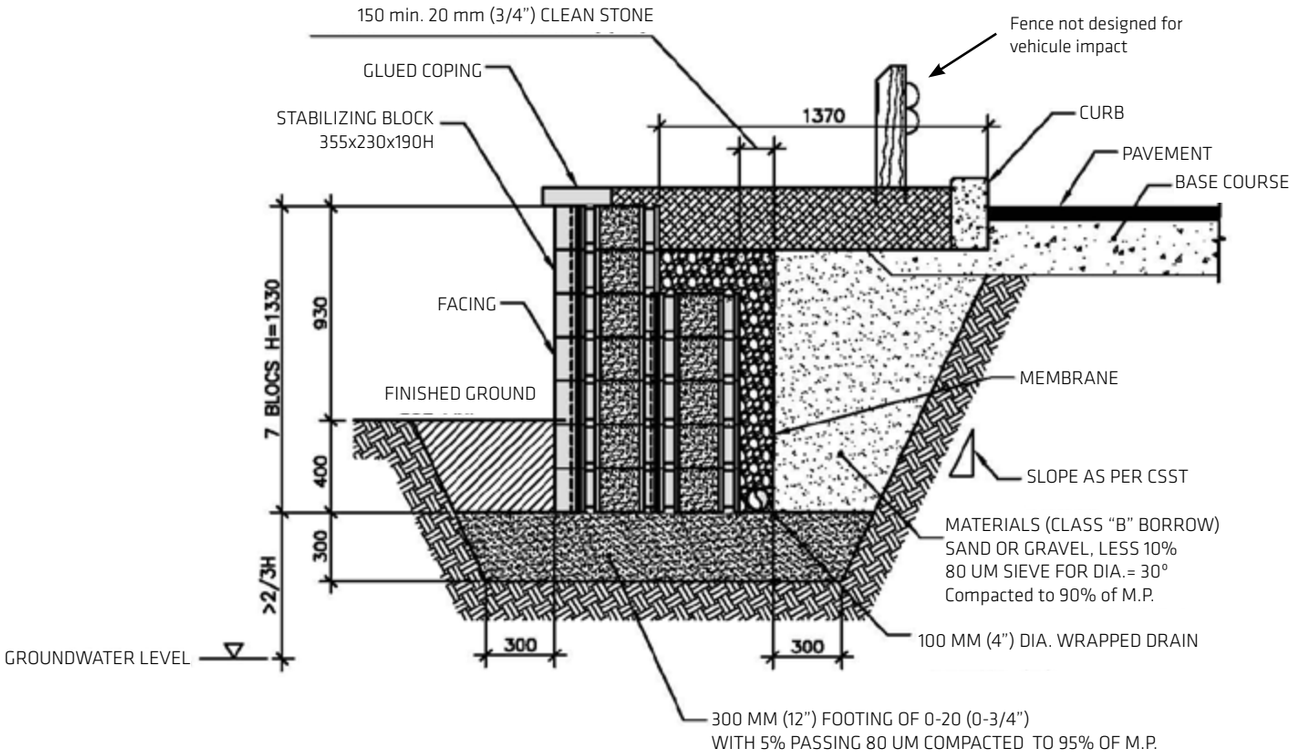
PRODUCT CHARACTERISTICS

FS² SYSTEM – TYPICAL WALL CROSS-SECTION

190 mm STABILIZING BLOCKS WITH FACING, 0° or 7°

Maximum above-ground height* of 1,012 mm (3'4")

WITH COMMERCIAL PARKING ON TOP



NOTE:
MINIMUM GROUND LOAD-BEARING CAPACITY: 100 kPa
HOR. SHEAR KEY CAPACITY = 1,340 daN/m (900 lbs./ft.)
MALE-FEMALE KEY CAPACITY = 1,100 daN/m (740 lbs./ft.)

NOTE:
These typical wall cross-sections are presented for illustrative purposes and integrate hypotheses and specific calculation parameters, which were used to produce these designs. Furthermore, all structures require final design verification based on the environment where they are to be used.

* COPING INCLUDED

For different heights or special conditions, please contact us.

RETAINING WALLS

Permacon Retaining Walls

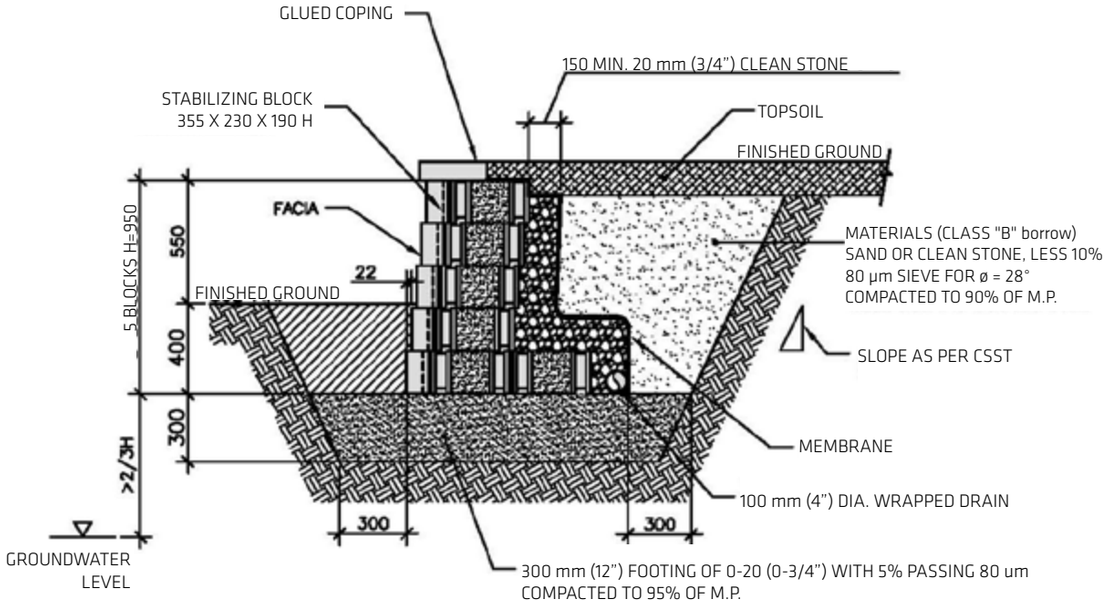
PRODUCT CHARACTERISTICS

FS² SYSTEM – TYPICAL WALL CROSS-SECTION

190 mm STABILIZING BLOCKS WITH FACING, 7°

Maximum above-ground height* of 632 mm (2'1")

WITHOUT SURCHARGE



NOTE:
MINIMUM GROUND LOAD-BEARING CAPACITY: 100 kPa
BLOCK/BLOCK CONNECTION – 670 daN/m (450 lbs./ft.)

NOTE:
These typical wall cross-sections are presented for illustrative purposes and integrate hypotheses and specific calculation parameters, which were used to produce these designs. Furthermore, all structures require final design verification based on the environment where they are to be used.

* COPING INCLUDED

NOTE: For residential applications, if the above-ground height of the FS² wall to be built is less than 800 mm, the 400 mm penetration height (footing) shown on the drawing can be reduced to at least 200 mm without compromising the stability of the structure. For above-ground heights exceeding 800 mm but below 1000 mm, a minimum penetration of 300 mm is required. In all other instances, a minimum penetration of 400 mm is required to prevent sliding of the wall in service.

For different heights or special conditions, please contact us.

RETAINING WALLS

Permacon Retaining Walls

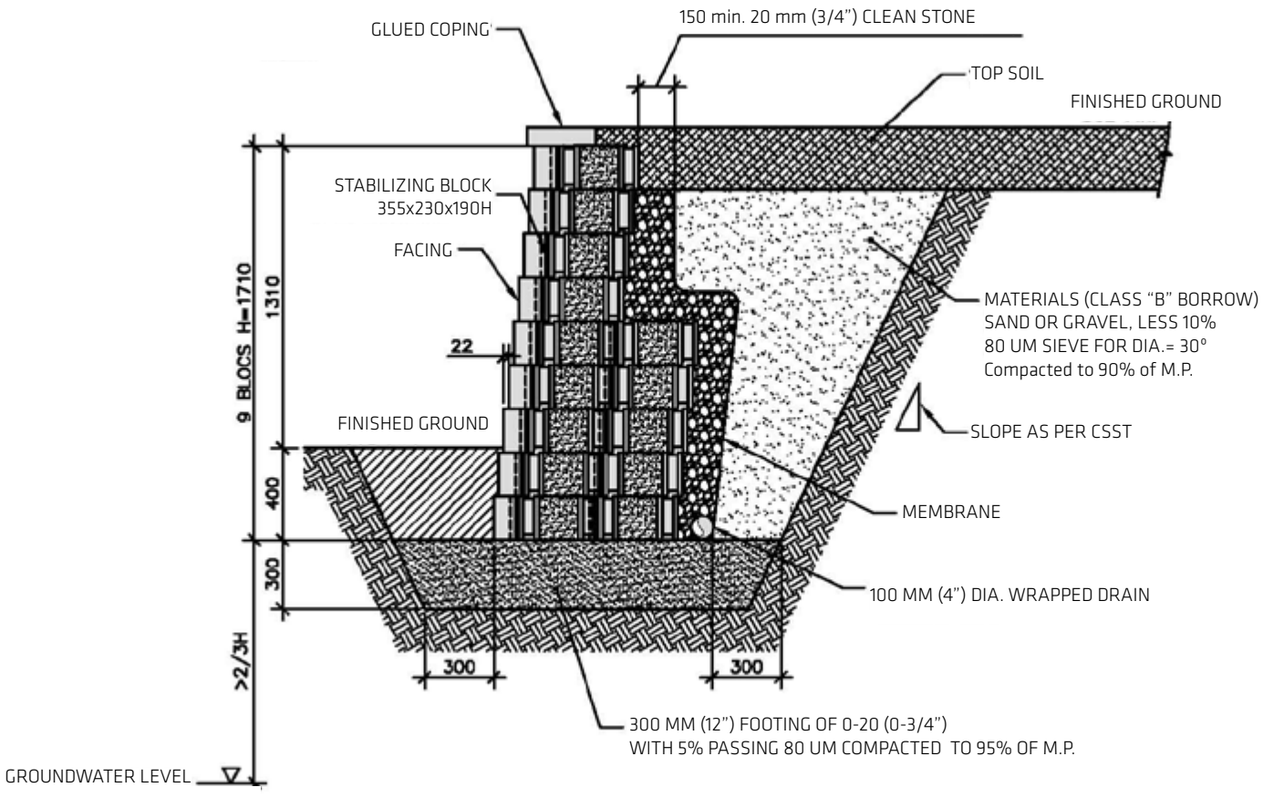
PRODUCT CHARACTERISTICS

FS² SYSTEM – TYPICAL WALL CROSS-SECTION

190 mm STABILIZING BLOCKS WITH FACING, 7°

Maximum above-ground height* of 1,392 mm (4'7")

WITHOUT SURCHARGE



NOTE:
MINIMUM GROUND LOAD-BEARING CAPACITY: 100 kPa
HOR. SHEAR KEY CAPACITY = 1,340 daN/m (900 lbs./ft.)
MALE-FEMALE KEY CAPACITY = 1,100 daN/m (740 lbs./ft.)

NOTE:
These typical wall cross-sections are presented for illustrative purposes and integrate hypotheses and specific calculation parameters, which were used to produce these designs. Furthermore, all structures require final design verification based on the environment where they are to be used.

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For different heights or special conditions, please contact us.

RETAINING WALLS

Permacon Retaining Walls

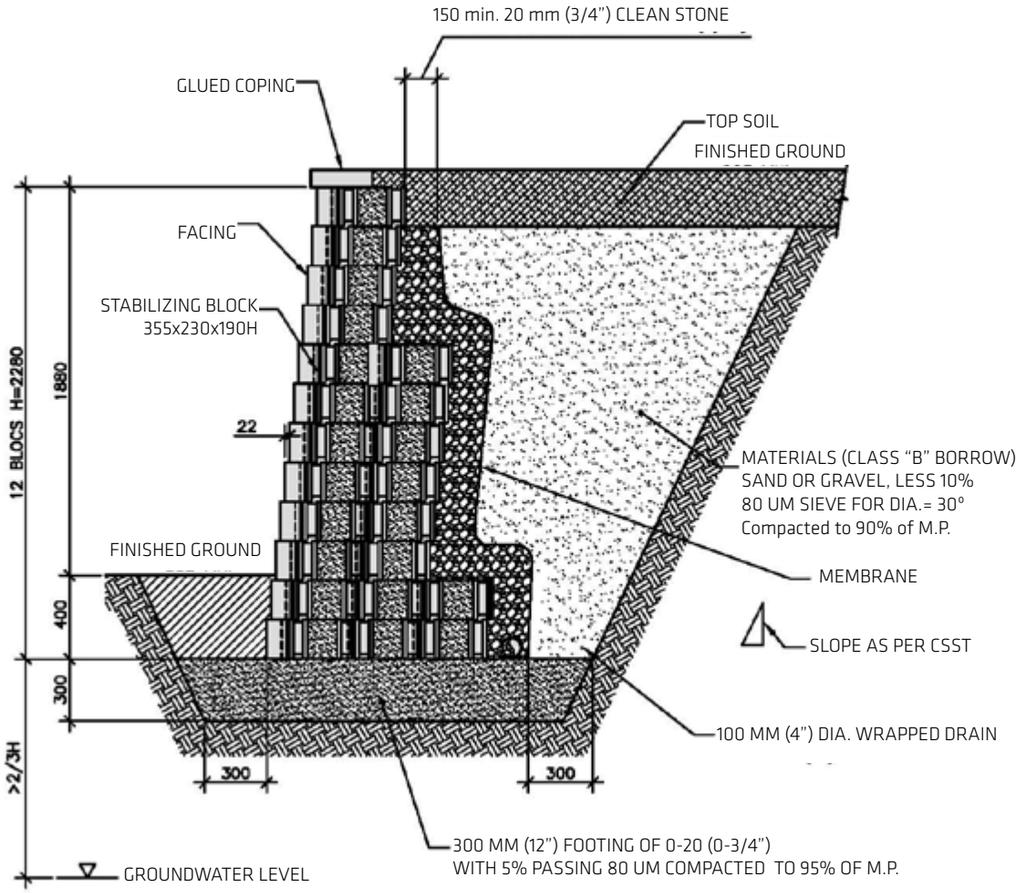
PRODUCT CHARACTERISTICS

FS² SYSTEM – TYPICAL WALL CROSS-SECTION

190 mm STABILIZING BLOCKS WITH FACING, 7°

Maximum above-ground height* of 1,962 mm (6'5")

WITHOUT SURCHARGE



NOTE:
MINIMUM GROUND LOAD-BEARING CAPACITY: 100 kPa
HOR. SHEAR KEY CAPACITY = 1,340 daN/m (900 lbs./ft.)
MALE-FEMALE KEY CAPACITY = 1,100 daN/m (740 lbs./ft.)

