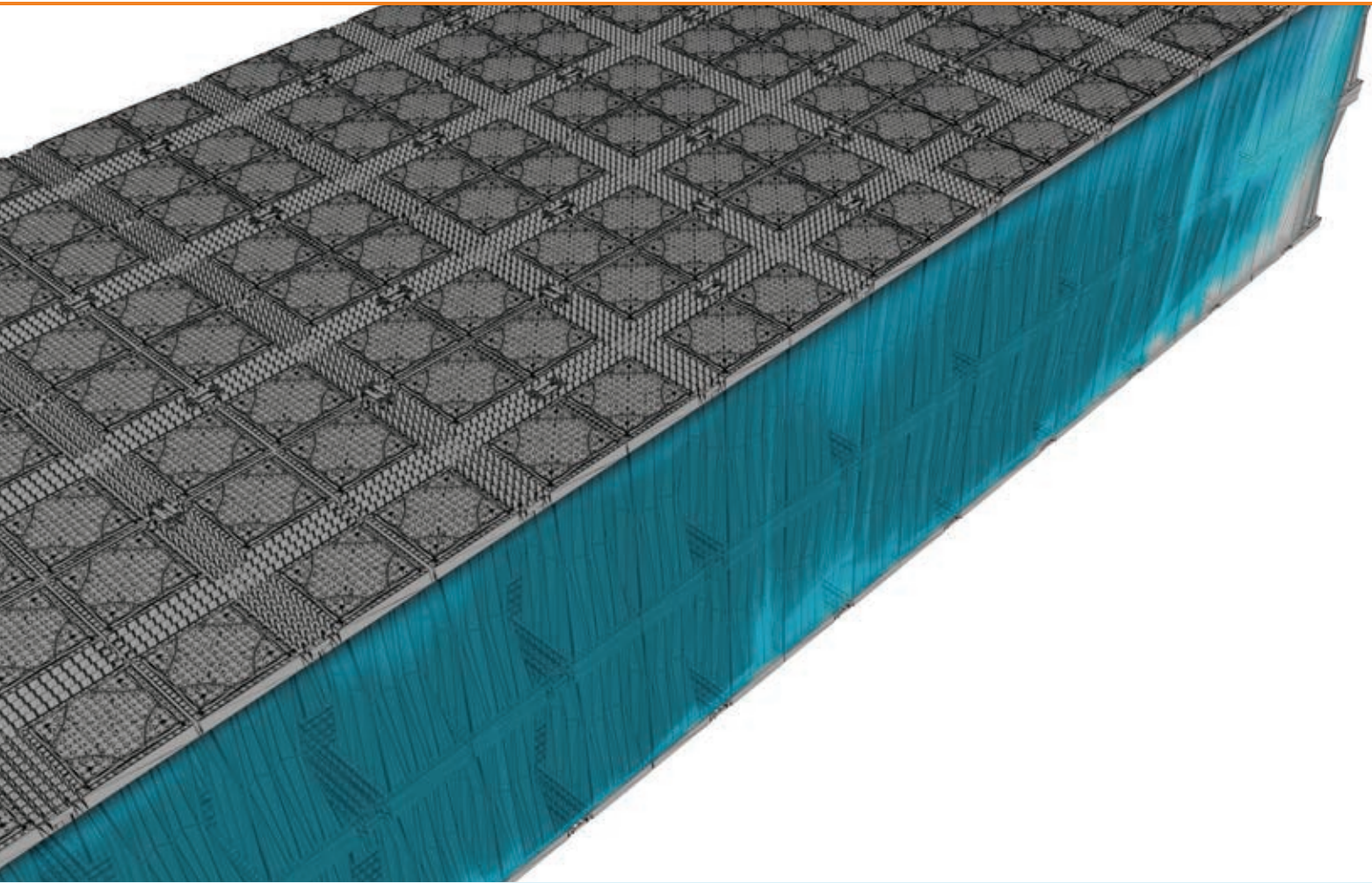
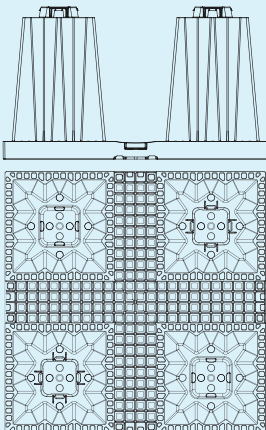
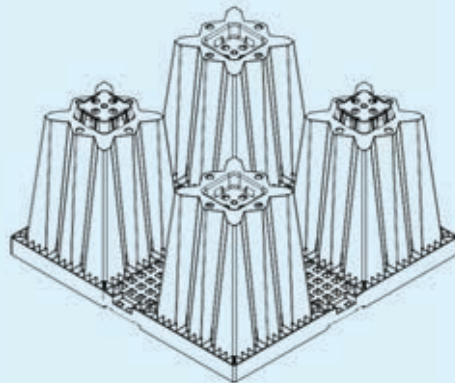




TECHNICAL MANUAL

AQUABOX

MODULAR SYSTEM FOR STORMWATER MANAGEMENT



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TECHNICAL MANUAL AQUABOX

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1. THE AQUABOX SYSTEM

1.1 PURPOSES AND FUNCTIONS

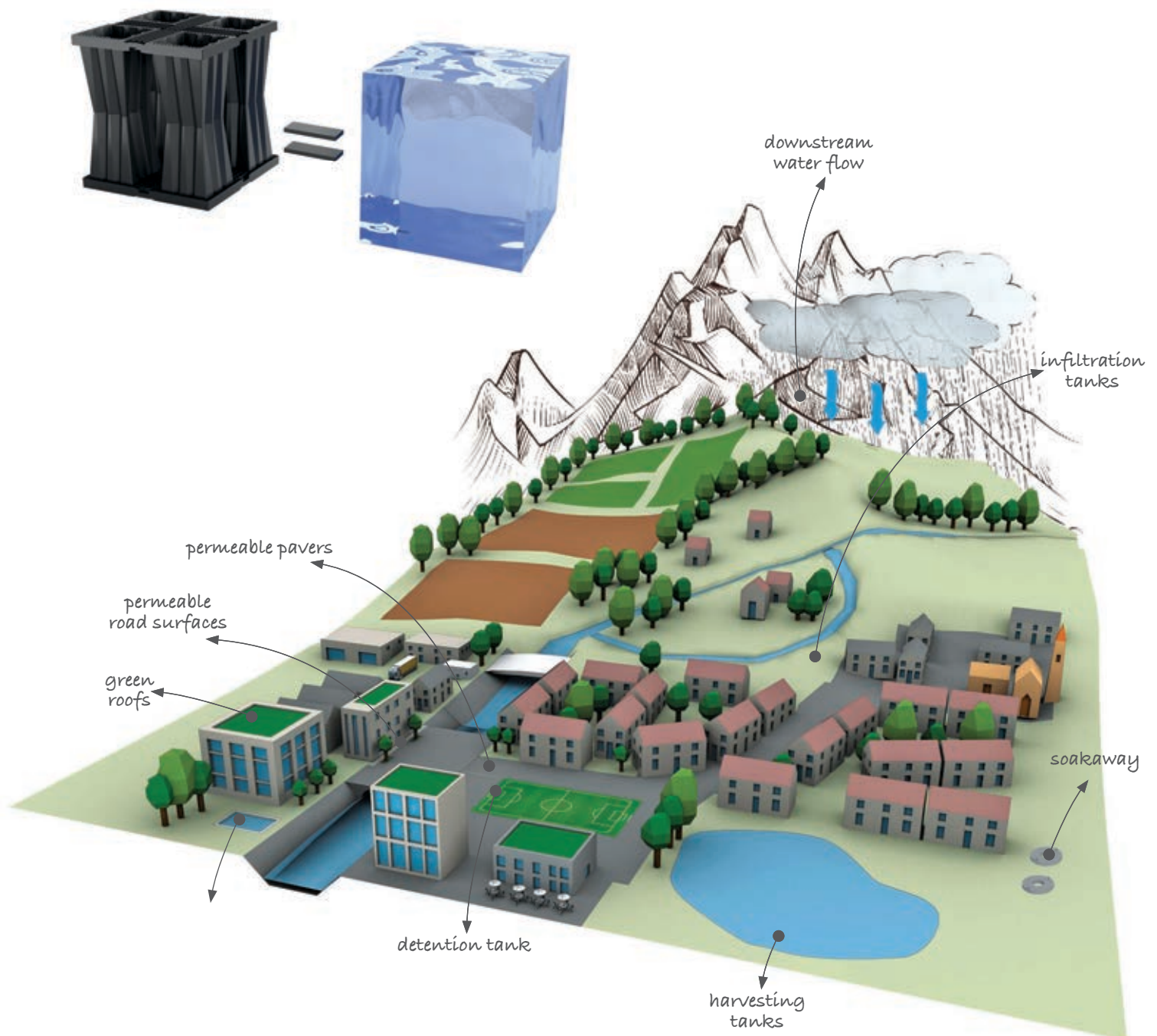
In recent years, due to the construction boom and the large-scale development of buildings, it has become necessary to assess hydrogeological issues, leading to the concept of “hydraulic invariance.”

The etymology of the term conveys the idea of restoring the quantity of water that was naturally drained into the ground prior to the construction of new developments, by providing storage systems that allow it to gradually infiltrate into the soil or be conveyed elsewhere.

In many areas particularly sensitive to this issue, new regulations have been introduced, such as Regional Regulation No. 7 of 2017 issued by the Lombardy Region, which defines the rules for hydraulic invariance in the case of new constructions.

The proper drainage of rainwater is therefore of considerable importance for its sustainable management over time.

Among the various solutions available on the market, the use of AQUABOX systems for the construction of infiltration or storage basins for stormwater proves to be highly effective and quick to implement.



1.2 SYNTHETIC DESCRIPTION

1.2.1 AQUABOX

AQUABOX is a modular element with a hollow truncated pyramid structure made from virgin or recycled polypropylene, available in four different versions.

It is designed to create underground basins for the sustainable management of rainwater.

In order to reduce potential flooding phenomena resulting from the increase in urbanised surfaces, AQUABOX is used for the control and disposal of rainwater by creating infiltration basins, storage and retention tanks, or collection systems to enhance water by reusing it. The dimensions of the assembled Aquabox element are 75x75x80 cm.

The elements are assembled on-site and laid dry. The modules are connected to each other using specific connectors that ensure the stability of the basin.

Thanks to its high mechanical resistance, AQUABOX can be installed in both urban and industrial/commercial areas where there is heavy traffic of large vehicles.

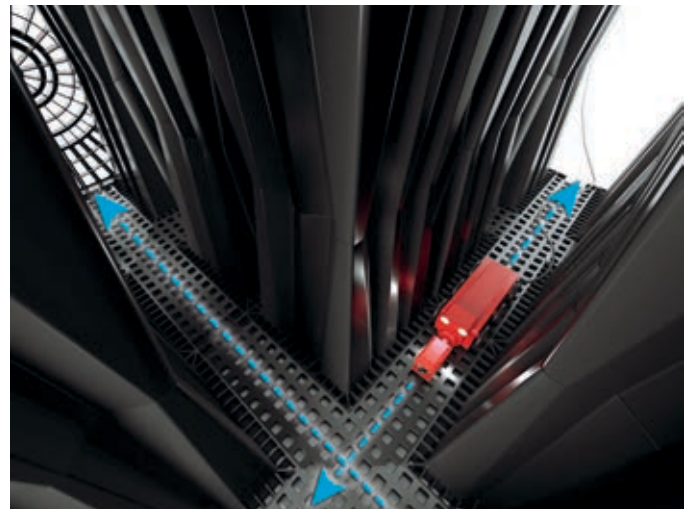
Below are the technical data relating to the individual piece: (1 AQUABOX = 2 pieces).



Thanks to the highest storage percentage of 96% allows for the accumulation of up to 432 litres of rainwater per module.

The system is also inspectable via the accessory AQUABOX CUBE.

Inspection can be carried out using robots and cleaning and maintenance through the insertion of a high-pressure mechanised hose.



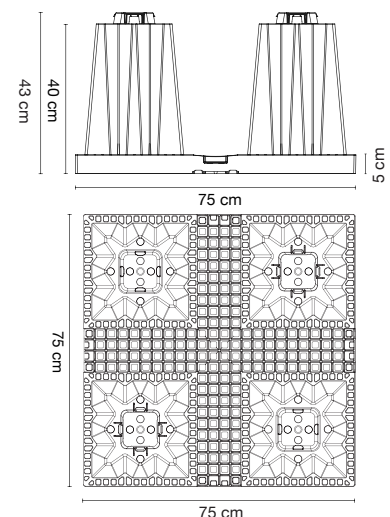
**AQUABOX
HPR**

**AQUABOX
HP**

**AQUABOX
STR**

**AQUABOX
ST**

Dimensions (cm)	75 x 75 x H43			
Material	Graplene			
Net storage volume (L/unit)	216			
Percentage of voids	96%			
Packaging dimensions (cm)	80 x 152 x H258			
Quantity (pcs)	80			
Product Code	EDAQUVE1540	EDAQUFV1540	EDAQUFV0540	EDAQUAB0400



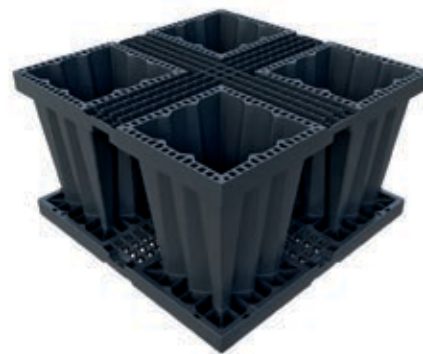
1.2.2 AQUABOX HALF

Among the evolutions of the AQUABOX system, there is AQUABOX HALF, a compact version designed for the creation of underground basins with a reduced height or flexible modular configurations. The system maintains the characteristics of modularity, mechanical resistance, and inspectability of the standard model. The dimensions of the assembled Aquabox Half element are 75x75x45 cm. Each HALF module allows for a net accumulation of 240 litres of rainwater, with a void percentage of 96%.

