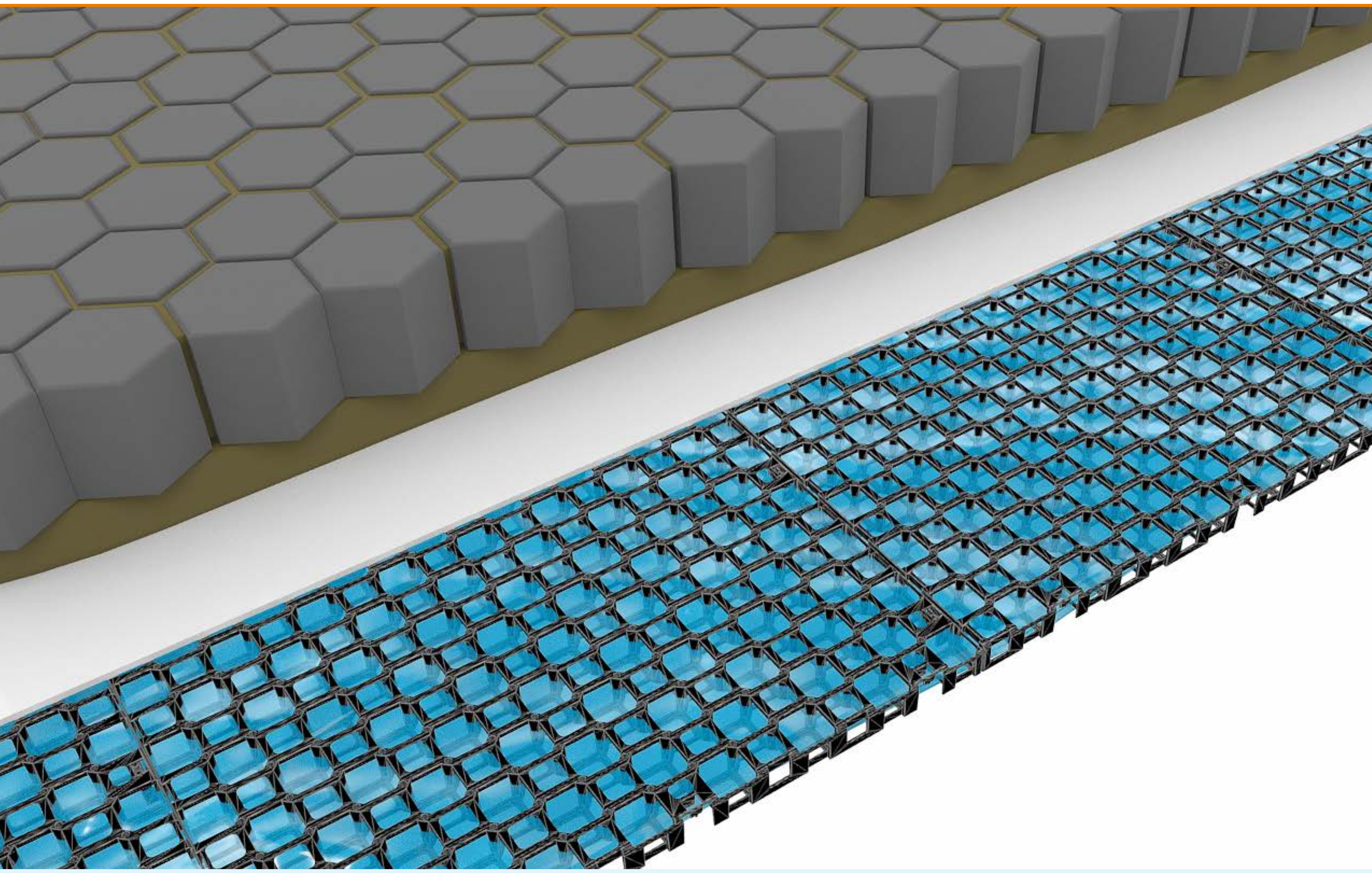
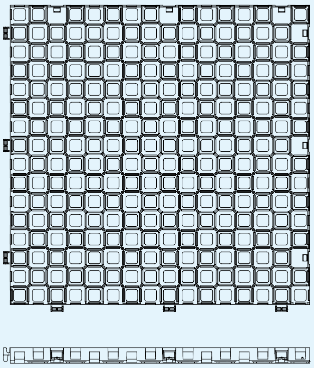
Geoplast Building beyond together

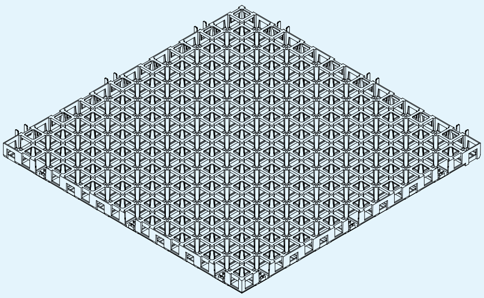
English



TECHNICAL MANUAL
GEOCELL

DRAINAGE PANEL WITH HIGH HORIZONTAL FLOW CAPACITY





GEOPLAST SOLUTIONS FOR WATER

GeoplastGlobal.com

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GEOCELL TECHNICAL MANUAL

ATTACHMENTS

INTRODUCTION

1. GENERAL INFORMATION

1.1 DESCRIPTION AND FUNCTIONALITY

The initial permeability of flooring over time reduces as a result of multiple causes, such as:

- clogged filtering material caused by dirt and rubbish;
- growth of vegetation favoured by the accumulation of material such as silt or mud in the flooring joints;
- layer compacting caused by the loads to which the flooring is subjected over time.

Bad weather, at times very intensive, and the presence of scarcely permeable foundations determine the progressive saturation of the drainage layer, which creates 2 types of problem:

- water that remains on the surface, given that the package can no longer drain;
- the hydraulic force on the flooring, with its resulting lifting.

Geocell is a protected panel that allows rainwater to drain away quickly under the interlocking flooring.

Geocell solves those problems typically connected with the use of interlocking panels laid on a scarcely permeable base; by guaranteeing effective, fast drainage, it prevents setting bed sand saturation, a condition that deteriorates the flooring and its lifting, in particular if it has to support vehicle traffic.

The system notably improves water drainage, drastically shortening removal time while at the same time reducing the thickness of the drainage package in comparison with traditional systems.

1.2 MATERIAL AND PRODUCTION PROCESS

Geoplast Spa has UNI EN ISO 9001:2000 quality certification.

The Geocell panel is injection moulded in the Geoplast Spa factory, which is located in Grantorto (Padua), Italy.

The material used is 100% regenerated polypropylene (PP). The characteristics of the material are given in the following table:

Characteristic	Method	U.D.M.	Value
MFI (230°C / 2,16 kg)	ASTM-D-1238	g/10’	5±1
Izod impact strength	ASTM-D-256	J/m	70-90
Bending modulus	ASTM-D-790	MPa	1.200-1.300
Softening temperature Vicat B/50N	ASTM-D-1525	°C	70-80
Density	ASTM-D-792	g/cm3	0,89-0,92

1.3 TRANSPORT AND STORAGE

The Geocell panel is stored and transported on pallets; the packaging has the following characteristics:

	Pallet size (cm)	No. of elements on each pallet (cm)	Pallet surface (m²)
GEOCELL PANEL	120 x 120 x H240	300	100

Mechanical means with forks or a crane with lifting straps can be used to unload and move the pallets.

To store correctly, we recommend choosing a stable surface that is as even as possible; the product must not come into contact with fuel, lubricants, chemical agents or acids.

IMPORTANT: Before installing, make sure the elements are not damaged or faulty.
Avoid laying if any damage or flaws are found in the elements.

TECHNICAL DATA

2. GEOCELL

2.1 APPLICATION FIELDS

The main application field of the system is the creation of two-way drainage under areas that are covered by interlocking pavement blocks, in particular in situations where the soil has a low drainage capacity.

