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# The Bentonite Construction Waterproofing Manual



The *original* needlepunched membrane for waterproofing



[www.naue.com](http://www.naue.com)



## Introduction

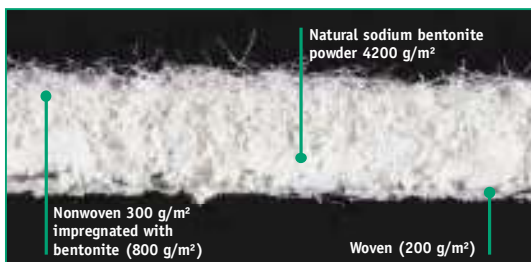
Whilst being a vital element necessary to sustain life, water can also have highly detrimental effects on the structures built by man. This phenomenon of being both life-sustaining and detrimental to our environment makes water a medium which we must consider very carefully with regard to engineering applications. Whether we need to take measures to contain and conserve it or protect against it, water is a valuable and irreplaceable natural resource.



In modern times, our respect for nature goes further-than-ever beyond the balance between social development and technological progress. Companies dealing within this sector must consider these aspects, with knowledge and experience being the driving force behind balancing social, environmental and economic

considerations. The development and constant growth in sales of our sealing product, **BENTOFIX®** is based upon the observance of these essential requirements. Innovative and dynamic, Naue Fasertechnik have become a leading force in hydraulic containment, providing sealing systems which have been used in a multitude of engineering applications by consulting companies and public authorities. We are able to offer full technical support from conceptual design through to installation, providing our clients with solutions through the use of our innovative products.

Cross-section of **BENTOFIX®** BFG 5000.



In 1987 **NAUE FASERTECHNIK** developed **BENTOFIX®**, a bentonite geosynthetic clay liner.

## The Effects of Water on Reinforced Concrete Structures

A well cast reinforced concrete element should be able to resist the penetration of water even under high water pressure, protecting its integral steel from corrosion. In reality, it is very difficult (even with most modern production plants) to produce such a perfect reinforced concrete mass, since the smallest inconsistency (such as aggregation of gravel) can cause imperfections in the concrete. Often, the water which penetrates into reinforced concrete is acidic and hence has an aggressive effect on the basic chemical elements of the concrete, as well as the steel reinforcement. This ultimately leads to the decay of the composite element. Small cracks can easily occur in the outer sections of a cast concrete mass during the curing period due to shrinkage. Concrete structures are also susceptible to cracking due to oscillations caused by traffic, as well as settlement of the underlying soil and natural phenomena such as earthquakes. The steel reinforcement, especially on the side adjacent to the outer surface, is particularly at risk from corrosion caused by the ingress of water via these cracks and via micro cracks by flexure of the element during its service life.

**BENTOFIX® BFG 5000** is a concrete sealing system which efficiently protects reinforced concrete structures, preventing the penetration of water and providing protection to the structure from attack by aggressive chemical substances present in the local surrounding soil.

## The Sealing System

The sealing technology of **BENTOFIX®** consists of two basic elements:

- natural sodium bentonite as the sealing material,
- robust geotextiles encapsulating and containing the bentonite.

Natural sodium bentonite is a naturally occurring material, which was geologically formed from volcanic ash approx. 100 million years ago. It originates mainly from the USA where the ash was deposited in the

oceans of that time. Being naturally formed, sodium bentonite is stable and provides predictable long-term performance. A special property of natural sodium bentonite is its ability to swell when it comes into contact with water, especially groundwater, which causes the dry clay to convert into an impervious gel. This, together with several other properties makes natural sodium bentonite the ideal material for the safe sealing of reinforced concrete structures.

Geotextiles play an important role in the sealing technology of **BENTOFIX**<sup>®</sup>. Upon contact with water, the volume of natural sodium bentonite enlarges by 18 times of its dry weight (approximate estimation). In order to benefit from this swelling process and hence gain the optimum sealing capacity, the bentonite must be contained from squeezing out of the sealing system. Geotextiles encapsulate the bentonite within millions of fibre bridges and prevent the bentonite gel (once hydrated) from extruding out of the composite synthetic liner. The correct installation between the reinforced concrete and the soil contributes to an efficient and permanent system.

Graphical scheme of the overlap of **BENTOFIX**<sup>®</sup> BFG 5000.

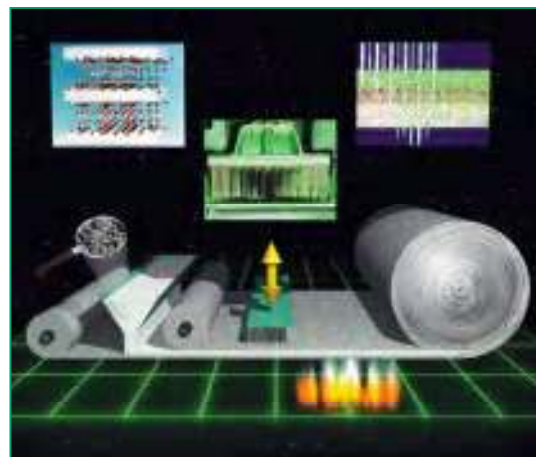


The key to the success of **BENTOFIX**<sup>®</sup> lies in the manufacturing process. Natural sodium bentonite is encapsulated within the void spaces of two geotextile layers in a special needle-punching process (produced under patent number EP 0 278 419 by **NAUE FASERTECHNIK**).

Water causes natural sodium bentonite to swell and transforms its consistency from a clay into a gel-like substance. Where a seal is required against a vertical face, such as a wall, bentonite will have the tendency to migrate due to the effects of gravity if it is not contained. Also, where flowing water is encountered, this may also cause the bentonite gel to migrate.

These and numerous other problems have been overcome with **BENTOFIX**<sup>®</sup>. Due to the patented process of needle-punching the sandwich of one layer of natural sodium bentonite between two geotextiles, the bentonite is retained in position by the labyrinth of fibre bridges formed during the manufacturing process.