This solution is particularly indicated for installations in urban areas with depth constraints or high water tables, as inspection chamber as optimising the available volume in projects that require intermediate heights between levels.

Inspection of the system is also guaranteed for AQUABOX HALF, which can be carried out via a robot, thus ensuring ease of control and maintenance.

Each AQUABOX HALF module consists of 1 AQUABOX unit + 1 AQUABOX BASEHALF.



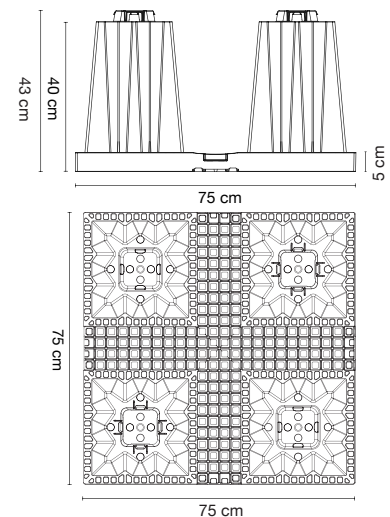
**AQUABOX
HPR**

**AQUABOX
HP**

**AQUABOX
STR**

**AQUABOX
ST**

Dimensions (cm)	75 x 75 x H43			
Material	Graplene			
Net storage volume (l/unit)	216			
Percentage of voids	96%			
Packaging dimensions (cm)	80 x 152 x H258			
Quantity (units)	80			
Product Code	EDAQUVE1540	EDAQUFV1540	EDAQUFV0540	EDAQUAB0400



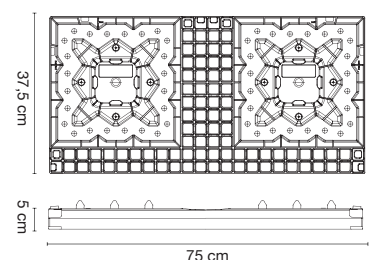
**AQUABOX
HALF BASE
HPR**

**AQUABOX
HALF BASE
HP**

**AQUABOX
HALF BASE
STR**

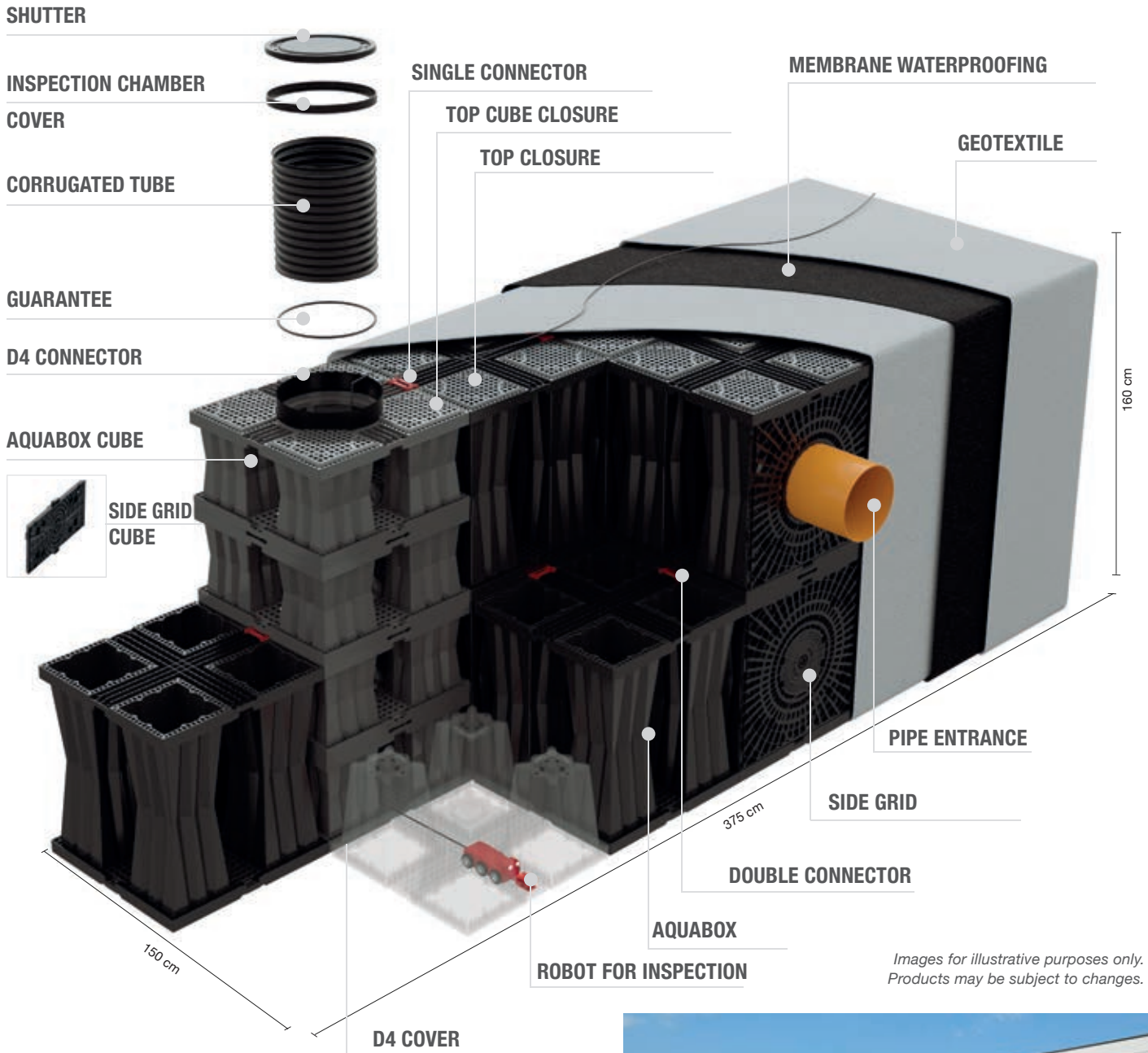
**AQUABOX
HALF BASE
ST**

Dimensions (cm)	37.5 x 75 x H5			
Material	Graplene			
Packaging dimensions (cm)	77 x 120 x H250			
Quantity (pcs)	144			
Product Code	EDQBHA3775	EDQBHB3775	EDQBHC3775	EDQBHD3775

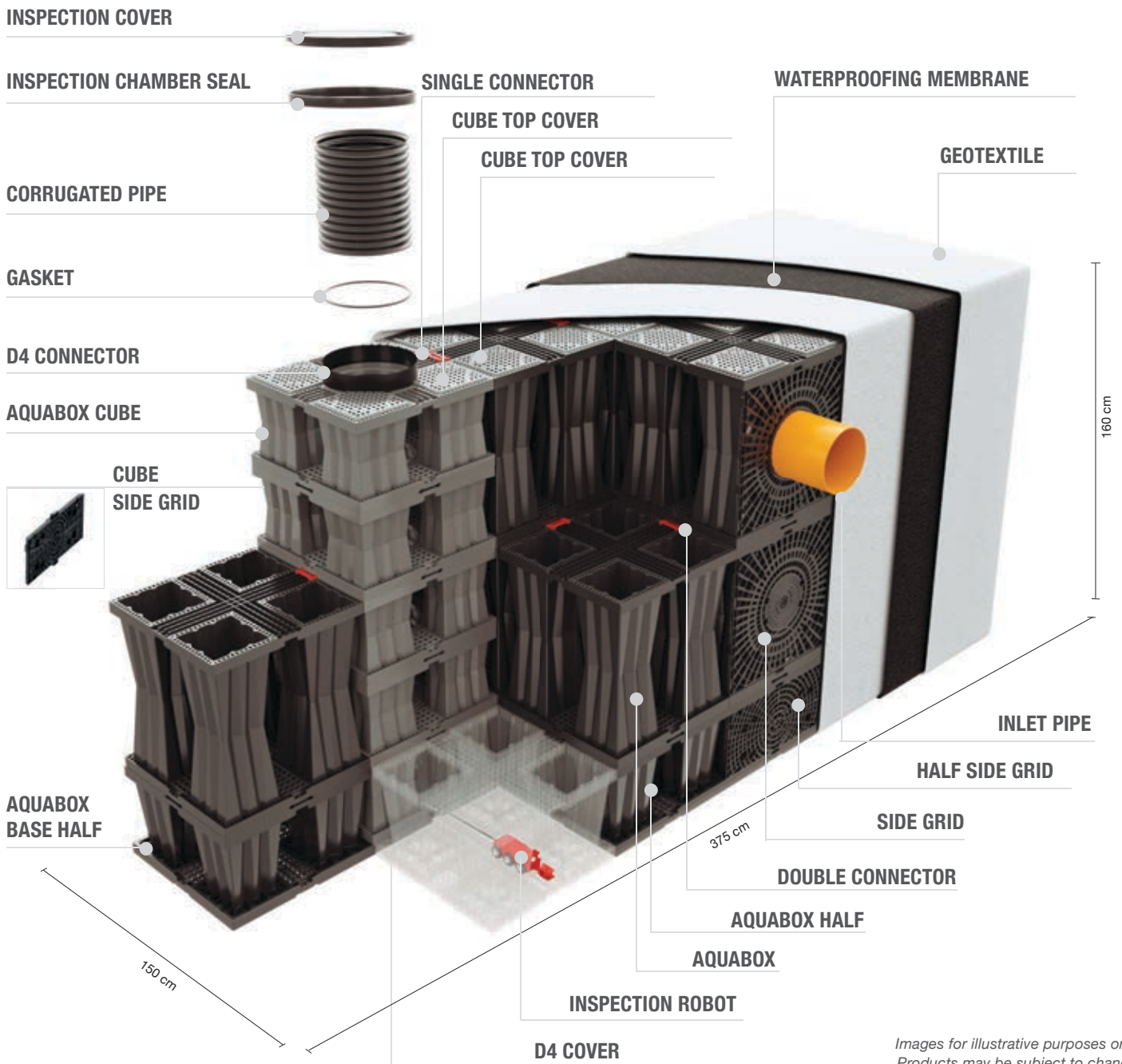


1.3 OVERVIEW

1.3.1 STANDARD AQUABOX SYSTEM



1.3.2 AQUABOX SYSTEM – STANDARD + HALF



*Images for illustrative purposes only.
Products may be subject to change.*

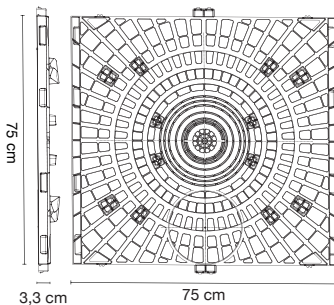


1.4 LIST OF ACCESSORIES AND TECHNICAL DATA

Below is the list of AQUABOX accessories and their technical data:

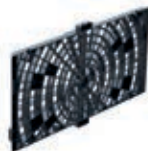
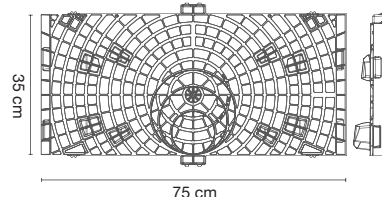
1.4.1 SIDE GRID

The AQUABOX side grid allows the lateral closure of each individual module and the entire basin. Installation is carried out with a simple clip-on attachment.

	SIDE GRID HPR	SIDE GRID HP	SIDE GRID STR	SIDE GRID ST	
Dimensions (cm)	75 x 75 x H3.3				
Material	Graplene				
Connection (DN/OD)	100, 110, 125, 160, 200, 225, 250, 315, 400, 500				
Packaging dimensions (cm)	75 x 150 x H255				
Quantity (pcs)	140				
Product Code	EDAQSWVE033	EDAQSWG033	EDAQSWFV033	EDAQSWG0033	

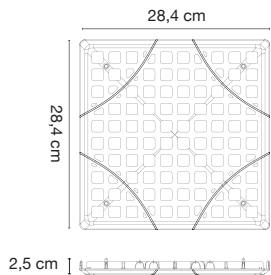
1.4.2 SIDE GRID HALF

The AQUABOX HALF side grid allows the side closure of each individual module and the entire basin. Installation is done with a simple clip-on attachment.

	GRID HALF HPR	GRID HALF HP	GRID HALF STR	GRID HALF ST	
Dimensions (cm)	35 x 75 H2.5				
Material	Graplene				
Connection (DN/OD)	100, 110, 125, 160, 200				
Packaging dimensions (cm)	77 x 120 x H250				
Quantity (pcs)	210				
Product Code	EDAQHSA0035	EDAQHSD0035	EDAQHSC0035	EDAQHSD0035	

1.4.3 TOP CLOSURE

The upper surface of each element is equipped with four perforated closure covers that allow the passage of water. At the same time, these closures create a homogeneous load-distribution surface useful both during installation and for the distribution of loads acting on the system.

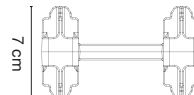
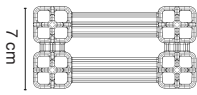
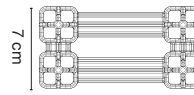
	CHIUSURA SUP. HPR	CHIUSURA SUP. HP	CHIUSURA SUP. STR	CHIUSURA SUP. ST	
Dimensions (cm)	28.4 x 28.4 x H2.5				
Material	Graplene				
Packaging dimensions (cm)	90 x 120 x H255				
Quantity (pcs)	800				
Product Code	EDAQTFV1524	EDAQTOCV024	EDAQTFV0524	EDAQTOC0024	

Universal Element for AQUABOX and AQUABOX CUBE

1.4.4 SINGLE AND DOUBLE CONNECTOR

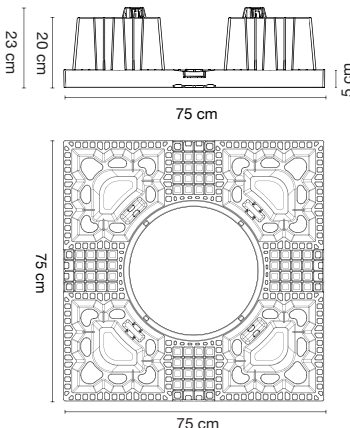
Single: allows for the simple and quick horizontal connection between modules located at the top level of the basin.

Double: allows for the simple and quick horizontal connection located on the intermediate levels.