2.2 SYSTEM COMPONENTS

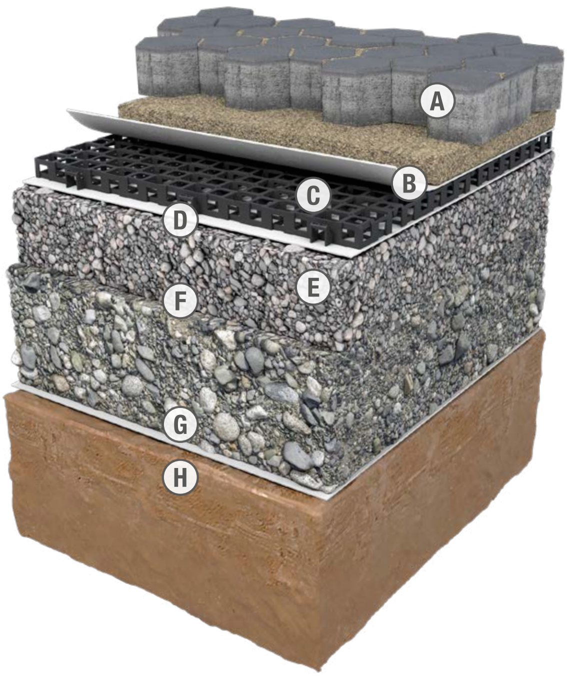


Figure 1 - components of the Geocell system

- (A) INTERLOCKING PAVEMENT BLOCK
- (B) SETTING BED SAND
- (C) (E) (H) GEOTEXTILE
- (D) GEOCELL
- (F) AGGLOMERATE FOR BASE LAYER
- (G) AGGREGATE FOR FOUNDATION LAYER

The heights of the different layers that make up the system vary according to the loads that the area has to support and the structural strength of the soil (see chap. 3.2 - Foundation bed analysis).

In a purely indicative manner, a stratigraphy of 80 cm can tolerate the transit of heavy traffic without difficulty. Refer to table 15 a on page 17 for more information.

We advise contacting Geoplast's Technical Office which can calculate the height of the different package layers according to the destination of use of the area.

2.2.1 PERIMETER EDGE

Made of cast or vibrated concrete, or of stone, the edges are of a height that is suitable for the side containment of the blocks chosen for the area.

2.2.2 INTERLOCKING FLOORING

Interlocking flooring for outdoor use, made up of vibrated-compressed concrete blocks, variable in height according to the destination of use of the area (see table 14 on page 16), in a double layer with a minimum thickness of 4 mm of wear. The layers are made up of a mix of quartz aggregates selected to confer optimal stopping surface and transit performance, and have the physical-mechanical characteristics indicated by the UNI EN 1338 standard for CE marking.

2.2.3 SETTING BED AND SEALING SAND

Sand of alluvial origin or coming from crushed rocks, unalterable, with a high mechanical resistance, with grain sizes included in the grading envelope as indicated in table 1 which follows. The granules obtained from grinding calcareous or soft rocks must never be used as setting material.

Sieve diameter (mm)	Percent passing in mass (%)
10	100
6	90-100
3	75-100
1	55-90
0,5	35-70
0,25	8-35
0,125	0-10
0,075	0-3

Table 1 - grain size grading envelope for setting sand

To seal the joints, only use sand of natural origin having a specific grain size, as indicated in table 2. Do not use sand from grinding procedures.

Sieve diameter (mm)	Percent passing in mass (%)
3	100
2	95-100
1	75-100
0.5	35-95
0,5	5-35
0,25	8-35
0,125	0-10
0,075	0-3

Table 2 - grain size grading envelope for the sealing sand

2.2.4 GEOTEXTILE

Non-woven geotextile with continuous fibres (spunbonded), mechanically needle-punched, of 100% polypropylene stabilised under UV rays, and having the following characteristics:

- tensile strength MD and CD > 20.0 kN/m (EN ISO 10319);
- elongation to failure MD and CD 100% (EN ISO 10319);
- punching resistance-CBR test > 2.900 N (EN ISO 12236);
- gradation test-hole diameter 19 mm (EN ISO 13433);
- vertical permeability h=50mm>80(l/m2)*sec. (EN ISO 11258);
- possible cloth overlapping, for at least 30 cm.

2.2.5 GEOCELL PANEL

The technical characteristics of the Geocell panel are given in the table and in the dimension drawings (fig. 2).
The product is black, with a smooth surface that does not present any incisions, air bubbles or inclusions.

Length	cm	58
Width	cm	58
Height	cm	3
Space volume	%	91
Surface void area	%	64
Accumulation capacity	l/m^2	27,6
Drainage capacity	$l/sec/m^2$	4
Weight	kg	0,97
Tensile strength	t/m^2	95
Colour	-	Nero
Material	-	PP

Table 3 - Geocell panel technical data

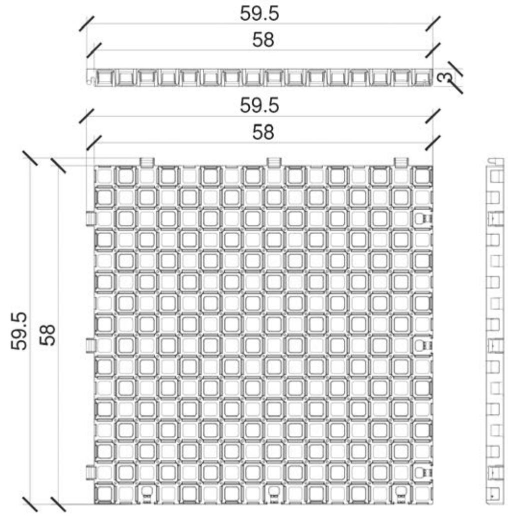
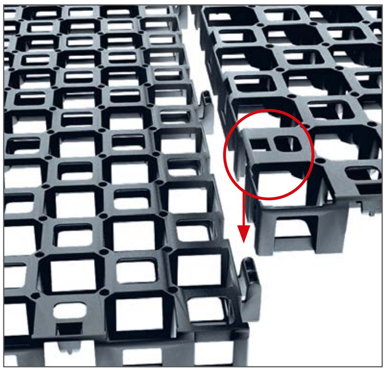


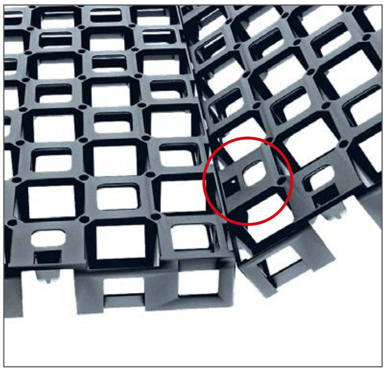
Figure 2 - Geocell panel dimension drawing

The panels are connected to each other by overlapping and snap fits. The recommended laying direction is from right to left and from up to down (see page 20).
The panels must all be directed in the same way, namely with the two "male" connecting rows positioned along the lower side and the left side.

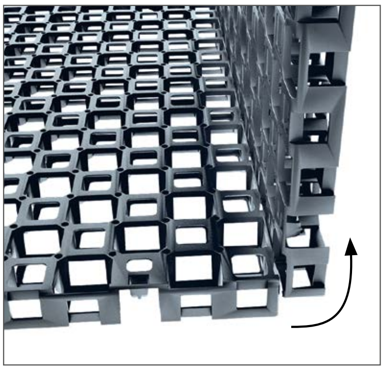
CONNECTION SEQUENCE



Overlapping



Connection



Possible rotation up to 90°

Figure 3 - Geocell panel connection sequence

2.2.6 LOOSE MIXED AGGREGATE FOR FOUNDATION AND BASE LAYERS

Mixed aggregate made up of a mix of stony aggregates that have not been recycled having the correct grain size composition (stabilised) included in the reference grading envelope indicated in table 4.
It can be seen that the grading envelope is different according to whether the material is to be used as a foundation layer or a base layer.