NOTE:
These typical wall cross-sections are presented for illustrative purposes and integrate hypotheses and specific calculation parameters, which were used to produce these designs. Furthermore, all structures require final design verification based on the environment where they are to be used.

* COPING INCLUDED

NOTE: For residential applications, if the above-ground height of the FS² wall to be built is less than 800 mm, the 400 mm penetration height (footing) shown on the drawing can be reduced to at least 200 mm without compromising the stability of the structure. For above-ground heights exceeding 800 mm but below 1000 mm, a minimum penetration of 300 mm is required. In all other instances, a minimum penetration of 400 mm is required to prevent sliding of the wall in service.

For different heights or special conditions, please contact us.

RETAINING WALLS

Permacon Retaining Walls

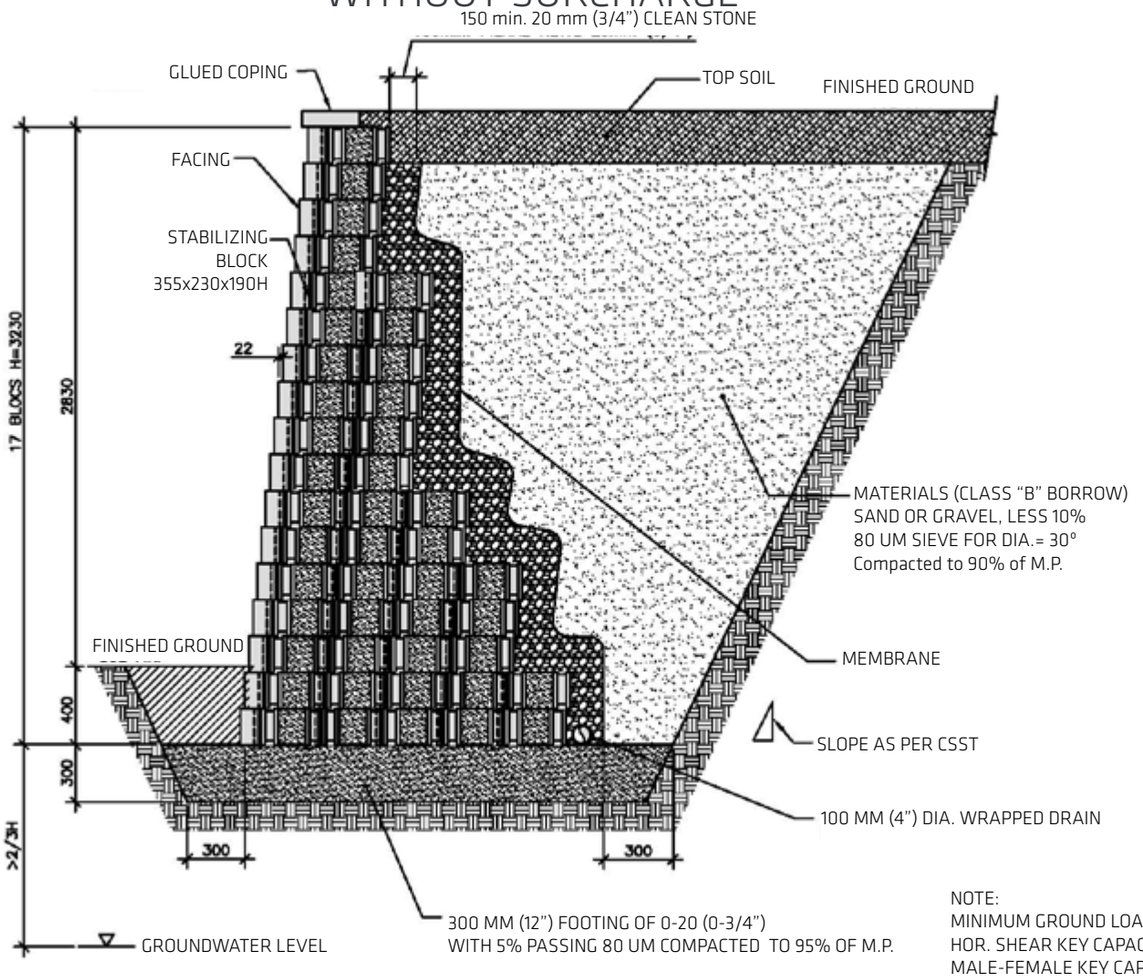
PRODUCT CHARACTERISTICS

FS² SYSTEM – TYPICAL WALL CROSS-SECTION

190 mm STABILIZING BLOCKS WITH FACING, 7°

Maximum above-ground height* of 2,912 mm (9'7")

WITHOUT SURCHARGE



NOTE:
MINIMUM GROUND LOAD-BEARING CAPACITY: 100 kPa
HOR. SHEAR KEY CAPACITY = 1,340 daN/m (900 lbs./ft.)
MALE-FEMALE KEY CAPACITY = 1,100 daN/m (740 lbs./ft.)

NOTE:
These typical wall cross-sections are presented for illustrative purposes and integrate hypotheses and specific calculation parameters, which were used to produce these designs. Furthermore, all structures require final design verification based on the environment where they are to be used.

* COPING INCLUDED

NOTE: For residential applications, if the above-ground height of the FS² wall to be built is less than 800 mm, the 400 mm penetration height (footing) shown on the drawing can be reduced to at least 200 mm without compromising the stability of the structure. For above-ground heights exceeding 800 mm but below 1000 mm, a minimum penetration of 300 mm is required. In all other instances, a minimum penetration of 400 mm is required to prevent sliding of the wall in service.

For different heights or special conditions, please contact us.

RETAINING WALLS

Permacon Retaining Walls

PRODUCT CHARACTERISTICS

FS² SYSTEM – TYPICAL WALL CROSS-SECTION

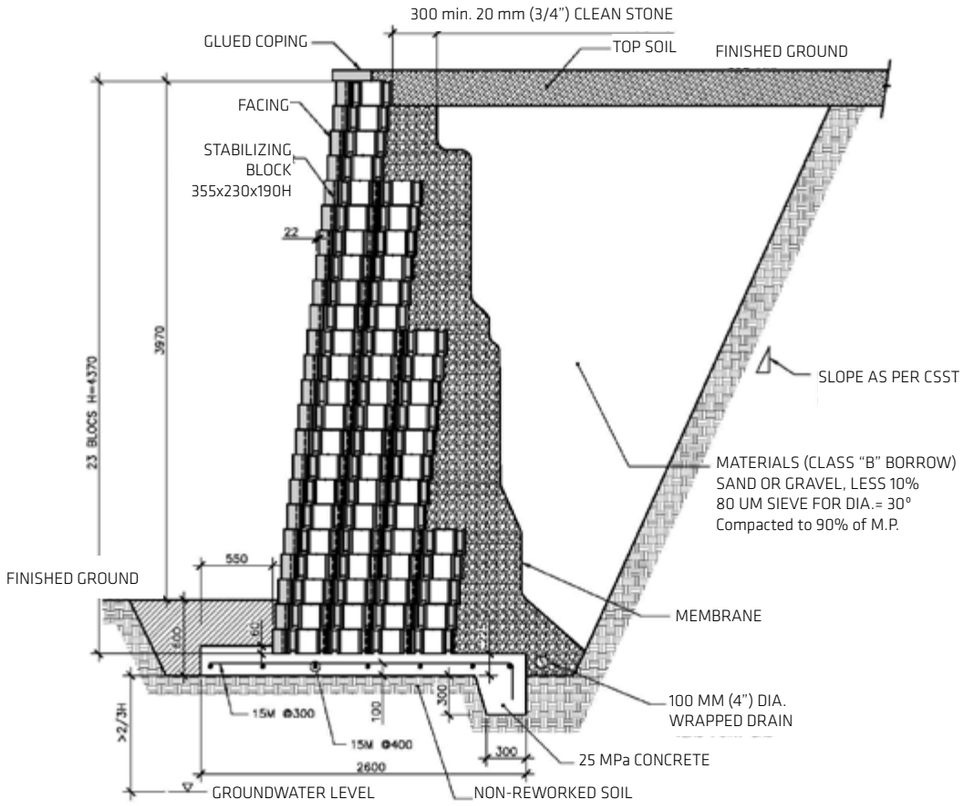
Very high FS² wall incorporating a reinforced concrete strip footing with vertical upward abutment

190 mm STABILIZING BLOCKS WITH FACING, 7°

(overlapping stabilizers)

WITHOUT SURCHARGE

When designing very high FS² walls, the minimum safe resistance to sliding is the key parameter for controlling the structural integrity of the wall (above-ground height at 2,912 mm). The use of a reinforced concrete strip footing built directly on the excavated, non-reworked soil serves as an abutment preventing the base of the wall from sliding while allowing the construction of a taller wall (see proposed drawing). First, it is imperative to ensure the load-bearing capacity of the soil as it relates to Permacon's specifications by conducting the required soil tests (approval of an engineer required). Finally Permacon provides independent design expertise ensuring the wall's safety and potential performance. Full compliance with all recommended construction details is essential.



NOTE:
LOAD-BEARING CAPACITY OF THE SOIL ASSUMED TO BE 100 MPa; TO BE CONFIRMED BY A SOIL LABORATORY
HOR. SHEAR KEY CAPACITY = 1,340 daN/m (900 lbs./ft.)
MALE-FEMALE KEY CAPACITY = 1,100 daN/m (740 lbs./ft.)

NOTE:
These typical wall cross-sections are presented for illustrative purposes and integrate hypotheses and specific calculation parameters, which were used to produce these designs. Furthermore, all structures require final design verification based on the environment where they are to be used.

For different heights or special conditions, contact us.

RETAINING WALLS

Permacon Retaining Walls

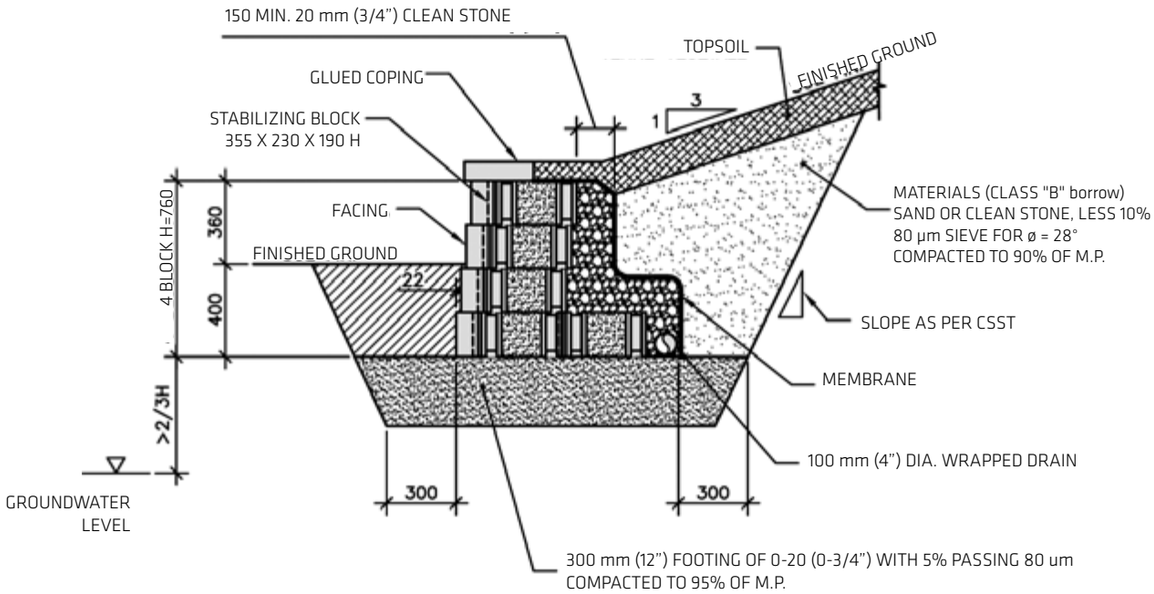
PRODUCT CHARACTERISTICS

FS² SYSTEM – TYPICAL WALL CROSS-SECTION

190 mm STABILIZING BLOCKS WITH FACING, 7°

Maximum above-ground height* of 442 mm (1'5")

WITH SURCHARGE



NOTE:
MINIMUM GROUND LOAD-BEARING CAPACITY: 100 kPa
BLOCK/BLOCK CONNECTION – 670 daN/m (450 lbs./ft.)

NOTE:
These typical wall cross-sections are presented for illustrative purposes and integrate hypotheses and specific calculation parameters, which were used to produce these designs. Furthermore, all structures require final design verification based on the environment where they are to be used.

* COPING INCLUDED

NOTE: For residential applications, if the above-ground height of the FS² wall to be built is less than 800 mm, the 400 mm penetration height (footing) shown on the drawing can be reduced to at least 200 mm without compromising the stability of the structure. For above-ground heights exceeding 800 mm but below 1000 mm, a minimum penetration of 300 mm is required. In all other instances, a minimum penetration of 400 mm is required to prevent sliding of the wall in service.

For different heights or special conditions, please contact us.

