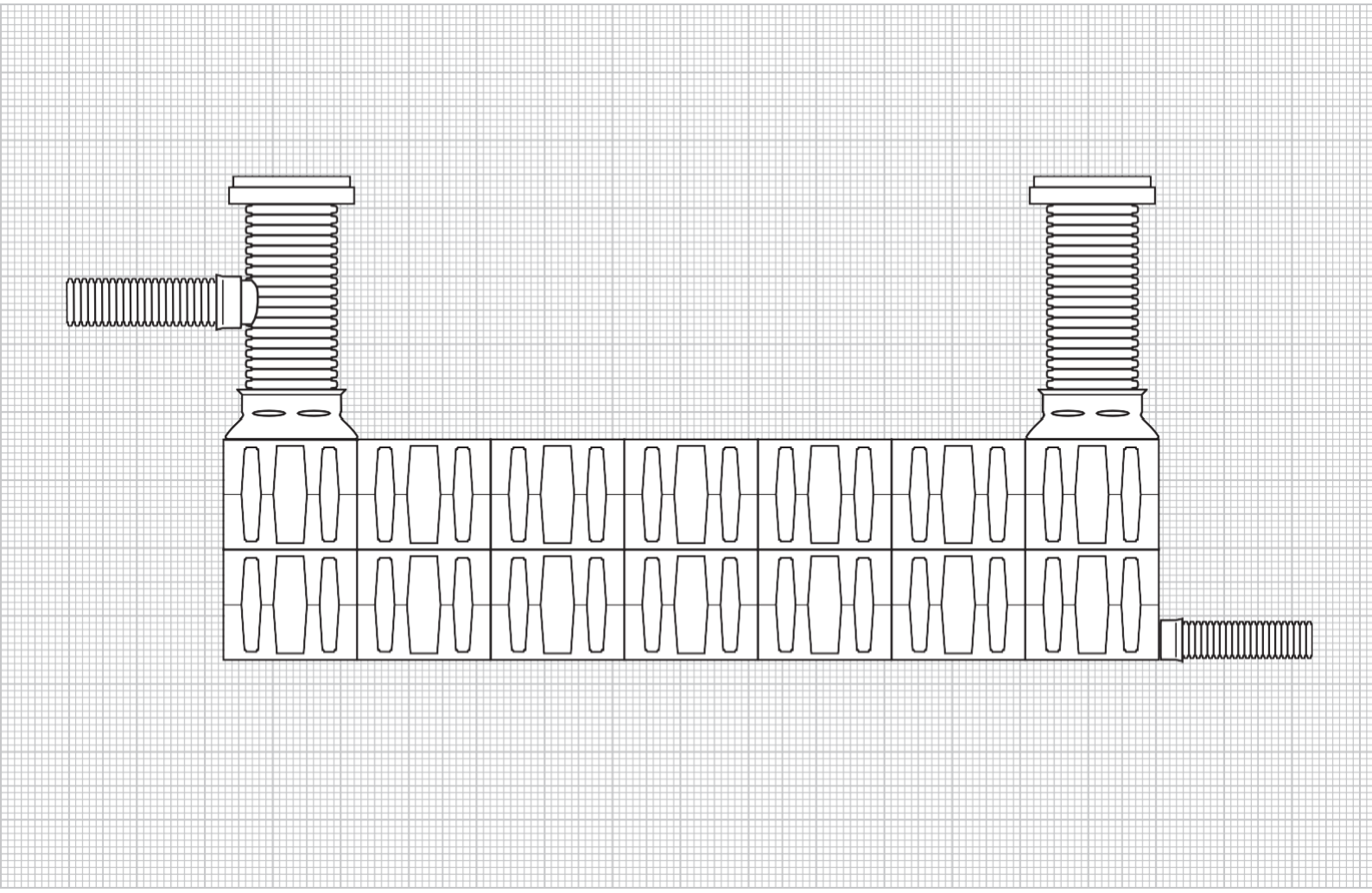
TRICEL

GENERATIONS OF INNOVATION

Installation manual

Rigofill® ST-A / Rigofill® ST-S



Underground storage/infiltration modules

Drainage Systems

www.tricel.ie

www.tricel.co.uk

Rigofill ST – system

Rigofill ST-Advanced

- Installation depth up to **6 m**
- Complies with EN 17152-1

- SLW 60/HGV 60

Rigofill ST-Standard

- Installation depth up to **4 m**
- Complies with EN 17152-1

- SLW 60/HGV 60

NB

In what follows, an illustrative explanation of the Rigofill system will be given by means of the green module.
All properties and advantages also apply to the Rigofill ST-S system. The systems have been optimised for different installation situations.

In the following, please be sure to pay attention to this sign.
Statements marked with this sign apply to both Rigofill ST-A and Rigofill ST-S.