	SINGLE CONNECTOR			DOUBLE CONNECTOR	
Dimensions (cm)	12 x 7 x H3.5		Dimensions (cm)	12 x 7 x H7	
Material	Graplene		Material	Graplene	
Colour	Red		Colour	Red	
No. of pieces per bag	400		No. of pieces per bag	300	
Product Code	EDAQJOI0035	12 cm	Product Code	EDAQDOJ0070	12 cm
Universal Element for AQUABOX and AQUABOX CUBE					

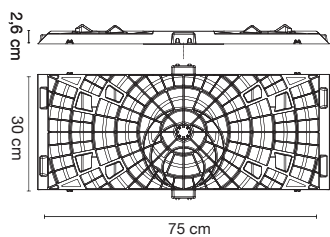
1.4.5 AQUABOX CUBE

AQUABOX CUBE is a modular element made of virgin or recycled polypropylene, designed to create inspection chambers for the management of underground basins.

		AQUABOX CUBE HPR	AQUABOX CUBE HP	AQUABOX CUBE STR	AQUABOX CUBE ST		
Dimensions (cm)		75 x 75 x H23					
Material		Graplene					
Net storage volume (l/unit)		106					
Percentage of voids		94%					
Packaging dimensions (cm)		80 x 152 x H250					
Quantity (units)		88					
Product Code		EDAQUVE0200	EDAQUBCV200	EDAQUFV0200	EDAQUBC0200		

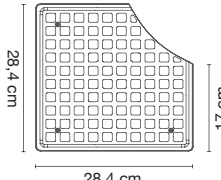
1.4.6 CUBE SIDE GRID

The AQUABOX CUBE side grid allows the side closure of each individual module if the inspection chamber is installed along the perimeter and/or at the vertex of the basin. If the AQUABOX CUBE inspection chamber is located within the basin, it does not require any side grid.

		CUBE SIDE GRILLE HPR	CUBE SIDE GRILLE HP	CUBE SIDE GRILLE STR	CUBE SIDE GRILLE ST		
Dimensions (cm)		75 x 30 x H2.6					
Material		Graplene					
Connection (DN/OD)		100, 160, 200					
Packaging dimensions (cm)		80 x 130 x H250					
Quantity (pcs)		280					
Product Code		EDAQUVE0026	EDAQSWG0026	EDAQUFV0026	EDAQSWG0026		

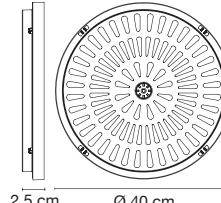
1.4.7 CUBE TOP COVER

The upper surface of each CUBE elements are equipped with four perforated closure covers that allow the passage of water. At the same time, these closures create a homogeneous walkable surface useful both during installation and for the distribution of loads acting on the system.

	CUBE TOP COVER HPR	CUBE TOP COVER CUBE HP	CUBE TOP COVER CUBE STR	CUBE TOP COVER CUBE ST	
Dimensions (cm)	28.4 x 28.4 x H2.5				
Material	Graplene				
Packaging dimensions (cm)	90 x 120 x H180				
Quantity (pcs)	800				
Product Code	EDACTOFV024	EDACTOCV024	EDACTOFV050	EDACTOPP024	

1.4.8 COVER D4

The lid D4 is used to close the AQUABOX CUBE inspection chamber at the bottom of the tank and, if necessary, to also close the upper side if the AQUABOX CUBE is not used as access to the tank itself.

	COVER D4 HPR	COVER D4 HP	COVER D4 STR	COVER D4 ST	
Dimensions (cm)	Ø40				
Material	Graplene				
Packaging dimensions (cm)	82 x 122 x H258				
Quantity (pcs)	312				
Product Code	EDAQCVE0400	EDAQCCDV400	EDAUQFV0400	EDAQCCD0400	

2. HYDRAULIC SIZING

2.1 CALCULATION OF NECESSARY VOLUME

The calculation of the necessary volume of water to be stored in the accumulation, attenuation, or infiltration basin is carried out through the determination of the catchment area, that is, the surface covered from which water is to be channelled and discharged into the reservoir composed of AQUABOX.

The catchment area in question may be, for example, the roof of a building, the paved external surface of a warehouse, the paving of a car park, or a green area.

For the calculation of the flow rate related to the storage system, it is assumed that at the beginning of the meteorological event there is the maximum outflow rate.

This simplistic assumption implies that the inflows to the storage system are overestimated, as are the volumes of attenuation.

It is therefore necessary to assess the design rainfall, meaning the maximum rainfall event that the system must withstand, corresponding to the most significant excess water that the system itself must control. In summary:

$$Volume_{inlet} = f(h(t), u, S, Q_{out})$$

For this purpose, the “rainfall method” is used. The following calculates the value of the volume of water entering the basin:

$$V_{in} = \varphi \cdot h(t) \cdot S$$

Where:

V_{in} = Inlet volume

φ = runoff coefficient

S = surface

$h(t) = a \cdot t^n$ = rainfall potential curve

h represents the rainfall height (in mm)

corresponding to an event of duration t

Consequently, the value of the output volume is calculated:

$$V_{out} = Q_{out} \cdot t$$

Where:

V_{out} = Out volume

t = time in h

In the case of a storage basin, the flow rate set for the discharge is:

$$Q_{out} = u_{out} \cdot S$$

u_{out} = the udometric coefficient that depends on the size and characteristics of the surfaces

S = tank surface

In the case of a infiltration basin the flow rate imposed on the outfall is:

$$Q_{out} = k \cdot S$$

k = soil permeability

$$S = S_b + \frac{1}{3} \cdot h_b \cdot p$$

where S_b is the surface of the tank's base

h_b net tank height

p tank's perimeter

The volume at time t will then be given by the difference between the volumes entering and exiting the system.

$$V_{tank} = V_{in} - V_{out} = \varphi \cdot a \cdot t^n \cdot S - Q_{out} \cdot t$$

It is therefore a matter of finding the duration of the rain for which the stored volume is maximised by deriving the formula for t from the previous expression.

t_{cr} = duration

The maximum condition is expressed as follows:

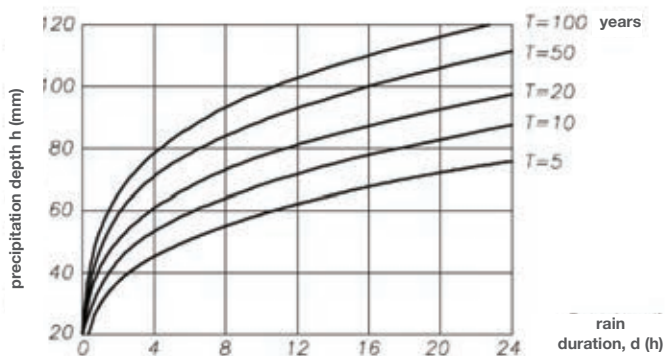
$$t_{cr} = \left(\frac{Q_{out}}{S \cdot \varphi \cdot a \cdot n} \right)^{\frac{1}{n-1}}$$

By substituting it into the previous equation, the storage volume is maximized.

$$V_{max} = S \cdot \varphi \cdot a \cdot \left(\frac{Q_{out}}{S \cdot \varphi \cdot a \cdot n} \right)^{\frac{1}{n-1}} - Q_{out} \cdot \left(\frac{Q_{out}}{S \cdot \varphi \cdot a \cdot n} \right)^{\frac{1}{n-1}}$$

The application of the method using the rainfall intensity–duration–frequency curves must be repeated since, once the basin characteristics and other imposed conditions are fixed, it has to be carried out for each of the six duration intervals (pairs of parameters a and n). In fact, since the critical duration is unknown, it is not possible to identify the curve that best represents the phenomenon.

Below is an example of rainfall intensity-duration-frequency curves.



2.2 TANK DIMENSIONS

The resulting tank dimensions depend on the calculated maximum inflow volume. For this calculation, the use of the AQUABOX calculator software is recommended:



[Aquabox Calculator – Geoplast](#)

Once completed, it displays on the right the list of materials needed to build the AQUABOX tank, given two possible types of input:

- INPUT 1)
 - Volume of water to be stored
 - Tank width
 - Basin height
 - Load data
 - Inspection locations
- INPUT 2)
 - Tank length
 - Tank width
 - Basin height
 - Load data
 - Inspection locations

The online AQUABOX calculator also supports configurations with HALF modules. It is possible to select half-level, one-and-a-half-level, or two-and-a-half-level configurations, even in combination with standard modules, to accommodate specific design constraints or to optimize the layering.

For custom sizing, please contact the Technical Office of Geoplast Spa.

3. STRUCTURAL DESIGN

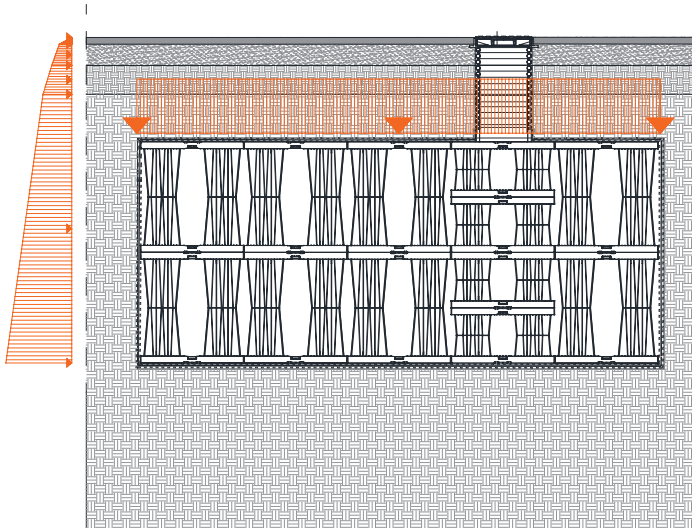
The calculation of the AQUABOX storage, dispersion, or retention basin is carried out by checking each individual element subjected to vertical and horizontal loads.

3.1 VERTICAL LOAD VERIFICATION

The verification of the AQUABOX element under vertical load is carried out according to this calculation scheme.

3.1.1 LOAD FROM SOIL WEIGHT

For the load due to the soil:



Vertical pressure [kN/m^2]

$$P_v = \sum_{i=1}^n \gamma_i \cdot h_i$$

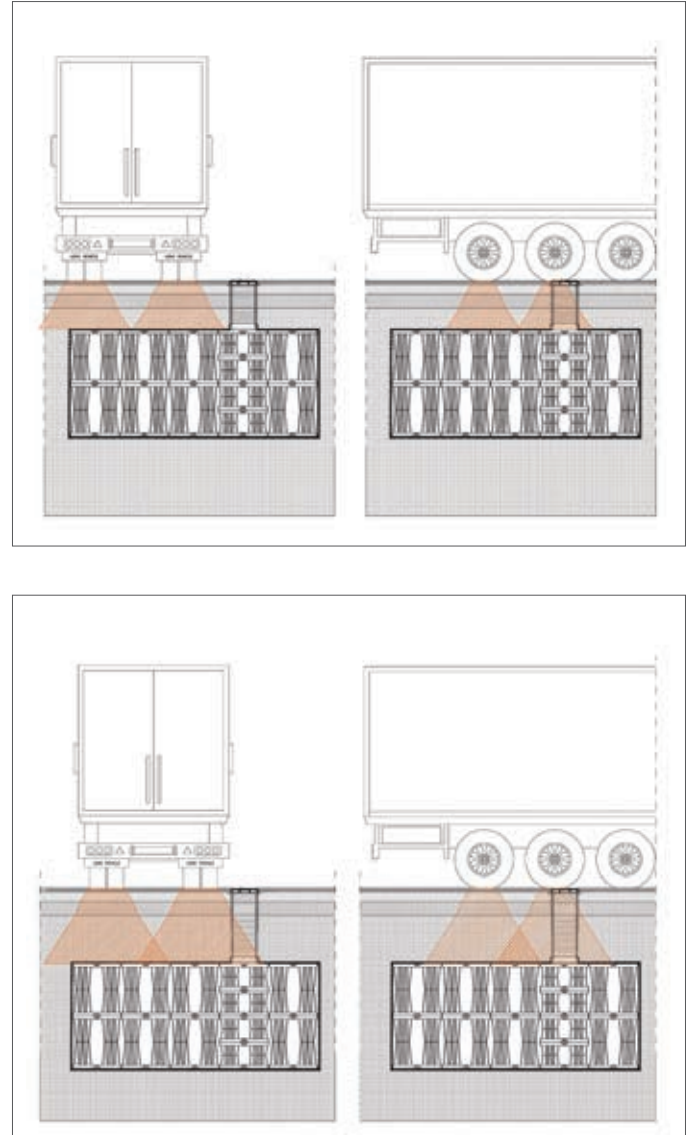
Legend:

γ_i : Density of the i-th layer [kN/m^2]

h_i : Height of the i-th layer [m]

3.1.2 LOAD DUE TO CONCENTRATED LOADS

For the load due to vehicles (concentrated) or other permanent concentrated loads:



Depending on the load footprint, it must be distributed through the considered layering.

Given the load footprints:

$A = \text{plate side in mm}$

in the direction of travel

$B = \text{plate side in mm}$

in the wheel-width direction

And given the distances between the wheels:

$\text{axle } A = \text{wheelbase}$

$\text{axle } B = \text{distance between wheels along the axis}$

The distributed footprints on the first support plane of the AQUABOX are calculated:

$$Aq = A + 2 \sum_i^n h_i \cdot tg(\theta_i)$$

$$Bq = A + 2 \sum_i h_i \cdot tg(\theta_i)$$

$h_i = \text{height of the layer}$

$\theta = \text{layer diffusion angle}$

The load to be considered varies depending on the value obtained from Aq and Bq , if:

1) $Aq < \text{axle } A$ and $Bq < \text{axle } B$

The load of a wheel is considered on the footprint $Aq \times Bq$;

2) $Aq < \text{axle } A$ or $Bq < \text{axle } B$

Then the load of two wheels is considered on the footprint $Aq \times Bq$;

3) $Aq < \text{axle } A$ and $Bq < \text{axle } B$

Then the load of four wheels is considered on the footprint $Aq \times Bq$.

