Rainbox 3S

Technical manual

DYKA

DUBORAIN by DYKA

It’s raining solutions and advice!

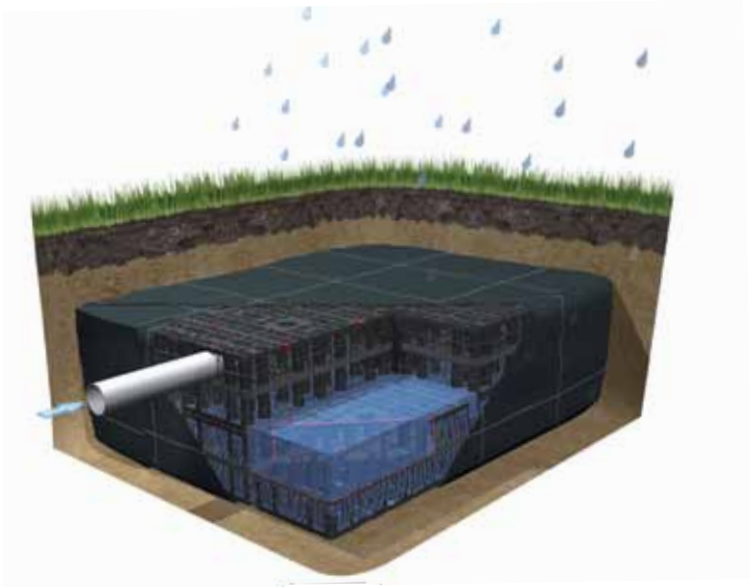
DYKA

We live in a world of increasing urban development, as ever more land is earmarked for construction projects. The area impermeable to water increases, while rainwater is less able to infiltrate the ground naturally.

This is why DYKA is helping support rainwater management with its comprehensive DUBORAIN concept.

The DUBORAIN range from DYKA is breaking new ground in the design and construction of comprehensive rainwater infiltration or retention systems.

rainbox® 3S

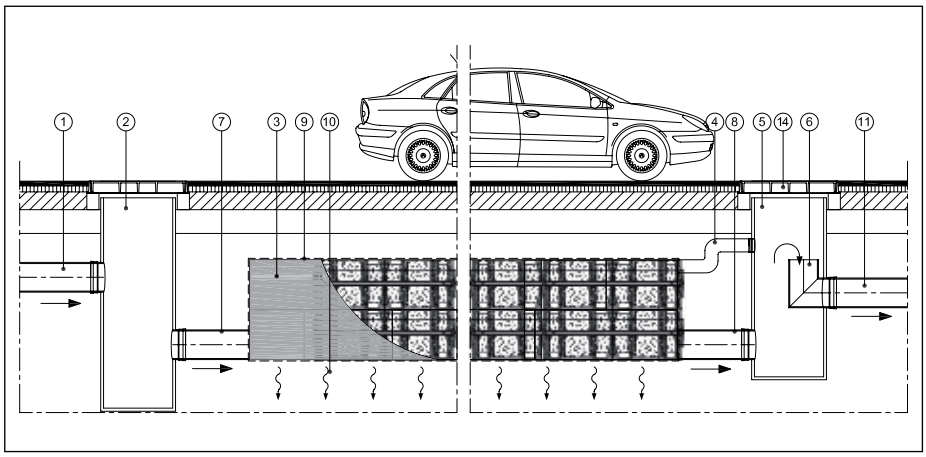


How the system works

Types

- **Infiltration**

  Rainwater (directed to the structure via a pipe) infiltrates the ground.
  The structure empties out gradually, therefore, through a process of infiltration. The basin is surrounded by a permeable geotextile to keep out any foreign matter, particularly backfill.