Table of contents

1 Rigofill® ST - Advanced - system 2

2 Rigofill® ST-A - system and system components 4

3 Rigofill® ST-A – storage / infiltration module 6

3.1 Transport and storage 6

3.2 Separating pallets 6

3.3 Excavating pit and creating bearing 7

3.4 Laying geotextile 7

3.5 Installation 8

4 Quadro®Control ST – shaft elements 11

4.1 Delivery 11

4.2 Shaft variants 11

4.3 Installation of shaft elements 12

4.4 Temporary construction site covers 14

4.5 Shaft covers 14

5 Final installation steps 15

5.1 Installing sidewall grids 15

5.2 Cutting openings in sidewall grids 16

5.3 Inserting adapters DN 315 / DN 400 / DN 500 16

5.4 Creating geotextile wrapping 17

5.5 Lateral backfilling 17

5.6 Creating cover SLW 60/HGV 60 18

5.7 Creating cover SLW 60/HGV 60 19

5.8 Use of construction vehicles during installation 20

6 Waterproof systems 20

7 Contact and service 21

8 Safety instructions 23

NB

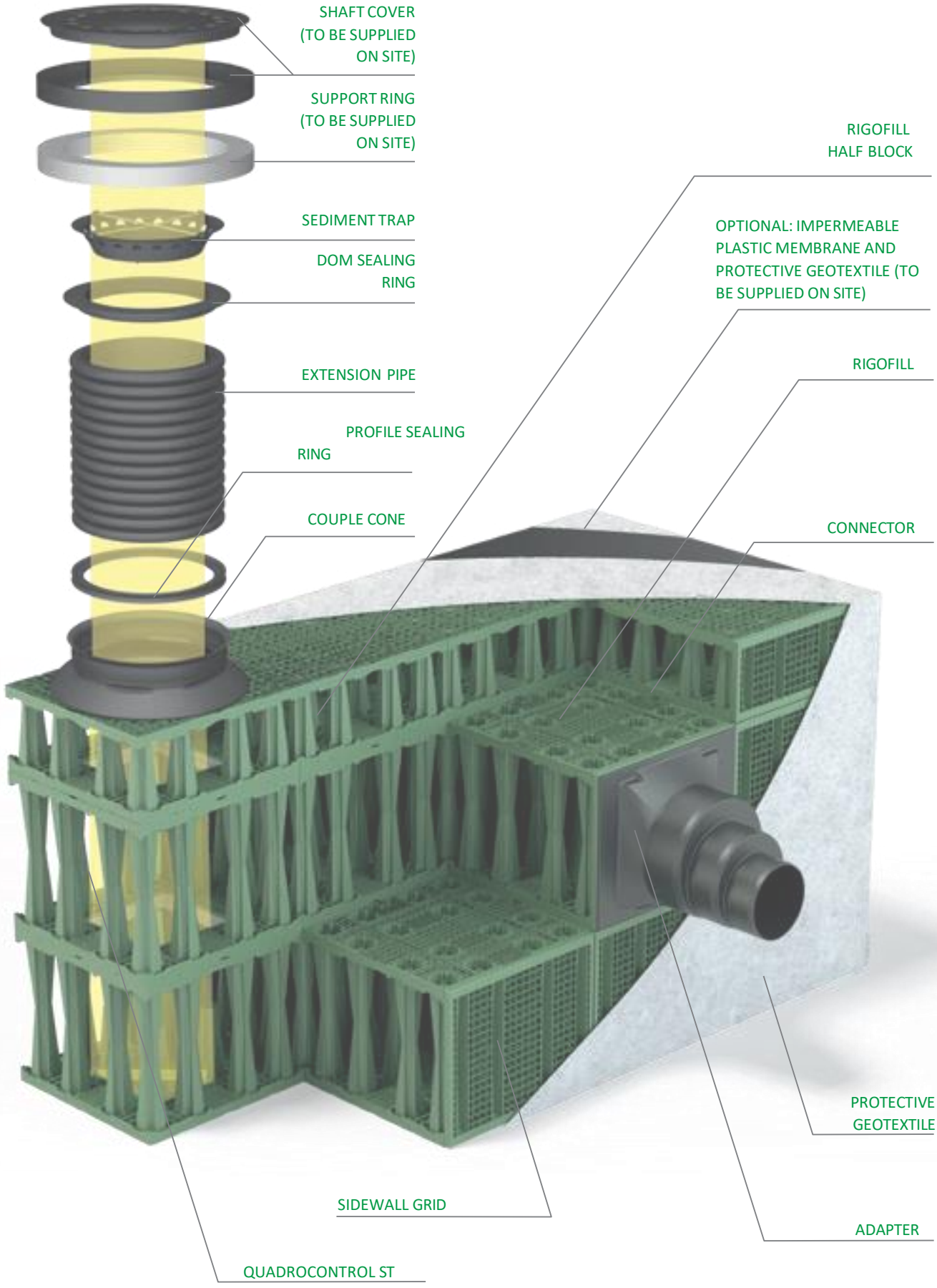
Please read this installation manual carefully and follow our instructions.

This installation manual applies to

- the temperate climate zone
- infiltration systems and watertight storage systems with Rigofill above the maximum groundwater level (e.g. according to ATV-A 138)

The relevant safety provisions of the building industry apply.

2 Rigofill® ST-Advanced - system and system components



Rigofill®ST-A

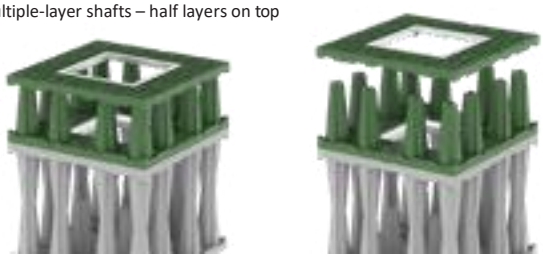
Rigofill® ST-A half block

Quadro® Control ST-A shaft

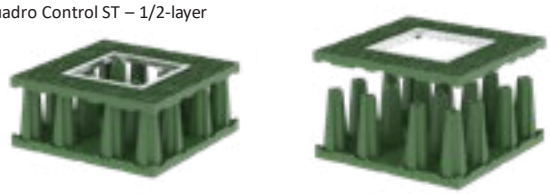
Example: 2-layer shaft

Quadro® Control ST-A shaft – half layers

Multiple-layer shafts – half layers on top



Quadro Control ST – 1/2-layer



Rigofill® ST-A with supporting grid

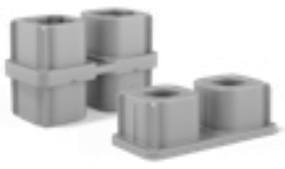
Quadro® Control ST with supporting grid

Couple cone

Sidewall grid

Adapter

Connector



3 Rigofill® – storage / infiltration module

3.1 Transport and storage

Rigofill modules are delivered stacked on pallets (1.60 m x 0.80 m). A pallet contains 68 half elements for 34 modules. When leaving the factory, two pallets are typically stacked on top of each other. Sidewall grids, supporting grids and roof slabs (required for half blocks only) are packed on separate pallets.

The components of the Quadro Control ST shaft are delivered pre-assembled on separate pallets. These pallets are marked correspondingly. Preferably unload the pallets using forklifts or other lifting tools. The lifting tools must have the technical equipment required for lifting gear operation.

Rigofill can be stored outdoors. Storage time outside should, however, not exceed **one year**. Protect the material from direct sunlight (e.g. store in the shade or cover with bright- coloured, light-tight foil).

Check the components for defects before installation. The impact strength of the material decreases in sub-zero temperatures. The relevant safety provisions of the building industry apply. **Damaged modules must NOT be installed!**

⚠ CAUTION

Solid and level ground is required for storage at the construction site. Avoid dropping, dumping and hitting the Rigofill modules against each other!

3.2 Separating pallets

We recommend using hoisting slings to separate both stacked pallets.

We recommend that you separate the pallets before removing the half elements.

3.3 Excavating pit and creating bearing

Excavate the pit according to design specifications. During excavation work, the walls of the pit must be sloped or constructed such that they pose no danger to the workers due to down sliding masses. Additionally, national regulations must be observed. Measures must be taken to ensure that the excavation pit is free from water during the entire execution time. This concerns especially the construction of watertight systems to avoid any upwards floating of the systems during the construction period.

In order to install the modules, a horizontal, level and stable bearing is essential. To this end, create a levelling layer of approx. 10 cm, preferably made of crushed stones (e.g. 2/5 mm) or gravel, above the bottom of the excavation pit. Compact and smooth this layer to achieve a level surface.
The degree of compaction D_{pr} should be larger than or equal to 97 %, and, depending on the requirements above the system, E_{v2} should be larger than or equal to 45 MN/m² or CBR should be larger than or equal to 12 % at the top edge of the bearing. If the soil has been included in the infiltration calculation, the permeability of the compacted layer must at least correspond to the permeability (k_f value) of the backfill
soil (soil groups GE, GW, SE, SW, SI, according to DIN 18196, are usually suited for this).