Sieve series and wind sifter UNI (mm)	Mesh % for foundation layer	Mesh % for base layer
70	100	-
30	70-100	100
15	-	70-100
10	30-70	50-85
5	23-55	35-65
2	15-40	25-50
0,4	8-25	15-35
0,075	2-15	5-15

Table 4 - grain size requirements for mixed aggregates in the foundation layer and in the base layer

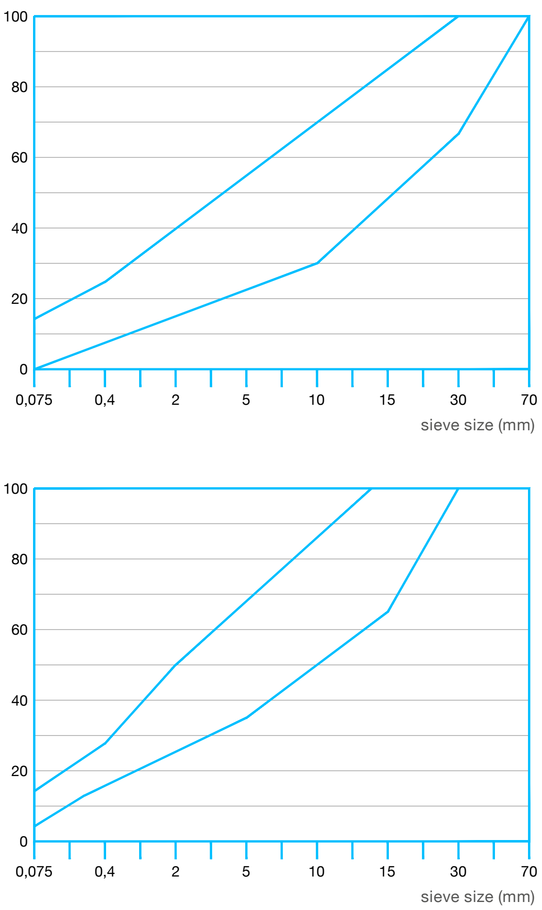


Figure 4 - grain size grading envelopes for foundation layer and base layer respectively

Mixed aggregate > 5 mm is called coarse aggregate, and must be made up of elements obtained by crushing solid rocks from quarries or of alluvial origin, or from natural elements with raw or rounded edges.
They can come from different places or be of a different petrographic nature, as long each type satisfies the requisites given in the following table.

Quality indicator			Floor layer	
Parameter	Test method	Unit of size	Fondation	Base
Los Angeles	UNI EN 1097 - 2	%	≤ 40	≤ 30
Micro Deval humid	UNI EN 1097 - 2	%	-	≤ 25
Quantity of crushed material	-	%	-	≥ 60
Maximum density	UNI EN 933 - 1	mm	63	63
Sensitivity to freezing	CNR 80/80	%	≤ 30	≤ 20

Table 5 - requirements for coarse aggregate in aggregate mixes

Mixed aggregate < 5 mm is called fine aggregate, and must be made up of natural or crushed elements that have the characteristics given in the following table.

Quality indicator			Floor layer	
Parameter	Test method	Unit of size	Fondation	Base
Sand equivalent (ES)	UNI EN 933 - 1	%	≥ 40	≥ 50
Plasticity index	UNI CEN ISO TS 17892 -12	%	≤ 6	not plastic
Liquid limit		%	≤ 35	≥ 25
Mesh of 0,075 mm	UNI EN 933 - 1	%	≤ 6	≤ 6

Table 6 - requirements for fine aggregate in aggregate mixes

The different components, and in particular the sand, must be completely free from organic, soluble, alterable and/or friable material.

3. ASSESSMENTS BEFORE LAYING

3.1 SOIL CHARACTERISTICS AND CLASSIFICATION

Soil classification is a preliminary analysis aimed at verifying if the materials extracted from the excavations can be used to create the stratigraphy without any particular precautions, or if suitable checks are instead necessary.

The usefulness of classifying soil is evident both during the design phase and as the work is being built: during the design phase it helps to quickly
assess the obligations connected with using the soil on site, so defining the costs of the various hypothesised solutions: during construction it helps establish, easily and quickly, the most suitable techniques to be implemented for using the materials coming from the excavations.

To classify soil from a grain size standpoint, reference is made to the UNI EN ISO 14688-1 standard, a summary of which is given in the table below.

Class	Sub-class	Symbol	Grain size (mm)
Very coarse soil	Large rock	Lbo	> 630
	Rock	Bo	200 ÷ 630
	Pebble	Co	63 ÷ 200
Coarse soil	**Gravel**	Gr	2 ÷ 63
	Coarse gravel	CGr	20 ÷ 63
	Medium gravel	MGr	6,3 ÷ 20
	Fine gravel	FGr	2 ÷ 63
	Sand	Sa	0,063 ÷ 2
	Coarse sand	Csa	0,63 ÷ 2
	Medium sand	Msa	0,2 ÷ 0,63
	Fine sand	Fsa	0,063 ÷ 0,2
Fine soil	**Silt**	Si	0,002 ÷ 0,2
	Coarse silt	Csi	0,02 ÷ 0,063
	Medium silt	MSi	0,006 ÷ 0,002
	Fine silt	Fsi	0,002 ÷ 0,006
	Clay	Cl	≤0,002

Table 7 - Soil classification according to UNI EN ISO 14688-1

When soil contains a certain percentage of fine parts, simply classifying it by grain size is not enough to decide on its use; its susceptibility to water, measured by identifying the liquid limit and plastic limit on the grain size that passes through a 0.4 mm sieve, and possibly the organic substance content, must therefore also be examined.

The American classification elaborated by the HRB (Highway Research Board) also considers other parameters in addition to the grain size, among which permeability, and proposes dividing soil into 8 groups, identified by classifications from A1 to A8, according to grain size and sensitivity to water (table 8):

		Fraction that passes through the sieve (mm)			LL	IP	IG
Group	**Sub-group**	**2**	**0,4**	**0,075**	**Liquid limit**	**Plasticity index**	**Group index**
A1	A1-a	≤50	≤30	≤15	-	<6	0
	A1-b		≤50	≤25			
A3			>50	≤10	-	-	0
A2	A2-4	-	-	≤35	≤40	≤10	0
	A2-5				≤40	≤10	
	A2-6				≤40	>10	≤4
	A2-7				≤40	>10	
A4	-	-	-	>35	≤40	≤10	≤8
A5	-	-	-	>35	>40	≤10	≤12
A6	-	-	-	>35	>40	≤10	≤16
A7	A7-5	-	-	>35	>40	>10	≤20
					IP≤LL-30		
	A7-6				>40	>10	
					IP≤LL-30		
A8	-	-	-	-	-	-	-

Table 8: soil classification according to the HRB

LL **Liquidity limit**	**IP** **Plasticity index**	**IG** **Group index**
Indicates the passage from plastic to liquid state. It is the water content value at which a groove made using a tool of normalised size on a sample contained in the cup of a Casagrande liquid limit device closes by 13 mm after the cup has fallen 25 times from a height of 1 cm.	This indicates the variation field of the water content inside which the soil remains plastic, i.e. inside which it can be deformed or renovated without changing volume and without cracks appearing. The IP value depends, in a given sample, on the percentage of clay, the type of clay, and the nature of the absorbed cations.	This is a concise soil quality index: the higher it is, the further the quality of the soil is from being considered optimal.

Finally, the most common types of material that make up each group and their important properties for use in embankments or as a foundation bed are indicated in the table below (table 9).