Given the above-mentioned cases, the equivalent distributed load is then calculated $qk [kN/m^2]$:

$$qk = \frac{Qk}{Aq \cdot Bq}$$

The same can also be done for a permanent load $G2k$.

3.1.3 LOADS AND SAFETY FACTORS ACCORDING TO NTC 2018

The loads are divided as follows and then multiplied by the corresponding safety factors:

$g1k = \text{self weight per } m^2$

$g2k = \text{distributed non structural dead load per } m^2$

$G2k = \text{concentrated dead load}$

$qk = \text{distributed live load per } m^2$

$Qk = \text{concentrated live load}$

According to the regulations, these are combined in their respective combinations SLE, SLU, and verified during the construction phase. NTC 2018 (Italian Technical Standards for Construction (NTC 2018))

$\gamma_{g1} = 1,3$

$\gamma_{g2, G2} = 1,5$

$\gamma_{q, Q} = 1,5$

UNI EN 1990:2006

$\gamma_{g1} = 1,35$

$\gamma_{g2, G2} = 1,5$

$\gamma_{q, Q} = 1,5$

AASHTO

$\gamma_{g1} = 1,25$

$\gamma_{g2, G2} = 1,5$

$\gamma_{q, Q} = 1,5 ; 1,75$

Coefficients in the construction phase UNI EN 1990:2006

$\gamma_{g1} = 1,05$

$\gamma_{g2, G2} = 1,35$

$\gamma_{q, Q} = 1,5$

Using the NTC2018, the STR (SLU) combination to be used is approach 2 (A1+M1+R3), in which the geotechnical parameters of the ground are considered with coefficients equal to $\gamma_m = 1,00$ the coefficients for the loads are those outlined above. Approach 2 proves to be the most unfavourable in the verification in question.

3.1.4 EXAMPLE OF CALCULATION

Below is an example calculation of the above, based on AQUABOX HP (weight 10.23 kg per unit) for a single level, bearing in mind that one AQUABOX module consists of two units:

$$g1k = 10,23 \cdot \frac{2}{0,75 \cdot 0,75} \cdot \frac{10}{1000} = 0,36 kN/m^2$$

Assuming a stratigraphy composed of:

- Self-locking massello

$$\gamma_1 = 15 [kN/m^2]$$

$$h_i = 0,08 m$$

$$\theta = 35^\circ$$

- Gravel and screed

$$\gamma_1 = 18 kN/m^2$$

$$h_i = 0,22 m$$

$$\theta = 30^\circ$$

- Vegetation

$$\gamma_1 = 20 [kN/m^2]$$

$$h_i = 0,50 m$$

$$\theta = 30^\circ$$

$$g2k = 15 \cdot 0,08 + 18 \cdot 0,22 + 20 \cdot 0,50 = 15,16 kN/m^2$$

A permanent non-structural load concentrated, for example, from a concrete block cast at a height of 20 cm and a base of 1 m x 1 m.

The widespread imprint becomes:

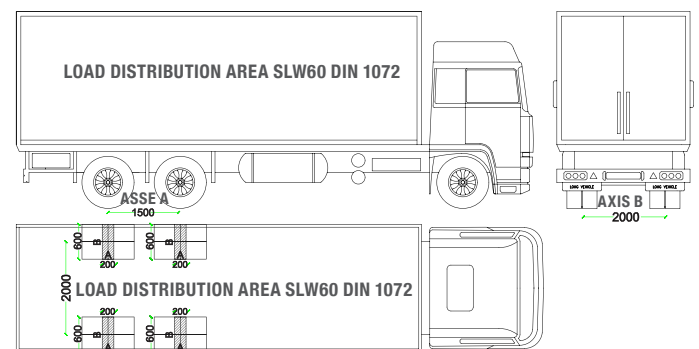
$$A = 1 + 2 \sum_i^n h_i \cdot tg(\theta_i) = 1,471 m$$

$$B = 1 + 2 \sum_i^n h_i \cdot tg(\theta_i) = 1,471 m$$

The loads are divided as follows to then be multiplied by the corresponding safety coefficients:

$$G2k = \frac{5}{(1,471 \cdot 1,471)} = 2,31 kN/m^2$$

Considering the DIN1072 standard with which it is possible to categorise heavy vehicles, the highest load class is chosen, namely SLW60, corresponding to a vehicle of 60 tonnes and a wheel load of 10 tonnes distributed over a footprint of 600 x 200 mm.



Considering the aforementioned stratigraphy, an equivalent footprint is obtained equal to:

Given the following footprints and distances between the wheels.

$$A = 1 + 2 \sum_i^n h_i \cdot tg(\theta_i) = 1,143 m$$

$$B = 1 + 2 \sum_i^n h_i \cdot tg(\theta_i) = 1,543 m$$

$$A = 200 mm$$

$$B = 600 mm$$

$$axle A = 2000 mm$$

$$axle B = 1500 mm$$

A< axis A e B> axis B therefore, double the load is considered.

Therefore:

$$Q2k = \frac{100 \cdot 2}{(1,143 \cdot 1,543)} = 113,33 \text{ kN/m}^2$$

Considering a load of $q2k = 5 \text{ kN/m}^2$ In the case of an accidental distributed load, the above-mentioned loads are combined following the Ultimate Limit State (ULS) combinations according to NTC 2018.

Carico SLU=

$$\begin{aligned} & \gamma_{g1} \cdot g1k + \gamma_{g2} \cdot g2k + \gamma_{G2} \cdot G2k + \gamma_{q,Q} \cdot q2k + \gamma_{q,Q} \cdot Q2k = \\ & 1,3 \cdot 0,36 + 1,5 \cdot 15,16 + 1,5 \cdot 2,31 + 1,5 \cdot 5 + 1,5 \cdot 113,33 = \\ & 204,20 \text{ kN/m}^2 \end{aligned}$$

While the breaking load limit of AQUABOX HP is to be considered equal to $Rk = 228,5 \text{ kN/m}^2$ to be reduced by a test and material coefficient of $\gamma_{test} = 2,00$ therefore:

$$Rd = 228,5 \text{ kN/m}^2$$

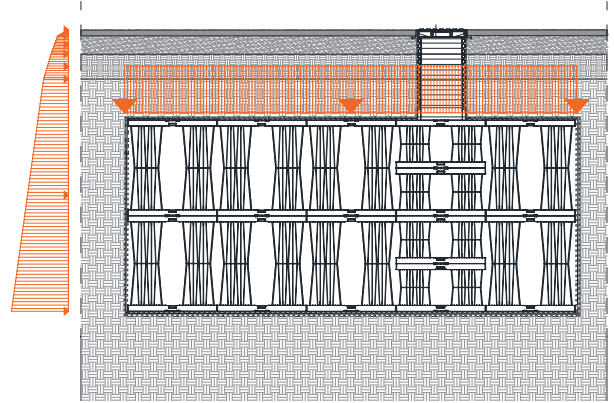
The utilisation index is therefore equal to

$$Sd/Rd = 204,20 / 228,5 = 0,89 < 1,00$$

verification satisfied.

3.2 VERIFICATION ON HORIZONTAL LOAD

The verification of the AQUABOX element under lateral load occurs according to this calculation scheme. For the load due to the ground:



3.2.1 HORIZONTAL LOADS DUE TO THE WEIGHT OF THE GROUND

Horizontal pressure [kN/m^2]

$$P_v = \sum_1^n \gamma_i \cdot h_i \cdot K_{Ai}$$

Where:

γ_i = Density of *ith* layer

h_i = Height of *ith* layer

K_{Ai} = Active pressure coefficient of the *ith* layer

$$= tg^2 \left(\frac{\pi}{4} + \frac{\phi'}{2} \right)$$

3.2.2 HORIZONTAL LOADS DUE TO VERTICAL DISTRIBUTED LOADS

The permanent distributed load (concrete pour or interlocking block or other type of paving) and accidental distributed load (for example, crowd load) are considered as follows:

$$P_v = q \cdot K_{An}$$

Where:

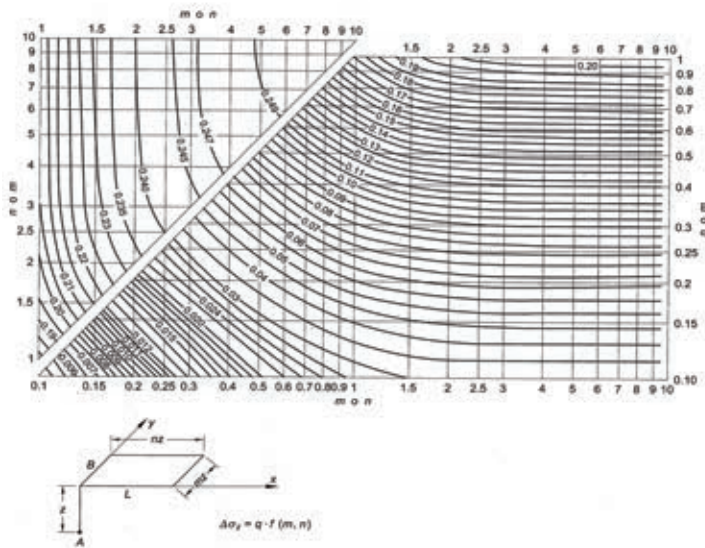
q = Distributed dead or live load

K_{An} = Active pressure coefficient of the *n-th* layer on Aquabox

3.2.3 HORIZONTAL LOADS DUE TO CONCENTRATED VERTICAL LOADS

The distribution of the load with increasing depth is provided by the analytical solution in terms of induced stresses and strains, provided by Boussinesq (1885).

The solution derived from Boussinesq's elastic problem for uniform pressure on a rectangular surface (permanent load G2k on footprint AxB or accidental load Qk on footprint AxB) is the solution of Newmark (1942).



The general formula results in the various components of stress in different directions, the stresses in x and y are as follows:

$L = A = \text{Width of the load footprint spread across the stratigraphy}$

$B = \text{Length of the load footprint spread through the stratigraphy}$

$z = \text{Depth of diffuse load impression through the stratigraphy}$

$$\sigma_x = \frac{q}{2\pi} \left[\arctan\left(\frac{L \cdot B}{z \cdot R_3}\right) - \frac{LBz}{R_1^2 \cdot R_3} \right]$$

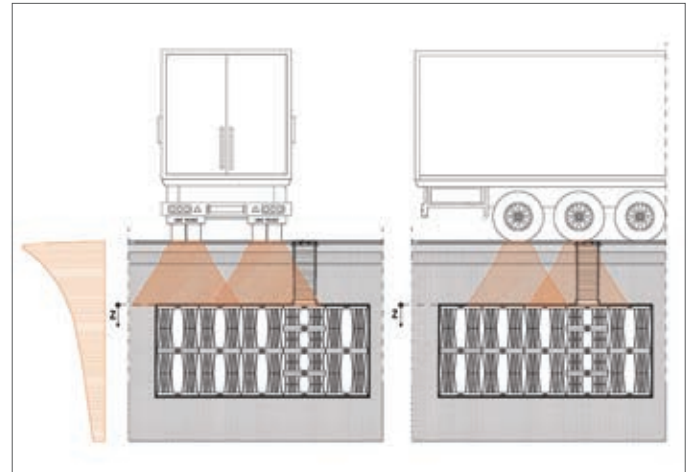
$$\sigma_y = \frac{q}{2\pi} \left[\arctan\left(\frac{L \cdot B}{z \cdot R_3}\right) - \frac{LBz}{R_2^2 \cdot R_3} \right]$$

“The two components result in a load expressed in kN/m². By multiplying this load by the lateral dimensions of the AQUABOX element, the resultant force at a given depth is obtained.

Depending on the direction, the component resulting in the highest load is always considered.

The aforementioned formulation is applied, as mentioned, both for concentrated permanent loads and for accidental loads, such as those from vehicle wheels.

Depending on the number of levels and the installation depth, the most stressed AQUABOX element is evaluated, and the lateral load check is performed as follows.



*This occurs when the horizontal load of the ground increases linearly with depth while the load due to permanent or accidental concentrated loads decreases with depth. For some combinations of AQUABOX cover-layer, the highest load must be assessed at all available depths.

3.2.4 LOADS AND SAFETY FACTORS ACCORDING TO NTC 2018

The loads are subsequently multiplied by the corresponding partial safety factors, and the most critical load combination is identified. In this case, it follows Approach 2 (A1 + M1 + R3), in which the geotechnical parameters of the soil are considered with factors equal to $\gamma_m = 1,00$ the coefficients for the loads are those exposed to the § 3.1.

3.2.5 LOADS AND SAFETY FACTORS ACCORDING TO NTC 2018

Below is an example calculation of the above, considering AQUABOX HP.

Assuming a stratigraphy composed of:

- Interlocking pave

$$\gamma_1 = 15 [kN/m_2]$$

$$h_i = 0,08 m$$

$$K_A = 0$$

$$\theta = 35^\circ$$

- Gravel and screed

$$\gamma_1 = 18 [kN/m_2]$$

$$h_i = 0,22 m$$

$$K_A = 0,22$$

$$\theta = 30^\circ$$

- Topsoil

$$\gamma_1 = 20 [kN/m_2]$$

$$h_i = 0,5 m$$

$$K_A = 0,36$$

$$\theta = 28^\circ$$

$$g2k = (15 \cdot 0,08 + 18 \cdot 0,22) \cdot 0,22 + 20 \cdot 0,5 \cdot 0,36 = 4,74 kN/m^2$$

A permanent non-structural load concentrated, for example, from a concrete block cast to a height of 20 cm and a footprint of 1m x 1m.

A permanent non-structural load concentrated, for example, from a concrete block cast to a height of 20 cm and a base of 1m x 1m.