The quality of the bedding is decisive for the quality of the installation and strongly affects both bearing and setting properties of the storage/infiltration systems, particularly in case of multiple- layer designs and higher loads (soil and traffic loads).

3.4 Laying geotextile

Wrap the entire storage/infiltration system in geotextile. Before starting to lay the modules, spread out the geotextile on the planum. The geotextile must have sufficient lateral excess length in order to eventually wrap up the entire system.

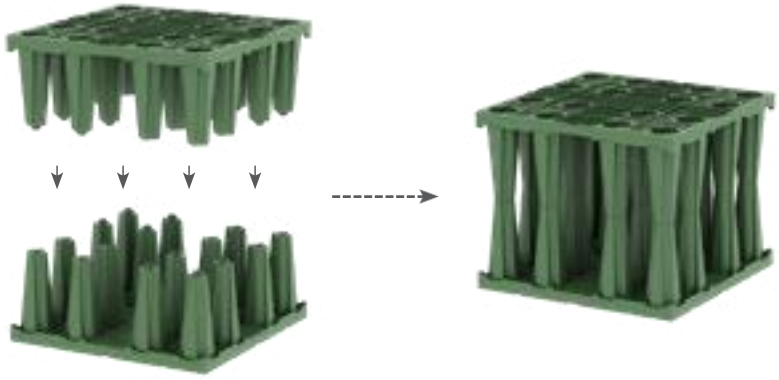
ATTENTION

Ensure that the geotextile surface is completely closed leaving no gaps even during backfilling! Edges should overlap at least 50 cm.

Important characteristics of the geotextile

- Thickness ≥ 2 mm
- Puncture resistance 2.0 kN
- Geotextile class 3
- Characteristic opening width 0.08 mm
- kf value (at 20 kPa): 6 x 10^{-2} m/s
- Water permeability acc. to EN ISO 11058: 80 l/sm²
- Mass per unit area 200 g/m²
- Resistance: Anticipated resistance of up to 50 years in all natural soil types with 4 ≤ pH ≤ 9 and soil temperature of ≤ 25 °C (B.4.2.2, EN ISO 13438)

3.5 Installation

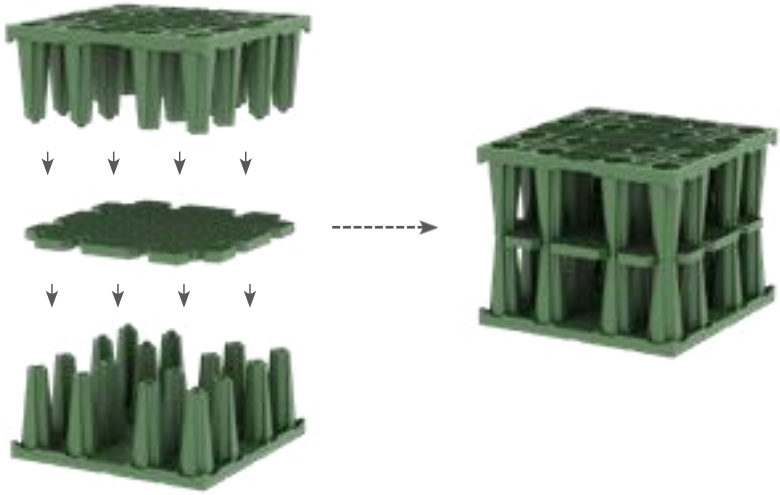


Full block installation

Each Rigofill module consists of two half elements. Slight hand pressure is enough to create a connection of high tensile strength.

The modules can be pre-assembled both inside and outside the excavation pit.

The pre-assembled modules must be arranged according to planning specifications.



Full block installation with integrated supporting grid

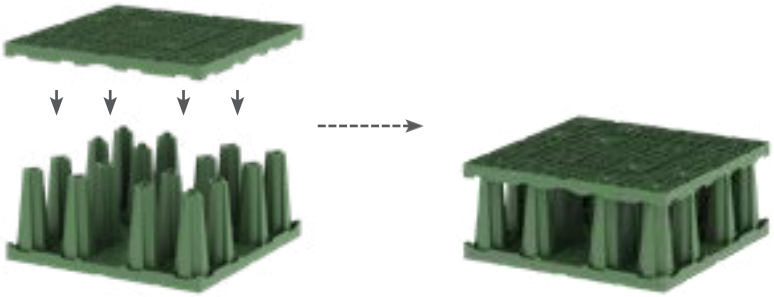
If the full block has an integrated supporting grid, this must be placed between the two half elements beforehand.

The modules can be pre-assembled both inside and outside the excavation pit.

The pre-assembled modules must be arranged according to planning specifications.

ATTENTION

Half blocks must be installed with the roof slab located on top.



Half block installation

Each Rigofill half block consists of one half element and one roof slab put together. Slight hand pressure is enough to create a connection of high tensile strength. The modules can be pre-assembled both inside and outside the excavation pit.

For a 0.5-layer system, the pre- assembled modules must be arranged on the planum according to planning specifications. **For multiple-layer systems, the half blocks must be arranged in the top layer.**

3.5.1 Pre-assembly outside the excavation pit

3.5.2 Pre-assembly inside the excavation pit

Assembly inside the excavation pit

⚠ CAUTION

Installation at sub-zero temperatures requires greater care (impact stability, please refer to the section on transport and storage). Modules are slippery when wet or frosty!

3.5.3 Connectors

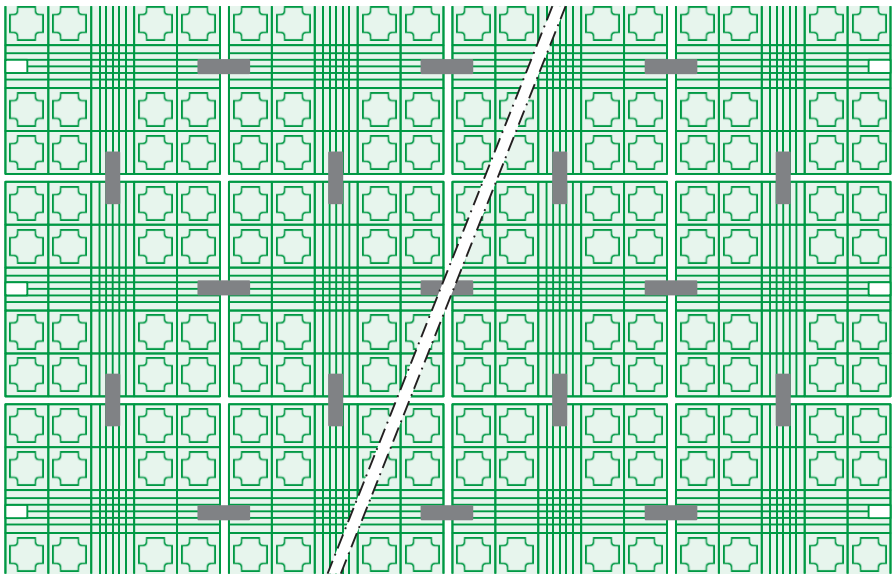
Use connectors to secure modules in position during installation. Install connectors according to the diagram below.