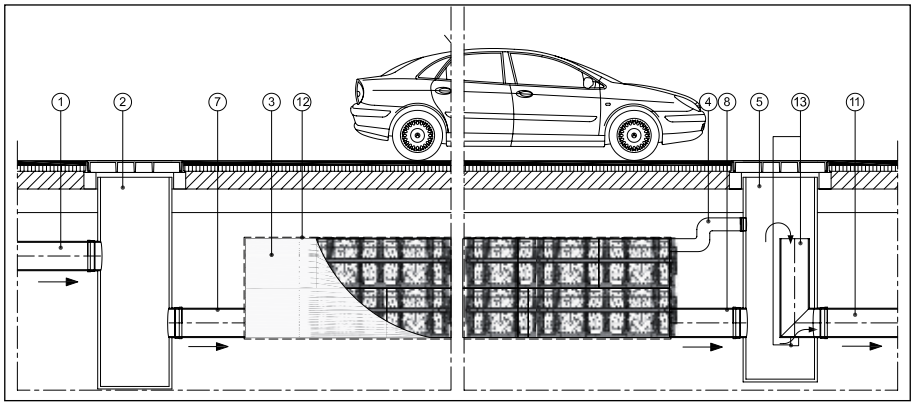


1. Rainwater collection unit
2. Inspection port
3. RAINBOX® 3S module
4. Vent
5. Inspection port with overflow
6. Overflow system
7. Inlet pipe for structure
8. Outlet pipe for structure
9. Geotextile
10. Infiltration
11. Outlet pipe towards outfall
12. Geomembrane
13. Overflow and flow limiter
14. Cover for ventilated port (vent)

- **Retention**

  Rainwater (directed to the structure via a pipe) is retained and stored on a temporary basis.
  The structure empties out via a regulated flow system towards a natural or artificial outfall or even towards a sewage network.

  The structure is surrounded by an impermeable geomembrane. If the water table becomes too close (higher than the lower part of the structure), it is essential to anticipate and calculate the risk of floating (see page 10).

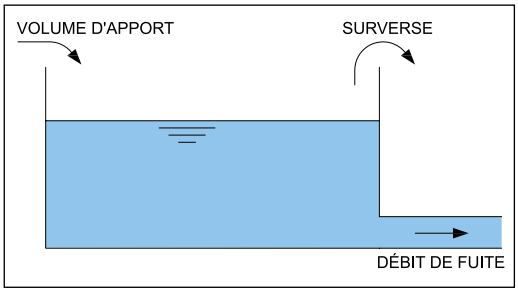


The flow may be regulated by a nozzle arrangement (a calibrated orifice), by a limiter based on a vortex effect, or by a guillotine-type regulator.

Flow

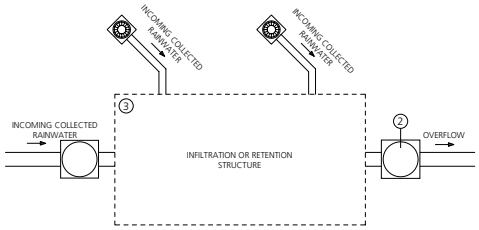
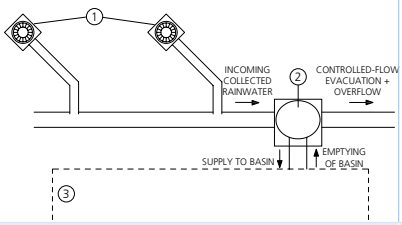
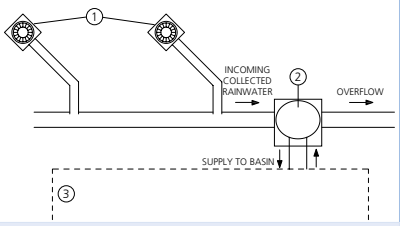
There are three major factors which determine the flows within a structure based on limited-flow retention or on infiltration:

- **Incoming volume:** the amount of water collected from roofs and covered areas and finding its way into the structure
- **Outward flow:**
  - infiltration into the ground (depends on the permeability of the ground and the area available for infiltration)
  - evacuation at a regulated flow rate towards existing networks (depends on local regulations)
- **Overflow:** overflow facility big enough to allow direct evacuation of excess water during periods of exceptional rainfall



The storage volume required for infiltration or retention purposes is based, therefore, on these three variables.