<table>
<tr><th>Group</th><th>Sub-group</th><th>Characteristic materials of the group</th><th>Characteristics as a foundation bed</th><th>Freezing</th><th>Shrinkage and swelling</th><th>Permeability</th><th>General classification</th></tr>
<tr><td rowspan="2">A1</td><td>A1-a</td><td rowspan="2">Gravel or pebble, sandy gravel or pebble, loamy sand, pumice, volcanic scoria, pozzolana</td><td rowspan="5">From excellent to good</td><td rowspan="3">None or slight</td><td rowspan="3">Null</td><td rowspan="3">Elevated</td><td rowspan="7">Clayey-sandy soil</td></tr>
<tr><td>A1-b</td></tr>
<tr><td>A3</td><td></td><td>Fine sand</td></tr>
<tr><td rowspan="4">A2</td><td>A2-4</td><td rowspan="4">Gravel or silty or clayey sand</td><td rowspan="4">Medium</td><td rowspan="4">Null or slight</td><td rowspan="6">Medium or scarce</td></tr>
<tr><td>A2-5</td></tr>
<tr><td>A2-6</td><td rowspan="7">From mediocre to poor</td></tr>
<tr><td>A2-7</td></tr>
<tr><td>A4</td><td>-</td><td>Silt that cannot be compressed much</td><td rowspan="2">Very high</td><td rowspan="2">Slight or medium</td><td rowspan="5">Silty-clayey soil</td></tr>
<tr><td>A5</td><td>-</td><td>Silt that can be greatly compressed</td></tr>
<tr><td>A6</td><td>-</td><td>Clay that cannot be compressed much</td><td>Medium</td><td rowspan="2">Elevated</td><td rowspan="3">Scarce or null</td></tr>
<tr><td rowspan="2">A7</td><td>A7-5</td><td>Clay that can be compressed greatly, moderately plastic</td><td>Elevated</td></tr>
<tr><td>A7-6</td><td>Clay that can be compressed greatly, very plastic</td><td>Medium</td><td>Very high</td></tr>
<tr><td>A8</td><td>-</td><td>Peat, organic debris of paludal origin</td><td>Unsuitable</td><td>-</td><td>-</td><td>-</td><td>Peat</td></tr>
</table>

Table 9: soil classification according to the HRB

3.2 FOUNDATION BED ANALYSIS

The following must be verified before making the stratigraphy package:

- the already-existing stratigraphy through coring of the soil to a recommended depth of 1 m (an example can be seen in figure 5);
- the carrying capacity of the foundation bed, through one of these tests:
  1. CBR test in a laboratory;
  2. plate load test;
- the water-into-soil infiltration speed.

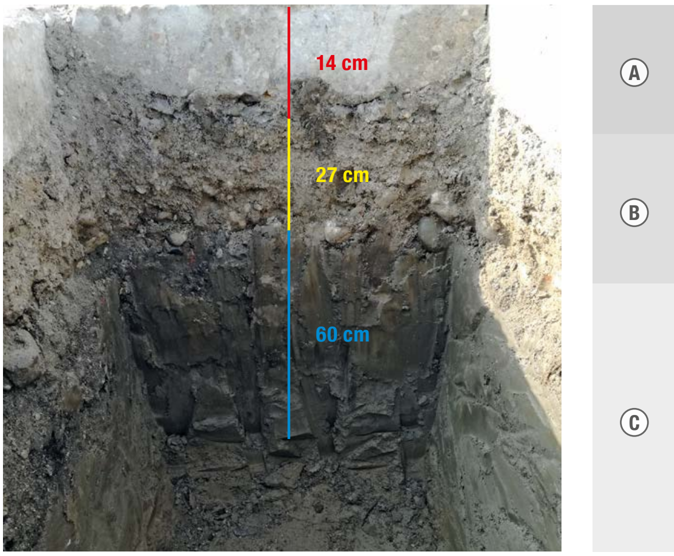


Figure 5: example of coring - depth 1 m

This will give a complete view of the geological composition of the soil and its structural strength and permeability. These analyses are also an essential parameter for assessing and preventing the risk of possible stagnant water caused by rain.

Thanks to these preliminary surveys it is possible to obtain the following useful parameters for the stratigraphic design of the area where the intervention is to be carried out:

Md= Plate deformation module (load interval 0,05-1,5 N/mm2)	N/m²
CBR Index	/
K=coefficient of vertical permeability of the soil	m/s

Table 10: parameters for assessing the foundation bed

According to the results of the CBR test or the plate load test, table 11 can be used to identify the geotechnical characteristics of the soil, attributing a lift class.

(A) ORDINARY CONCRETE, NOT REINFORCED, AVERAGE THICKNESS 14 CM

(B) NATURAL MIX OF SAND AND GRAVEL, AVERAGE THICKNESS 27 CM

(C) SILTY-CLAYEY SOL, THICKNESS 60 CM TO THE DEPTH OF THE EXCAVATION

Traffic class	Visual check of behavior under load (axis 13 f)	Geotechnical characteristics		Examples of soil types
		Module of deformation N/mm²	CBR Index	
0	Circulation impossible: unsuitable soil, very deformable foundation base	$M_d \leq 15$	CBR ≤ 3	Saturate fine clay, peat, soil with low dry density, soil containing organic and similar materials
1	Formation of ruts behind the test axis: deformable foundation bed	$15 < M_d \leq 30$	3 < CBR ≤ 6	Plastic limits, clayey and clay-plastic, coarse alluvial material very sensitive to water
2	No rut behind the test axis: deformable	$30 < M_d \leq 50$	6 < CBR ≤ 10	Alluvial sand, clayey or fine silty, clayey or silty gravel, marl with less than 35% of fine parts
3	No rut behind the test axis: not very deformable	$50 < M_d \leq 120$	10 < CBR ≤ 20	Natural alluvial sand with fine parts < 5%, gravelly, clayey or silty with fine parts < 12%
4	No rut behind the test axis: not very deformable	$120 < M_d \leq 250$	20 < CBR ≤ 50	Materials that are not sensitive to water, natural sand and gravel, healthy rocky materials, old road carriageways
5	No rut behind the test axis: not deformable	$M_d > 250$	CBR > 50	

Table 11: classification of the foundation bed lift

3.3 TRAFFIC CLASSES

When the soil lift class has been defined, in order to identify the correct stratigraphy it is essential to determine the loads that the interlocking flooring will support. Table 12 gives some reference values of these loads according to the most frequent destinations of flooring use.

Type of traffic	Maximum load KN	Maximum pressure N/m²	Average pressure N/m²
Pedestrians only (compact crowd)	1	0.01	0.004
Cars only	5	0.20	0.005
Motor vehicles ≤ 3,5 t	10	0.30	0.008
Lorries/vans and articulated lorries >3.5 t	60	1.00	0.025
Container storage bays	150	2,50	0,050

Table 12: load types and corresponding pressure on the flooring

To correctly design the stratigraphy for laying interlocking flooring, the following must also be determined:

- the maximum strain caused by the heaviest load from among those that will use the superstructure;
- the cumulated damage caused by strain repetition induced by all the loads per axis that transit on the superstructure and so the fatigue life of the flooring.

To identify the correct traffic class according to the structural sizing of the flooring, it is a good idea to refer to the simplified classification, derived from the SETRA-LCPC proposal, based on factors that can be easily identified (table 13).

Class of traffic		Daily maximum traffic			Description
		No of heavy means with payload >5	No of vehicles with gross vehicle weight >3,5	Total no. of vehicles without definition of load	
	**1**	-	-	-	pedestrian only spaces; parks, swimming pools, pavements; bike paths
	2A	-	2	50	courtyard areas; access roads for division with less than 10 residences, urban spaces for pedestrians with service vehicle access; residential parking areas, parks, swimming pools, pavements; bike paths
	**2B**	-	10	200	access roads for division with from 10 to 300 residences; urban pedestrian roads with access for service and delivery vehicles; public and business parking areas
	3A	25	30	500	urban roads or similar, subject to a maximum of 500 vehicles per day and per circulation direction, without load distinction
	3B	50	60	700	urban roads or similar subject to a maximum of 700 vehicles per day and per circulation direction, without load distinction; parking areas for the slow manoeuvring of heavy means (up to 60 vehicles/day with a gross vehicle weight of >3.5 tons)
	**3C**	100	125	1000	urban roads or similar subject to traffic, maximum 1000 vehicles per day and per circulation direction, without load distinction; parking areas for slowly manoeuvring heavy means (up to 125 vehicles/day with a gross vehicle weight of >3.5 tons)
	**4**	>100	>125	>1000	urban roads or similar subject to traffic of more than 1000 vehicles per day and per circulation direction, without load distinction; parking areas for slowly manoeuvring heavy means (up to 125 vehicles/day with a gross vehicle weight of >3.5 tons)