Single-layer connector for installation in the roof slab of half-/single-layer systems

Multiple-layer connector for installation in multiple-layer systems between different layers, for connecting layers with each other

Determination of requirements

Connector		Application	Requirement	
Single-layer		for half-layer/single-layer installation	requirement for **single-row** installation	1 pc(s). per module
			requirement for **multiple-row** installation	2 pc(s). per module
Multiple-layer		for multiple-layer installation, between the layers	requirement for **2-layer** installation	1 pc(s). per module
			requirement for **3-layer** installation	1.3 pc(s). per module

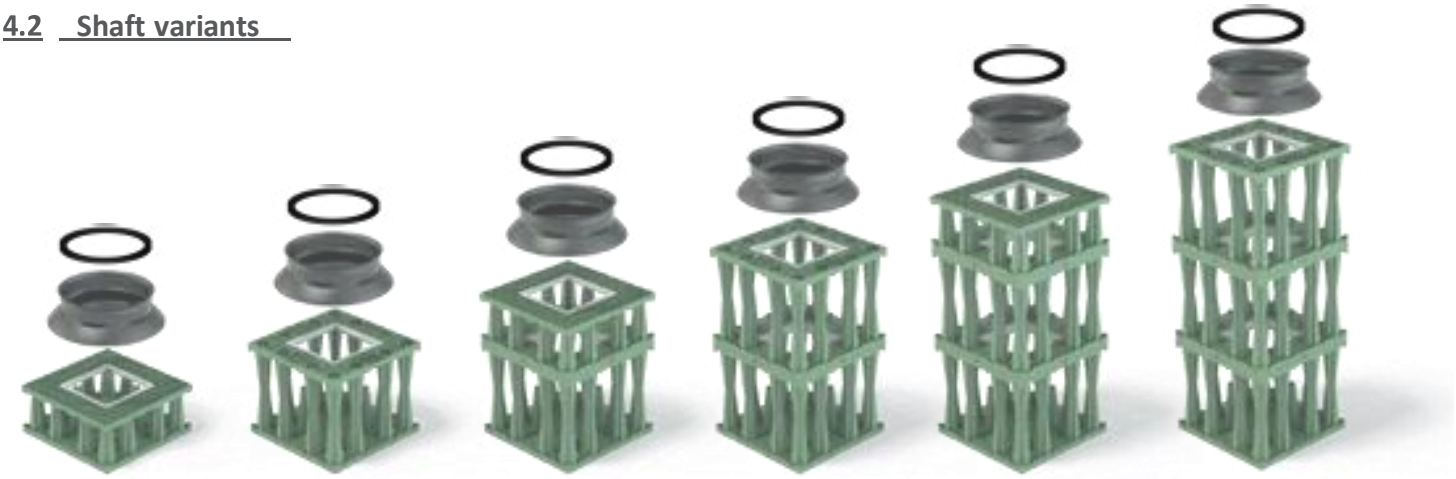


4 Quadro®Control ST – shaft elements

4.1 Delivery

The components of the QuadroControl ST shaft are delivered to the site pre-assembled and packed on a pallet.

4.2 Shaft variants



1/2-layer 1- layer 1 1/2-layer 2- layer 2 1/2-layer 3- layer

Product		Cone	Profile sealing ring for extension pipe	Shaft half element	Shaft roof slab with frame	Half element
		pc(s).	pc(s).	pc(s).	pc(s).	pc(s).
QuadroControl ST-A 1/2	51504005	1	1		1	1
QuadroControl ST-A 1	51504010	1	1	1		1
QuadroControl ST-A 1 1/2	51504015	1	1	2	1	1
QuadroControl ST-A 2	51504020	1	1	3		1
QuadroControl ST-A 2 1/2	51504025	1	1	4	1	1
QuadroControl ST-A 3	51504030	1	1	5		1
QuadroControl ST-A 3 1/2	51504035	1	1	6	1	1
QuadroControl ST-A 4	51504040	1	1	7		1
QuadroControl ST-S 1/2	51504205	1	1		1	1
QuadroControl ST-S 1	51504210	1	1	1		1
QuadroControl ST-S 1 1/2	51504215	1	1	2	1	1
QuadroControl ST-S 2	51504220	1	1	3		1
QuadroControl ST-S 2 1/2	51504225	1	1	4	1	1
QuadroControl ST-S 3	51504230	1	1	5		1

4.3 Installation of shaft elements

The basis of a QuadroControl ST shaft – no matter the design – is always a closed half element, as used in a Rigofill ST-A module. In the following, special shaft elements with recess and metal frame are positioned.

The shaft cone always forms the upper end of each shaft.
The cone will later form the transition from the shaft to the extension pipe.

Shaft design

The normal shaft design consists of shaft half elements with recess and a metal frame (except the closed half element forming the base).

The shaft half element can be rotated 180° like a normal half element – when put together, two half elements form a full layer.

Shaft design half-layer

Use the shaft roof slab with frame for half-layer shafts.

ATTENTION

Half-shaft on top (open at the bottom)

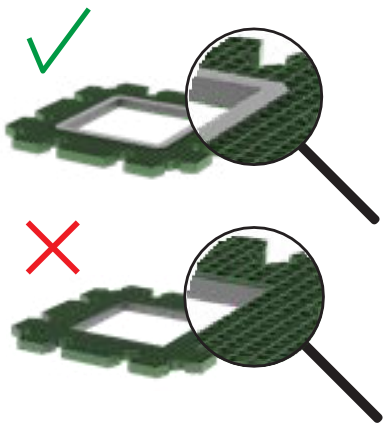
ATTENTION

QuadroControl 1/2-layer

Shaft design with supporting grid

Proper installation is mandatory for systems with supporting grids due to reasons of stability. For QuadroControl ST shafts with an integrated supporting grid, this must be placed between the half elements beforehand.

Supporting grid



NB

During installation, make sure that the metal frame integrated in the supporting grid faces upwards.

The shaft is constructed layer by layer and it grows as construction of the unit progresses. The installation of the bottom layer of the QuadroControl ST shaft always starts with connecting the half element and the shaft half element.

Install the shaft bottom in the intended position in the layout. Please ensure that the opening with the metal frame faces upwards. Use connectors to connect to the adjacent Rigofill modules.