Integration within the network

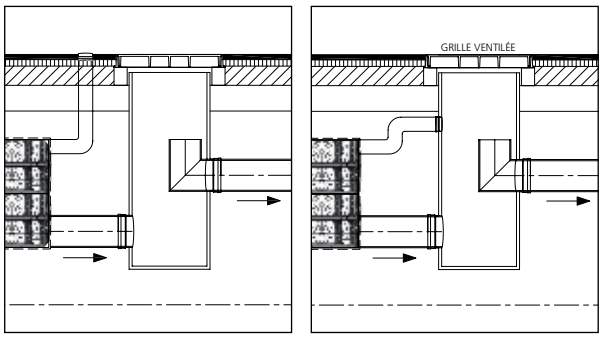
Structure in main circuit	Structure offset from main circuit	
Retention / Infiltration	**Retention**	**Infiltration**
		
The total volume of rainwater passes through the structure. The injection point and outflow are situated at different locations. The drains can be directly connected to the structure.	The inlets and outlets are connected to the same port. The structure only fills up during periods of heavy rainfall. This form of buffer is better, given its suitability during periods of intense rain or storms. In addition, this principle allows flows to follow their course within the network without causing flooding if the injection point becomes obstructed. The drains are linked to the pipe upstream of the branch for the port.	The inlets and outlets are connected to the same port. The structure fills up as a matter of course. The drains are linked to the pipe upstream of the branch for the port.

(1) Drains (with filtration system)
(2) Inspection port with overflow
(3) Basin (retention/infiltration)

How the system works

Ventilation

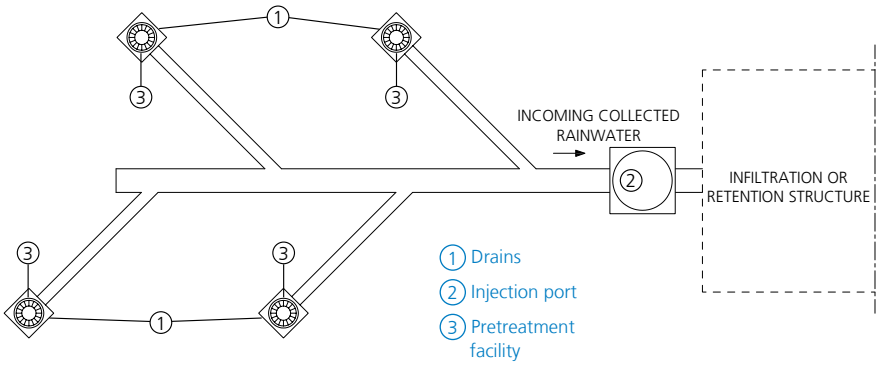
The structure must have vents to preserve a balance between internal and external pressure levels.
These are positioned by means of special shafts or preferably towards upstream/downstream ports, with these being ventilated.



Pretreatment

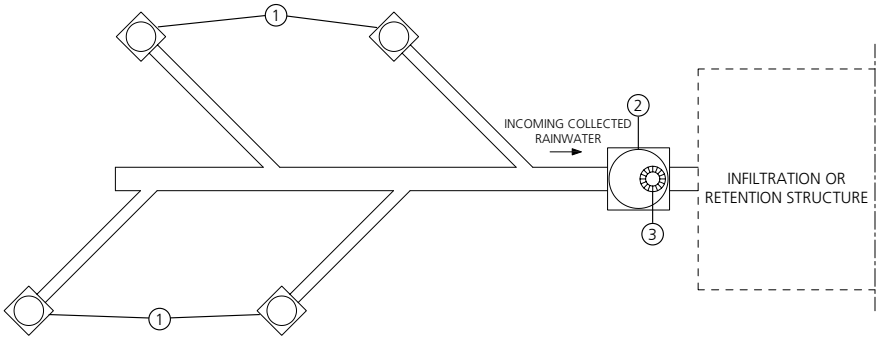
The pretreatment structures are critical in terms of ensuring the system as a whole works effectively over the long term.
Their design and dimensions must reflect the kinds of pollution they will have to deal with (filtering, removal of dirt, sand, oil, etc.).
They are easy to maintain (traditional methods and resources associated with network maintenance) and the frequency can be stepped up, if required.
If there is any deficiency in this respect, the alarm is effectively raised when they overflow.
It is simply a case of cleaning things out in order to return to normal, with no damaging after-effects as far as the basin is concerned.