The mechanical joining of the geotextiles used as containment layers and the overall robustness and stability of the composite **BENTOFIX**<sup>®</sup> product is ensured by needle-punching. Thousands of specially barbed needles penetrate through the mat in alternating upward and downward direction, forcing the fibres of the upper nonwoven geotextile through the bentonite layer and anchoring them in the retaining lower (carrier) woven layer. A synthetic fibre labyrinth is generated for the entire product in which the particles of bentonite are held in a stable position. In this process, 2 to 3 million fibres per m<sup>2</sup> are anchored and give the system a particular mechanical coherence. The protruding fibres on the woven geotextile side are then heat-treated which provides an additional resistance to bursting due to bentonite swell. The high quality natural sealing capacity of bentonite is maintained and also improved owing to the increased pressure generated in confining the swelling within the composite through the mechanical needle-punching of the geotextile layers. The result of this manufacturing process is a product that is able to contain the hydrated natural sodium bentonite, even when installed in a vertical position. Where flowing water is encountered, the bentonite is contained without being washed out, and counteracts against excessive elongation that could lead to a detrimental increase of the permeability.



Manufacturing process of **BENTOFIX**<sup>®</sup>.

Furthermore, the selection of the geotextiles used in manufacturing **BENTOFIX® BFG 5000** gives the sealing system flexibility, optimum mechanical and physical properties and allows a simple installation.

### .....Description of **BENTOFIX® BFG 5000**

Because reinforced concrete structures are porous by nature and are susceptible to cracking, natural sodium bentonite is an ideal sealing material due to its ability to swell when in contact with water, creating an impermeable barrier. The gel-like consistency of hydrated sodium bentonite allows it to mould to the profile of the reinforced concrete element, sealing small surface cracks as well as those occurring when the structure is in service. For this system to function correctly, it is essential that the bentonite barrier has direct contact with the reinforced concrete element it is protecting. So it prevents fluid flow between the element surface and the sealing system itself.

**BENTOFIX® BFG 5000** is ideally suited for waterproofing applications since the outer layer of the nonwoven geotextile is impregnated with an additional layer of natural sodium bentonite over its entire surface area. The product is installed with the nonwoven geotextile abutting the concrete element. This gives continuity and an intimate contact over the entire area where the bentonite meets the surface of the reinforced concrete structure. Once hydrated, the sodium bentonite impregnated into the outer surface of the nonwoven geotextile swells into small cracks or imperfections, sealing them from the ingress of water. Also, this ensures that all overlaps of the **BENTOFIX® BFG 5000** are sealed, even if panels are cut to size or trimmed to fit around protrusions. A special patented manufacturing process allows the stable encapsulation of bentonite powder inside the nonwoven pores.

**BENTOFIX® BFG 5000** uses powdered natural sodium bentonite which enables a homogeneous coverage of the concrete surface. The small particle size of the powdered bentonite reacts immediately to the presence of water, drastically reducing the activation time of the bentonite. On site this means an immediate waterproofing ability.

**BENTOFIX® BFG 5000** is a robust, weather resistant product which makes full use of the physical and mechanical properties of its component products. In addition to the excellent sealing properties of the sodium bentonite, a high puncture resistance and protection against mechanical damage occurring during installation on site are provided by the composite geotextiles.

Between the reinforced concrete and the backfill, usually no other protection is necessary.

The flexibility of the geotextiles allows **BENTOFIX® BFG 5000** to be used with almost all types of reinforced concrete profiles, ensuring a perfect seal to all edges and hollow spaces.



Although we recommend installing **BENTOFIX® BFG 5000** in a dry state, it has been used on many construction projects where the bentonite was hydrated before coming into contact with the structure or the soil. The needle-punched construction of the product prevents the bentonite from extruding out by confining the swelling within the composite liner. However major point pressures, such as foot prints should be avoided once the membrane is hydrated.



In a dry state, **BENTOFIX® BFG 5000** has a thickness of 6 mm. Once hydrated, the thickness of the product increases by approx. 4 to 5 mm after a few days of free swelling (not subjected to any confining stresses from external sources). Providing the product remains hydrated, this value does not vary over time.



**BENTOFIX® BFG 5000** is manufactured in three standard sizes and is delivered in rolls. Depending on the particular application, the choice of roll size allows simple on-site storage and handling. Full waterproof seals are achieved by simple overlapping, making installation quick and easy. The dimensions of the liners are as follows

**Micro liner (1.20 m x 2.42 m)**

installation overlap of 10 ÷ 15 cm

**Mini liner (2.42 m x 15 m)**

installation overlap of 15 ÷ 20 cm

**Maxi liner (4.85 m x 40 m)**

installation overlap of 20 ÷ 30 cm

**Micro liner:**

For backfill areas or vertical applications.

**Mini liner:**

For lining in areas with many obstructions or where access is restricted.

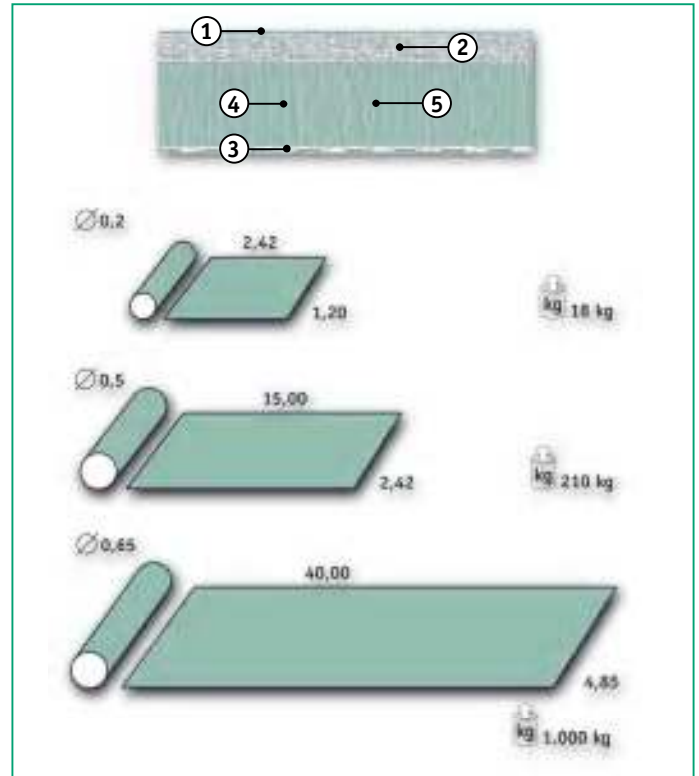
**Maxi liner:**

For lining large open areas such as horizontal floor slabs.