Additional complete layers

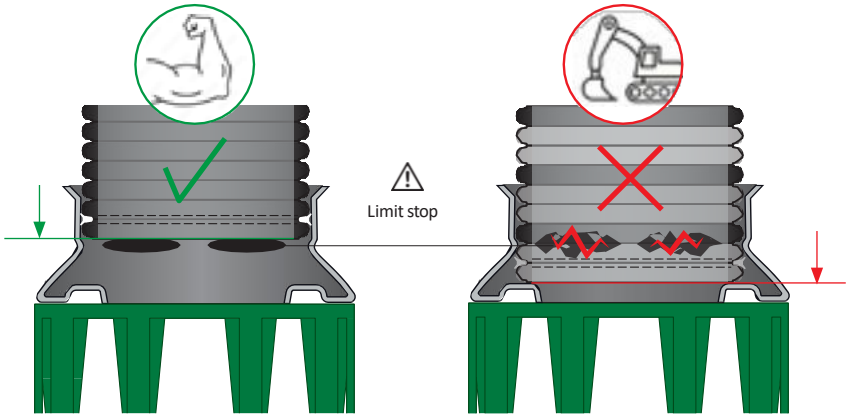
Each of these layers is made of two shaft half elements combined. Place the shaft components onto the already existing shaft bottom using multiple-layer connectors.

How to place cones

Regardless of the number of layers, the couple cones provide the transition to the extension pipes. The couple cones are preferably to be put on the shaft openings only after the upper system layer has been completed. Before installing the couple cones, the entire storage/infiltration system incl. shafts must be covered with the wrapping geotextile. The geotextile must be cut out at the square openings.

Installation of extension pipes

The extension pipes are inserted into the cone coupling by means of sealing rings included in the delivery (please use lubricant). Prior to that, profile sealing rings must be placed into the **first** corrugation trough of the extension pipes. Make sure that the extension pipes are installed upright and do not shift during compaction.



ATTENTION

Mount the sealing ring onto the first corrugation trough. Make sure that the extension pipe is only inserted up to the limit stop (use lubricant).

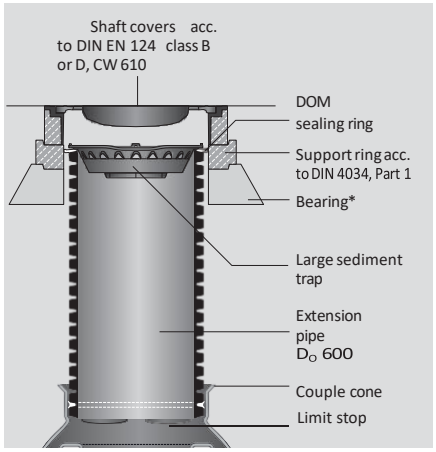
4.4 Temporary construction site covers

Extension pipes are delivered with temporary construction site covers. They are used to prevent backfill or other dirt from entering the shafts during installation. The construction site cover is not accessible and may not be trafficked! Do not remove temporary construction site covers before installing permanent shaft covers.

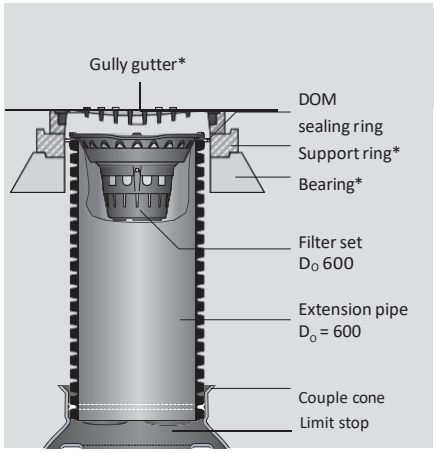
Purpose of temporary construction site covers when backfilling

Temporary construction site cover for extension pipes

4.5 Shaft covers



Shaft cover on the shaft (e.g. inspection shaft)
* to be supplied on site



Gully gutter on the shaft
(e.g. swale emergency overflow)
* to be supplied on site

DOM sealing ring

After installing the cover (see next Section), shaft covers can be placed. Cut the extension pipe D_O 600 such that it reaches the support ring. The gap between the support ring and the shaft cover must be sealed using a DOM sealing ring. Mount the sealing ring onto the last corrugation of the extension pipe. Place a sediment trap D_O 600 on the extension pipe. If, according to the design specifications, the shaft must feature a gully gutter, place the filter set D_O 600 on the extension pipe.

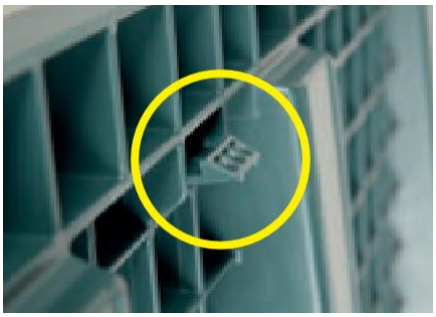
Shaft covers or gully gutters and concrete support rings are not included in the scope of delivery and must be supplied on site. Shaft covers must be carried out and installed according to planning specifications. The inside diameter must be at least 610 mm.
Shaft covers must be suitable for the expected traffic loads. If national guidelines such as EN 124 are applicable, they must be observed.

Put a support ring h = 100 mm on an appropriate bearing under the shaft cover/gully gutter.
Create the bearing from compacted bearing layer material or in-situ concrete C 16/20.

Avoid interlocking of the bearing with the corrugations of the extension pipe (use casing aid!). Vertical loads may only be transferred to the load-bearing underground.

5 Final installation steps

5.1 Installing sidewall grids



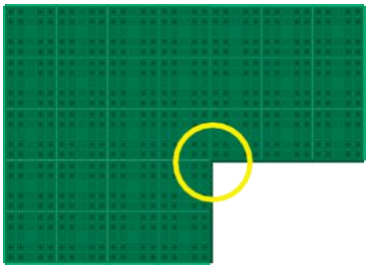
Use sidewall grids to cover tunnel ends of the storage/infiltration system. Place the sidewall grid in the centre. Pressing the sidewall grid is enough to connect the module tight using four locking pins.

Depending on on-site requirements, the installation of the sidewall grids can already take place outside the excavation pit.

ATTENTION

If there is enough space, the installation of all sidewall grids can alternatively be carried out after the installation of modules has been completed.

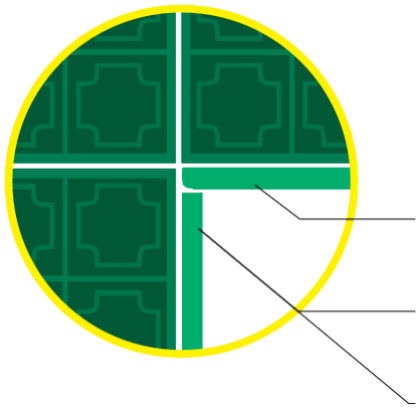
Similar application with sidewall grid/half block.



Special quality: inside corner

NB

In storage/infiltration designs with inside corners, shortened sidewall grids are used at one side.