Tabella 13: classificazione del traffico

3.4 CHOICE OF INTERLOCKING PAVEMENT BLOCKS

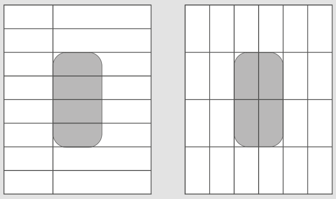
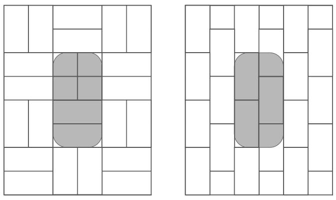
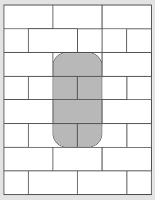
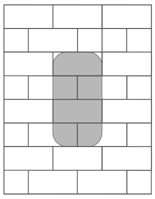
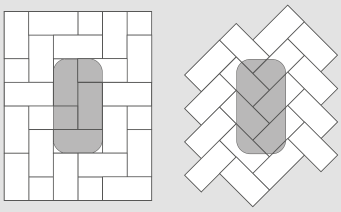
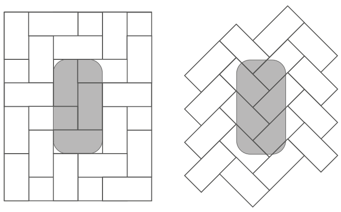
Traffic class	Minimum block thickness (cm)	Prescriptions for laying	
1	4,5		none
2 A	6		none
2 B	6		without continuous joint lines in the main circulation
3 A	8		without continuous joint lines in the main circulation direction
3 B-C	8		without continuous joint lines in the main circulation direction
4	10		herringbone or equivalent system

Table 14: choice of thickness of the block and laying diagram

On the basis of the traffic classes given in table 13, it is now possible to identify the correct thickness of the interlocking pavement blocks (in cm) and the laying plan. Refer to the above table for guidance.

4. SYSTEM LAYING

4.1 REFERENCE STRATIGRAPHY

According to the soil lift class and the traffic class that the area will be subjected to, the recommended stratigraphy and the size of the interlocking pavement blocks can now be identified.

Lift class (from table 11)	Traffic class (from table 13)						
	1	**2A**	**2B**	**3A**	**3B**	**3C**	**4**
5	Foundation and base layers not required						
4	Foundation and base layers not required	6 / 8	6 / 9	8 / 12	8 / 19	8 / 28	Not envisaged for the destination of use
3	Foundation and base layers not required	6 / 9	6 / 12	8 / 22	8 / 36	8 / 46	Not envisaged for the destination of use
2	6 / 8	6 / 12	8 / 20	8 / 36	8 / 48	Not envisaged for the destination of use	Not envisaged for the destination of use

Table 15: reference stratigraphy (the numbers indicate layer thickness in cm)

SURFACE LAYER

- (A) INTERLOCKING PAVEMENT BLOCK
- (B) SETTING BED SAND
- (C) GEOCELL PANEL

FOUNDATION LAYER

- (D) LOOSE AGGREGATE

When the nature and state of the soil do not make it possible to reach the required lift values (minimum value 2) with tamping only, the following can be done as an alternative:

- a soil stabilisation treatment;
- deeper excavation to replace a suitable layer of existing material with suitable fillers.

4.2 LAYING

4.2.1 EXCAVATIONS AND DEMOLITION

Cutting the flooring (where present) and digging the underlying soil to the depth indicated by the project sections above, with transport of the rubble to a landfill.

Figure 6: area excavation

4.2.2 LAYING THE SIDE CONTAINING EDGES

Interlocking flooring needs to be confined along the sides to oppose the horizontal strain caused by vehicle transit. Suitably sized containing edges of concrete or stone must therefore be used with the flooring.

The containing edges must be laid before laying the flooring. The containing edges are laid on a concrete bed at the level indicated by the project and are suitably reinforced.

Considering the subsequent work phases, the following prescriptions must be observed:

- the concrete bed and/or reinforcement must not obstacle the subsequent laying of the flooring terminal elements (see the figure that follows);
- the space between individual adjoining edges must be minimum, and must not allow any loss of setting bed sand: if the opening is excessive, it must be suitably sealed with grout or protected by a permeable geotextile facing.

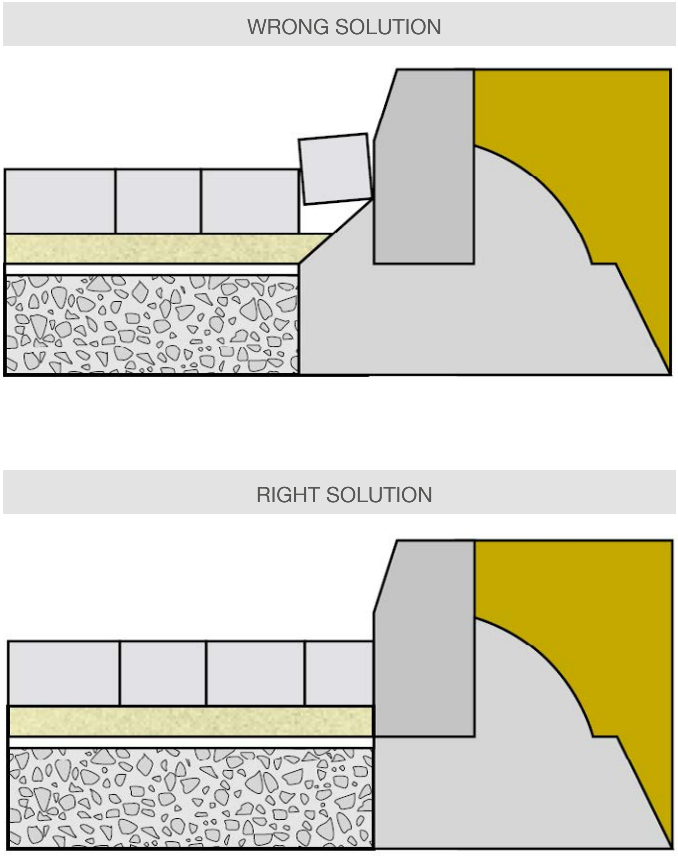


Figure 7: laying the containing edges

4.2.3 LAYING THE PEIT GEOTEXTILE, 200 g/m²

Laying the geotextile of weight 200 g/m² on the excavation base.

Figure 8: laying the geotextile on the excavation base

4.2.4 LAYING THE LOOSE AGGREGATE FOR THE FOUNDATION AND BASE LAYERS

The material must be laid in subsequent phases in layers that are no more than 25 cm thick and must, after tamping, be uniformly mixed so that there is no component segregation.

Use rollers or vibrating plates of suitable power to tamp and finish, until an optimal on-site density is obtained. The finishing surface of the base layer must be level according to the finite slopes of the flooring: in no case can these slopes be obtained by varying the setting bed thickness indicated in the project.

To ensure that the roadbed has been executed correctly, it is a good idea to carry out these tests:

- for the lift: circular plate load tests with double cycle (CNR Official Gazette 146/1992) for each field, showing the corresponding values in the interval 0.15-0.25 N/mm^2;
- permeability tests;
- 3 on-site tests (ASTM c 1701 or equivalent) for each field.

Figure 9: laying aggregate for base layer

4.2.5 LAYING THE PPST GEOTEXTILE 300 g/m^2

Laying the geotextile of weight 300 g/m^2 on the aggregate layer

Figure 10: laying the geotextile on the aggregate layer

4.2.6 LAYING THE GEOCELL PANEL

Positioning the Geocell panel above the geotextile, verifying correct connection.