RETAINING WALLS

Permacon Retaining Walls

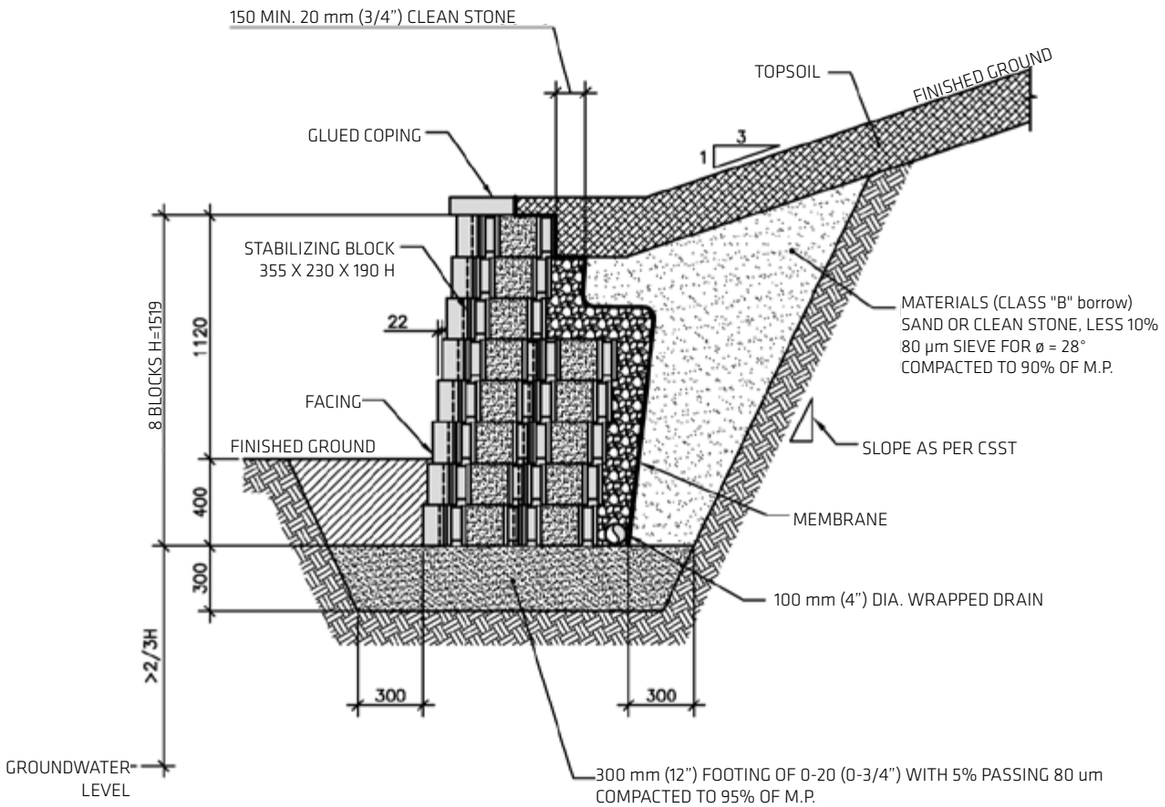
PRODUCT CHARACTERISTICS

FS² SYSTEM – TYPICAL WALL CROSS-SECTION

190 mm STABILIZING BLOCKS WITH FACING, 7°

Maximum above-ground height* of 1,202 mm (4'0")

WITH SURCHARGE



NOTE:
LOAD-BEARING CAPACITY OF THE SOIL ASSUMED TO BE 100 MPa; TO BE CONFIRMED BY A SOIL LABORATORY
HOR. SHEAR KEY CAPACITY = 1,340 daN/m (900 lbs./ft.)
MALE-FEMALE KEY CAPACITY = 1,100 daN/m (740 lbs./ft.)

NOTE:
These typical wall cross-sections are presented for illustrative purposes and integrate hypotheses and specific calculation parameters, which were used to produce these designs. Furthermore, all structures require final design verification based on the environment where they are to be used.

* COPING INCLUDED

NOTE: For residential applications, if the above-ground height of the FS² wall to be built is less than 800 mm, the 400 mm penetration height (footing) shown on the drawing can be reduced to at least 200 mm without compromising the stability of the structure. For above-ground heights exceeding 800 mm but below 1000 mm, a minimum penetration of 300 mm is required. In all other instances, a minimum penetration of 400 mm is required to prevent sliding of the wall in service.

For different heights or special conditions, please contact us.

RETAINING WALLS

Permacon Retaining Walls

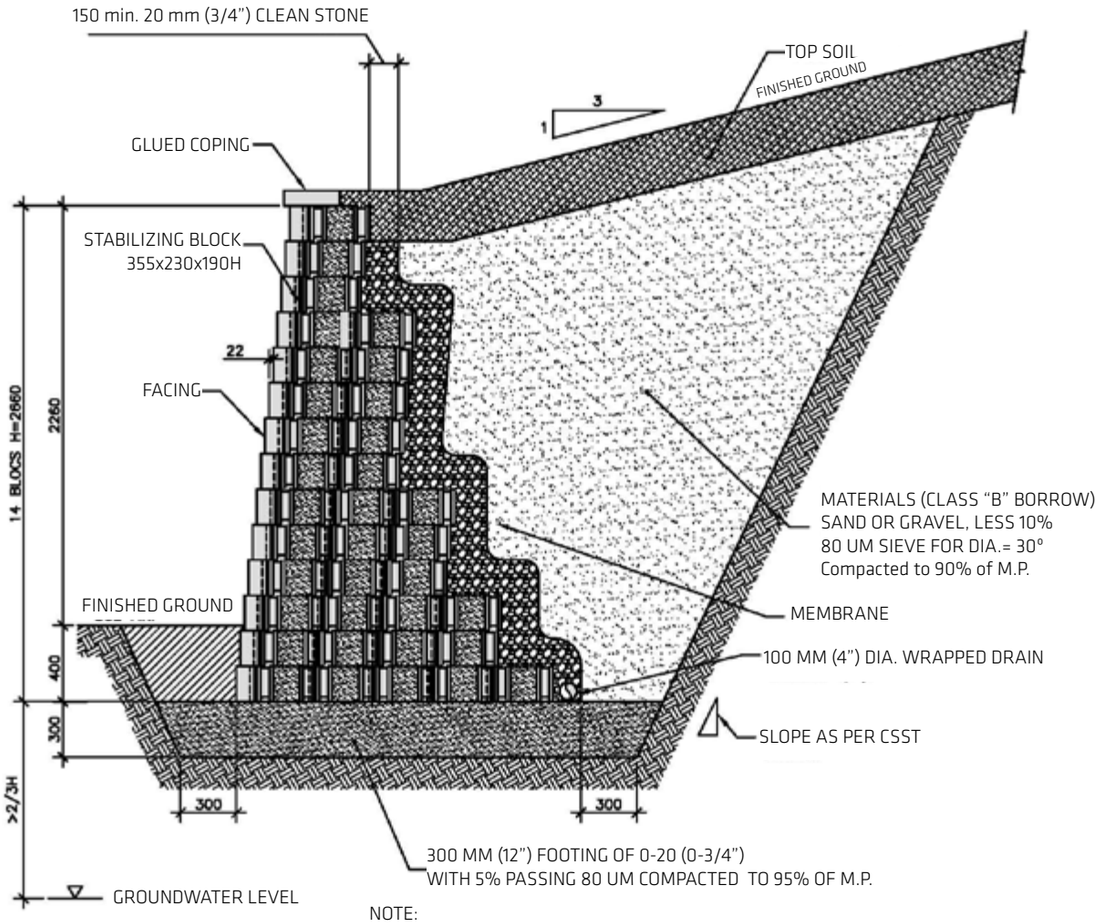
PRODUCT CHARACTERISTICS

FS² SYSTEM – TYPICAL WALL CROSS-SECTION

190 mm STABILIZING BLOCKS WITH FACING, 7°

Maximum above-ground height* of 2,342 mm (7'8")

WITH SURCHARGE



NOTE:
MINIMUM GROUND LOAD-BEARING CAPACITY: 100 kPa
HOR. SHEAR KEY CAPACITY = 1,340 daN/m (900 lbs./ft.)
MALE-FEMALE KEY CAPACITY = 1,100 daN/m (740 lbs./ft.)

NOTE:
These typical wall cross-sections are presented for illustrative purposes and integrate hypotheses and specific calculation parameters, which were used to produce these designs. Furthermore, all structures require final design verification based on the environment where they are to be used.

* COPING INCLUDED

NOTE: For residential applications, if the above-ground height of the FS² wall to be built is less than 800 mm, the 400 mm penetration height (footing) shown on the drawing can be reduced to at least 200 mm without compromising the stability of the structure. For above-ground heights exceeding 800 mm but below 1000 mm, a minimum penetration of 300 mm is required. In all other instances, a minimum penetration of 400 mm is required to prevent sliding of the wall in service.

For different heights or special conditions, please contact us.

RETAINING WALLS

Permacon Retaining Walls

PRODUCT CHARACTERISTICS

FS² SYSTEM – PRIVACY WALL – DESIGN

Safe design and construction

A privacy wall is considered a structure. This type of freestanding structure is held upright by its own weight. Design and construction must be carried out in compliance with prevailing construction codes and best industry practices.

Important

Strict compliance with specifications relating to the typical wall cross-sections proposed by Permacon is required in the execution of the work.

Performance in service

A privacy wall must withstand strong winds, earthquakes and other strong impacts in service (to be specified). The engineer designing a privacy wall must ensure that the structure will perform in service, proposing safe plans and specifications for the wall to be built, in order to avoid any buckling, toppling or settling. Furthermore, to avoid the collapse of a privacy wall, it is imperative to design acute angles (90° singles or doubles) limiting the maximum length of a straight wall section without lateral support to a given above-ground height.

Design

At the design stage and before any work is undertaken, the construction of a privacy wall requires detailed planning to determine its optimal configuration (the maximum length of the straight wall based on its projected above-ground height). Furthermore, any structure to be built must be protected from service impacts (vehicles, snow-clearing, various stresses, etc.) It is also imperative to protect the subgrade against freezing using a rigid insulating material, since any ground movement could upset the structure's balance and ultimately lead to its collapse. This design approach is essential for ensuring that the wall will hold up safely and retain its structural integrity over the long term.

NOTE:
VARIOUS PRIVACY WALL CROSS-SECTIONS PROPOSED BY Permacon
These typical wall cross-sections are presented for illustrative purposes and integrate the hypotheses and specific calculation parameters, which were used to produce these designs. Furthermore, all structures require final design verification based on the environment where they are to be used.

RETAINING WALLS

Permacon Retaining Walls

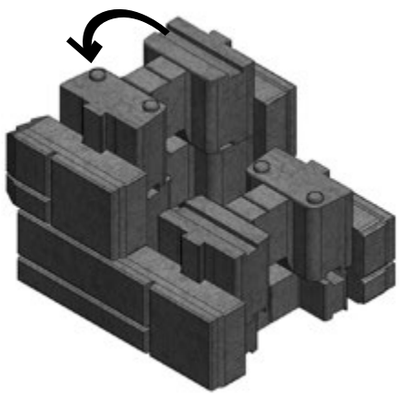
PRODUCT CHARACTERISTICS

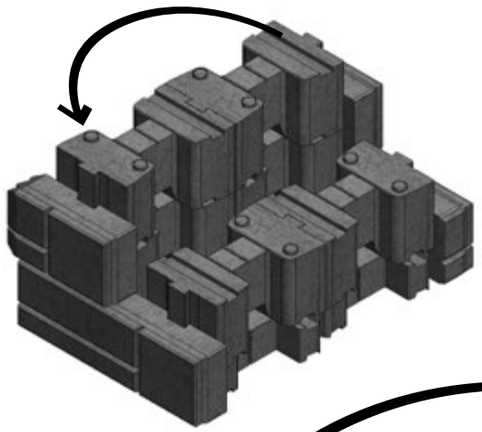
FS² SYSTEM – STRAIGHT PRIVACY WALL – ASSEMBLY

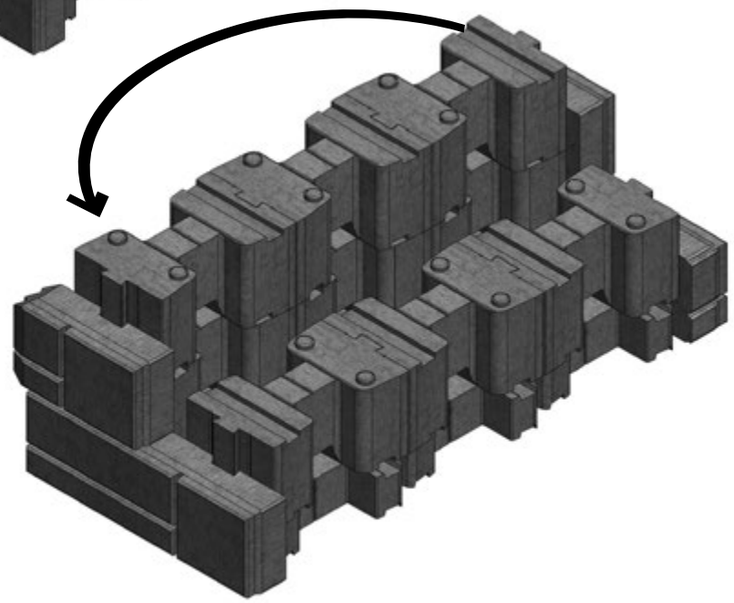
Assembly of FS² stabilizing blocks

Stabilizing blocks incorporate a concrete alignment key at one of their extremities. Inserted in the groove of a stabilizing block above, this key serves to lock the blocks between rows, and keep them from sliding off the wall in service. It also makes it possible to stagger rows during construction. To keep the privacy wall vertical, simply turn the stabilizing block or set of several stabilizing blocks connected to each other) horizontally by 180 degrees (see following assemblies).

Stabilizing blocks must be assembled by overlaying them one over the other when building each of the rows of a privacy wall. Finally, building a curved concave or convex privacy wall requires the use of mid-height 95 mm male/female stabilizing blocks glued to each other.







NOTE: When starting construction, build the first row using mid-height 95 mm stabilizers, then continue building using full height 190 mm stabilizers and complete the last row beneath the coping by placing mid-height stabilizing blocks to fill the remaining space. This will enable the stabilizers to lock the facings to each other, increasing the structure's overall stability.