Rigofill ST-S sidewall grid

Cat. no. **51994200**

Rigofill ST-S sidewall Cat. grid, short

no. **51994210**

Rigofill ST-S half block sidewall grid, short Cat.

no. **51994211**

Rigofill ST-A sidewall grid

Cat. no. **51994000**

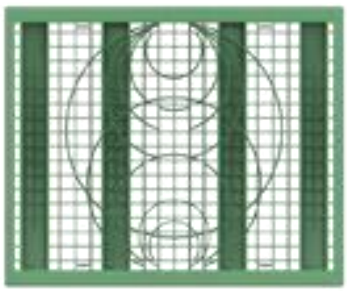
Rigofill ST-A sidewall grid, short Cat.

no. **51994010**

Rigofill ST-A half block sidewall grid,

short Cat. no. **51994011**

5.2 Cutting openings in sidewall grids



Module layers	Connection height
1/2-layer	0.04 m
1-layer	0.04 m
1 1/2-layer	0.70 m
2-layer	0.70 m
2 1/2-layer	1.36 m
3-layer	1.36 m
3 1/2-layer	2.02 m
4-layer	2.68 m

Connection heights (independent of nominal diameter) from the swale bottom

To directly connect supply pipe and drain pipe, the sidewall grids have pre-marked circles for solid wall pipes with nominal diameters of DN/OD 110 to 500 (DN/OD 110 to 250 for sidewall grid/half block).

NB

We recommend using a jigsaw.

5.3 Inserting adapters DN 315 / DN 400 / DN 500

NB

An angular grinder is best suited for cutting. Please cut approx. 1 cm from the edge to maintain the insertion chamfer. Mount the prepared adapter to the module just like a sidewall grid and secure it using an adapter fastener.

The adapter must be cut to the nominal diameter according to planning specifi- cations. You can establish pipe connec- tions directly to the KG spigot using a KG coupling.

The pipe DN 315 can be connected directly. The adapter can be installed at soil level or turned by 180° at crown level.

5.4 Creating geotextile wrapping

Rigofill systems must be wrapped completely in geotextile. At the edges, sufficient overlapping shall be provided (at least 50 cm) to make sure no backfill material enters the system. Produce sand-tight pipe inlets by cross-shaped cutting of the geotextile.

ATTENTION

Ensure that the geotextile surface is completely closed leaving no gaps even during backfilling!

5.5 Lateral backfilling

⚠ CAUTION

Compacting using vibratory rollers and explosion rammers is not permissible!

Connectors secure the individual Rigofill modules and prevent the storage/infiltration system from shifting during backfilling. Use non-cohesive, non-frozen earthwork material with a maximum grain size of 32 mm for backfilling. Distribute the backfill material evenly and compact it in layers of max. 30 cm using a light or medium compacting machine (area vibrator or vibratory rammer). In doing so, a compaction level D_{pr} of larger than or equal to 97 % should be achieved. The modules must NOT be damaged. National guidelines for earthworks (such as ZTV E-StB) must be adhered to.

Make sure that the geotextile overlapping is not pulled apart during backfilling and compacting and that the Rigofill modules are not damaged!

The permeability of the backfill must at least correspond to the permeability of the backfill soil.

5.6 Creating cover SLW 60/HGV 60

The storage/infiltration system must be covered according to design specifications. Non-cohesive, compactable graded earthwork material with a maximum grain size of 32 mm should be used for the cover, which is a mandatory requirement under traffic areas! **Frozen soil is not permissible!** Additionally, national guidelines for earthworks (such as ZTV E-StB) apply here as well.

Rigofill ST-A
SLW 60 / HGV 60

Stability analysis

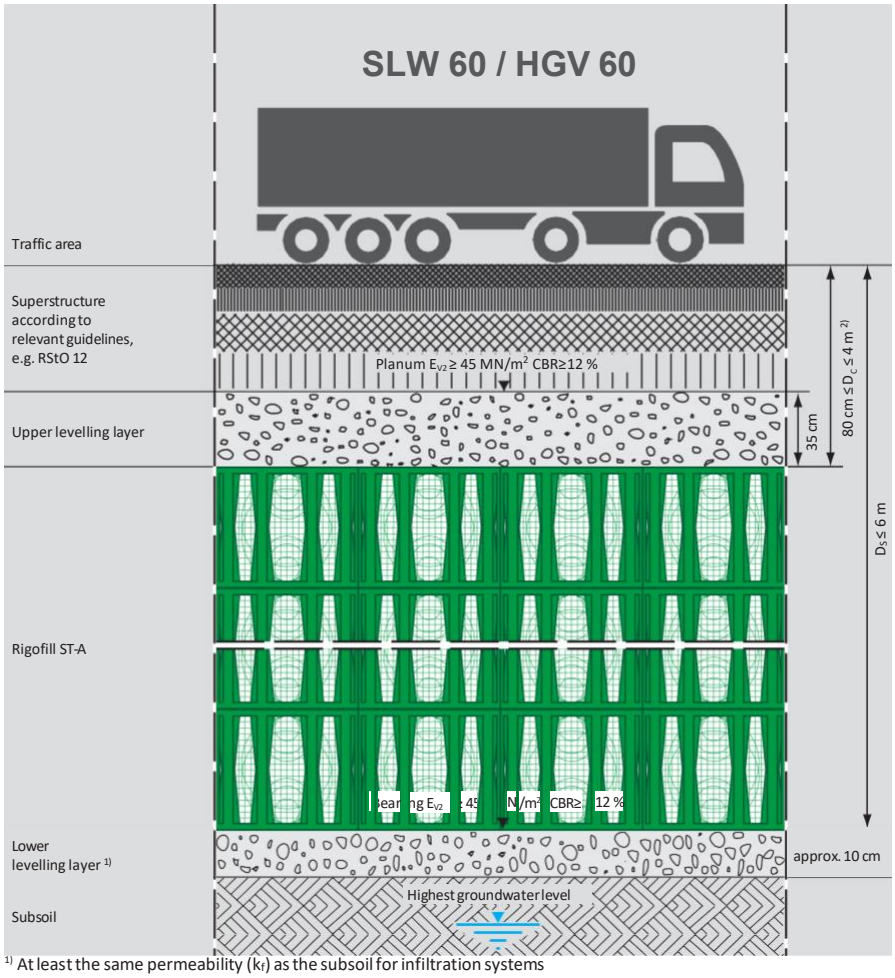
Storage/infiltration systems are subsoil structures and must have sufficient load-carrying capacity against impacting soil and traffic loads. The stability must be proven according to Eurocode, taking into account partial safety factors and/or limiting factors. With conventional installation parameters*, depths of cover of D_C of max. 4 m and soil depths of D_S of max. 6 m are possible for infiltration systems. A project-specific stability analysis can be prepared by Tricel. Under traffic areas, a minimum cover D_C of 80 cm must be observed.

* HGV 60; specific weight of soil 19 kN/m³; friction angle 30°; K = 0.3; mean soil temperature 23 °C

ATTENTION

Note for groundwater over structure soil: **Rigofill ST-A** systems, which are used as watertight storage systems with impermeable membranes, have been designed for application above the highest groundwater level. Use in groundwater is possible under corre- sponding technical conditions after consultation with Tricel. Please contact us!

Standard installation under a traffic area



¹⁾ At least the same permeability (k_f) as the subsoil for infiltration systems

²⁾ Lower cover upon request

National guidelines, e.g. RStO 12, must always be observed for installation under traffic areas. To build the planum for the subsequent road construction, an upper levelling layer must be provided, preferably a gravel sub-base with a thickness of at least 35 cm, which depends on the required modulus of deformation. Other construction materials normally lead to greater carrier layer thicknesses.