Figure 11: laying the Geocell panel

GEOCELL must be laid starting from the top right-hand edge of the intervention area and continuing to the left and down, as shown in the figure below:

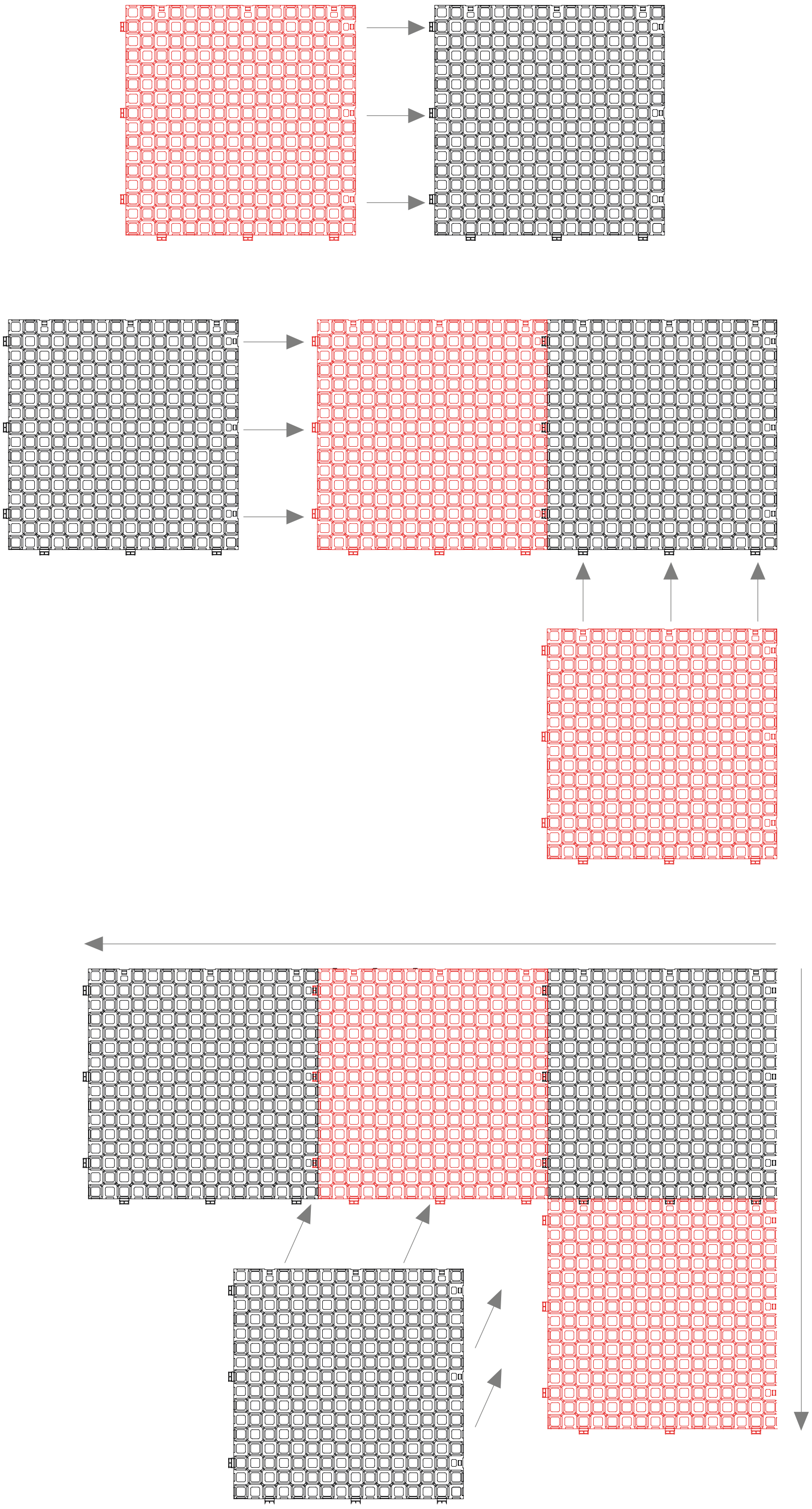


Figure 12: Geocell laying plan

4.2.7 LAYING THE PPST GEOTEXTILE 300 g/m²

The Geocell element is then covered with the laid geotextile weighing 300 g/m².

Figure 13: laying the geotextile above the Geocell

4.2.8 LAYING THE SETTING BED SAND AND THE INTERLOCKING PAVEMENT BLOCKS

After the geotextile and the perimeter edges have been positioned, a setting bed of sand of alluvial origin or coming from crushed unalterable rocks with a high mechanical resistance must be laid.
After this, the interlocking pavement blocks can be laid, observing the prescriptions indicated by their producer.

Figure 14: laying the sand setting bed and the interlocking pavement blocks

Figure 15: compacting the interlocking pavement blocks

The flooring must also be compacted using suitable means.

Figure 16: joint sealing

4.3 COMPLETION

4.3.1 RAINWATER COLLECTION

When rainfall is intense, and as a result of the scarce permeability of the foundation bed or saturation of the stratigraphy below the interlocking block flooring, the water will tend to rise and create underlying water pressure which will compromise surface stability.

The Geocell panel, thanks to its high horizontal flow capacity, helps prevent this phenomenon by carrying all the rising water towards a drainage mesh.
Under the flooring, the water that is drained by the system can be managed by laying perforated pipes of suitable size, which then discharge the water into a drainage / detention basin.

- the run-off water is managed through a prefabricated channel positioned before the containing edge;

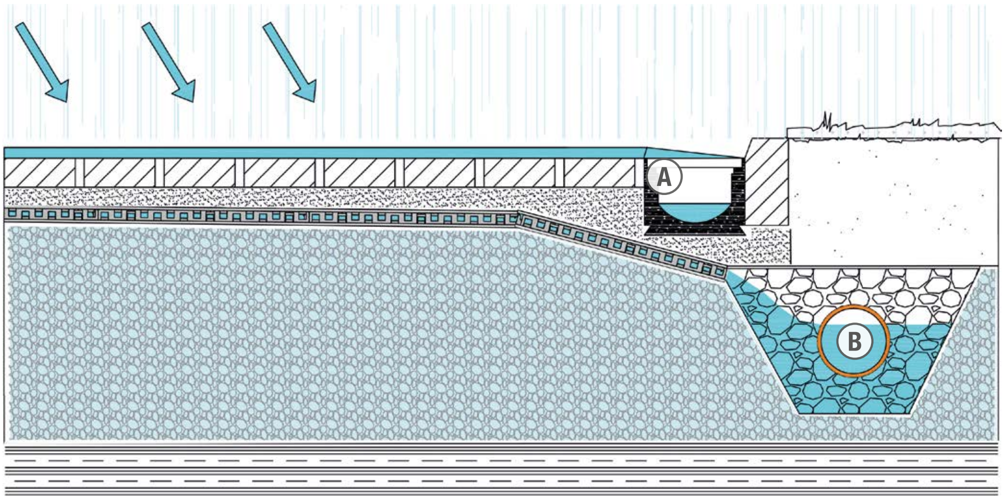


Figure 17: rainwater collection using a prefabricated channel

Ⓐ CHANNEL FOR RUN-OFF WATER DRAINAGE

Ⓑ PERFORATED PIPE FOR DRAINING THE WATER COMING FROM GEOCELL

- a containing edge is used with the drainage channel inserted inside it;

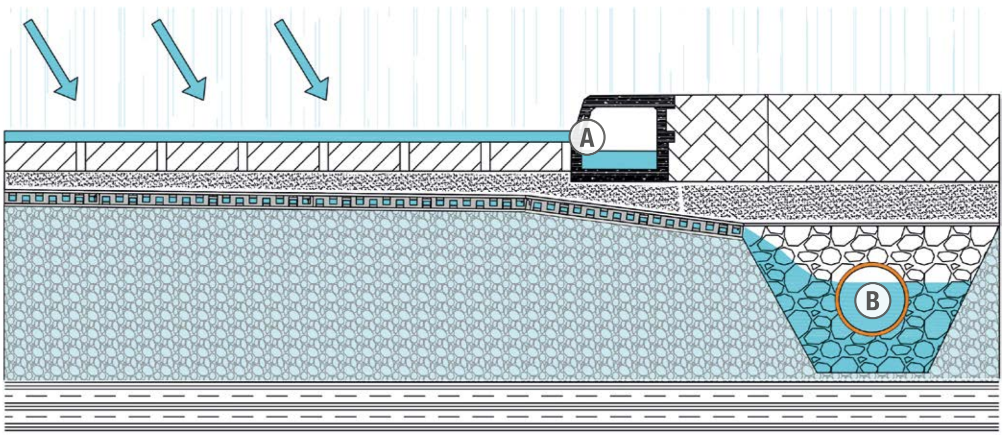


Figure 18: rainwater collection using a perforated containing edge

Ⓐ CHANNEL FOR RUN-OFF WATER DRAINAGE

Ⓑ PERFORATED PIPE FOR DRAINING THE WATER COMING FROM GEOCELL

The water collected by the surface channel and the perforated pipe can be collected in a well that discharges it into a dispersion system (like Drening by Geoplast).