• **Offset pretreatment:** all upstream drains are fitted with a pretreatment system.



This kind of offset arrangement for pretreatment may be achieved with a honeycomb cartridge filter (with the capacity adapted to the flow rate for a structure with a single collection facility).

• **Centralised pretreatment:** a pretreatment system is placed within the port before the injection point.



This kind of centralised pretreatment may involve a circular filter with a high flow rate (capacity adapted to the flow rate for a collection structure).

Technical characteristics

General characteristics

- **Dimensions** L 1200 x l 600 x H 420 mm
- **Gross Volume** 302 L
- **Usable Volume** 290 L
- **Void ratio** 96 %
- **Materials** PP
- **Recyclable** 100 %
- **Approximate weight** environ 11,5 Kg
- **Linking of modules using clips**

> RAINBOX®3S
(2 half-modules + 1 plate)
Article code 20047088

> Single clips
(Bag of 50 pieces)
Article code 20047091

> Double clips
(Bag of 50 pieces)
Article code 20047090

Connection options:

- Direct for DN110, DN125 and DN160,

- Via a connector for DN200, DN250, DN315 and DN400.

Optimal strength

This exceptional strength is achieved through a combination of several parameters:

- **The alignment of the columns** ensures loads are transferred down through the entire structure as effectively as possible.

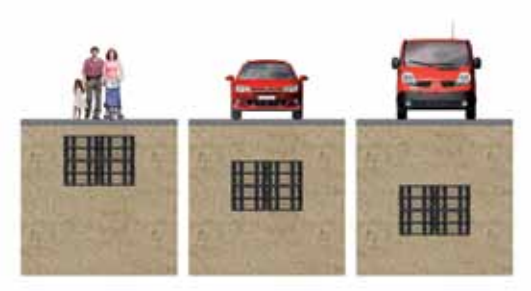
- **The geometry** around the edge of the chamber ensure a perfect compromise between high levels of perforation and an even distribution of loads. The modules are connected together by clips distributed across a horizontal plane and centring blocks running vertically This makes for a very cohesive structure and provides great durability, even under stress.

Technical characteristics

Implementation restrictions

Vertical to the structure, these are determined by the cumulative loads associated with the backfill and any loads linked to operations (mobile loads or loads associated with storage). Horizontally, these are determined by the pressure exerted by the earth.

The two resulting implementation restrictions are the minimum and maximum covering height and the excavation depth.



Installation depth	Pedestrians	Car/ PKW	Truck/ LKW12
Min. ground coverage*	0,20	0,50	0,60
Max. ground coverage*	1,50	1,30	1,30
Installation depth** f=25°	2,40	2,30	N/A
Installation depth** f=35°	3,60	3,60	N/A
Installation depth** f=40°	4,00	4,00	4,00

f angle of internal friction
* From top side of the Rainbox® 3S
** From bottom side of the Rainbox ® 3S

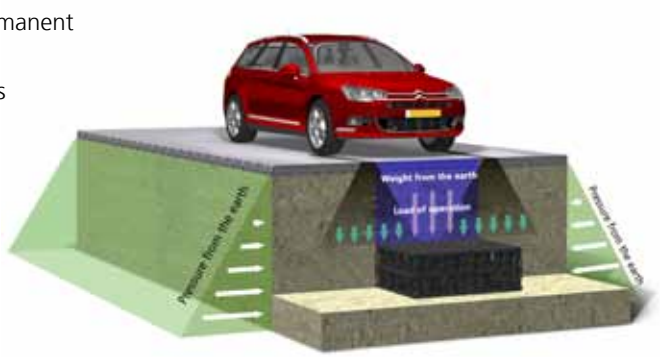
Close to buildings, the minimum horizontal distance between the building concerned and the basin must be equal to one times the depth of the structure. For infiltration, this distance must be a minimum of 5 m (unless a specific study makes it possible to recommend a shorter distance).