RETAINING WALLS

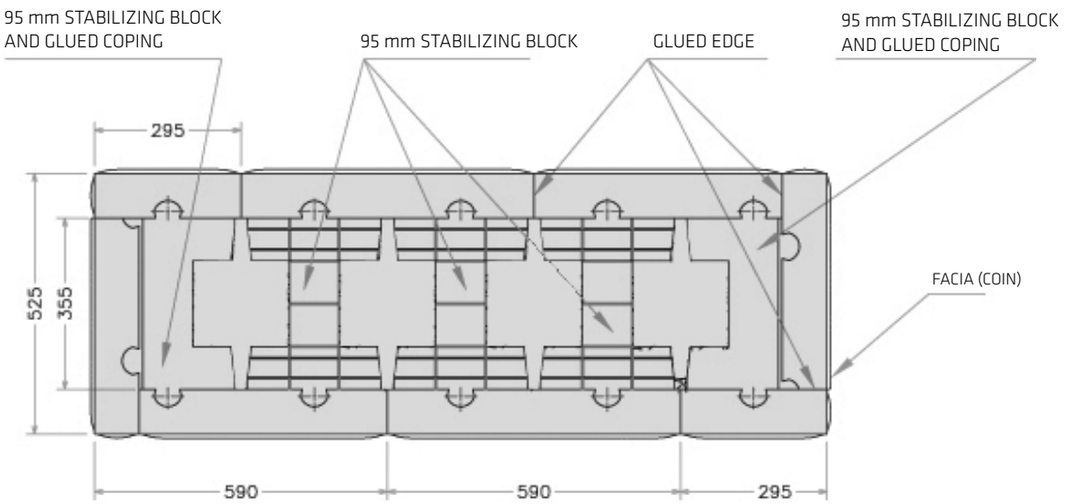
Permacon Retaining Walls

PRODUCT CHARACTERISTICS

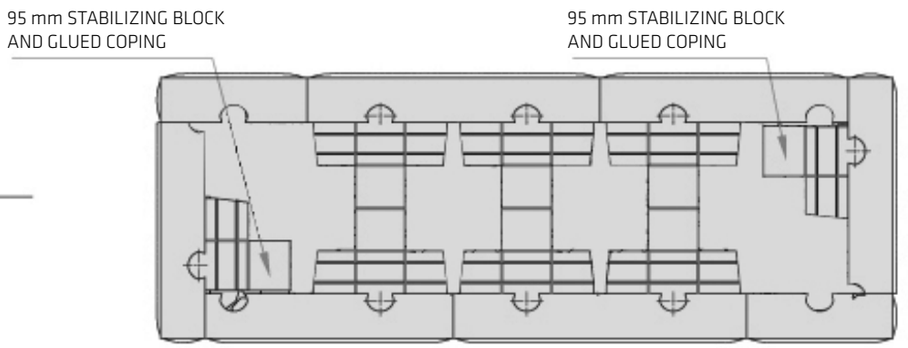
FS² SYSTEM – STRAIGHT PRIVACY WALL – DESIGN

Example:
Corner assembled with corner modules

ROW 1 - STEP 1



ROW 1 - STEP 2



NOTE: To increase the seismic resistance of a freestanding wall, 20 mm clean stone must not be used to fill spaces between the stabilizing blocks after the structure's construction.

RETAINING WALLS

Permacon Retaining Walls

PRODUCT CHARACTERISTICS

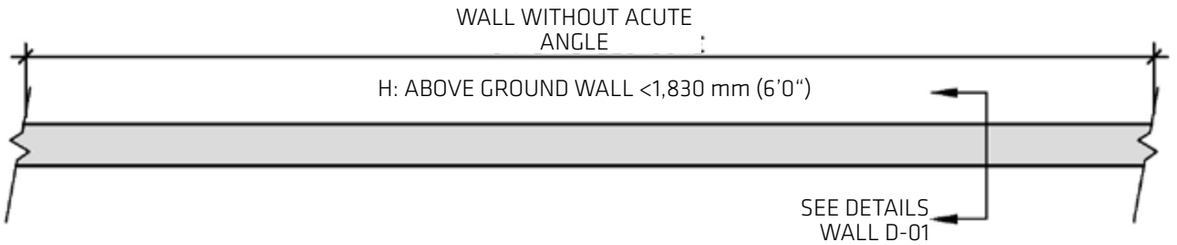
FS² SYSTEM – STRAIGHT PRIVACY WALL – REQUIRED CONFIGURATION

Note

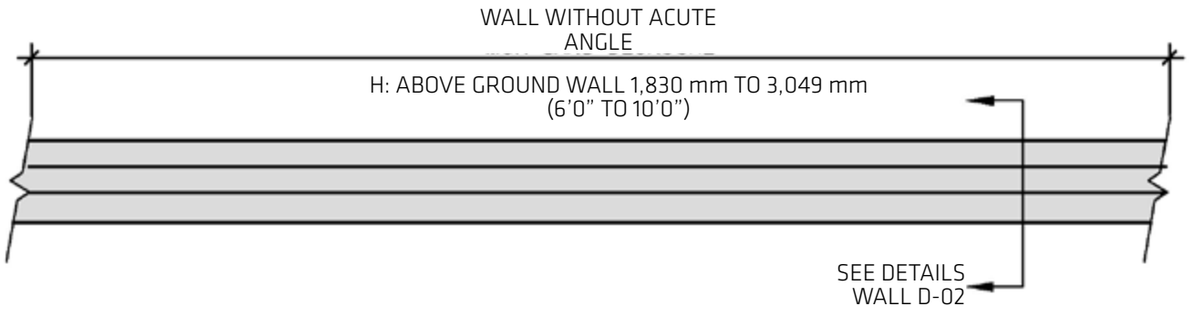
Before proceeding with the design and construction of a privacy wall, it is necessary to read the introduction to design and construction at the start of this section.

Important

From an above-ground height of 3,050 mm (10 ft.), all straight sections of a privacy wall must be built with a lateral support at both extremities. Incorporate a single or double acute angle in the construction. The maximum length between two acute angles must be based on the above-ground heights (H) of the wall. Furthermore, all acute angles on the wall must be reinforced and concreted to 60% of the wall's above-ground height. See the following drawings and strictly comply with the instructions and requirements stipulated on all of these drawings.



PLAN VIEW: 1-BLOCK PRIVACY WALL



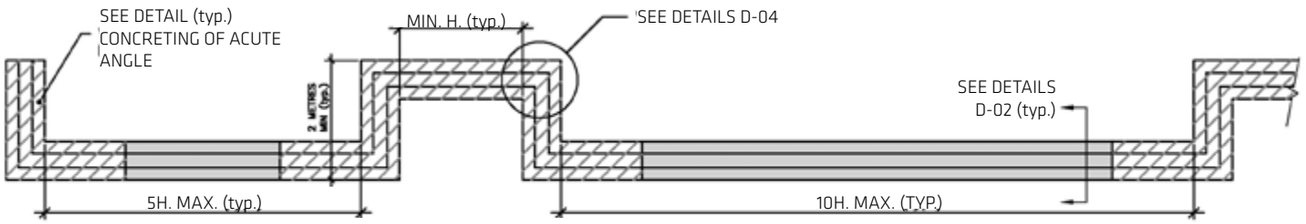
PLAN VIEW: 2-BLOCK PRIVACY WALL

RETAINING WALLS

Permacon Retaining Walls

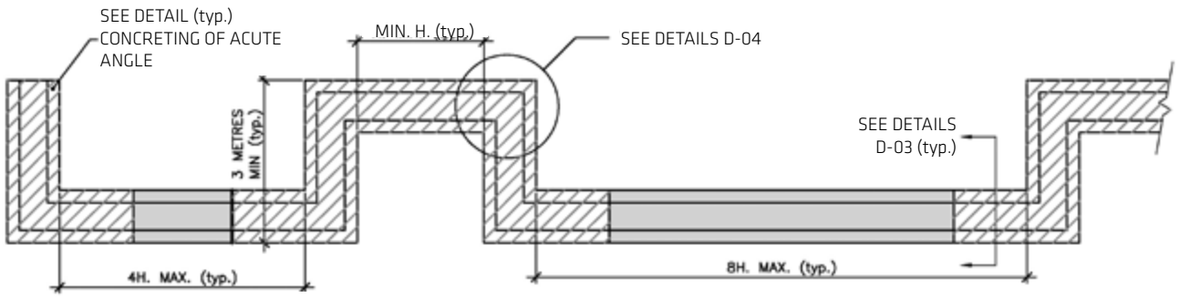
PRODUCT CHARACTERISTICS

FS² SYSTEM – STRAIGHT PRIVACY WALL – REQUIRED CONFIGURATION



PLAN VIEW: 2-BLOCK PRIVACY WALL WITH ACUTE ANGLES

H: ABOVE GROUND HEIGHT
3,050 mm TO 3,659 mm
(10'0" TO 12'0")



PLAN VIEW: 3-BLOCK PRIVACY WALL WITH ACUTE ANGLES
SCALE: NO SCALE

H: ABOVE GROUND HEIGHT
3,660 mm TO 4,589 mm
(12'0" TO 15'0")

CONCRETING OF ACUTE ANGLES

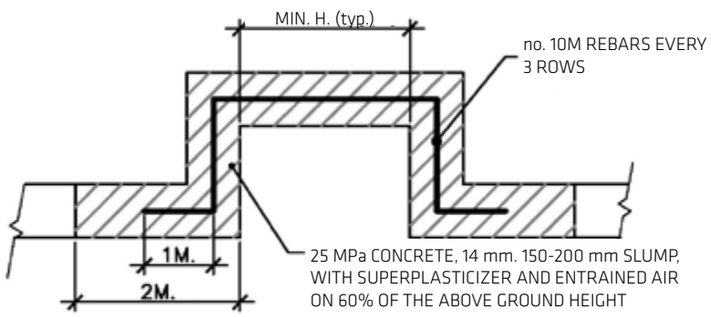
(concrete acute angles to 60%
of the wall's total above ground height)

Volume of concrete required:

. 2 stabilizers: $^1/_3$ of m^3/m^2 of the built wall

. 3 stabilizers: $^1/_2$ of m^3/m^2 of the built wall

D-04 corners details



DETAIL: CONCRETING OF ACUTE ANGLE
SCALE: NO SCALE

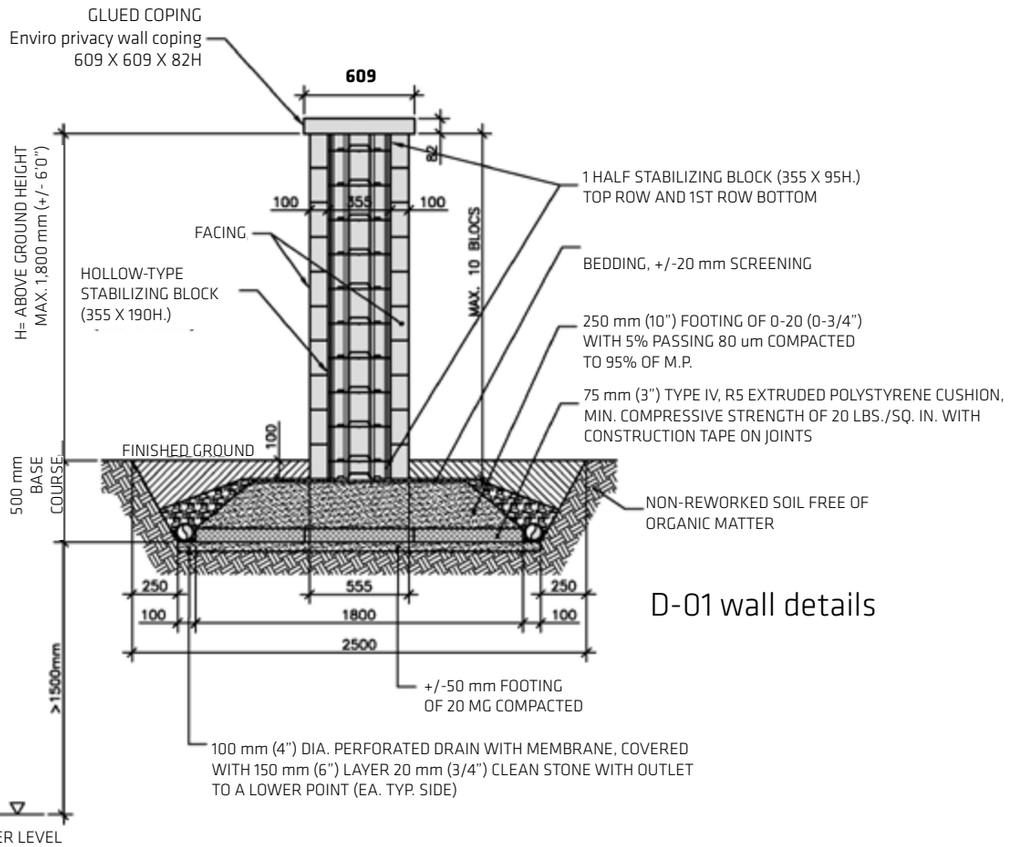
RETAINING WALLS

Permacon Retaining Walls

PRODUCT CHARACTERISTICS

FS² SYSTEM – STRAIGHT PRIVACY WALL – TYPICAL CROSS-SECTION

One 190 mm STABILIZING BLOCK without clean stone WITH FACING
Maximum above-ground height of 1,800 mm (6'0")
NOISE BARRIER, PRIVACY WALL, FENCE



D-01 wall details

NOTES:
- 100 mm (4") FOR DAY-INDEX UNDER 18° >5,000 (COLDER REGIONS)
- EXCAVATE THE BOTTOM TO PROVIDE AN EVEN SURFACE AND NON-REWORKED SOIL FREE OF ORGANIC MATTER
- MINIMUM GROUND LOAD-BEARING CAPACITY: 100 kPa
- NO LATERAL STRESS ALLOWED ON THE WALL OTHER THAN WIND AND SEISMIC LOADS.

NOTE:
These typical wall cross-sections are presented for illustrative purposes and integrate hypotheses and specific calculation parameters, which were used to produce these designs. Furthermore, all structures require final design verification based on the environment where they are to be used.

For different heights or special conditions, please contact us.