**BENTOFIX® BFG 5000** is manufactured by Naue Faser-technik under the ISO 9001 : 2000 quality control re-

gime. Under this scheme, all our manufacturing plants and products are subject to strict monitoring by internal and external bodies.

**The structure of BENTOFIX® BFG 5000**



- ① Natural sodium bentonite powder encapsulated in the upper nonwoven. This filling over the entire area allows the bentonite mass to achieve an intimate contact with the structure to be sealed. It is a unique and continuous layer with the bentonite contained between the encapsulating geotextile layers.
- ② Upper nonwoven made of polypropylene.
- ③ Lower supporting layer consisting of slit film woven made of polypropylene. This is the anchoring layer for the needle-punched fibres and gives the whole product remarkable mechanical properties.
- ④ Core layer made of natural sodium bentonite.
- ⑤ The bentonite intermediate layer is kept in position by the dense needle-punching, consisting of 2 to 3 million fibres per m<sup>2</sup>. The fibres are anchored from the nonwoven into the woven and thus form a sandwich system.

### The structure

The membrane consists of a continuous layer of natural sodium bentonite, sandwiched between a needle-punched nonwoven polypropylene (PP) geotextile (cover layer) and a slit film woven (PP) geotextile (carrier layer). The components are needle-punched uniformly together across the entire membrane. The cover layer of the membrane is filled during manufacture with the same bentonite as used in the core layer as an extra manufacturing process to facilitate impermeable overlap joints.

### Specification text

The sealing of „Project Name“ will be achieved by the use of a natural sodium bentonite geosynthetic clay liner. The membrane will be a composite needle-punched product consisting of a natural sodium bentonite impregnated upper geotextile overlying a carrier with a layer of powdered natural sodium bentonite sandwiched inbetween.

The bonding of the two geotextile layers shall be made by means of homogeneous dense needle-punching of the synthetic fibres which shall reach from the upper layer of the nonwoven into the lower supporting woven layer and shall be anchored by a heat treatment process. The needle-punching of the product will produce in excess of 2 million fibre bridges per m<sup>2</sup> between the woven and nonwoven geotextiles, providing high resistance to shear forces and ensuring that the hydrated bentonite is kept in a stable position when the product is installed in a vertical position. The synthetic materials encapsulating the bentonite must be chemically resistant to typical groundwater compositions and be non-biologically degradable in order to ensure the long-term stability of the sealing system. The average hydraulic conductivity 'k' of the membrane must be  $2 \times 10^{-11}$  m/s.

The upper geotextile should be manufactured from nonwoven needle-punched PP crimped fibres with an average mass per unit area of 300 g/m<sup>2</sup>, which is saturated with 800 g/m<sup>2</sup> of natural sodium bentonite throughout its cross section and over the whole surface area. The supporting lower layer shall be a woven geo-

textile made from slit-film PP with a average mass per unit area of 200 g/m<sup>2</sup>. The sealing layer shall be a natural sodium bentonite with a mass per unit area of 4,200 g/m<sup>2</sup> (total bentonite weight 500 g/m<sup>2</sup> at approx. 12 % water content).



### Application

**BENTOFIX® BFG 5000** can be used as water-stop protection on almost all types of reinforced concrete construction elements. It is particularly effective on foundation structures which are below the water table and hence subject to attack by groundwater.

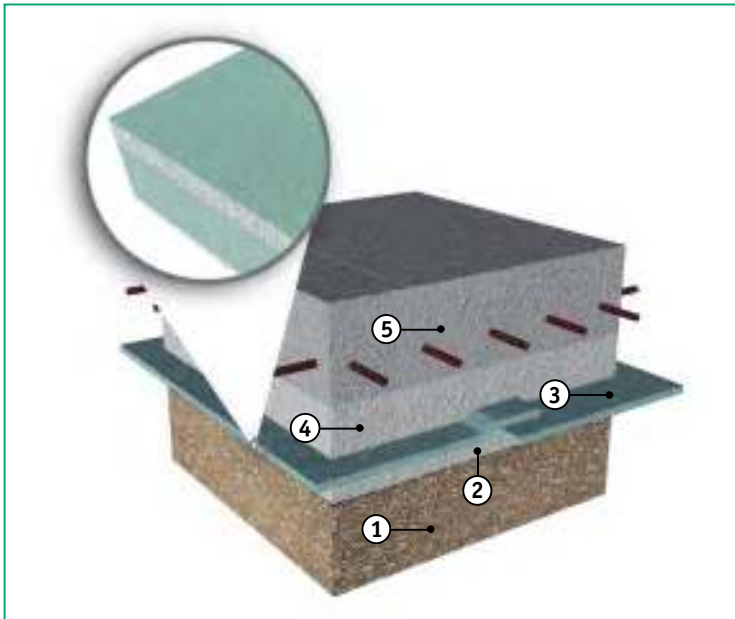
### Remarks

**BENTOFIX® BFG 5000** should only be installed where an intimate contact can be made on both sides (e. g. concrete on one side, soil on the other or concrete on both sides) of the membrane across its entire surface with the two media to be sealed. Natural sodium bentonite should only be hydrated with normal ground water. For applications where water with a high salt content or where highly contamination is present, please contact our technical office for advice.