Each project will be the subject of an individual study by our design team with a view to checking the dimensions (in hydraulic and mechanical terms) and refining them (ground area covered, depth, layout, and integration).

Load resistance

Given the very significant loads to which the RAINBOX® 3S module will be exposed following installation, it has been designed to cope perfectly with these extreme mechanical demands. The image below provides an overview of the forces to which the module will be subjected.

These loads can be grouped into two categories:
- **Permanent**: weight and lateral pressure from the earth and any permanent loads associated with storage facilities
- **Temporary**: weight and lateral pressure from mobile loads and loads associated with materials stored during work on site
  These are transferred through the ground towards the buried basin.



Reduce environmental impact

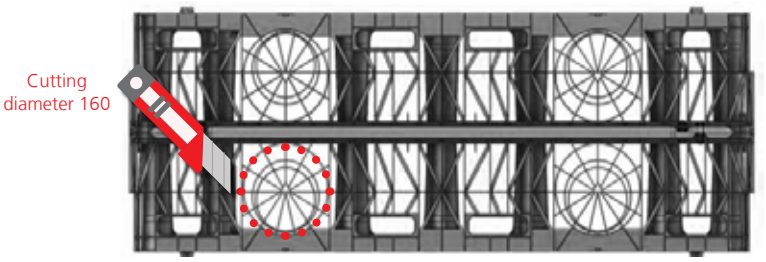
The RAINBOX® 3S is designed to be packed and stacked with the elements interlinked together.

This reduces the carbon footprint by 50% from a transport perspective.

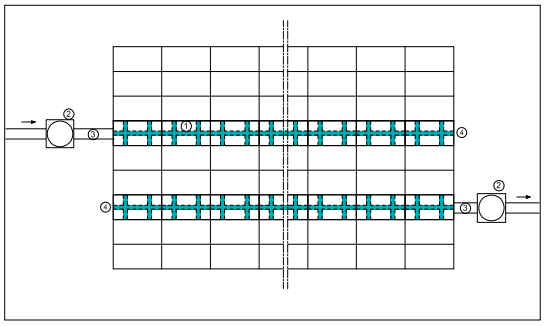
Similarly, stock takes up less space on site.

Ease of inspection and cleaning

Once the cut-outs provided on the lateral walls of the RAINBOX® 3S chambers have been removed, inspection channels can be fitted to the unit:



Inspection by camera can also be carried out along the selected axes:
Example :



The shape of the RAINBOX® 3S element makes it possible to pass a camera through for inspection purposes.
The kind of camera which may be used might be a variety with 'six motorised wheels'.
The mobile head of the machine features a high-definition camera coupled with a lighting system, which makes it possible to inspect the entire structure. The entire operation may be followed from the surface via monitors. Access to the inspection channels must be provided via directly connected inspection ports.
The structure is inspected via the lower level, which is the area closest to any possible decantation.

The RAINBOX® 3S module has been tested and is able to withstand a water jet with a pressure setting of 120 bars.

Note: This functionality in no way diminishes the importance of upstream pretreatment structures in terms of facilitating collection of floating or suspended elements and thereby preventing any clogging of the structure.

Installation advice

Earthworks - formation level

This is arranged in accordance with current best practice and those following regarding earthworks projects above ground.

The set-up is as follows:

- **For infiltration:** horizontal formation level
- **For retention:** sloping formation level between 0.5 and 1%, linear structures may require some partitioning.

Flatness tolerance:

- **Generally 0.1%** of the structure's length in a range between 2 and 5 cm
- **Measured using the 3 m rule:** 1 cm maximum

Installation bed

This is a 10 cm bed made up of materials supplied (sand, gravel, or any other material meeting the criteria for the G1 or G2 ground types.