RETAINING WALLS

Permacon Retaining Walls

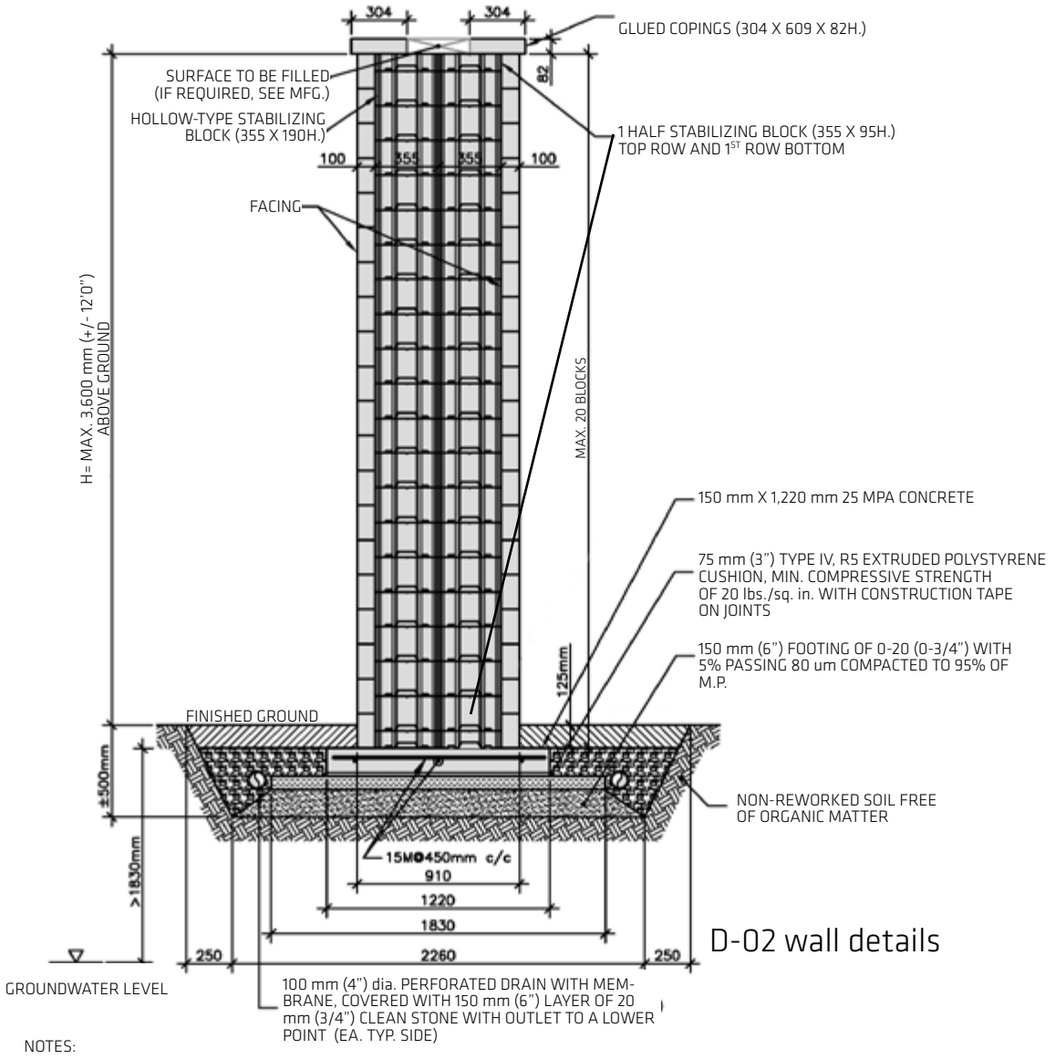
PRODUCT CHARACTERISTICS

FS² SYSTEM – STRAIGHT PRIVACY WALL – TYPICAL CROSS-SECTION

Two 190 mm STABILIZING BLOCKS without clean stone WITH FACINGS

Maximum above-ground height of 3,600 mm (12'0")

NOISE BARRIER, PRIVACY WALL, FENCE



D-02 wall details

NOTES:

- 100 mm (4") FOR DAY-INDEX UNDER 18° >5,000 (COLDER REGIONS)
- EXCAVATE THE BOTTOM TO PROVIDE AN EVEN SURFACE AND NON-REWORKED SOIL FREE OF ORGANIC MATTER
- MINIMUM GROUND LOAD-BEARING CAPACITY: 100 kPa
- NO LATERAL STRESS ALLOWED ON THE WALL OTHER THAN WIND AND SEISMIC LOADS.

NOTE:

These typical wall cross-sections are presented for illustrative purposes and integrate hypotheses and specific calculation parameters, which were used to produce these designs. Furthermore, all structures require final design verification based on the environment where they are to be used.

For different heights or special conditions, please contact us.

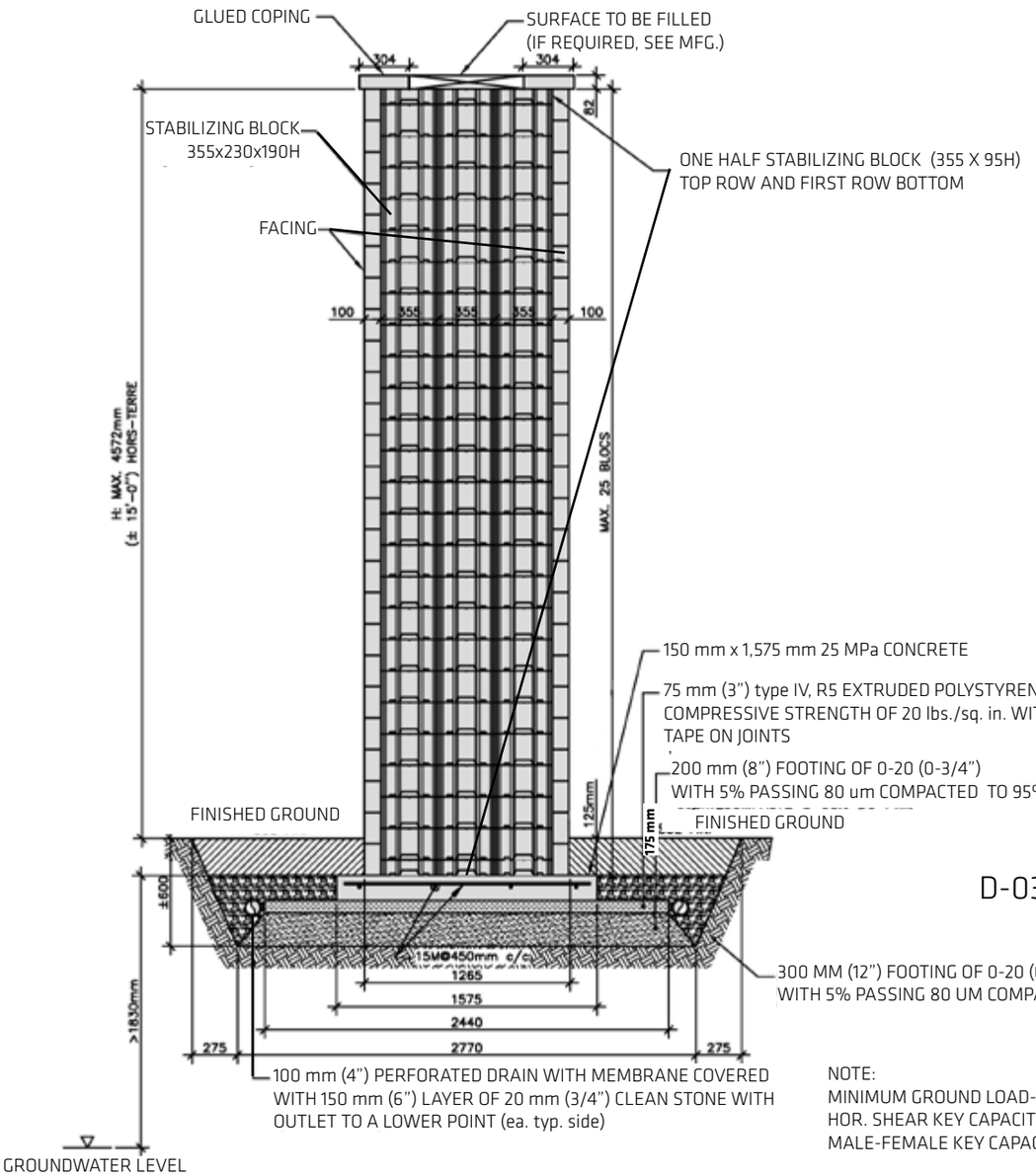
RETAINING WALLS

Permacon Retaining Walls

PRODUCT CHARACTERISTICS

FS² SYSTEM – STRAIGHT PRIVACY WALL – TYPICAL CROSS-SECTION

Three 190 mm STABILIZING BLOCKS without clean stone WITH FACINGS
Maximum height of 4,572 mm (15'0")
NOISE BARRIER



D-03 wall details

NOTE:
MINIMUM GROUND LOAD-BEARING CAPACITY: 100 kPa
HOR. SHEAR KEY CAPACITY = 1,340 daN/m (900 lbs./ft.)
MALE-FEMALE KEY CAPACITY = 1,100 daN/m (740 lbs./ft.)

NOTE:
These typical wall cross-sections are presented for illustrative purposes and integrate hypotheses and specific calculation parameters, which were used to produce these designs. Furthermore, all structures require final design verification based on the environment where they are to be used.

RETAINING WALLS

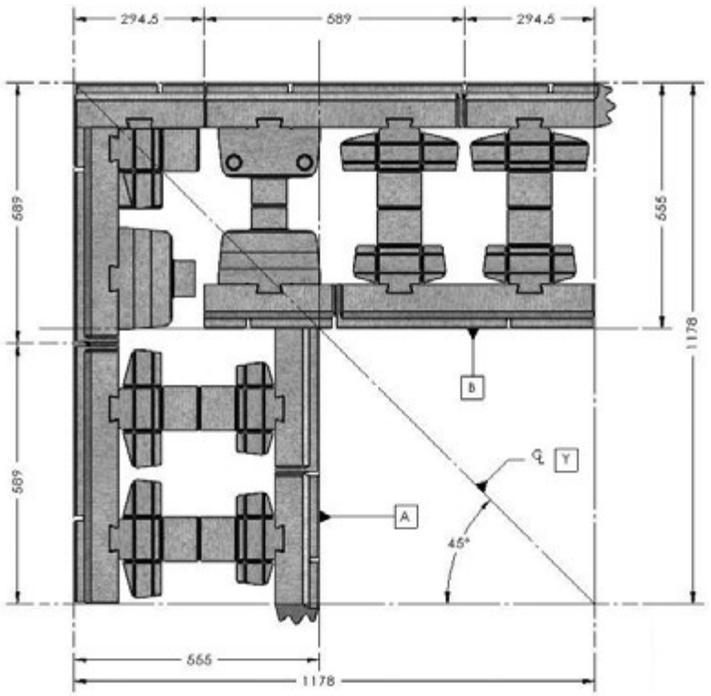
Permacon Retaining Walls

PRODUCT CHARACTERISTICS

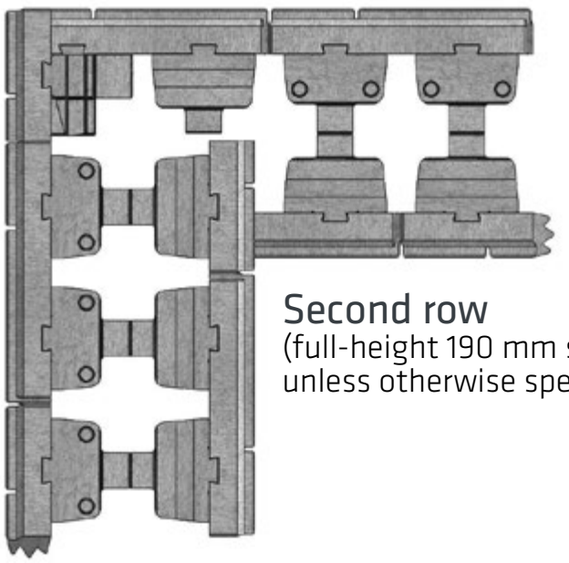
FS² SYSTEM – STRAIGHT PRIVACY WALL – ACUTE ANGLE CONSTRUCTION DETAILS

PRIVACY WALL WITH 90-DEGREE CORNER

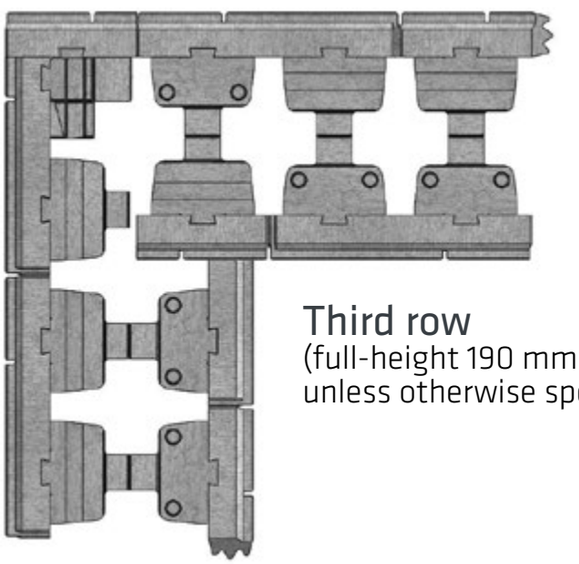
(construction details for 1 stabilizing block)



First row
(mid-height 95 mm stabilizers, unless otherwise specified)



Second row
(full-height 190 mm stabilizers, unless otherwise specified)



Third row
(full-height 190 mm stabilizers, unless otherwise specified)

CONTINUE CONSTRUCTION

Fourth row
(construction similar to second row)

Fifth row
(construction similar to third row)