### Quality controls

**BENTOFIX® BFG 5000** is manufactured under the ISO 9001 : 2000 scheme. As such, the product is subject to constant quality control carried out within the company and by third parties. Additionally, testing by independent testing laboratories ensures the highest quality of the product and adherence to the technical properties indicated by the manufacturer.

## Sealing of Reinforced Concrete Floor Slabs



- ① *Compacted and level subsoil.*
- ② *Optional lean concrete blinding layer, thickness variable from 4 to 6 cm, as alternative to lean concrete a sand or gravel layer may be used.*
- ③ **BENTOFIX® BFG 500**
- ④ *Optional lean concrete top-blinding protection layer, thickness variable from 4 to 6 cm, useful as a surface site traffic.*
- ⑤ *Reinforced concrete base slab.*



### Sealing of the floor slab

Following the required groundwork preparation ①, a blinding layer consisting of either lean concrete or sand or gravel ② can be placed. This layer usually has a thickness of approx. 5 cm and provides a level working platform for the placement of the waterproofing membrane. The completed platform should have a smooth surface and be free from any debris.

Onto this, **BENTOFIX® BFG 5000** ③ is installed by simply rolling out the product and trimming to fit. A water-tight seal will be achieved by overlapping the panels of the unrolled product to the manufacturer's recommendations. Care must be taken that the nonwoven geotextile (which is saturated with additional natural sodium bentonite) is facing upwards so that it will be in contact with the fresh concrete when it is poured.

After placement of the **BENTOFIX® BFG 5000**, an optional reinforced concrete blinding layer with a thickness of approx. 5 cm can be placed on top, creating a protective and level working platform to allow the erection of shuttering and steel fixing for the floor slab to commence.

Finally, the reinforced concrete floor slab (minimum 150 mm thickness) can be cast ⑤.

**BENTOFIX® BFG 5000** must be installed on flat smooth surfaces without the presence of wrinkles or folds in the product. Any traces of humidity or water stains visible on the surface do not affect the performance of the product, if strong point pressures are avoided.

Where **BENTOFIX® BFG 5000** is overlapped to produce a water-tight seal, the area of overlap should be clean and free from any debris. A minimum overlap of 10 cm should be used, however it is recommended that this figure be doubled for larger roll sizes (maxi liner) to safeguard the integrity of the impermeable barrier against the inaccuracies in placing the product on-site. The liners can be installed manually or by means of an approved spreader bar.

Planning should be given to the direction of overlaps, which should all run in a uniform direction. The concrete should then be placed on top of the membrane following the direction of overlapping. This removes the possibility of the slumping wet concrete from folding back the membrane panel and destroying the continuous impermeable layer.

Where construction joints are to be made above the membrane, the exposed sections of **BENTOFIX® BFG 5000** should be covered with a suitable weather resistant liner, protecting the membrane from premature hydration. Also, the protection liner should guard against accidental mechanical damage and site vehicles and personnel should be forbidden from trafficking this area. If continuing placement of membrane to a previously installed area, particular care should be taken to conform with the overlapping recommendations detailed above with regard to cleanliness of the product.

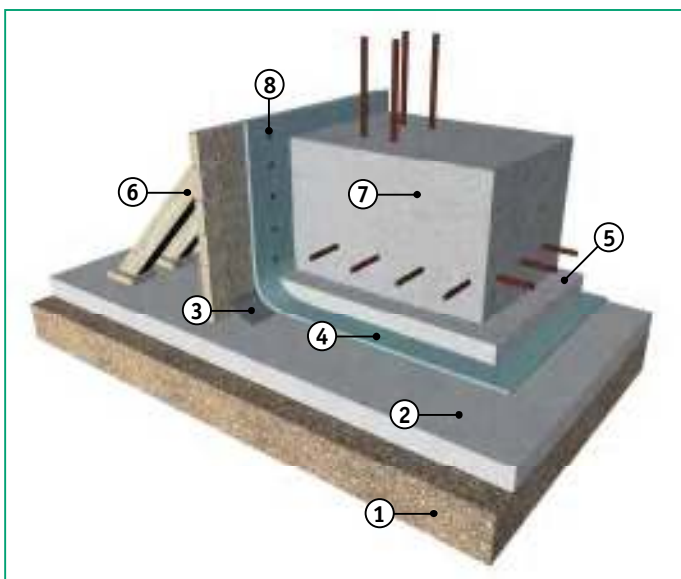
To provide the most efficient seal, it is recommended that the bentonite is kept dry until the placement of fresh concrete. This ensures that when the bentonite hydrates and hence swells, the weight of the overlying fresh concrete further confines the swelling providing a high pressure impermeable clay sealing barrier.

### Installation against shuttering

### Installation against shuttering

Where a transition between a horizontal and vertical surface is encountered such as a wall, the **BENTOFIX® BFG 5000** liner is installed horizontally under the floor slab then simply turned up by 90° and nailed to the side shuttering. If using flat head nails, it is important to remove the nail heads prior to casting the concrete element. This is so the nails can be removed either with the shuttering or from the shuttered side once the section of the structure is completed without damaging the tanking seal. Nails should only be used where the membrane is to be overlapped and should be used every 25 to 30 cm. This ensures that when the bentonite swells, it will seal the penetration of the nail through the membrane with a double layer.