The widespread imprint becomes:

$$A = 1 + 2 \sum_i^n h_i \cdot tg(\theta_i) = 1,471 m$$

$$B = 1 + 2 \sum_i^n h_i \cdot tg(\theta_i) = 1,471 m$$

$$G2k = \frac{5}{(1,471 \cdot 1,471)} = 2,31 kN/m^2$$

The Boussinesq formulation is then applied, yielding:

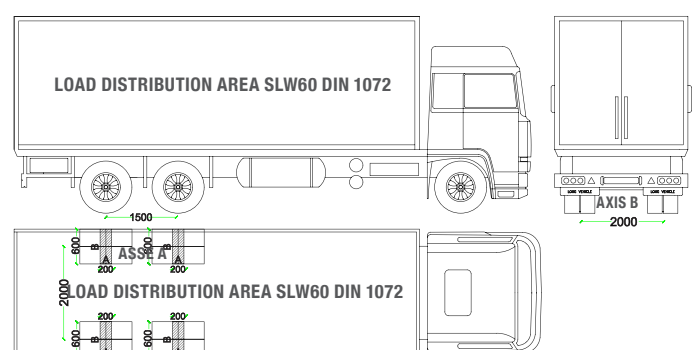
$$\sigma_x = 0,38 kN/m^2$$

$$\sigma_y = 0,38 kN/m^2$$

The tension between the two highest is multiplied by the lateral surface area of an AQUABOX 0.8 x 0.75 obtaining:

$$G2k = 0,38 \cdot 0,75 \cdot 0,8 = 0,228 kN$$

Considering the DIN1072 standard, which allows for the categorisation of heavy vehicles, the highest load class is chosen, namely SLW60, corresponding to a vehicle of 60 tonnes and a wheel load of 10 tonnes distributed over a footprint of 600 x 200 mm.



Considering the aforementioned stratigraphy, an equivalent imprint is obtained equal to:

Given therefore the following imprints and distances between the wheels.

$$A = 1 + 2 \sum_i^n h_i \cdot tg(\theta_i) = 1,143 \text{ m}$$

$$B = 1 + 2 \sum_i^n h_i \cdot tg(\theta_i) = 1,543 \text{ m}$$

$$A = 200 \text{ mm}$$

$$B = 600 \text{ mm}$$

$$\text{axle A} = 1500 \text{ mm}$$

$$\text{axle B} = 2000 \text{ mm}$$

A < axle A e B > axle B therefore, the double of the load is considered.

Therefore:

$$Q2k = \frac{100 \cdot 2}{(1,143 \cdot 1,543)} = 113,33 \text{ kN/m}^2$$

Thus, the Boussinesq formulation is applied, deriving:

$$\sigma_x = 18,23 \text{ kN/m}^2$$

$$\sigma_y = 16,36 \text{ kN/m}^2$$

The tension between the two highest is multiplied by the lateral surface of a AQUABOX 0.8 x 0.75 resulting in:

$$G2k = 18,23 \cdot 0,75 \cdot 0,8 = 10,94 \text{ kN}$$

Considering a load of $q2k = 5 \text{ kN/m}^2$ as an accidental distributed load, the aforementioned loads are combined according to the SLU combination ref. NTC2018.

$$q2K = 5,00 \cdot 0,8 \cdot 0,36 \cdot 0,75 = 1,08 \text{ kN}$$

Load SLU=

$$\gamma_{g1} \cdot g1k + \gamma_{g2} \cdot g2k + \gamma_{G2} \cdot G2k + \gamma_{q,Q} \cdot q2k + \gamma_{q,Q} \cdot Q2k =$$

$$1,5 \cdot 4,74 + 1,5 \cdot 0,228 + 1,5 \cdot 1,08 + 1,5 \cdot 1,08 + 1,5 \cdot 10,94 = 25,3 \text{ kN/m}^2$$

While the breaking load limit of the lateral AQUABOX HP is to be considered equal to $Rk = 117,4 \text{ kN/m}^2$ to be reduced with a test and material coefficient of $\gamma_{test} = 2,0$ therefore:

$$Rd = 25,50 \text{ kN/m}^2$$

The utilisation index is therefore equal to

$$Sd/Rd = 25,03 / 25,50 = 0,99 < 1,00,$$

verification satisfied.

3.3 UPLIFT LOAD CHECK

For the lifting verification, check the maximum piezometric level with a return period of 50 years.

The installation of the product must always take place above the maximum piezometric level of the aquifer recorded.

For further information, please contact the Technical Office of Geoplast Spa.

3.4 TESTS CARRIED OUT ON THE PRODUCT

The product has been tested following the standards:

UNI EN 17150:2019

UNI EN 17151:2019

UNI EN 17152:2019

CIRIA 737D

Load tests on the complete element and accessories such as AQUABOX CUBE have been carried out by an accredited third party; load certificates are available to the customer upon request.

3.5 REPORT BY CALCOLO GEOPLAST SPA

Upon request, the static and/or hydraulic verification calculation report for the accumulation or dispersion basin with AQUABOX elements will be provided.

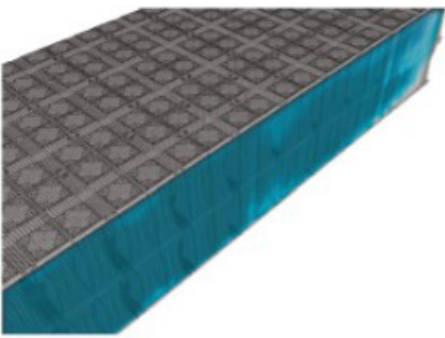
To request the pre-dimensioning or calculation reports, please contact the Technical Office of Geoplast Spa.



Geoplast
Building beyond together

REPORT DI PRE DIMENSIONAMENTO

**BACINO ISPEZIONABILE SISTEMA AQUABOX HP
VERIFICA STATICA**



CLIENTE		RIF. GEOPLAST	

PROGETTO				

REV.	DATA	DESCRIZIONE	AUTORE	CONTROLLO
	21/05/2024			

CODIFICA ELABORATO				
Prog.	Tipologia oggetto	Fase	Tavola	Rev.



Geoplast
Building beyond together

5. VERIFICHE

5.1. VERIFICA STATICA

I carichi concentrati permanenti non strutturali e accidentali vengono diffusi dall'impronta di carico attraverso la stratigrafia considerata. Il carico concentrato accidentale coincide con la ruota di un veicolo o mezzo pesante ed a seconda della sua diffusione attraverso il terreno e la stratigrafia considerata, possono considerarsi ai fini delle verifiche 1, 2 o 4 ruote.

Distanza tra le ruote B	B0 [mm]	1500.00
Distanza tra due assi A	A0 [mm]	3000.00
Impronta di carico diffusa per carichi accidentali B	B [mm]	1543.47
Impronta di carico diffusa per carichi accidentali A	A [mm]	1543.47
Carico equivalente distribuito del carico accidentale concentrato	Qsk [kN/m²]	113.33
Impronta di carico diffusa per carichi permanenti non strutturali B	B [mm]	1471.71
Impronta di carico diffusa per carichi permanenti non strutturali A	A [mm]	1471.71
Carico equivalente distribuito del carico perm. non strutt. concentrato	Qsk [kN/m²]	2.31

Tabella 12 - Carico distribuito equivalente per carichi concentrati accidentali e permanenti non strutturali

Carico da ruota SUU distr. equivalente	Qd ULS	113.33	[kN/m²]
Carico totale SUU distr. equivalente	QEd ULS	204.17	[kN/m²]
Carico distribuito limite verticale	QEd	436.70	[kN/m²]
Coefficiente di sicurezza	γs	1.00	
Verifica	SR	0.89	<1 OK

Tabella 13 - Verifica per carichi verticali

Carico orizzontale del terreno SUU	QH	4.81	[kN]
Carico totale SUU terreno+permanent+accidentali	QH ULS	28.29	[kN]
Carico distribuito limite orizzontale	QEd	50.82	[kN]
Coefficiente di sicurezza	γs	1.00	
Verifica	IR	1.00	<1 OK

Tabella 14 - Verifica per carichi orizzontali

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Italia

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Capitale Sociale € 2.000.000.00 i.v.
O.v. R. n. 200867
R.L. n. 200867

4. INSTALLATION OF AQUABOX INFILTRATION BASIN

As indicated by the Hydraulic Invariance regulations, in newly urbanized areas it is necessary to ensure proper planning of the maximum flows discharged into receiving water bodies compared to those existing prior to urbanization. It is therefore of considerable importance to evacuate rainwater for sustainable management over time. In general terms, the verification of hydraulic invariance requires that the new flow generated by the urban modification is less than or equal to the existing flow or below the maximum values allowed by the regulation or accepted by the managing entity of the receiving water body.

In order to maintain invariance, the possible interventions, which may also be combinable, are as follows:

- infiltration when the soil permeability allows it;
- accumulate in the event that there is a possibility of connecting to a sewer system or to a receiving watercourse.

The AQUABOX module is a modular element made of plastic that allows for:

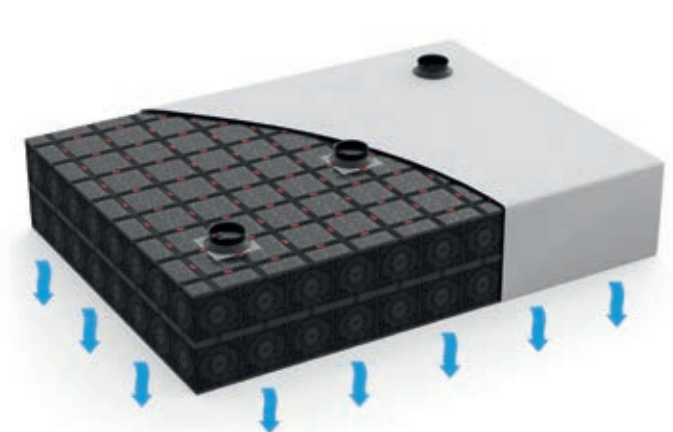
- infiltrate all stormwater into the ground creating a soakaway;
- infiltrate a portion of the stormwater into the ground while the remaining part will be channeled to a network or a stream, creating a retention basin;
- retain stormwater in order to regulate discharges into the clear water network or into watercourses, creating a storage basin.

4.1 DISPERSION SPEEDS

The AQUABOX system enables the creation of stormwater dispersion basins.

The dispersion and emptying speed of the basin depends on the soil characteristics.

Below are the installation steps for the construction of a soakaway trench with AQUABOX.”



4.2 PRELIMINARY INVESTIGATIONS

Preliminarily it is recommended to conduct geotechnical and geological investigations at the site where the basin will be constructed in order to verify its suitability.

In particular, the following should be evaluated:

- check minimum distances from existing buildings and constructions;
- soil permeability;
- bearing capacity of the soil;
- maximum level of the aquifer.

4.3 EXCAVATION AND PREPARATION OF THE INSTALLATION BED

The excavation must be carried out according to the design specifications. During the work, the walls of the excavation must be sloped or constructed in such a way as to not pose a danger to workers due to possible falling rocks.

It is advisable to maintain a perimeter clearance of at least 50 cm between the plastic structure and the excavation wall.

Furthermore, national regulations must be observed, and all verification measures must be taken to ensure that the excavation is free of water throughout the entire installation phase. For the correct installation of the AQUABOX and AQUABOX CUBE modules, it is essential to create a flat and stable bedding layer. To this end, it is recommended to create a leveling layer of at least 10 cm above the bottom of the excavation, preferably using gravel or fine stone.

The layer must be thoroughly compacted and levelled to ensure a flat laying surface. For particularly soft sub-bases (shear strength <40 kPa o CBR < 3, according to the report CIRIA 737) A thorough evaluation is required in order to adopt the optimal technical solution.

In general, it is recommended to:

- Increase the thickness of the base layer using granular material;
- Use of geogrids or reinforcing geotextiles laid on the bottom of the excavation;
- Compaction of the backfill material every 60 cm.

The quality of the bedding layer is crucial for the installation of the modules and significantly affects both their vehicular capacity and installation performance, particularly in the case of multi-layer systems and high loads (soil load and vehicular traffic load).



4.4 LAYING OF THE GEOTEXTILE

The entire infiltration system must be wrapped with a geotextile in order to ensure mechanical protection and prevent the intrusion of backfill soil into the basin.

Before starting the installation of the modules, the geotextile is placed on the installation bed.



The geotextile must have sufficient excess lateral length to potentially wrap the entire system. It must overlap by at least 10 cm on all edges and seams at the overlap points. The characteristics of the geotextile are important and must meet these minimum standards:

CHARACTERISTIC	STANDARD	VALUE
Thickness (mm)	EN ISO 9863-1	0,75
Grammage (g/m ²)	EN ISO 9864	190
Static puncture resistance CBR (kN)	EN ISO 12236	0.30
Tensile strength (kN/m)	EN ISO 10319	1,8
Opening size (µm)	EN ISO 12956	60
Normal plane permeability	EN ISO 11058	100
Material	-	PEIT

4.5 LAYING OF AQUABOX MODULES

Once the geotextile is laid on the bottom of the excavation, the AQUABOX modules are placed.

Each AQUABOX module consists of two half-elements, each 43 cm high. Thanks to the Aqualock facilitated overlapping system, each module can be pre-assembled without the use of cranes or mechanical means. In fact, a light pressure is sufficient to create a high-strength connection.

The modules can be pre-assembled both inside and outside the excavation. The pre-assembled modules must then be positioned according to the project specifications.



During the installation, it is possible to walk above the elements. The transit of operating machines, even small ones, over the structure without adequate covering is prohibited. The AQUABOX modules can be stacked in multiple levels.

Each AQUABOX module is connected to another via specific connectors:

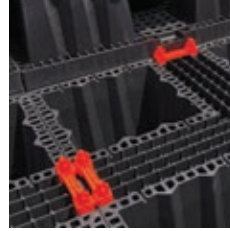
SINGLE CONNECTOR:



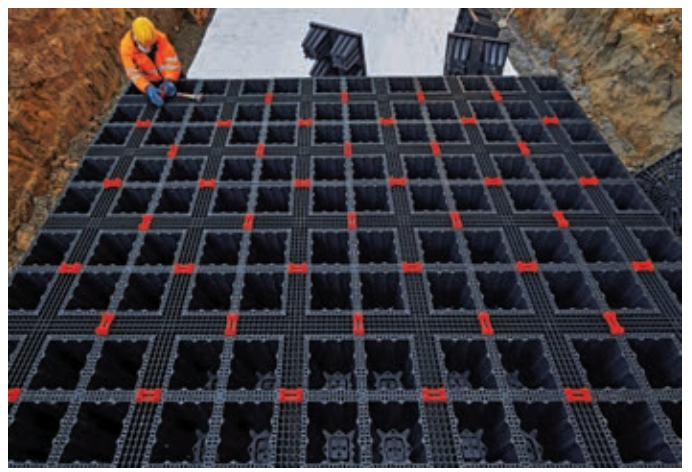
Allows for the simple and quick horizontal connection of AQUABOX modules located on the top level of the basin (see photo).