Unless defined otherwise by national guidelines, at the surface of the cover (= planum), a uniform modulus of deformation E_{V2} ≥ 45 MN/m² or CBR ≥ 12 % must be achieved. Other required moduli of deformation lead to greater or smaller thicknesses of the upper levelling layer.

Soil layers must always be provided and compacted in layers of no more than 30 cm. The compaction level D_{pr} should be larger than or equal to 97 %.

Carry out compacting using light or medium area vibrators only!

⚠ CAUTION

Compacting using vibratory rollers and explosion rammers is not permissible!

5.7 Creating cover SLW 60/HGV 60

The storage/infiltration system must be covered according to design specifications. Non-cohesive, compactable graded earthwork material with a maximum grain size of 32 mm should be used for cover, which is a mandatory requirement under traffic areas! **Frozen soil is not permissible!** Additionally, national guidelines for earthworks (such as ZTV E-StB) apply here as well.

Rigofill ST-S
SLW 60 / HGV 60

Stability analysis

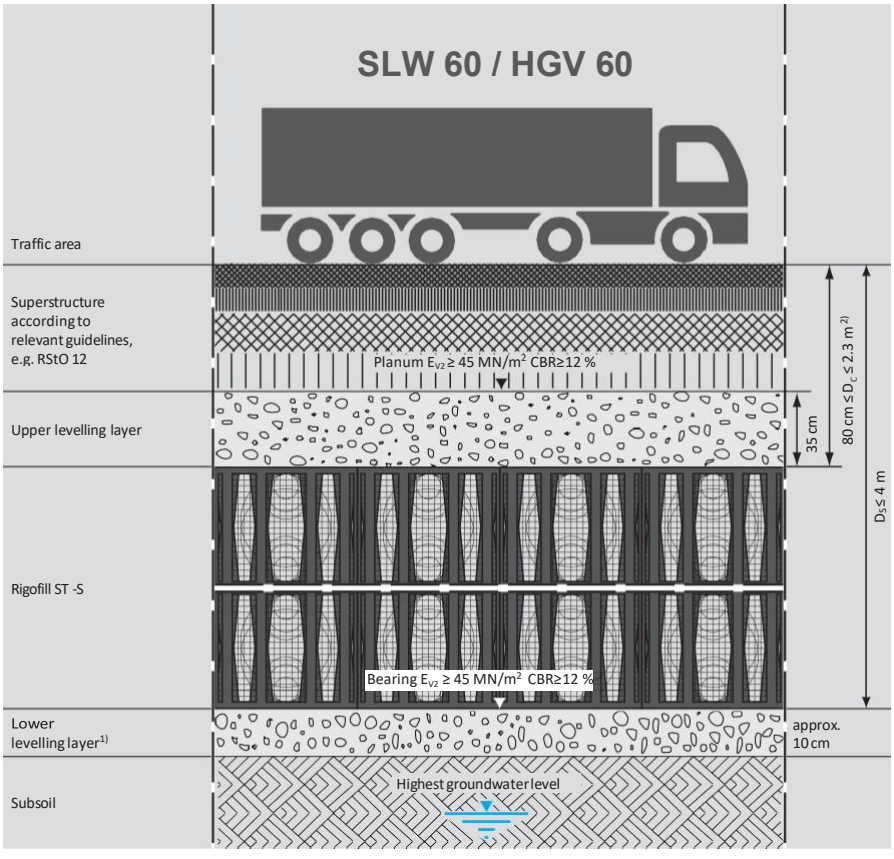
Storage/infiltration systems are subsoil structures and must have sufficient load-carrying capacity against impacting soil and traffic loads. The stability must be proven according to Eurocode, taking into account partial safety factors and/or limiting factors. With conventional installation parameters*, depths of cover of D_C of max. 2.5 m and soil depths of D_S of max. 2,30 m are possible for infiltration systems. A project-specific stability analysis can be prepared by Tricel. Under traffic areas, a minimum cover D_C of 80 cm must be observed.

* HGV 60; specific weight of soil 19 kN/m³; friction angle 30°; κ = 0.3; mean soil temperature 23 °C

ATTENTION

Note for groundwater over structure soil: **Rigofill ST-S** systems, which are used as watertight storage systems with impermeable membranes, have been designed for application above the highest groundwater level.
Use in groundwater is possible under corresponding technical conditions after consultation with Tricel. Please contact us!

Standard installation under a traffic area



National guidelines, e.g. RStO 12, must always be observed for installation under traffic areas. To build the planum for the subsequent road construction, an upper levelling layer must be provided, preferably a gravel sub-base with a thickness of at least 35 cm, which depends on the required modulus of deformation. Other construction materials normally lead to greater carrier layer thicknesses.

Unless defined otherwise by national guidelines, at the surface of the cover (= planum), a uniform modulus of deformation E_{V2} ≥ 45 MN/m² or CBR ≥ 12 % must be achieved. Other required moduli of deformation lead to greater or smaller thicknesses of the upper levelling layer.

Soil layers must always be provided and compacted in layers of no more than 30 cm. The compaction level D_{pr} should be larger than or equal to 97 %.

Carry out compacting using light or medium area vibrators only!

[1] At least the same permeability (k_f) as the subsoil for infiltration systems

[2] Lower cover upon request

⚠ CAUTION

Compacting using vibratory rollers and explosion rammers is not permissible!

5.8 Use of construction vehicles during installation

⚠ CAUTION

It is not permissible to drive construction vehicles directly on the modules!

Use of vehicles when applying the first cover layer:

The first cover layer can be applied, for example, using a wheel loader or a front-type mobile excavator. For a wheel loader or mobile excavator with a maximum total weight of 15 tons (chain, 4 wheels, twin-tyres), a compacted cover of at least 30 cm must be placed over the storage/infiltration system. Possible formation of ruts must be taken into account! Avoid steering manoeuvres at this construction stage.

Use of construction vehicles

Driving over the cover with heavy construction vehicles with a wheel load of up to 50 kN (e. g. HGV 30) is possible if the thickness of the compacted cover is not less than 60 cm. Possible formation of ruts must be taken into account!
When dumping the earthwork material, the wheel load of 50 kN must not be exceeded; if necessary, load distribution plates must be used.

6 Waterproof systems

Applications

- Stormwater retention
- Stormwater harvesting (tank)
- Fire water storage
- Combined applications

Modular reservoir construction for many applications

When using Rigofill for stormwater storage, the system can be wrapped in impermeable plastic foil. Please observe the manufacturer's specifications when installing the impermeable plastic foil.

In addition to the static verification, uplift verification is required in case of groundwater. Dewatering measures are to be checked and, if necessary, provided during construction in order to prevent upwards floating of watertight systems if these are not yet sufficiently covered.