RETAINING WALLS

Permacon Retaining Walls

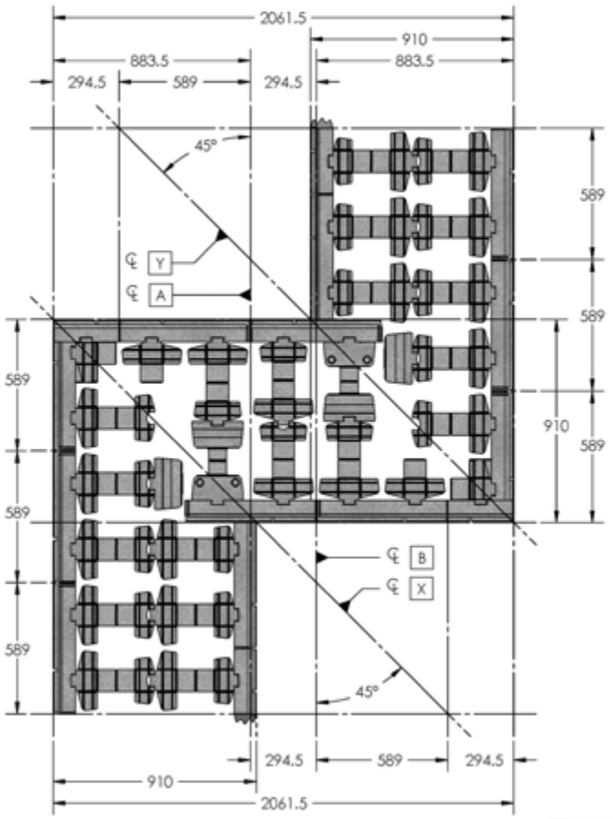
PRODUCT CHARACTERISTICS

FS² SYSTEM – STRAIGHT PRIVACY WALL – ACUTE ANGLE CONSTRUCTION DETAILS

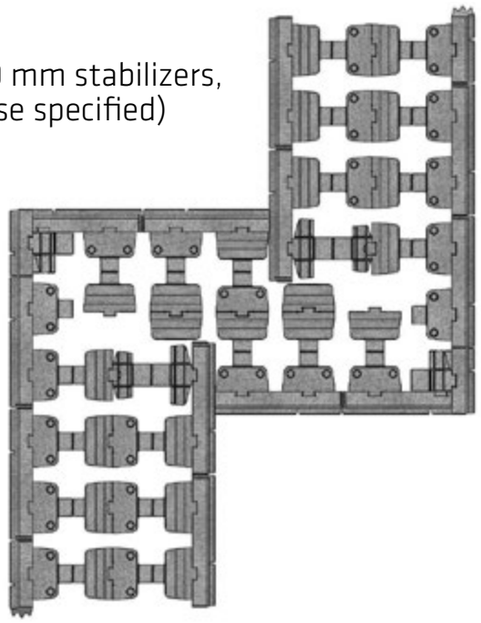
PRIVACY WALL WITH CONCRETED ACUTE ANGLES

(construction details for 2 stabilizing blocks)

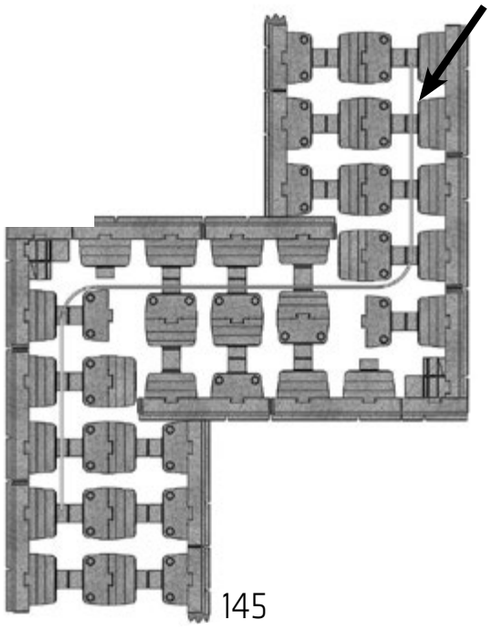
First row
(mid-height 95 mm stabilizers, unless otherwise specified)



Second row
(full-height 190 mm stabilizers, unless otherwise specified)



10M rebars every third row



CONTINUE CONSTRUCTION

Third row
(full-height 190 mm stabilizers, unless otherwise specified)

Fourth row
(construction similar to second row)

Fifth row
(construction similar to third row)

RETAINING WALLS

Permacon Retaining Walls

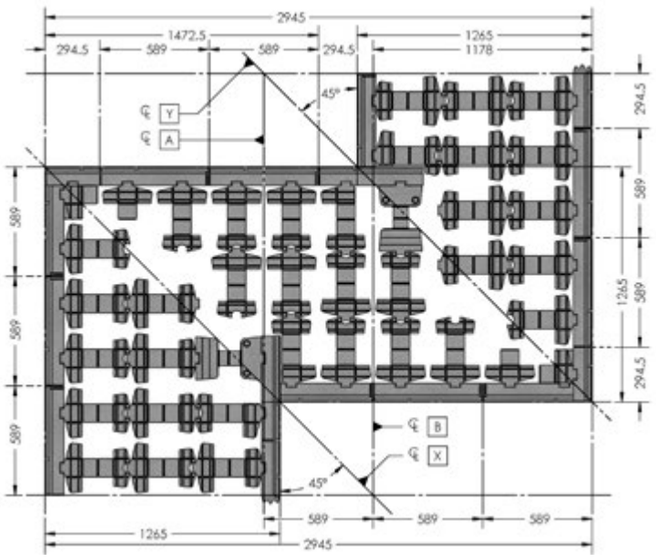
PRODUCT CHARACTERISTICS

FS² SYSTEM – STRAIGHT PRIVACY WALL – ACUTE ANGLE CONSTRUCTION DETAILS

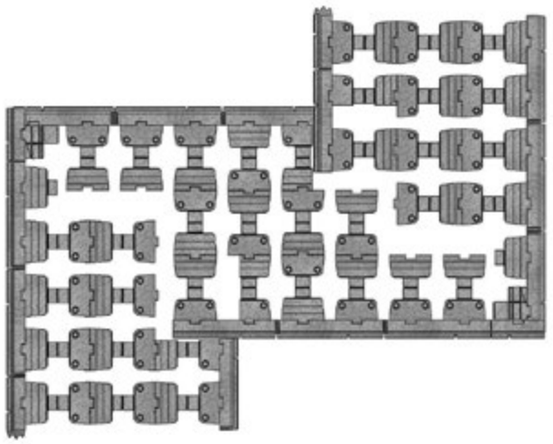
PRIVACY WALL WITH CONCRETED ACUTE ANGLES

(construction details for 3 stabilizing blocks)

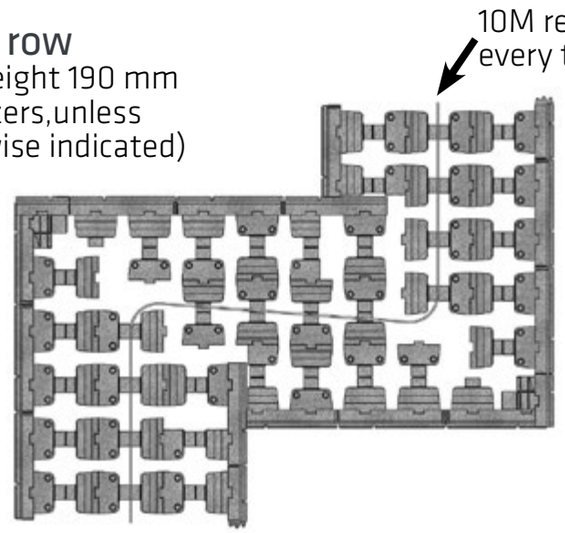
First row
(mid-height 95 mm stabilizers,
unless otherwise indicated)



Second row
(full-height 190 mm stabilizers,
unless otherwise indicated)



Third row
(full-height 190 mm
stabilizers,unless
otherwise indicated)



CONTINUE
CONSTRUCTION

Fourth row
(construction similar to second row)

Fifth row
(construction similar to third row)

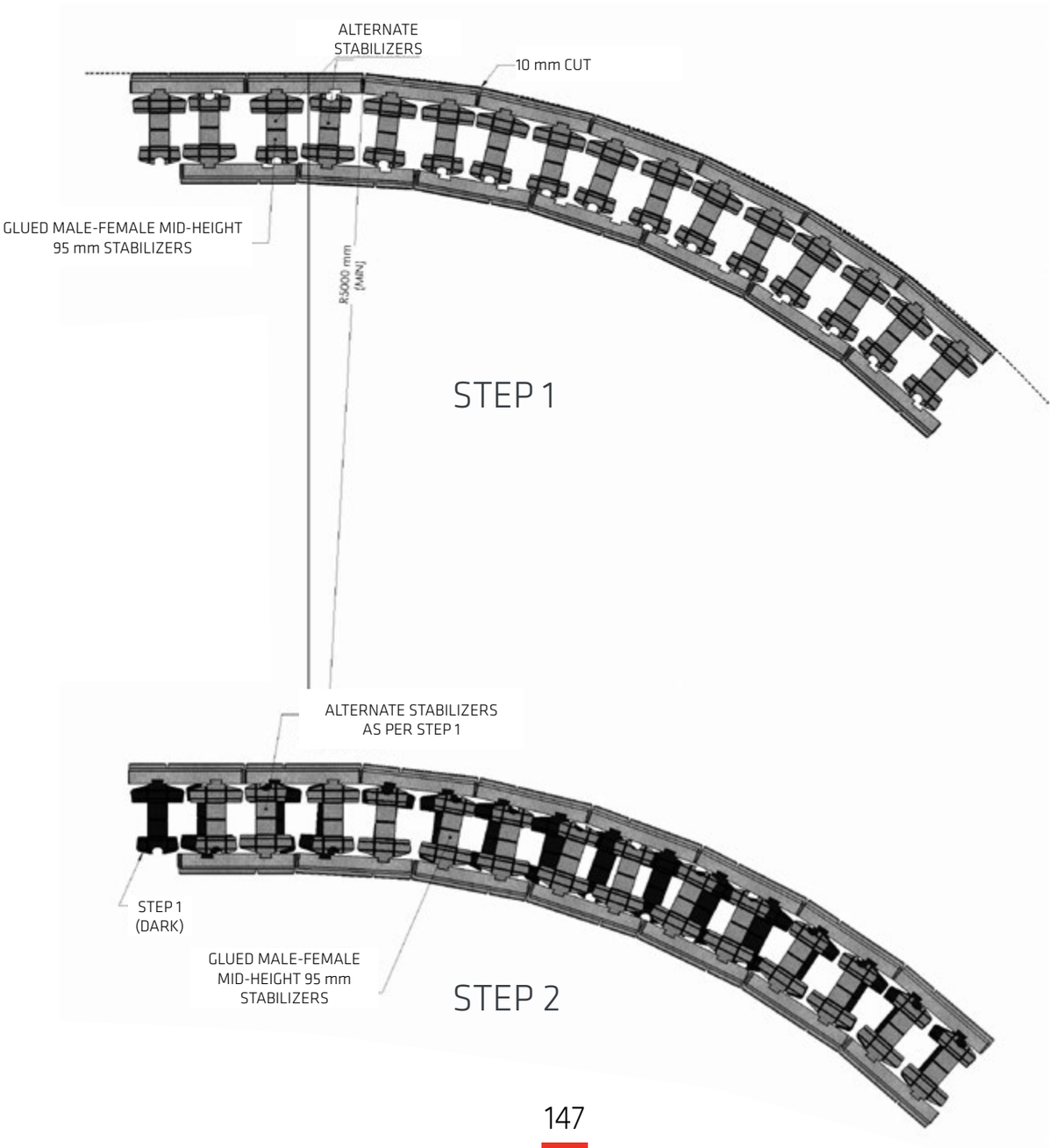
RETAINING WALLS

Permacon Retaining Walls

PRODUCT CHARACTERISTICS

FS² SYSTEM – CURVED PRIVACY WALL – ASSEMBLY

The construction of curved privacy walls requires the use of mid-height FS² stabilizers, which lend themselves to the production of a wall finished on both sides and of different lengths. As shown in the 2 proposed steps for the construction of a row, the specific orientation of the stabilizers makes it possible to give the structure a curve. Finally, all stabilizers and copings must be glued to ensure the integrity of the overall structure.