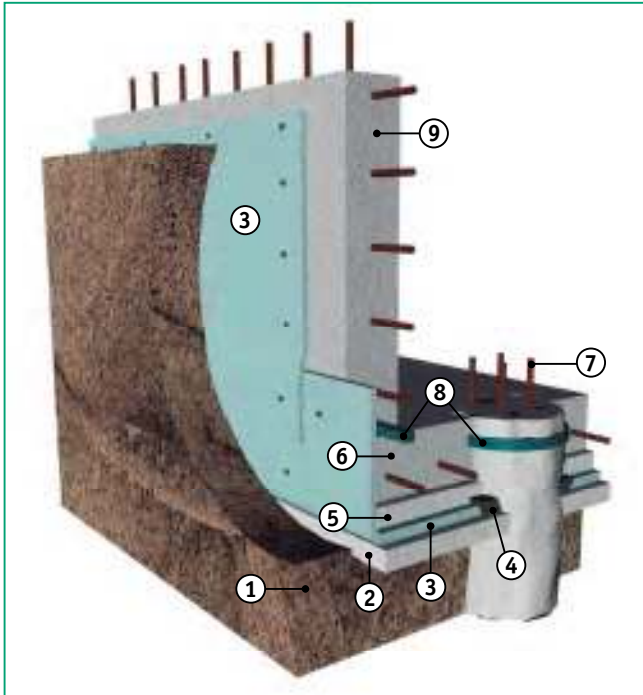
It is important to ensure that the membrane is properly overlapped to produce a water-tight seal. Sometimes, due to the geometry of the structure, it may be necessary to fill the area with natural sodium bentonite. This can be done with the bentonite in a dry condition or mixed with water in the following proportion: approx. 4 parts water, 1 part sodium bentonite powder.



- ① *Compacted and level subsoil*
- ② *Optional lean concrete blinding layer, thickness variable from 4 to 6 cm, as an alternative to lean concrete a sand or gravel layer may be used.*
- ③ *Sodium bentonite or approved fillet*
- ④ **BENTOFIX® BFG 5000**
- ⑤ *Optional concrete blinding protection layer*
- ⑥ *Shuttering*
- ⑦ *Reinforced Concrete Slab*
- ⑧ *Nails*



## .....Sealing of foundation piles



- ① Soil
- ② Optional lean concrete with the function to level the surface on which **BENTOFIX® BFG 5000** is installed
- ③ **BENTOFIX® BFG 5000**
- ④ Pre-swollen sodium bentonite around pile
- ⑤ Optional concrete top-blinding protection layer
- ⑥ Reinforced concrete pile cap
- ⑦ Steel reinforcement for e.g. connection wall
- ⑧ **BENTOSTRIP®** waterstop
- ⑨ Concrete wall

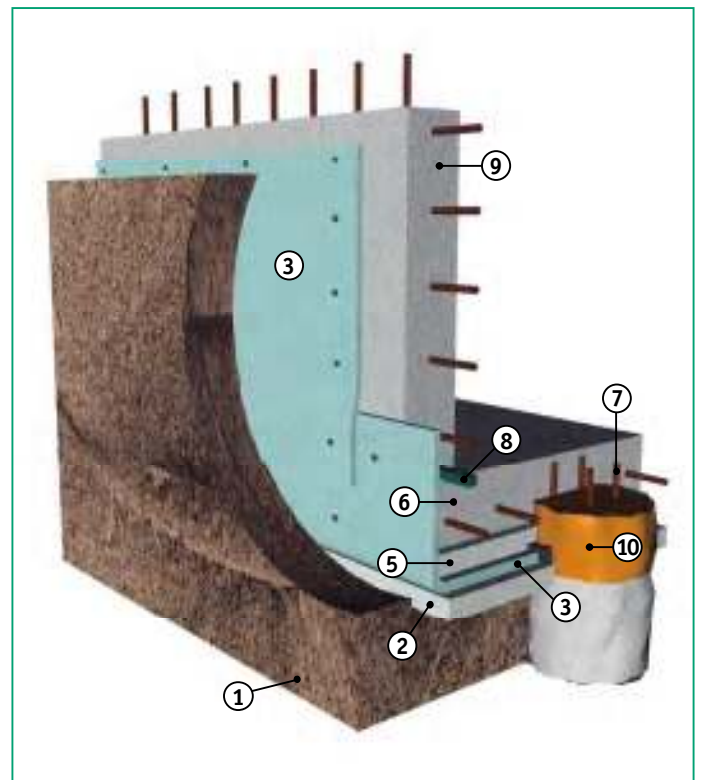


### Sealing of foundation piles

The area around the foundation piles to be sealed must be completely clean and free from any surface irregu-

larities. This surrounding area is then covered with sodium bentonite (4). A pre-trimmed **BENTOFIX®** panel is then slipped over the protruding steel reinforcement pile or is laid against the pile. It might be necessary to pull **BENTOFIX®** up the pile. Alternatively a waterproofing slurry (10) might be recommended.

It is important to check that no unsealed areas remain around the pile. Over the **BENTOFIX®** paste covered area, another micro liner or an accurately pre-trimmed membrane panel fixed with nails to the lower layer should be placed to protect the pre-hydrated sodium bentonite layer (4) from possible wash-out caused by the pouring of fresh concrete.