Taking delivery on site - handling - storage

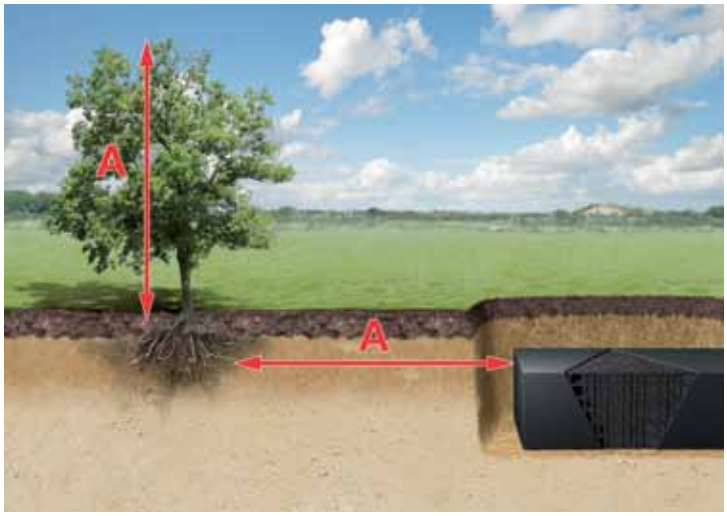
The RAINBOX® 3S elements are packed on blocks.

They should be unloaded with a forklift truck or manually if unpacked.

They should be stored on a flat and clean surface.

For longer storage periods (several months), it is advisable to store them away from direct sunlight.

Where **there are plants or other vegetation**, a root-repelling film must be applied at a distance less than or equal to the height of the vegetation when mature.



Geotextile - geomembrane

The kind of geosynthetic composite material used will depend on the application.
Installation must reflect best practice, particularly in terms of ensuring there is an overlap of at least 50 cm between the strips of geotextile in order to prevent any materials finding their way into the structure. The geomembrane must be glued or welded during installation (any pipes must also be made completely tight).

Characteristics of the geotechnical composite material to be used

For **infiltration purposes**, the geotextile must be of a non-woven type and weigh more than 250 g/m² (class 6).

For **retention purposes**, the geomembrane must be surrounded by two layers of geotextile.
The resulting composite material must have have the following minimum characteristics:

- PP, PEHD, PVC geomembrane at least 1.0 mm thick
- Protective geotextile at least 300 g/m²

Installation advice

Assembly

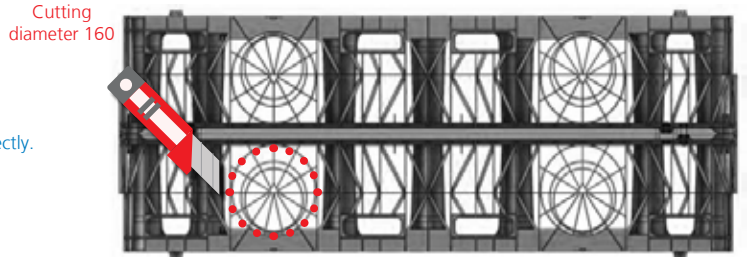
> Installing the modules (except trench)

The RAINBOX® 3S modules consit of two half-boxes and an intermediary plate; assemble these prior to their implementation in the trench.

> Preparation of inspection channels

The RAINBOX® 3S module walls used to create the inspection channels must always be cut before implementation.

Ensure that all modules that are part of the inspection channel are cut out correctly.



> Installation of RAINBOX® 3S elements

Install the RAINBOX® 3S modules into the trench, following the direction of fitting stated in the installation folder and on the plans.

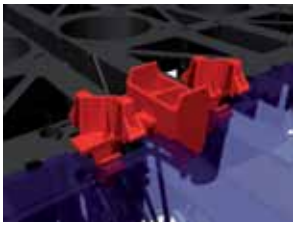
Assemble the modules using the clips, at a ratio of two clips per contact side.

Use the single clips for the internal and upper sides of the basin.

Use the double clips for the intermediary levels within the structure.

Insert the units for the higher levels into those already installed.

The various levels are assembled in the same direction (there are mechanisms to prevent mistakes).



> Creating a surround for the structure

Once all the blocks have been installed, surround the entire structure with the geotextile. The geotextile will prevent fine matter from the backfill finding its way into the structure.