DOUBLE CONNECTOR:



Allows for the simple and quick horizontal connection of AQUABOX modules located on the intermediate levels (see photo).



CONNECTOR	APPLICATION	SPECIFICATIONS	
Single	for single-level installations	for AQUABOX installations at 1 level	2 pcs per module
		for AQUABOX multi-level installations	1 pcs per module
Double	for multi-level installations	for 2-level installations	1 pcs per module
		for 3-level installations	1.3 pcs per module

The AQUABOX HALF modules are installed like the standard ones.

The installation always occurs on a leveled and compacted bedding.

Half-level or mixed-level configurations allow the system to be adapted even in contexts with geometric or structural constraints.

The integration between HALF modules and standard modules enables the achievement of intermediate heights (e.g., 1.5 or 2.5 levels).

4.6 PLACEMENT OF AQUABOX CUBE INSPECTION CHAMBERS

Inside the AQUABOX dispersion basin, AQUABOX CUBE inspection chambers can be positioned to ensure proper inspection and maintenance of the system.

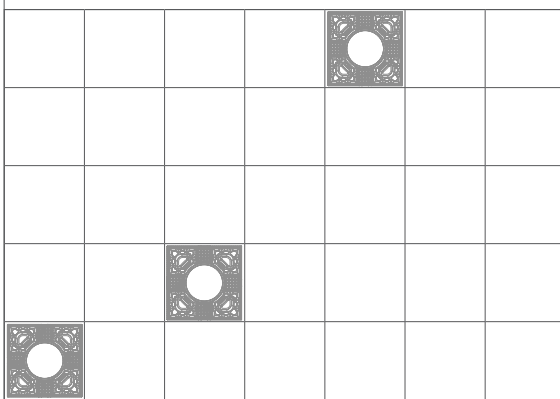
These chambers can be placed in any position of the system depending on the trench geometry and design requirements.

The placement of inspection chambers must follow best practice guidelines, so 1 chamber every 10 m or 1 chamber every 100 m³.

The chamber must be installed in the layout position as specified in the design.

POSITIONING CUBE

The AQUABOX CUBE inspection chamber can be placed at any point in the basin.

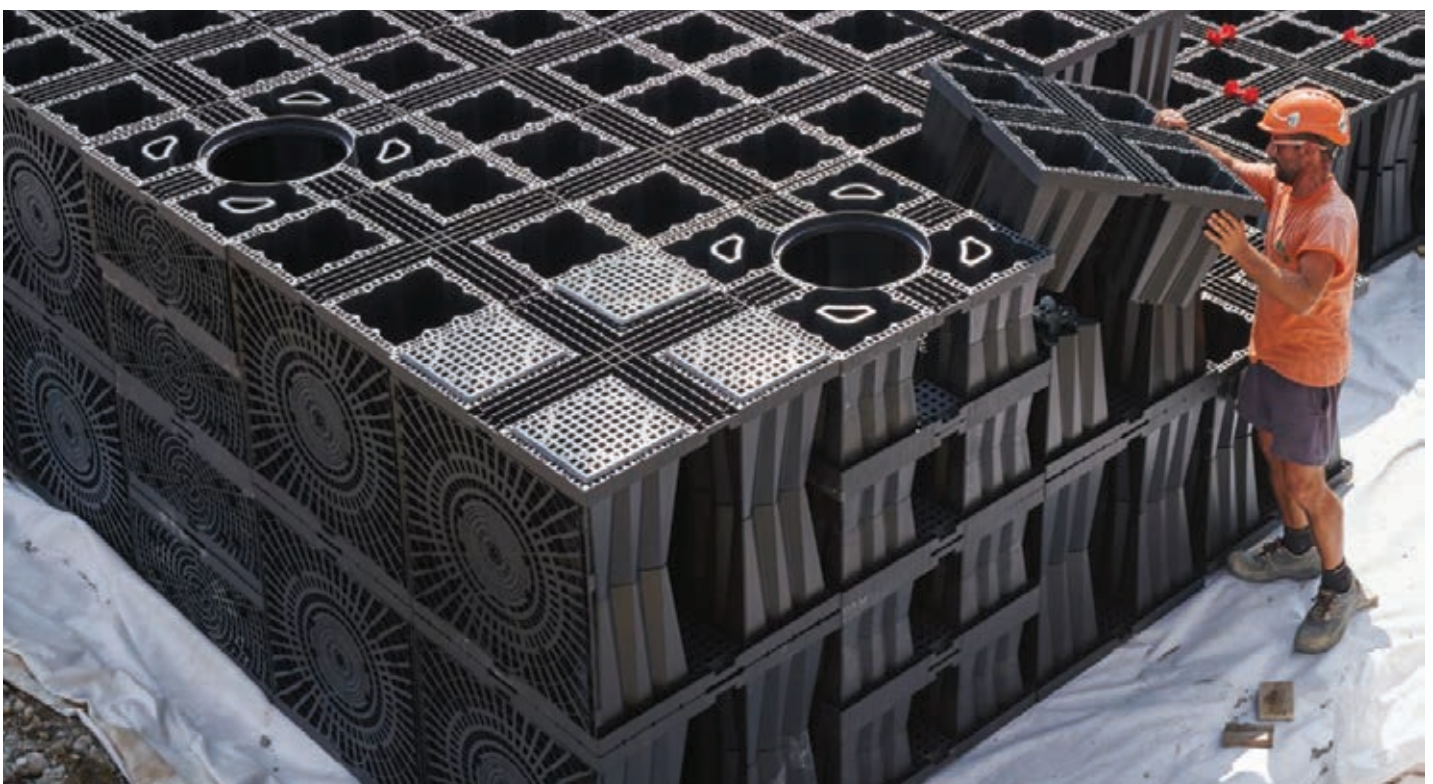


Single connectors are used to connect the inspection chamber to the adjacent AQUABOX elements in the top layer of the system.

Double connectors, on the other hand, are used to connect the inspection chamber to the adjacent AQUABOX elements in the intermediate layers.



- ① Assembly AQUABOX CUBE
- ② Installation and assembly of connectors
- ③ Assembly AQUABOX CUBE and placement



The AQUABOX CUBE elements feature a central hole with a diameter of DN 400 that allows for the insertion of a smooth or corrugated PVC pipe to reach the required height, on which an appropriately sized Inspection chamber cover will be placed based on the expected project loads.

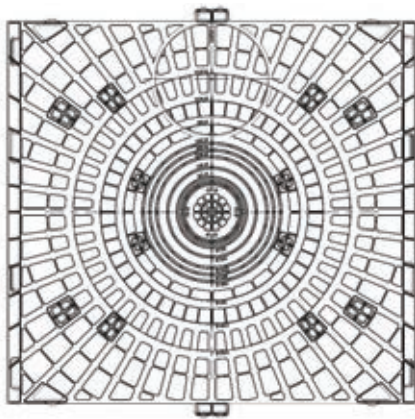
For the closure of the base layer (at the level in contact with the ground), it is required that the D4 cover be installed to close the system.



4.7 INSTALLATION OF SIDE AND TOP CLOSURE GRIDS

For the closure of system AQUABOX and AQUABOX HALF, side and top grids are used. The side grids are used on the sides of the trench. This allows for a uniform distribution of lateral loads and the easy installation of geotextiles or waterproof membranes.

Additionally, being pre-shaped allows for the insertion of pipes of different diameters for managing inflows and outflows.



The upper closure grid of the AQUABOX allows for the closure of each individual module placed on the top level of the entire basin. Installation occurs with a simple clip attachment for both closures as can be seen in the photos. It is recommended, in case of problems with the attachment of the side grids, to use a rubber mallet

to force the interlocking of the grids. Do not use metal hammers.

The instructions are the same for the AQUABOX CUBE side grid, which allows for the side closure of each individual module if the inspection chamber is installed along the perimeter and/or at the vertex of the basin. If, however, the AQUABOX CUBE inspection chamber is located inside the basin, no side grid is needed.

The upper closure grids of the AQUABOX CUBE are the same as those of the AQUABOX, except that they need to be shaped before installation (see the figure below).



4.8 COVERING OF THE SYSTEM WITH GEOTEXTILE

The AQUABOX systems must be completely wrapped in the geotextile that was laid on the installation surface of the AQUABOX.

At the edges, it is important to ensure sufficient overlap of the geotextile (at least 30 cm) to prevent the intrusion of the fill material into the system, creating a true separation layer in order to preserve the functionality and capacity of the system.

Create the entrance for the sealed pipes by making a cross-shaped cut in the geotextile.

Ensure that the surface of the geotextile is completely closed and free of openings before backfilling.



4.9 LATERAL BACKFILL

For lateral backfilling, it is recommended to use a non-cohesive, non-frozen material with a maximum grain size of 32 mm.

The space alongside the infiltration or retention basin must be filled with backfill material free of stones. The fill material shall be placed uniformly and compacted in layers of a maximum thickness of 30 cm, ensuring even distribution across the entire basin. Compaction shall be carried out using manual equipment or light to medium-heavy vibratory machinery, with a maximum compaction force of 3 tonnes.

The gap between the structure and the excavation edge shall initially be filled, progressing uniformly in elevation. Backfilling must not be performed on one side only while leaving the others unfilled.

A compaction level of $D_{pr} \geq 97\%$ must be achieved.

The modules must NOT be damaged.

National guidelines for earthworks (such as ZTV E-StB) shall be complied with.

It must always be ensured that the geotextile is properly overlapped and not damaged during filling and compaction operations.

Notes for lateral backfilling:

- Do not use coarse/crushed backfill materials > 30 mm, and do not use clayey materials;
- Do not damage the geotextile and/or the geomembrane.



4.10 COVERING OF THE SYSTEM

Depending on the intended use of the area, the planned surface finish shall be completed.

The top covering of the drainage/retention system must be executed according to the design thickness (minimum 30 cm), always spreading the layers uniformly across the entire basin and compacting them using manual equipment. In the case of installation under a roadway or parking area, an appropriate covering must be designed to withstand the considered loads.

It should be noted that Geoplast Spa shall not be held responsible for any damage to the system if the above specifications are not followed.

4.11 EQUIPMENT ACCESSIBLE DURING SYSTEM INSTALLATION

The first layer of covering (of the minimum thickness specified in the previous paragraph) can be placed using equipment such as wheel loaders or small mobile excavators.

For the passage of a wheel loader or mobile excavator with a maximum total weight of 15 tonnes (tracks, 4 wheels, or dual tires), an adequately compacted covering of at least 30 cm must be placed above the AQUABOX system. During this phase, sudden maneuvers such as sharp turns must be avoided.



The passage of heavy vehicles over the infiltration/retention basin with a wheel load exceeding 50 kN (e.g., HGV 30) is permitted only if the covering thickness is adequately compacted and not less than 60 cm.

When unloading earthworks material, the wheel load must not exceed 50 kN; otherwise, load distribution plates can be used to spread the load.

4.12 HYDRAULIC CONNECTION

The water entering the basin must be as clean as possible to prevent system clogging and contamination of the final receptor.

The required level of treatment depends on:

- The quality of the incoming water.
- The current regulatory requirements (Legislative Decree 152/2006 and applicable local regulations).
- The final receptor..

In the absence of regulatory requirements, it is recommended to:

- Provide systems for the removal of coarse solids (sediment traps). It is also possible to increase the depth of the inlet Inspection chambers to promote sedimentation.
- Install an oil separator if the system handles runoff water from a parking area and the final discharge is to the subsurface.

The design of the pipelines is the responsibility of the project engineer.

The maximum pipe diameter that can be connected to the structure is Ø 500 mm.

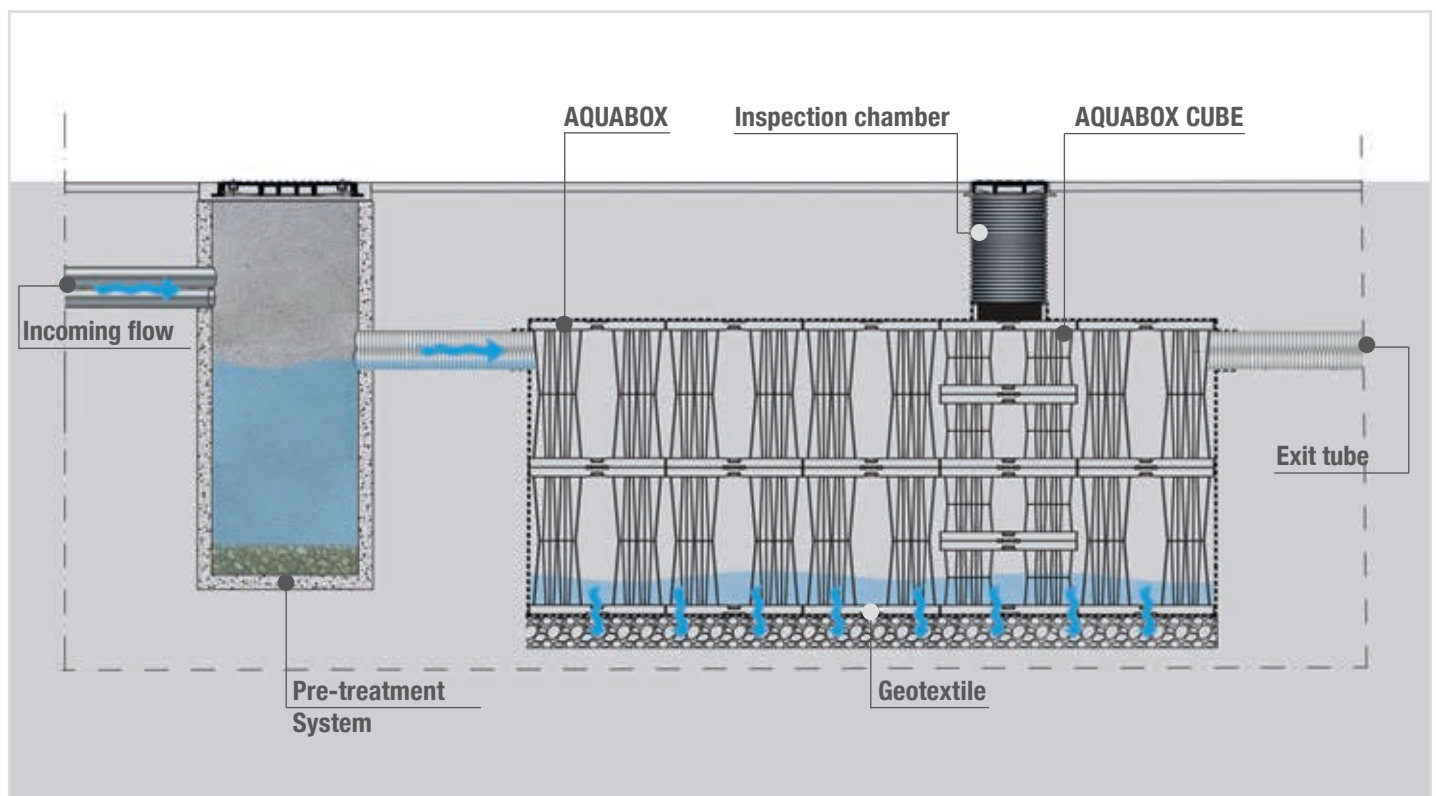
The adoption of a system outlet line must be evaluated during the design phase. As a rule, it is common practice to provide a controlled-flow outlet in cases where:

- The soil is poorly draining, and its emptying must be facilitated within a reasonable time.
- The basin must operate purely for flow attenuation.
- Maximum hydraulic safety must be ensured in the event of exceptional events.