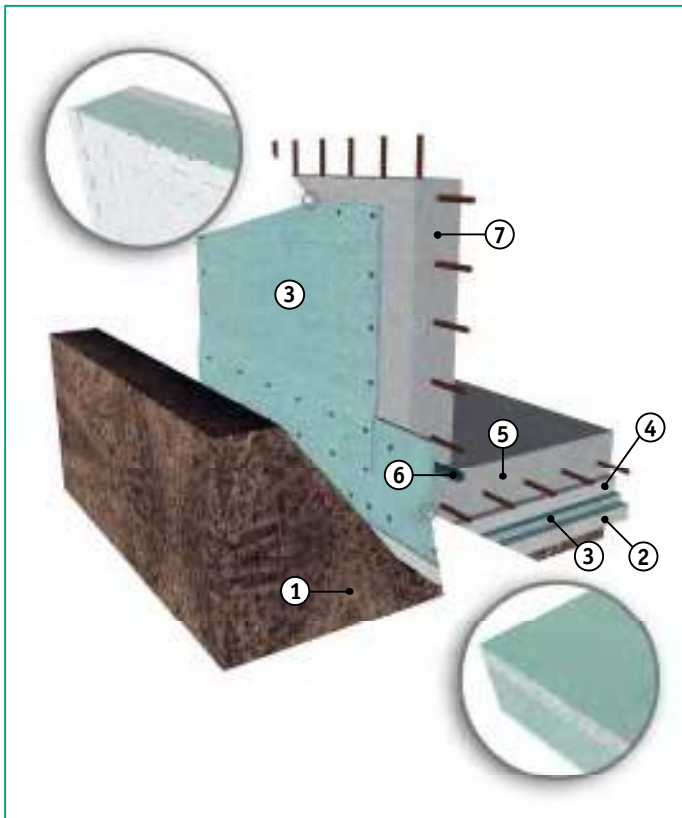


- ① Soil
- ② Optional lean concrete blinding layer
- ③ **BENTOFIX® BFG 5000**
- ⑤ Optional concrete top-blinding protection layer
- ⑥ Reinforced foundation
- ⑦ Steel reinforcement bars anchored in the pile
- ⑧ **BENTOSTRIP®** waterstop
- ⑨ Concrete wall
- ⑩ Waterproofing slurry



The bentonite powder (supplied in 30-kg-bags) is mixed with water in the ratio of approx. 4 parts water and 1 part sodium bentonite. This transforms the dry bentonite powder into a soft smooth gel-like consistency allowing easy handling and moulding for repairs and additional seals.

### ..... Installation on vertical walls



### Installation on vertical walls

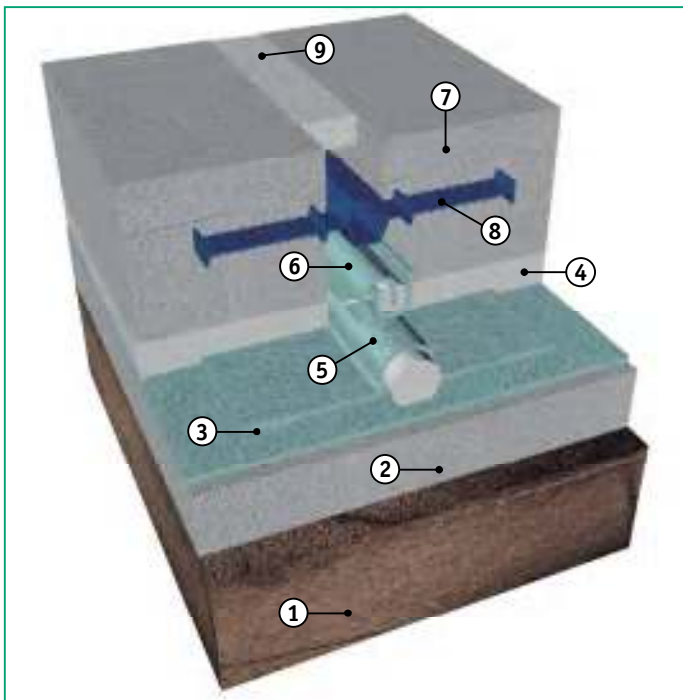
The installation of **BENTOFIX® BFG 5000** to vertical walls should - depending on the height of the walls - be carried out by using mini liners 1.20 m x 2.42 m, especially manufactured for this purpose, or by using micro liners sized 2.42 m x 15 m. Following completion of the reinforced concrete wall, the **BENTOFIX® BFG 5000** membrane should be attached to the wall face by nailing with soft washer fixings, ensuring that the natural sodium bentonite impregnated geotextile is placed against the soil side of the wall. The liners must have a minimum overlap of 10 cm and be nailed every 25 to 30 cm along the top edge within the overlap area to the reinforced concrete. It is not necessary to nail the remaining area of each liner. Nailing connections is permitted. The vertical liner overlaps must be flat and free from folds or wrinkles ensuring a good intimate contact with the concrete structure and the soil. The overlap of the membrane between the kicker and the wall must be a minimum of 35 cm, and this area must be nailed tightly. If necessary, an additional membrane sealing strip with a width of 40 cm can be used. This



- ① *Compacted and level soil*
- ② *Optional lean concrete blinding layer, thickness variable from 4 to 6 cm, as alternative to lean concrete a sand or gravel layer may be used.*
- ③ **BENTOFIX® BFG 5000**
- ④ *Optional concrete protection layer, for load distribution and support of the reinforcement in a thickness, variable from 4 to 6 cm, useful to facilitate site traffic.*
- ⑤ *Reinforced concrete base*
- ⑥ **BENTOSTRIP** waterstop
- ⑦ *Vertical wall*

should be placed directly over the construction joint, running parallel to it such that the overlap zones of the liners at the connection are sealed tightly. Each liner panel overlap should be placed in the form of roof tiles. The upper liner overlaps the lower. This prevents the penetration of soil into the overlap zones during back-filling of the wall. The back-fill soil must be free from any sharp or protruding object which could damage the membrane and should be compacted as tightly as possible against the structure. To prevent soil or other materials from damaging the installed liners, a 10 to 15 cm long wooden protection board can be fixed to the **BENTOFIX® BFG 5000** and can be anchored by nails 20 to 30 cm beneath the maximum height of the vertical sealing.

### Making of a horizontal expansion joint



#### Making of the horizontal expansion joint

The expansion joint must be sealed with an appropriate PVC waterbar (8) cast into the reinforced concrete or another approved system. Beneath the base plate where the connection piece ends, it is necessary to install a double layer of **BENTOFIX® BFG 5000** liner.

The upper layer with a length of 1 to 1.20 m has the shape of an omega which protrudes into the expansion joint (5).

The expansion joint must be filled with one or two strips of the membrane in order to prevent any ingress of water into the interior of the joint (6).

The strips of the membrane are nailed to the previously cast concrete section.