Follow the steps described in this manual to install the modules.
Install and weld the impermeable membrane and execute the impermeability test of individual weld seams according to the instructions of the manufacturer/installer.

7 Contact and service

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Notes

8 Safety instructions

ATTENTION

Staff responsible for installation, assembly, operation, maintenance and repair must have appropriate qualifications required for this kind of work. The builder is responsible for organising in detail authority, responsibility and supervision of staff.

The operational safety of the system components supplied is only guaranteed in case of proper installation and correct use. Technical threshold values must not be exceeded.

Observe the accident prevention regulations and relevant standards and directives for installation, fitting, operation, maintenance, and repair of systems, pipes, and shafts!

These are inter alia (in extracts):

- Accident prevention regulations
  - Construction work BGV C22 *(Bauarbeiten BGV C22)*
  - Technical wastewater systems GUV-V C5 *(Abwassertechnische Anlagen GUV-V C5)*
- Safety regulations for working in enclosed spaces of technical wastewater systems GUV-R 126
  (Sicherheitsregeln für Arbeiten in umschlossenen Räumen von abwassertechnischen Anlagen GUV-R 126)
- Handling biological working materials in technical wastewater systems GUV-R 145
  (Umgang mit biologischen Arbeitsstoffen in abwassertechnischen Anlagen GUV-R 145)
- Directives for working in tanks and narrow spaces BGR 117
  (Richtlinien für Arbeiten in Behältern und engen Räumen BGR 117)
- Standards
  - Excavations and trenches – Slopes, planking and strutting, breadths of working spaces DIN 4124
    (Baugruben und Gräben-Böschungen, Verbau, Arbeitsraumbreiten)
  - Construction and testing of drains and sewers DIN EN 1610
    (Verlegung und Prüfung von Abwasserleitungen und -kanälen)
- Tool for safety and health protection in technical wastewater systems

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⚠ WARNING

- Hazards from gases and vapours such as risk of suffocation, risk of poisoning and risk of explosion
- Risk of falling
- Risk of drowning
- Germ pollution and wastewater with sewage
- High physical and psychological stress during work in deep, narrow and dark spaces
- And others

⚠ DANGER

Non-compliance with the operating manual may result in considerable property damage, injury or death.

⚠ CAUTION

The systems, pipes and shafts are part of an entire network.
During installation, maintenance, service and repair work, always consider the entire system. Avoid work during rain.

Changes or modifications may only be carried out with the agreement of the manufacturer. For safety reasons, use original spare parts and accessories approved by the manufacturer. The use of other parts voids the liability for any consequences arising therefrom.

General information on using our products and systems:

Information about or assessments of the use and installation of our products and systems are exclusively provided on the basis of the information submitted. We do not assume any liability for damage caused by incomplete information. If the actual situation deviates from the planned situation or if a new situation occurs or if different or new installation techniques are applied, these must be agreed upon with TRICEL, since these situations or techniques may lead to different conclusions. Notwithstanding the above, the customer is solely responsible for verifying the

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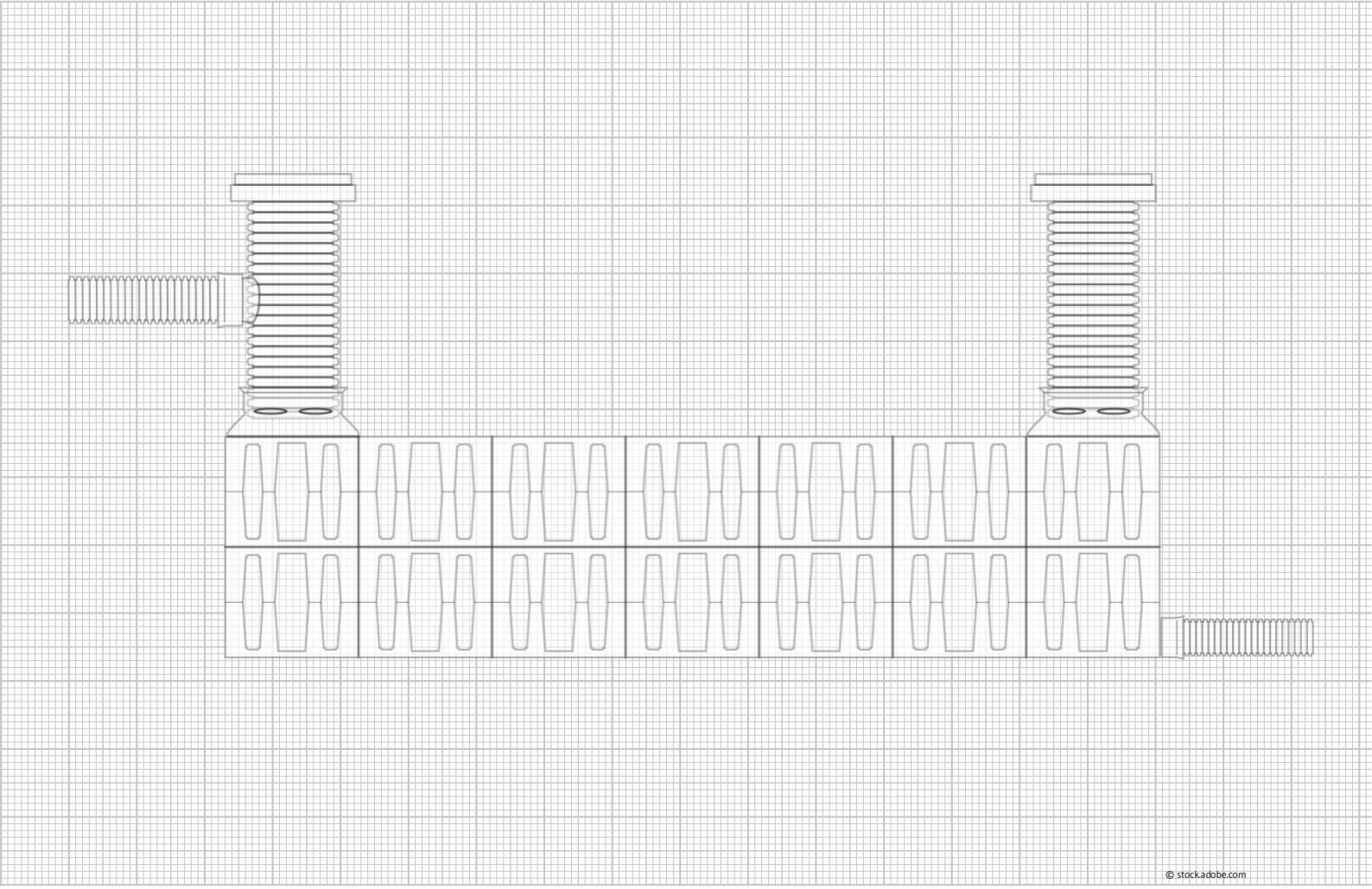

TRICEL
GENERATIONS OF INNOVATION

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For more information or to receive a quote, contact your Tricel's representative.

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