An emergency bypass can also be provided in case of failure of the drainage system.

4.13 INFILTRATION BASIN SCHEMATIC

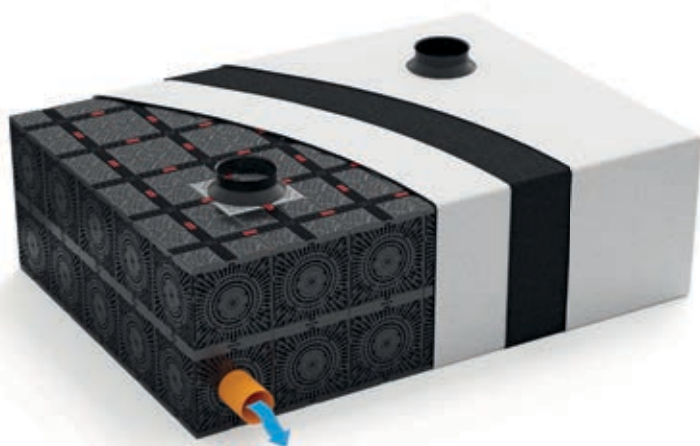
Below is the technical schematic for an infiltration basin constructed with AQUABOX:



5. INSTALLATION OF THE AQUABOX SYSTEM - STORAGE AND REUSE

AQUABOX can be used for the creation of storage basins and reuse of rainwater.

AQUABOX can therefore be used to retain stormwater in order to regulate flows in the clear water network or in water-courses, creating a retention basin.



5.1 PRELIMINARY INVESTIGATIONS

It is recommended to conduct geotechnical and geological investigations at the site where the basin will be constructed in order to verify its suitability. In particular, the following should be evaluated:

- Soil bearing capacity.
- Maximum level of the unconfined aquifer.

To discharge excess flows into a receiver, it is necessary to know:

- Medium level and Maximum discharge capacity (according to the regulations of the managing authority).
- Soil permeability in the case of a discharge into the subsoil.

With regard to the quality of discharged waters, reference must be made to the current legal limits (Legislative Decree 152/2006 and regional P.T.A.) for discharge into the subsoil or a receiving water body, in order to provide adequate treatment facilities upstream of the dispersal system.

5.2 EXECUTION OF THE EXCAVATION OF THE INSTALLATION BED

See what is stated in the paragraph 4.3 -

5.3 INSTALLATION OF GEOTEXTILE

See what is reported in the paragraph 4.4 -

5.4 INSTALLATION OF THE WATERPROOF GEOMEMBRANE AND COVERING WITH GEOTEXTILE

To make the basin watertight, in order to ensure the accumulation of rainwater, a layer of waterproof membrane is laid that will wrap around the entire trench. The membrane must be welded in place and around the inlet and outlet pipes and the AQUABOX CUBE pipes to make the basin watertight. Both sides of the membrane must be protected with a woven fabric. The specifications of the membrane (according to Report CIRIA 737) and the geotextile are listed in the following tables:

GEOTEXTILE

CHARACTERISTIC	STANDARD	VALUE
Thickness (mm)	EN ISO 9863-1	0,75
Grammage (g/m ²)	EN ISO 9864	190
Static puncture resistance CBR (kN)	EN ISO 12236	0.30
Tensile strength (kN/m)	EN ISO 10319	1,8
Aperture size (μm)	EN ISO 12956	60
Normal plane permeability	EN ISO 11058	100
Material	-	PEIT

WATERPROOF COAT

CHARACTERISTIC	STANDARD	VALUE
Thickness (mm)	EN ISO 1849-2	0,6
Grammage (g/m ²)	EN ISO 1849-2	380
Static puncture resistance (N)	UNI EN ISO 12236	4.7
Tensile strength (kN/m ²)	UNI EN ISO 527-4	26
Shear strength (N/50 mm)	UNI EN ISO 12317-2	964
Thermal expansion (%)	DIN 53377	±3
Liquid tightness (m ³ m ² *d-1)	UNI EN 14150	< 10 ⁻⁶

5.5 INSTALLATION OF AQUABOX MODULES

See what is reported in the paragraph 4.5-

5.6 INSPECTION CHAMBER COVERS AQUABOX CUBE

See what is reported in the paragraph 4.6-

5.7 INSTALLATION OF SIDE AND TOP CLOSURE GRILLES

See what is reported in the paragraph 4.7-

5.8 LATERAL BACKFILL OF THE SYSTEM

See what is reported in the paragraph 4.9 -

5.9 LAYING OF GEOTEXTILE

See what is reported in the paragraph 4.10 -

5.10 CONSTRUCTION VEHICLES PASSABLE DURING INSTALLATION

See what is reported in the paragraph 4.11 -

5.11 HYDRAULIC CONNECTIONS

The water entering the basin must be as clean as possible to avoid clogging the system and potential contamination related to the reuse of collected water. It is recommended to:

- Provide systems for the removal of large solids (filters or sediment traps). It is possible to anticipate an increase in the depth of the incoming Inspection chambers to promote the settling of sediments;
- Install a separator if the system collects runoff water from a parking lot.

The sizing of the collectors is the responsibility of the project designer. The maximum diameter of the pipe that can be connected to the structure is Ø 500 mm.

If the collector has a diameter greater than this, branches of the line must be provided with connections to the system through reductions to the diameter.

The number of branches will depend on the expected incoming flow;

The adoption of a discharge line is necessary for the disposal of incoming flows exceeding the expected storage volume.

6. USAGE SPECIFICATIONS

Below are some guidelines useful for choosing the right product based on the expected load.

6.1 INSTRUCTIONS FOR WALKABLE SURFACE

For pedestrian surfaces with occasional access by emergency vehicles such as ambulances or medical guards, the product to use is AQUABOX ST. The verification of the element upon request is conducted using the loads from crowds expected for pedestrian areas as per NTC2018:

$$g1k = \text{Weight of the element } kN/m^2$$

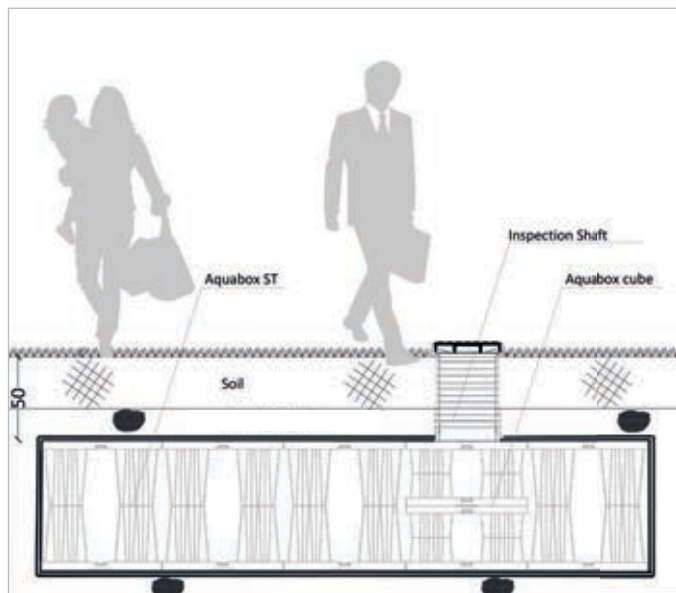
$$g2k = \text{Weight of the stratigraphy } kN/m^2$$

$$q2k = 5,00 \text{ } kN/m^2$$

$$Q2k = 10 \text{ } kN \text{ on an area } 200 \times 200 \text{ } mm^2$$

The following images present typical stratigraphies for the application of AQUABOX ST on pedestrian surfaces (measurements in cm):

PEDESTRIAN LOADS



6.2 INSTRUCTIONS FOR VEHICULAR SURFACE SLW30

For trafficable surfaces with light vehicles or light trucks, the product to be used is AQUABOX STR. The verification of the element upon request is conducted using loads from DIN1072 with the equivalent traffic load of SLW30:

$$g1k = \text{Weight of the element } kN/m^2$$

$$Q2k = 50 \text{ } kN$$

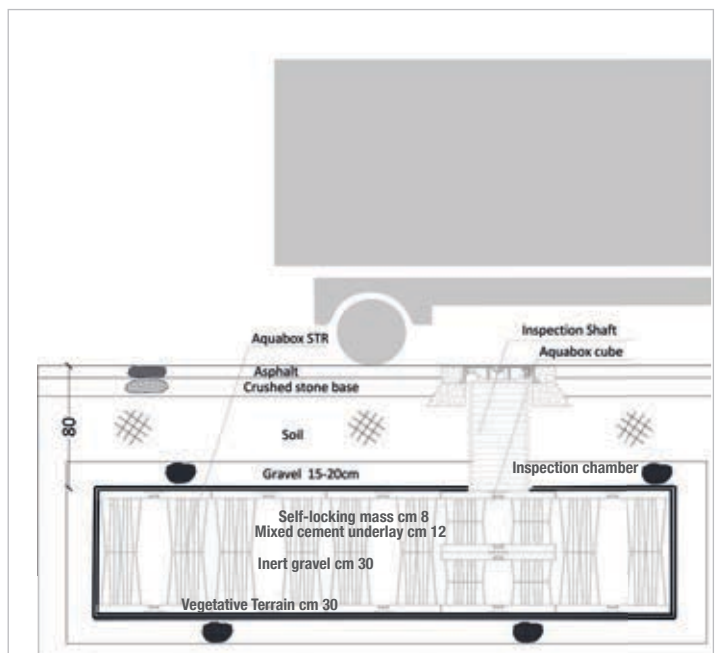
$$Q2k = 50 \text{ } kN \text{ on an area}$$

$$A = 400 \text{ } mm \text{ } B = 200 \text{ } mm \text{ ed}$$

$$\text{and axle spacing } axle \text{ } A = 2000 \text{ } mm \text{ } axle \text{ } B = 1500 \text{ } mm$$

The following images present typical strategies for the application of AQUABOX STR on pedestrian surfaces (measurements in cm):

SLW30 (TRUCK FROM 30 TON, 10 TON AS IS)



6.3 REQUIREMENTS FOR VEHICULAR SURFACES SLW60

For trafficable surfaces with heavy vehicles, the product to use is AQUABOX HP. The verification of the element upon request is conducted using loads from DIN1072 with the equivalent traffic load of SLW60.

$$g1k = \text{Weight of the element } kN/m^2$$

$$q2k = 2,50 \text{ kN/m}^2$$

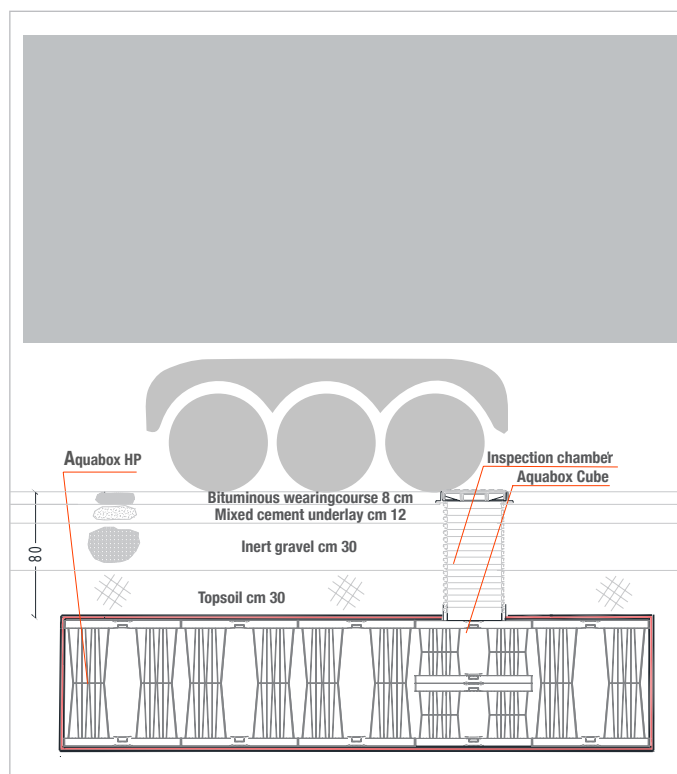
$$q2k = 4,00 \text{ kN/m}^2$$

$$Q2k = 100 \text{ kN on an area}$$

$A = 600 \text{ mm}$ $B = 200 \text{ mm}$ ed
and axle spacing $axle A = 2000 \text{ mm}$ $axle B = 1500 \text{ mm}$

The following images present typical stratigraphies for the application of AQUABOX HP on trafficable surfaces (measurements in cm):

SLW60 (TRUCK FROM 60 TON, 20 TON PER AXIS)



6.4 OTHER PRESCRIPTIONS AND LIMITS OF USE

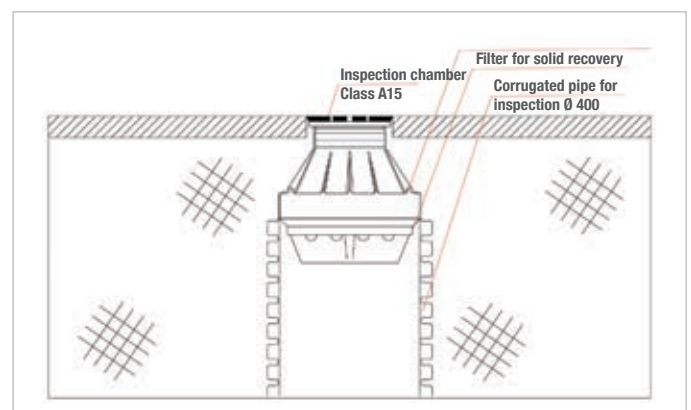
With regard to the use of AQUABOX to increase drainage in surfaces not typically considered for dispersion, attenuation, or retention basins, it is recommended to contact Geoplast's Technical Office, which will be available to provide a customized design.