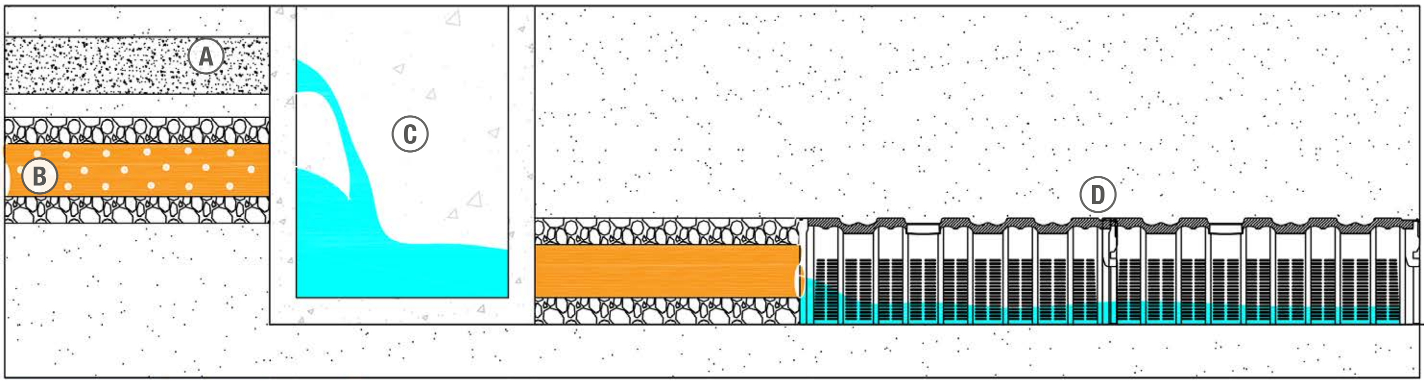


Figure 19: rainwater collection, final position

Ⓐ CHANNEL FOR RUN-OFF WATER DRAINAGE

Ⓑ PERFORATED PIPE FOR DRAINING THE WATER COMING FROM GEOCELL

Ⓒ WATER COLLECTION WELL

Ⓓ DRENING ACCUMULATION AND DISPERSION SYSTEM

4.4 MAINTENANCE PLAN AND ON-SITE VERIFICATIONS

As the interlocking action develops prevalently because of the friction in the joints, the routine maintenance plan is limited to making sure that sealing is correct and reintegrating the sand if necessary. Loss of material from the joints is always a hint that the flooring is not in perfect condition, and a solution must be found as soon as possible.

Considering that the special characteristic of this type of flooring is to progressively develop increased interlocking because of sand tamping in the joints caused by traffic and the accumulation of surface debris, these checks must be carried out more frequently during the first year of life of the flooring; after this, a yearly check is sufficient.

The behaviour assessment inspections during operation must be carried out at the same frequencies as indicated in the routine maintenance plan above, and the following recorded:

- the extent of possible vertical failure along the reference sections;
- the extent of possible horizontal block misalignment, verifying that this does not cause the corresponding joints to open by more than 5 mm and/or leads to the sealing sand coming out of the joints in an irregular manner;
- the absence of edge chipping and/or interlocking element breakage caused by excessive movement when under load. Additional plate load and/or permeability tests can be carried out periodically.

Inspection	Frequency
1_{st} inspection	15 days after work has ended
2_{nd} inspection	30 days after the previous inspection
3_{rd} inspection	3 months after the previous inspection
4_{th} inspection	6 months after the previous inspection
5_{th} inspection	yearly

Table 16: routine maintenance plan

5. COMPARATIVE ANALYSIS

5.1 INTRODUCTION

The initial permeability of a floor reduces over time because the filtering materials become clogged by dirt, debris and/or polluting particles, for example tyre wear, environmental emissions, mineral oil residues, road salt. Environmental conditions can also cause accumulations in the material that fills the sand, silt or clay joints and its transport, with the resulting proliferation of vegetation.
The layer compacting effect caused by load repetition is an additional factor that reduces permeability over time: as this reduction increases, so do layer compressibility and the tendency of the granules to become dust (can be estimated from the Los Angeles soil value).
In special conditions the initial permeability can be cancelled in a few years, not just in one of the foundation bed layers but also in the space material and even in flooring with openings of above 20%.

In the presence of bad weather and a scarcely permeable base, the gravel drainage layer tends to become progressively more saturate.
Once it is completely saturate, the water will rise, creating two main problems (fig. 21):

- water on the surface, because the package is no longer able to drain;
- the hydraulic force on the flooring, which in some conditions can cause localised lifting.

All base conditions being equal, Geocell allows the water to flow even longitudinally to reach the drainage mesh (fig. 22).
In this manner the water does not rise to the surface and the blocks do not lift.

STRATIGRAPHY WITHOUT GEOCELL

Figure 21 - hydraulic forces acting on the interlocking surfaces WITHOUT Geocell

STRATIGRAPHY WITH GEOCELL

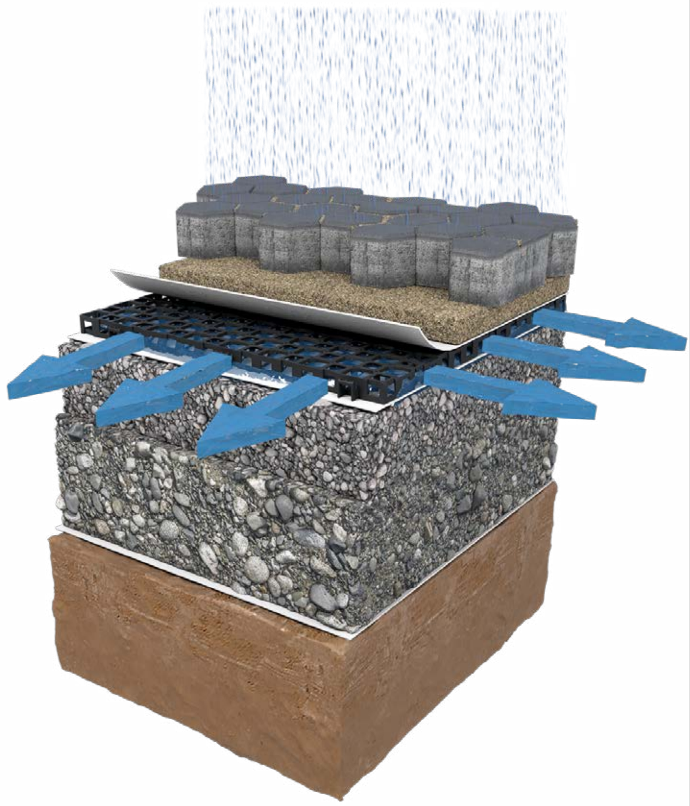


Figure 22 - behaviour of interlocking flooring WITH Geocell

5.2 A COMPARISON BETWEEN THE GEOCELL SYSTEM AND TRADITIONAL PACKAGES

A comparison between a generic stratigraphy for interlocking flooring and a stratigraphy with a Geocell panel inserted.

Both the rainwater drainage capacities between the two stratigraphies and the reductions in excavation tied to using Geocell were compared.

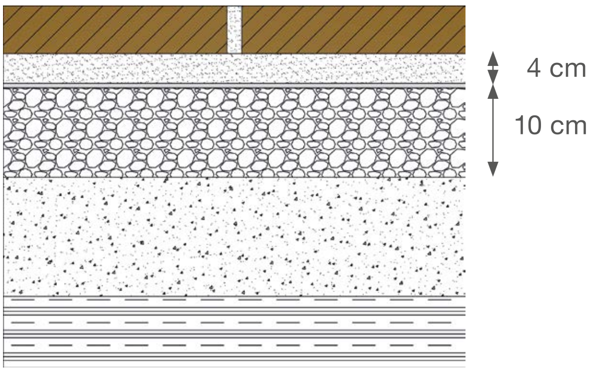
5.2.1 RAINWATER DRAINAGE

The assessment was made using impermeable base (e.g. clayey soil), considered as the most unfavourable for interlocking flooring, because intense rainfall causes the base to become fully saturated, which compromises flooring stability (creation of hydraulic forces).