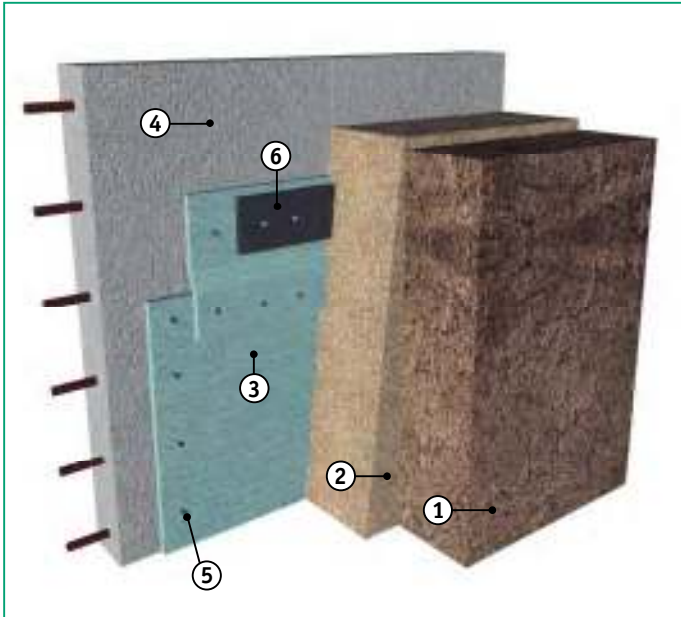
The upper sealing of the expansion joint is carried out with polystyrene (9).

If possible, a pre-hydrated bentonite paste with the ratio approx. 4 parts water and 1 part of sodium bentonite powder (which is e. g. supplied in bags with 30 kg each) can be used in the void of the expansion joint.

- ① Soil
- ② Optional lean concrete blinding, on which **BENTOFIX® BFG 5000** is laid.
- ③ Double-layered **BENTOFIX® BFG 5000**
- ④ Optional concrete layer for protection of **BENTOFIX® BFG 5000**
- ⑤ **BENTOFIX® BFG 5000**, which has been put up and protrudes into the joint area.
- ⑥ Strip of **BENTOFIX® BFG 5000**
- ⑦ Base plate/foundation plate
- ⑧ Waterbar
- ⑨ Polystyrene



## Termination Bar



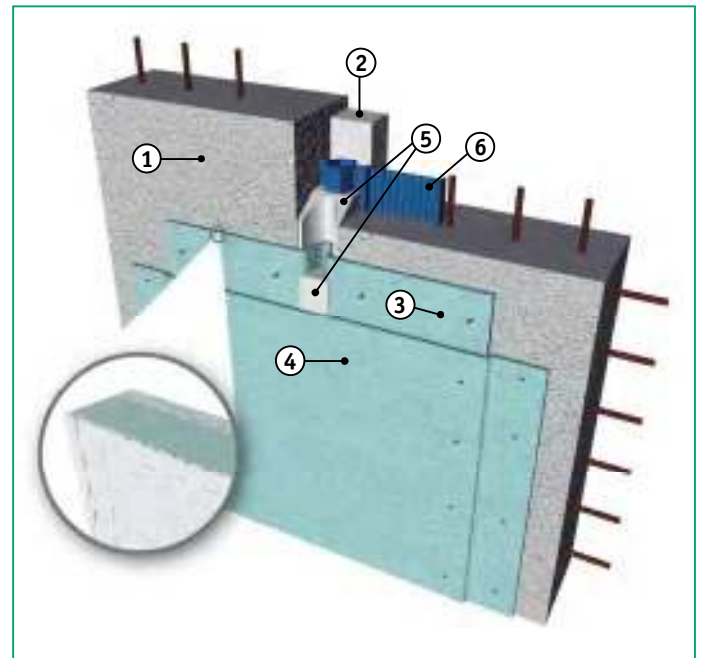
- ① Soil
- ② Drainage material
- ③ **BENTOFIX® BFG 5000**
- ④ Concrete wall
- ⑤ Nails
- ⑥ Termination Bar



## Termination Bar

To prevent the possible intrusion of soil or other materials between the panel edges of **BENTOFIX® BFG 5000** and the reinforced concrete structure, a protective cover element may be installed. This element should be attached to the structure slightly below the tanking line (10 to 15 cm) around the whole structure. It is common to use non-degradable boards or bars for this purpose.

## Sealing of expansion joints in vertical walls



- ① Vertical reinforced concrete wall
- ② Polystyrene filling
- ③ First **BENTOFIX® BFG 5000** liner
- ④ Second **BENTOFIX® BFG 5000** liner
- ⑤ Filling with pre-hydrated sodium bentonite
- ⑥ Waterbar

## Sealing of expansion joints in vertical walls

The expansion joint must be sealed with an appropriate PVC waterbar cast into the reinforced concrete or another approved system. On the outer side of the wall, it is necessary to install a double layer of **BENTOFIX® BFG 5000** liner.

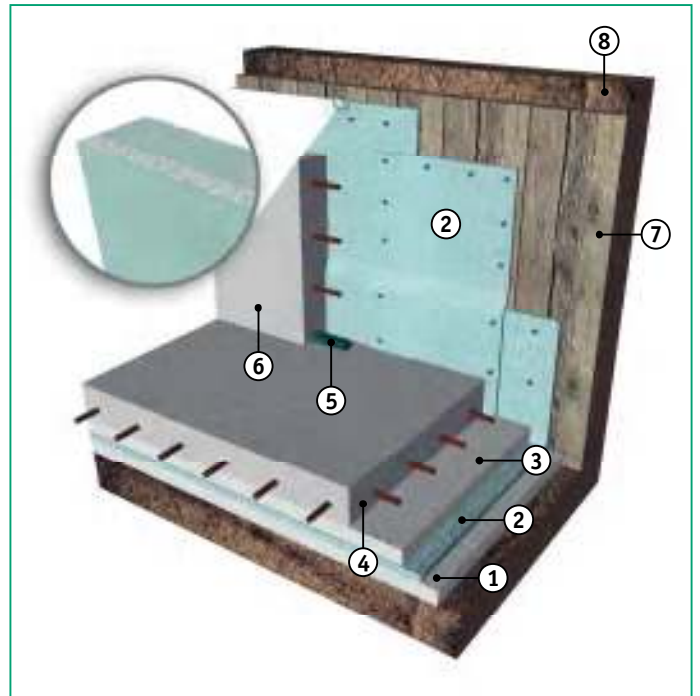
The inner layer with a length of 1 to 1.20 m has an omega shape which protrudes into the expansion joint.