In the case of using the product for an attenuation basin, i.e. a watertight system wrapped with a geomembrane, it is recommended to keep the system above the maximum piezometric level of the groundwater table.

Depending on the design load, the installation of the pipe and the inspection chamber should be carried out as described in the following images.

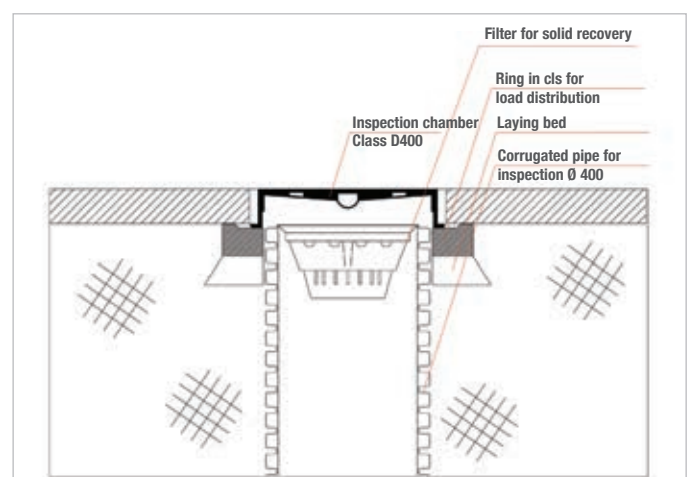
In the case of purely pedestrian load, the Inspection chamber cover can be connected directly to the Ø 400 mm pipe.

POZZETTO AQUABOX CUBE DETAIL FOR PEDESTRIAN AREA



In the case of driveable areas, the Inspection chamber cover rests on the reinforced concrete ring specifically sized for load distribution in the ground.

POZZETTO AQUABOX CUBE DETAIL FOR VEHICULAR AREA



7. CALCULATION OF VOLUME OF RESERVOIR THROUGH MODULAR CONFIGURATIONS

7.1 SPECIFICATIONS OF THE SYSTEM AQUABOX HP



Dimensions (cm)	75 x 75
Height (cm)	80
Volume of fill (m ³)	0,432
Void percentage	96%
Material	Recycled polypropylene PP
Inspection	Inspection tunnel
Short-term vertical compressive strength	>400 kN/m ²
Short-term horizontal compressive strength	>100 kN/m ³
Diameter of inlet/outlet pipe	Ø100-500 mm
Certification	Technical notice CSTB A Tec no. 17.2/23-367_V1

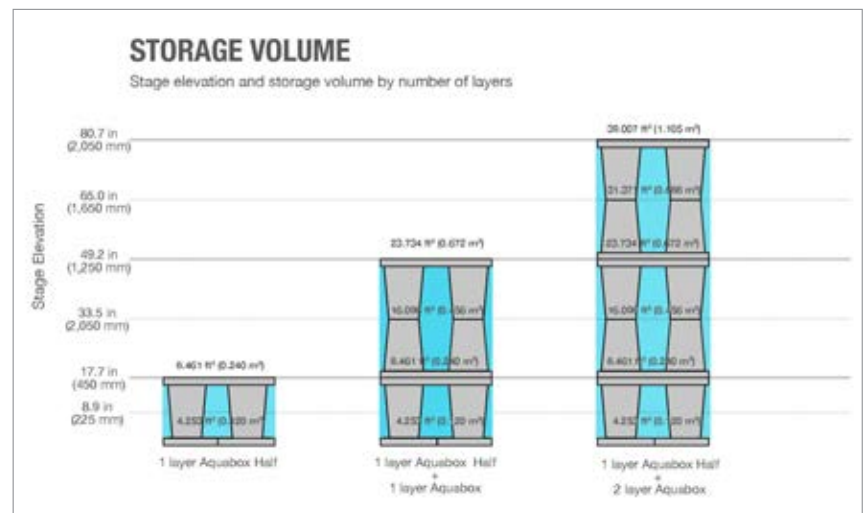
7.2 PRACTICAL EXAMPLE OF ESTIMATING STORAGE VOLUME THROUGH MODULAR CONFIGURATIONS

Configuration	Total Height (cm)	Net Volume (l)	Application Notes
0.5 levels (1 HALF)	45	240	Spaces with reduced height, retrofit, high slope
1 level (1 STANDARD)	80	432	Standard configuration
1.5 levels (1 STANDARD + 1 HALF)	125	675	Intermediate height, greater capacity

Configuration	Total Height (cm)	Net Volume (l)	Applicative Notes
2 levels (2 STANDARD)	160	864	Large volumes, deep installations
2.5 levels (2 STANDARD + 1 HALF)	205	1107	Volumetric optimisation
3 levels (3 STANDARD)	240	1296	Maximum capacity, high depth

The table provided is used to determine the net volume of the reservoir for each module based on its configuration in levels. Each configuration (e.g. 0.5 levels, 1 level, 2.5 levels, etc.) corresponds to an overall height of the module and an approximate net volume expressed in litres.

This information is particularly useful during the design phase, when you have a floor plan and know the total number of modules planned and their configuration in height.



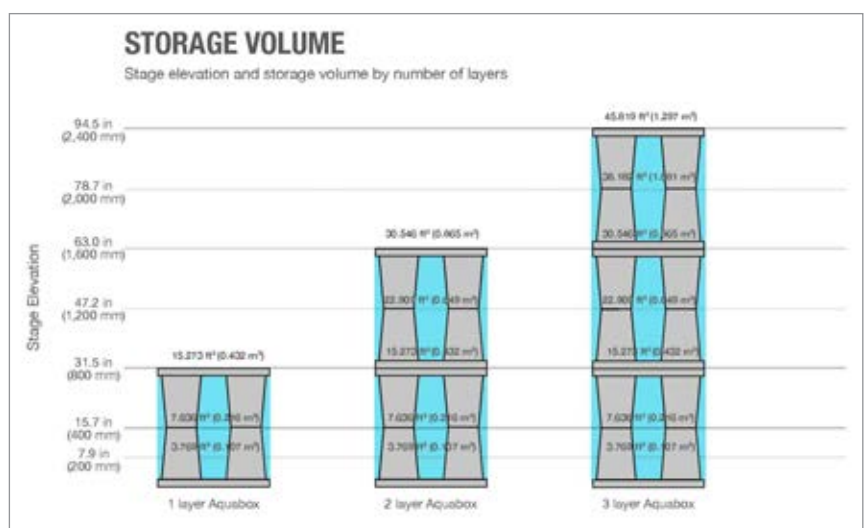
For example:

Suppose we have a floor plan that includes 20 modules, each configured at 2.5 levels. From the table, we know that a module at 2.5 levels has a net capacity of 1107 litres.

The total volume of the reservoir will therefore be:

20 {modules} x 1,107 {litres/module} = 22,140 {litres}

This calculation makes it possible to quickly estimate the overall capacity of the storage or infiltration basin, facilitating the verification of design and regulatory requirements.



8. MAINTENANCE AND CLEANING MANUAL

PREFACE

During the construction phase, it must always be ensured that no foreign bodies or objects enter the pipes or the infiltration modules. Particular attention is required if, immediately after construction, a high pollutant load is expected from the connected areas.

The first inspections (and any necessary cleaning) should be carried out before handover and immediately after completion of the system installation. A visual inspection of the system and the inlet inspection chambers, as well as a camera inspection, is recommended. These inspections should then be recorded in a maintenance logbook.

Further inspections, if necessary, should be carried out every six months during the first year of operation. These will provide useful information for future cleaning and inspection activities.

For this purpose, cleaning operations should begin with flushing the inlet pipes and the upstream inspection chambers, especially if they also act as sediment traps. It is advisable to inspect and clean the trench at least twice a year, preferably in spring and autumn. Naturally, in the event of extreme weather events, it is always recommended to inspect and/or clean the trench.

System inspection is therefore essential during the following periods:

- at the end of construction activities;
- after particularly intense rainfall events;
- in the event of failure or malfunction of any pre-treatment units, where provided;
- at least once a year.

8.1 CLEANING OF AQUABOX INFILTRATING MODULES

As a general rule, the drainage system can be cleaned by flushing and vacuuming debris from the inspection inspection chamber.

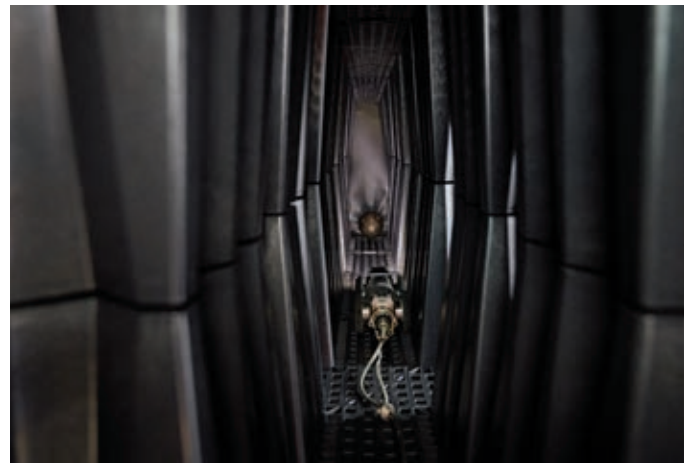
Cleaning operations should begin with flushing the inlet pipes and the upstream inspection chambers, especially if they also act as sediment traps.

In the case of heavy contamination (high sediment load) in the area concerned, the trench must be cleaned by means of high-pressure flushing of the channels within the trench.

For cleaning with a spray probe, the use of a 90° rotating nozzle with a 45° water jet is recommended.

The nozzles used should operate at a pressure between 80 and 120 bar; higher pressure values may damage the geotextile.

The clear opening inside the Aquabox modules is 170 mm. Please ensure that any inspection or cleaning equipment used inside the tank does not exceed this width.





9. CERTIFICATIONS AND TESTS

For requests for certificates and load tests, please contact the Geoplast Technical Office.

10. TRANSPORT AND LOGISTICS

AQUABOX modules are delivered stacked on pallets measuring $80 \times 152 \times H 258$ cm. Each pallet contains 80 half-elements, corresponding to a total of 40 AQUABOX modules. Thanks to the product's structural geometry and its stackability, the total transportable volume on a standard articulated truck is equivalent to 460 m^3 .

The side closure grates and the top closure grates are packaged on separate pallets. The inspection components for AQUABOX CUBE are also delivered on separate pallets measuring $75 \times 150 \times H 250$ cm. These pallets are appropriately labeled to distinguish them from the others.

For unloading and handling the pallets, mechanical equipment with forks or cranes equipped with lifting slings may be used.

For proper storage, it is recommended to choose a stable and as level a surface as possible. The product must be protected from any contact with fuels, lubricants, chemicals, or acids. Exposure to UV radiation should be minimized as much as possible.

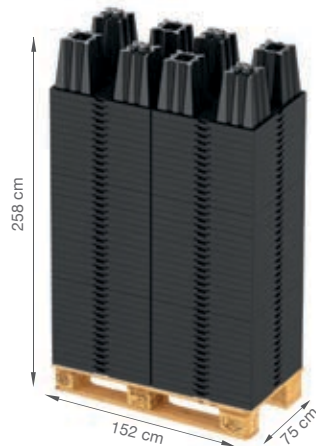
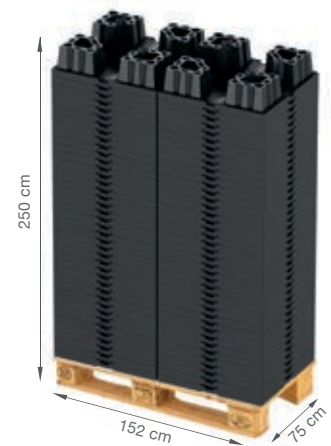
Once the elements are removed from the pallet, the following operations must be avoided:

- Improper storage (stacking pallets on top of each other, random piling of elements, etc.);
- Improper handling (throwing the elements, dragging them, etc.);
- Contact or impact with blunt or sharp objects (stones, blades, etc.).

Stackable

The modules are stackable and are delivered on pallets containing 80 pieces, corresponding to 18 m^3 each.

The pallet dimensions are: $80 \times 152 \times H 258$ cm.



Easy installation

With the "Aqualock" stacking system, two half-modules are assembled together to create a cubic element, ready to be placed in the excavation to form the infiltration basin.



Ready to use

Once assembled, the modules are ready to be placed in the excavation to create the basin. The side walls serve as connections for the inlet and outlet pipes of stormwater.





IMPORTANT: Before installation, it must be verified that the elements are not damaged or defective (they must meet the specifications described in paragraphs 1.2). Avoid laying if there are any damages or defects in both the panels and the grids. Damaged modules **MUST NOT** be installed!



Geoplast
Building beyond together

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