TRADITIONAL SYSTEM

Soil permeability = 10^{-7} m/s
Infiltration capacity = 10^{-7} m^3/s

Gravel porosity = 30%
Sand porosity = 40%
$V_{accumulation}$ gravel= 0.1* 1* 0.3 =0.03 m^3
$V_{accumulation}$ sand= 0.04* 1* 0.4 =0.016 m^3



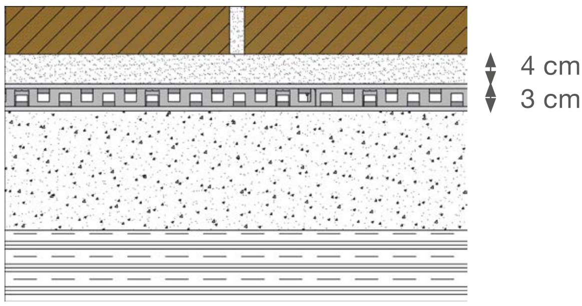
$V_{accumulation}$ gravel (10 cm) + $V_{accumulation}$ sand (4 cm) = 0,046 m^3/m^2 = 46 mm
Emptying time = 0,046 / 10^{-7} ≈ 6 days

GEOCELL

Soil permeability = 10^{-7} m/s
Infiltration capacity = 10^{-7} m^3/s

Geocell drainage capacity= 0,004 m^3/s
Sand porosity = 40%
Geocell void index= 91%

$V_{accumulation}$ sand= 0.04* 1* 0.4 =0.016 m^3
$V_{accumulation}$ Geocell 0.03* 1* 0.91 =0.028 m^3



$V_{accumulation}$ Geocell (3 cm) + $V_{accumulation}$ sand (4 cm) = 0,044 m^3/m^2 = 44 mm
Emptying time = 0,05/(0,004+10-7) < 1h

As demonstrated by this example, where the accumulation volume is the same, when the base permeability is very limited the Geocell stratigraphy can drain the water more quickly than gravel, and the result is that the flooring bed does not become saturate.

With the traditional system, only vertical drainage is considered, with an infiltration capacity of values that are typical for clayey soil, because horizontal drainage is negligible. For the Geocell system, however, the horizontal drainage capacity, equal to 4 l/s, is considered.

5.2.2 EXCAVATION REDUCTION

On a stratigraphy level, Geocell helps limit the base layer, which reduces the excavation depth.
As an example, a comparison between stratigraphies referring to the passage of heavy vehicles:

Traditional System

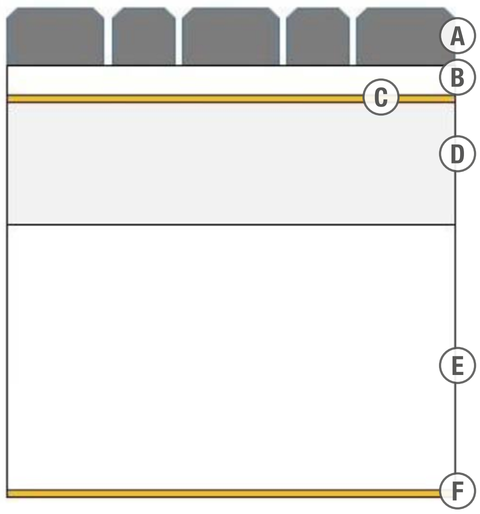


Figure 23: indicative stratigraphy without Geocell

- (A) INTERLOCKING PAVEMENT BLOCK IN CONCRETE 8 CM
- (B) SETTING SAND 4 CM
- (C) (F) GEOTEXTILE
- (D) LOOSE AGGREGATE FOR BASE LAYER 30 CM
- (E) LOOSE AGGREGATE FOR FOUBNDATION LAYER 50 CM

GEOCELL

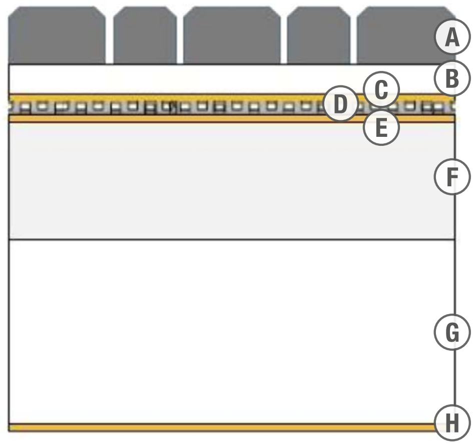


Figure 24: indicative stratigraphy with Geocell

- (A) 8 CM CONCRETE INTERLOCKING PAVEMENT BLOCK
- (B) 4 CM SETTING SAND
- (C) (E) (H) GEOTEXTILE
- (D) GEOCELL 3 CM
- (F) LOOSE AGGREGATE FOR BASE LAYER 25 CM
- (G) LOOSE AGGREGATE FOR FOUNDATION LAYER 40 CM

Using Geocell makes it possible to reduce the excavation depth by 15 cm.

ATTACHMENTS

ATTACHMENT A

MATERIAL SAFETY SHEET

POLYMER COMPOSITION/INFORMATION

INGREDIENTS	C.A.S. No.	%
Random Polypropylene	9010-79-1	97-99
Additives	Not available	1-3

HAZARDOUS COMPONENTS

This product cannot be classified as hazardous material as defined by EEC 1999/45 and the subsequent legal provisions.
Physical state: Solid.
Problems: If the polymer is subjected to high temperatures it can produce vapours that irritate the breathing system and the eyes.

FIRST AID MEASURES

Inhalation of decomposition products: keep the patient calm, move him/her to the open air and call for medical assistance.
Contact with the skin: the parts that come into contact with the loose material must be quickly placed under running water and a doctor contacted.
Eye contact: wash the eyes for at least 15 minutes under running water, keeping the eyelids open.
Contact with particles of material is not particularly dangerous, except for the possibility of wounds caused by abrasion.
Finer particles can cause irritation.
Ingestion: No special measures need to be taken.

FIRE PREVENTION MEASURES

Extinguishing materials: water, foam or dry extinguishing materials.
Unsuitable extinguishing materials: none. Substances released in the event of fire:
prevalently carbon dioxide (CO2) and vapour. Other substances that can form: carbon monoxide (CO), monomers, other decomposition products.
Special protective devices: in the event of fire wear breathing apparatus.
Other regulations: dispose of the combustion refuse and the contaminated extinguishing material as indicated by local laws in force.

MEASURES IN THE EVENT OF ACCIDENTAL RELEASE

Not classified as hazardous material. Can be recycled, incinerated or disposed of in a landfill, in agreement with local laws in force.

STORAGE AND HANDLING

Laws in force on powders must be considered when the product is ground. Keep the product in a dry place.

EXPOSURE / PERSONAL PROTECTION

Respiratory tract protection: if breathable powders form use P1 filters (DIN 3181).
Skin protection: no special precautions are necessary.
Eye protection: safety goggles in the presence of loose particles.

CHEMICAL-PHYSICAL PROPERTIES

Form	Panels
Colour	Dark grey-black
Odour	Faint
Changes in the physical state	Melting point: 140°C Combustion temperature: above 400°C
Flammable properties	None
Density	0.91-0.97 kg/dm^3
Solubility in water	Insoluble
Solubility in other solvents	Soluble in aromatic solvents

STABILITY AND REACTIVITY

Conditions to avoid	do not overheat to prevent thermal decomposition. The process begins at around 300 °C
Products from thermal decomposition	monomers and other by-products

TOXICOLOGY INFORMATION

Acute toxicity: data not available (not experimented on animals, impossible because of product conformation).
Insoluble in water.

ECOLOGY INFORMATION

Decomposition in nature: Insoluble in water.
Behaviour and environmental destination: the product is environmentally compatible because made of recycled plastic.
It is apparently not biodegradable because of its insolubility in water and its consistency.

CONSIDERATIONS ON DISPOSAL

100% recyclable product. Can be disposed of in a landfill or incinerated, in accordance with local laws in force.

INFORMATION ON TRANSPORT

Not classified as dangerous to transport.

INFORMATION ON REGULATIONS

Not subject to CE marking.

Geoplast

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