Installation advice

Connections

You can arrange connections to create branches to the collection units and vents and/or ensure access to inspection channels.

> Collection units

The DN110,125 and 160 collection units can be joined directly to the module via the recesses provided (using a technique known as 'tapping'). Use a sabre saw, jig saw, or similar tool to make an opening in the walls.

A specific module with a customised tapping fitting must be used for DN200, 250,315 and 400.

If the DN is higher than 400, the collection unit may be connected to the basin using a concrete structure. The collection units are connected to the basin at the lower level of the modules (no branching off downwards).

As far as structures for infiltration are concerned, special precautions must be taken to prevent any erosion of the formation level. Incorporating some kind of spreader rake will make it possible to avoid this risk (acts as an energy brake).

> Vents

Vents must be used to regulate the pressure levels inside the structure and provide it with ventilation.

The cross-section of the vent(s) should be 30% of the cross-section of the inlet collection unit(s) connected to the basin.

Depending on how the structure is configured, the vents may either open out into the ports attached to the systems, which will have to be ventilated, or via specific shafts.

Backfilling

Backfilling must be performed in accordance with the rules relating to the selection of materials and compacting set out in the applicable standard.

- **Lateral backfill:** this must take the form of homogeneous peripheral layers to prevent the structure from becoming displaced.
- **Top backfill:** a protective layer of the geosynthetic composite material, at least 10 cm thick, must be applied across the whole of the basin.

It is then a question of the type of backfill to use - either topsoil or road-building materials. This will depend on where the structure is situated. As the successive layers of backfill are being deposited, it is important to ensure a minimum coverage of 50 cm has been applied before performing any heavy compacting.

Movement of construction machinery

You may use a range of different construction machinery to backfill the trench. It is forbidden to run compactors, whether vibrating or not, directly over the elements of the structure because of the dynamic extra loads applied to the structure.

Below is a list of the covering levels required for various pieces of machinery based on backfill with an angle of internal friction $\varphi \geq 45°$.

Coverage (in m)	Compacting machinery properties
Min. 0.1	Hand-operated compactor, vibrating plate **Total weight:** around 700 kg **Distributed:** evenly across two balls **Dimensions:** 0.9 x 0.7 m
Min. 0.2	Light compactor **Total weight:** around 2.5 t **Distributed:** evenly across two balls **Dimensions:** 1.2 x 3.2 m
Min. 0.5	Articulated compactor, backhoe **Total weight:** around 12 t **Distributed:** evenly across two balls **Dimensions:** 5.9 x 2.3 m
Min. 0.8	Lorries ≤ 30 tonnes

Reference elements to be used for technical specifications

Ultra-light cellular structure

- Polypropylene materials
- Void ratio: 96%
- Dimensions: 1.20 x 0.60 x 0.42
- Linkage via clips
- Resistance to heavy loads (HGVs up to 12 T)*
- Coverage depth under heavy loads: 0.50 to 0.60 m
- Maximum excavation depth depending on type of ground at the site*

*See the implementation restrictions below.

Implementation

EaVentilation

Vents must be used to regulate the pressure levels inside the structure and provide ventilation: the cross-section of the vent(s) should be 30% of the cross-section of the inlet collection unit(s) connected to the basin

Connection

- DN110, 125, and 160 collection units: connected directly to the module using a technique known as 'tapping'
- DN200, 250, 315 and 400 collection units: connected via a specific module with an appropriate fitting
- DN > 400 collection units: connected via an intermediary structure (spreader rake)
- Connection to the basin at the lower level of the modules (no branching off downwards)

Pretreatment

The pretreatment structures upstream are particularly important, because this makes it possible to collect as many as possible of the elements floating or suspended in the drained rainwater and thereby prevent any clogging of the system.

Implementation restrictions

For loads of light vehicles:

- Minimum coverage = 0.50 m
- Maximum coverage = 1,5 m
- Excavation depth where ground φ′ 35° = 2.50 m
- Excavation depth where ground φ′ 45° = 3.00 m

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PLASTIC PIPE SYSTEMS

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