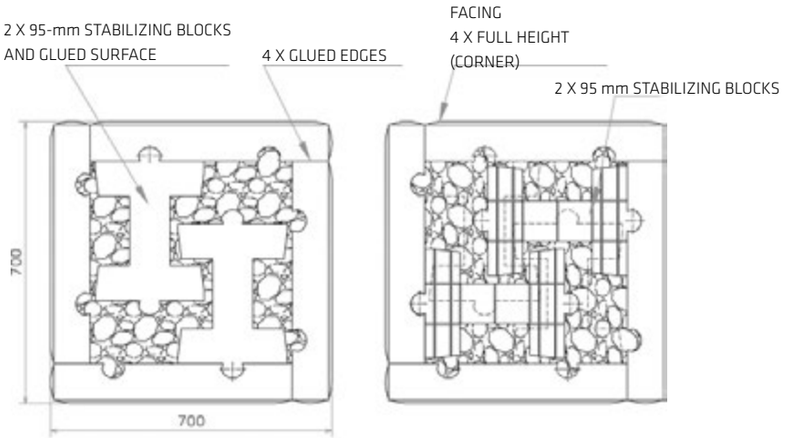
RETAINING WALLS

Permacon Retaining Walls

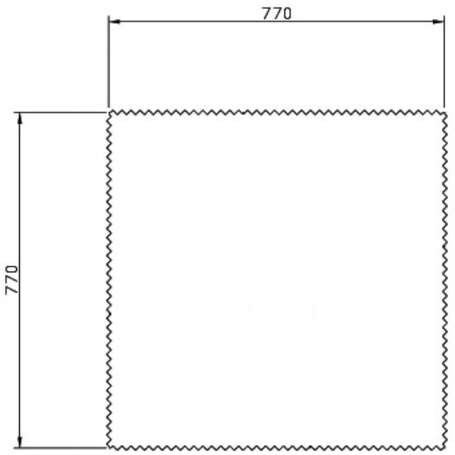
PRODUCT CHARACTERISTICS

FS² SYSTEM – COLUMN AND STEPS – CONSTRUCTION DETAILS

BUILDING A COLUMN

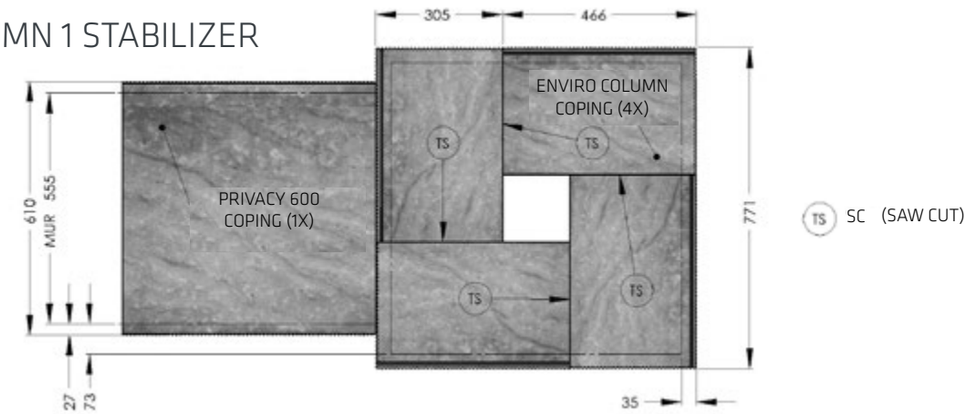


ROW 1 - STEP 1 ROW 1 - STEP 2



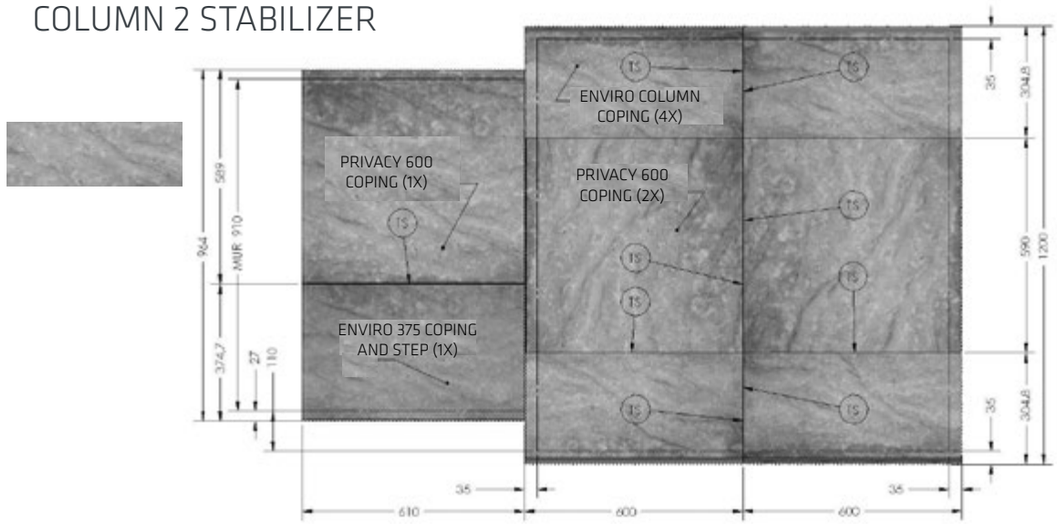
Natural stone coping

COLUMN 1 STABILIZER



TS SC (SAW CUT)

COLUMN 2 STABILIZER



TS TRAIT DE SCIE

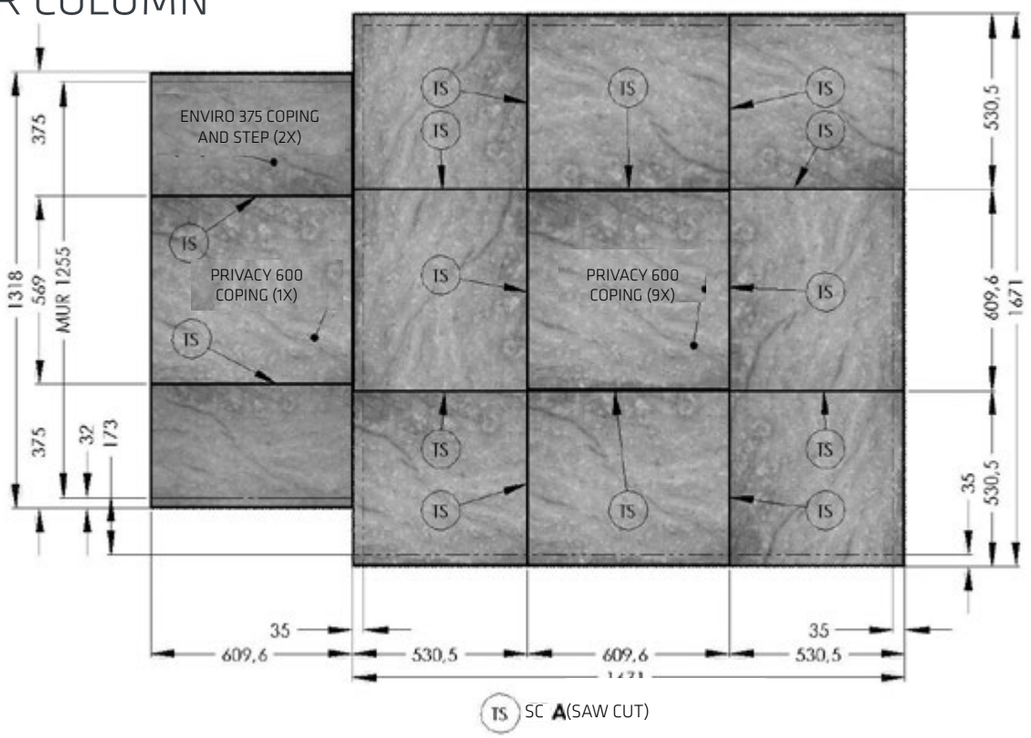
RETAINING WALLS

Permacon Retaining Walls

PRODUCT CHARACTERISTICS

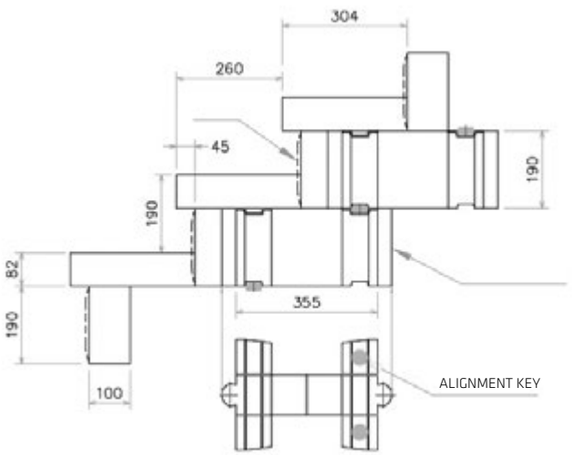
FS² SYSTEM – COLUMN AND STEPS – CONSTRUCTION DETAILS

3-STABILIZER COLUMN

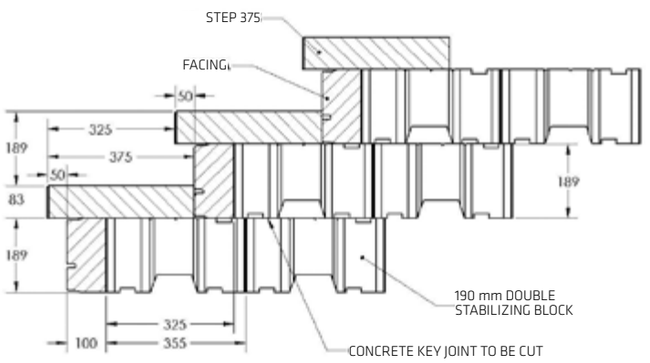


STEPS

COPINGS (304 mm depth)



STEPS (375 mm depth)



NOTE: For the coping and step to use, see page 140.

RETAINING WALLS

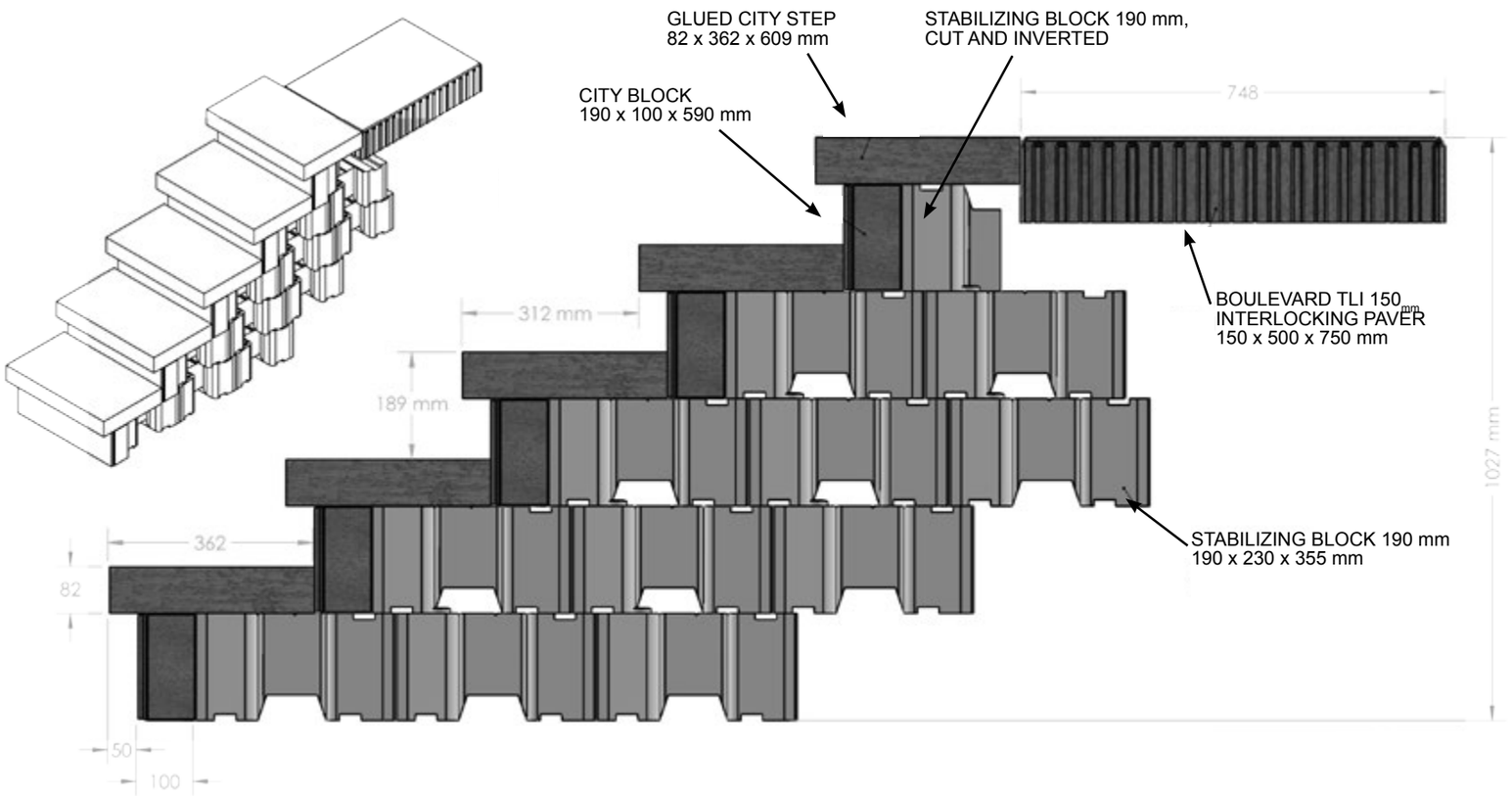
Permacon Retaining Walls

PRODUCT CHARACTERISTICS

FS² SYSTEM – COLUMN AND STEPS – CONSTRUCTION DETAILS

USE OF TRIPLE STABILIZERS FOR INCREASED STABILITY

Increasing the number of stabilizers installed behind the risers is highly recommended to increase the stability of steps built using the FS² system. The presence of triple stabilizers lends greater support to the risers, the step's stabilizers, and the top riser to be built. See the following application example using 150-mm thick pavers.



RETAINING WALLS

Permacon Retaining Walls

PRODUCT CHARACTERISTICS
KEYSTONE WALL SYSTEM

RETAINING WALLS

Permacon Retaining Walls

PRODUCT CHARACTERISTICS
KEYSTONE WALL SYSTEM

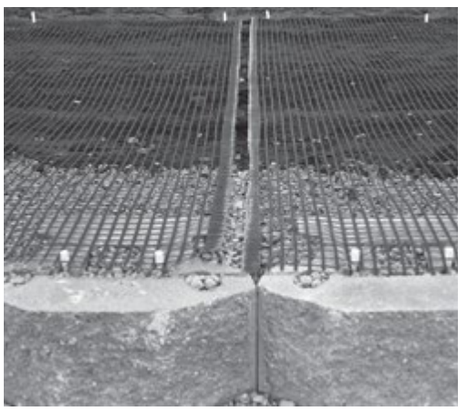
The Keystone wall system is designed specifically for the construction of large-scale retaining walls. Both cost-effective and aesthetic, it is an economical replacement for reinforced concrete walls. Combined with geogrid-type reinforcement, Keystone walls can be erected to a height of 9.0 m (30.0 ft). They are also very easy to build.

DESCRIPTION AND TYPICAL APPLICATIONS

The system is comprised of concrete blocks mechanically held together by high-strength, fibreglass anchor rods and geogrid-type soil reinforcement to ensure great structural stability. The visible surface of the wall has a split finish with a straight or rounded face. The system can be used for straight or curved walls. Keystone wall is available in two colours—smoke grey, Sheffield beige and black.

This type of wall is intended for commercial, industrial and institutional applications around the margins of viaducts, bridges and culverts. It has been one of the retaining walls approved by the Ministry of Transport of Quebec (MTQ) since 2001. It is perfectly suited for road landscaping, truck access routes, parking lots, loading bays and for retaining all kinds of slopes.

Large-scale, economical and aesthetic walls



Use of geogrid reinforcement

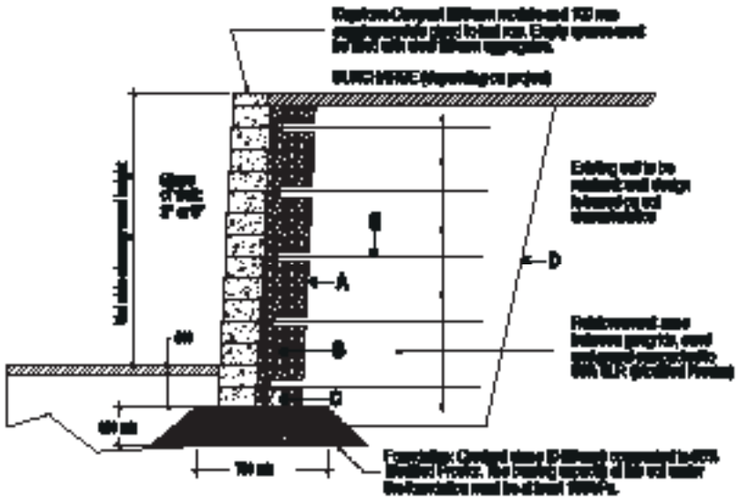
RETAINING WALLS

Permacon Retaining Walls

PRODUCT CHARACTERISTICS
KEYSTONE WALL SYSTEM

Features and benefits

KEYSTONE WALL CROSS-SECTION



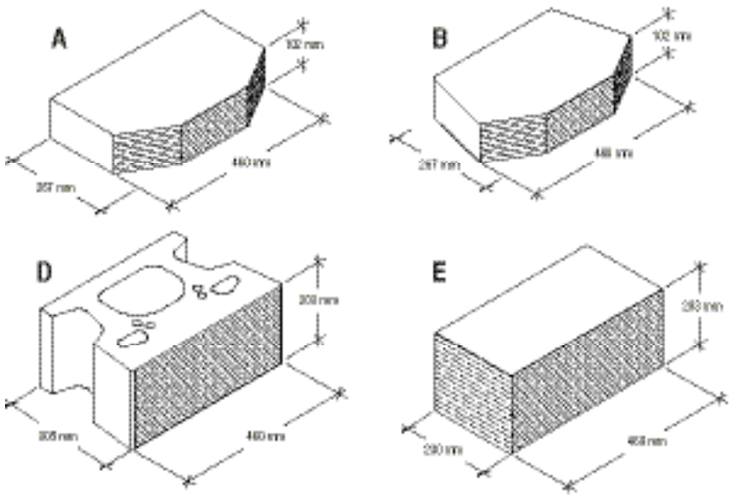
A - Texel 7609 geotextile membrane
B - Clear 20 mm aggregates (300 mm at the rear of wall)
C - 100 mm perforated drain pipe (connected to stormwater drainage system)
D - Excavation slope
E - Standard geogrids (planned according to project)

LIMITATIONS OF USE

Maximum height of gravity wall limited to 0.7 m (2.33 ft)
Reinforced walls may reach heights up to 9.0 m (30 ft)

- The Keystone wall system is particularly cost-effective compared with reinforced retaining walls cast in place.
- Permits fast, manual construction of straight or curved walls without special handling equipment.
- Requires no formwork and can even be erected in cold weather.
- Strict monitoring of product quality ensures compliance with rigorous requirements of government agencies involved. The Keystone wall system meets the highest quality standards to enable the product to withstand the harsh northern climate.
- The Keystone system has been used across America for over 25 years, and hundreds of walls have been constructed in Quebec and Ontario with exemplary performance.

Compact module with straight face



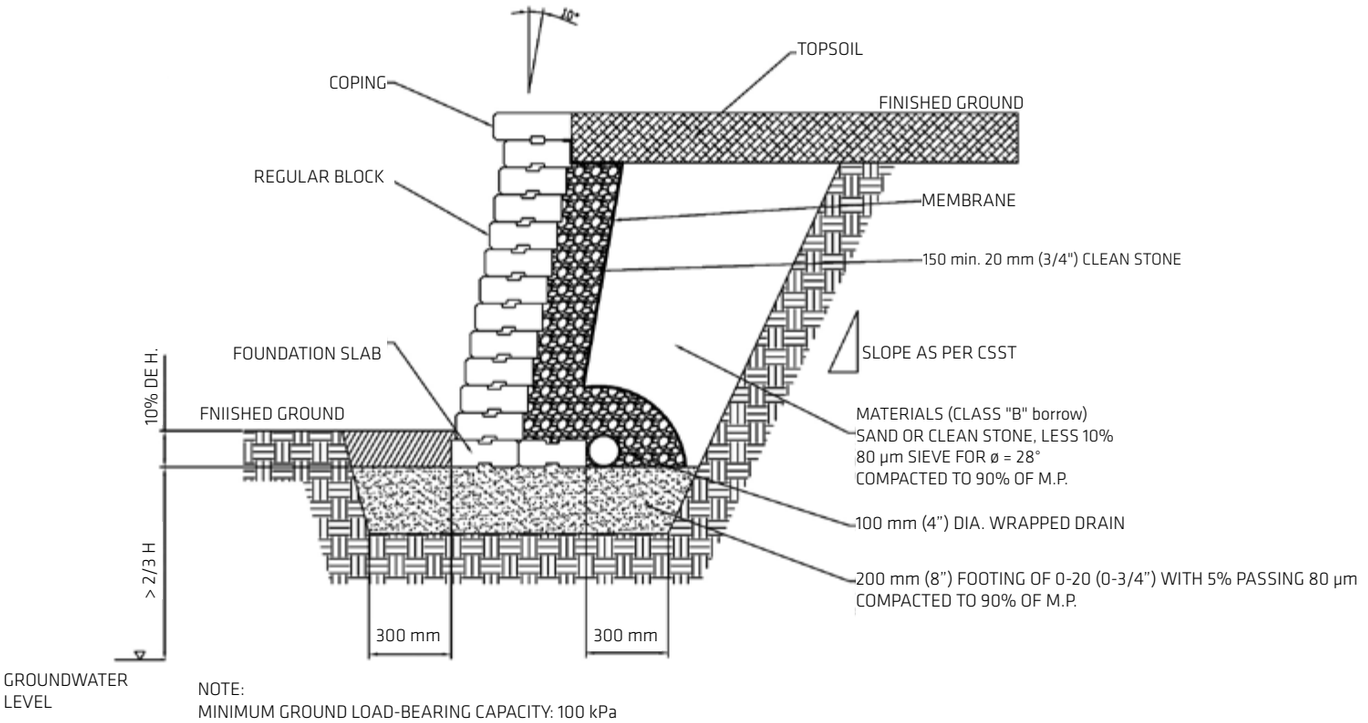
KEYSTONE SYSTEM

A - Right-angled capping module
B - Bevelled capping module
C - Compact module with straight face
D - Compact module with rounded face
E - Corner module

RETAINING WALLS

Gravity Retaining Wall Installation Guide

TYPICAL CROSS-SECTION OF A GRAVITY WALL



IMPORTANT

The following summarizes the construction of retaining walls using products manufactured by Permacon. It should be noted, however, that these walls must not be subjected to stresses other than the pressure of the soil and their height must not exceed values shown on the following page.

NOTE: The construction of walls whose height exceeds values shown on the following page is possible, but requires the use of a geogrid-type ground reinforcement or equivalent geotextile.

Before undertaking the work, mark off the site. This will enable you to determine the volume of granular materials and fill required as well as the area to be covered.

Before starting excavation, if you suspect the possible presence of underground wires or pipes, contact the public utilities involved.

RETAINING WALLS

Guide d'installation des murs de soutènement gravitaires

EXECUTION OF THE WORK

Dig a trench 300 mm (12 in.) deep by at least 900 mm (36 in.) wide, or take the size of the base of the retaining wall to be built and add at least 600 mm (24 in.) [extra 300 mm (12 in.) width on each side of the base of the wall]. Next, level and tamp down the bottom of the excavation, taking care not to unduly disturb the soil in place. Cover the bottom of the trench and embankment to be secured with a geotextile, to avoid contaminating granular materials and prevent possible obstruction of the drainage system.

Line the bottom of the trench with at least 200 mm (8 in.) of 0 to 20 mm (0 to 3/4 in.) crushed stone (unless otherwise specified). Level and compact the stone. To more quickly and easily reach the final level and obtain a footing with the required uniformity, build bedding consisting of concrete sand with a maximum level thickness of 25 mm (1 in.). At the back of the trench, install a perforated drain measuring at least 100 mm (4 in.) in diameter. It is important for this drain to be connected to an existing drainage system or, at the very least, that it be capable of evacuating water that could accumulate behind the wall.

If required, install foundation slabs, ensuring that they are level and in a straight line (using a Mason's line). Install the first row of retaining blocks. Then stagger the second row so that their joints are lined up with the middle of a block on the first row. Use half blocks at the ends. When space is required between blocks, add a second geotextile right behind the blocks to keep the clean stone from falling between the embankment and the concrete blocks.

Every second row, fill the space behind the wall with 20 mm (3/4 in.) of clean stone. Level and lightly tamp down the backfill. Continue building the wall ensuring that each row is level and well aligned, then fold the geotextile over, towards the wall, to cover the clean stone.

For a better finish, install copings then level the soil behind the wall. For safety reasons, it is necessary to glue the copings to the final row of retaining blocks, using an appropriate adhesive.

Section IV

URBAN CURBS

URBAN CURBS

Permacon Urban Curbs

PERMACON PRECAST STREET CURBS

Versatility

Precast curbs can be used in the construction of roads, streets, parking lots, industrial yards, etc. The range of integrated components allows for a variety of design possibilities such as: sidewalk curbs, driveway access ramps, 90 degree angles, as well as raise medians and planters.

Durability

Fabrication and controlled curing in the factory give the Permacon curbs high compressive strength, and make them highly resistant to freeze-thaw cycles, de-icing salts, and to impact and abrasion.

Economy

Street curbs prove to be the economic choice in a very short time: their life-span is about twice that of poured concrete curbs. Their speed of installation allows work to be completed more rapidly. The modular components permit repairs or changes to be carried out quickly and economically.

Furthermore, the Ministère des Transports du Québec acknowledges the work done using precast street curbs like the ones made by Permacon has a value-added which is 40% greater than work done using pored-in-place curbs.

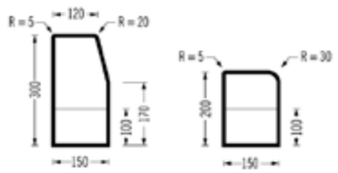
URBAN CURBS

Permacon Urban Curbs

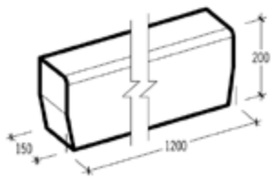
PERMACON PRECAST STREET CURBS

STREET CURBS * Dimensions shown in millimeters.

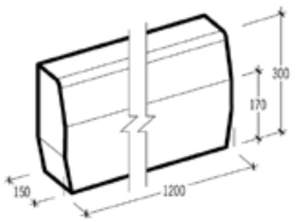
Profile



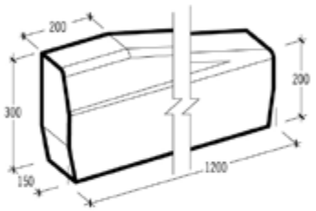
Level curb



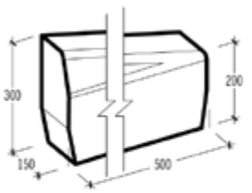
Raised curb



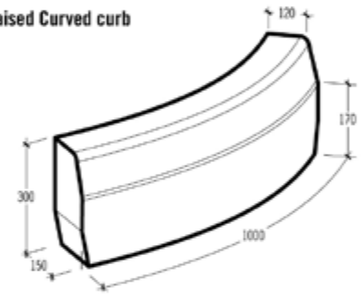
Long transition curb



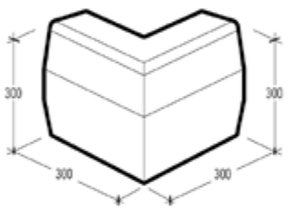
Short transition curb



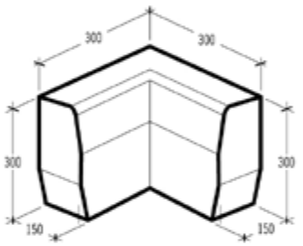
Raised Curved curb



Monolithic outside corner



Monolithic inside corner



URBAN CURBS

Permacon Urban Curbs

PERMACON PRECAST STREET CURBS

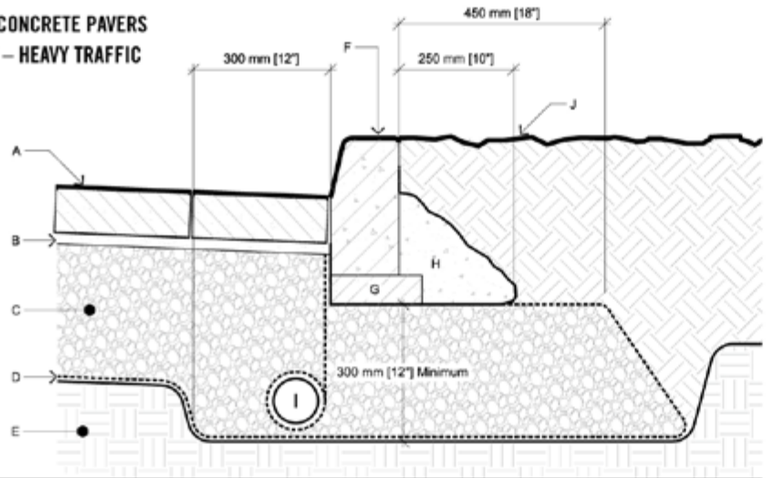
CHARACTERISTICS

- Compressive strength: 45 MPa minimum
- Water absorption: less than 5%
- Resistant to freeze and taw cycles expose to de-icing salts, maximum lost of mass after 50 cycles: 0.50 kg/m²
- Conformity with Québec standard NQ 2624-210

INSTALLATION GUIDE

Place each curb on two concrete bricks, located at the ends. The bricks should rest on a well-compacted granular foundation. Pour lean (15 MPa) concrete behind and underneath the curbs. This is not required when the curbs separate a street and a sidewalk.

CROSS SECTION – PRECAST CONCRETE PAVERS AND STREET CURB ROADWAY – HEAVY TRAFFIC



A Concrete pavers 100 mm
B Laying bed 25 mm
C Compacted granular foundation (0–20 mm)
D Geotextile
E Existing soil
F Precast concrete street curb
G Backup bricks
H Lean-mix concrete 15 MPa
I Precast drainage system
J Planting area

NUMBER OF CURVED CURBS PER SEGMENT OF CIRCLE

ANGLE \ RADIUS	0.625	1.25	2.50	5.00	7.5	10.00
45°		1	2	4	6	8
90°	1	2	4	8	12	16
135°		3	6	12	18	24
180°	2	4	8	16	24	32
225°		5	10	20	30	40
270°	3	6	12	24	36	48
315°		7	14	28	42	56
360°	4	8	16	32	48	64

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