The expansion joint must be filled with one or two strips of the membrane or bentonite paste in order to prevent any ingress of water into the interior of the joint.

The strips of the membrane are nailed to the concrete wall sections.



## Sealing of vertical walls against retaining structures



- ① *Optional lean concrete blinding layer*
- ② **BENTOFIX® BFG 5000**
- ③ *Optional concrete protection layer*
- ④ *Reinforced slab*
- ⑤ **BENTOSTRIP** waterstop
- ⑥ *Concrete Wall*
- ⑦ *Retaining Wall*
- ⑧ *Soil*

The inner sealing of the expansion joint is carried out with polystyrene ②.

If possible, a pre-hydrated bentonite paste with the ratio approx. 4 parts water and 1 part sodium bentonite powder (which is e. g. supplied in bags of 30 kg) can be used in the void of the expansion joint.

After **BENTOFIX® BFG 5000** has been installed in the expansion joints, the wall must be backfilled. The back-fill soil must be free from any sharp or protruding object which could damage the liner and should be compacted as tightly as possible.



### Sealing of vertical walls against retaining structures

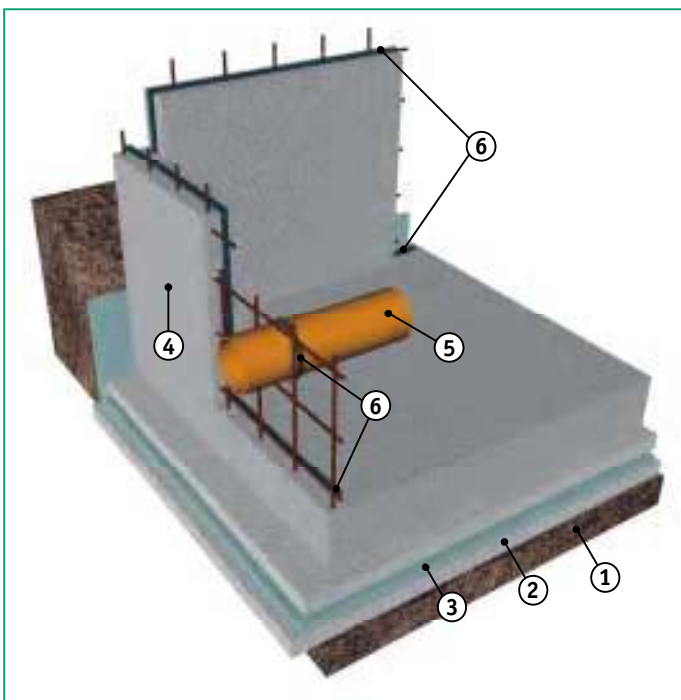
The sealing of reinforced concrete walls against retaining structures requires an application procedure which is carried out vice versa compared to a conventional sealing of walls standing against the soil.

Before the wall is constructed, it is necessary to fix **BENTOFIX® BFG 5000** directly onto the retaining wall. The nonwoven geotextile side of the GCL saturated with natural sodium bentonite must be installed against the fresh concrete side.

**BENTOFIX® BFG 5000** adjusts itself easily to the irregularities of the retaining wall due to its flexible nature and the tight fibre reinforcement. However, it would be useful to make the subsoil of the retaining wall as smooth as possible.

The nailing of the overlaps is carried out every 25 to 30 cm. It is important that the liners are installed evenly and have a good intimate contact within the overlap area.

### ..... BENTOSTRIP waterstop



### Hydro-expansive joint ribbons BENTOSTRIP

**BENTOSTRIP** is a waterstop joint ribbon used for sealing of concrete working joints and consists of 75 % natural sodium bentonite and 25 % butyl rubber. Upon contact with water **BENTOSTRIP** expands more than 400% providing a watertight seal. Because of its rubber/bentonite composition **BENTOSTRIP** remains flexible even at freezing temperatures up to minus 15°C. **BENTOSTRIP** resists chemicals such as fresh concrete. **BENTOSTRIP** is tested by the Laboratory of Concrete Research Magnel of the University of Ghent and is COPRO certified.

### Installation

**BENTOSTRIP** is positioned in the middle of the construction joint and fixed at 30 to 40 cm with steel nails. **BENTOSTRIP** can be protected with the metal fastening profile „Bentonet“ against damage by newly poured concrete or to reinforce the strip when installed vertically. **BENTOSTRIP** is applied to a dry and even surface. For uneven surfaces the **BENTOSTRIP** can be glued in place. Concrete cover of at least 75 mm is required. The ends of the **BENTOSTRIP** can be buttjointed.



- ① Soil
- ② Optional lean concrete blinding layer
- ③ **BENTOFIX® BFG 5000**
- ④ Concrete wall
- ⑤ Penetration
- ⑥ **BENTOSTRIP** waterstop

### Manufacturing and technical properties

**BENTOSTRIP** comes as a rectangular strip supplied in rolls of 10 linear metres. There are 4 rolls per box. The cross sectional dimensions of the joint ribbons are

25 mm x 19 mm. Pre-punched protection strips are supplied in 1 m lengths

**Specification text**

Delivery and installation of the hydro-expansive self-sealing joint ribbon, consisting of 75 % natural sodium bentonite and 25 % butyl rubber, suitable for sealing

of concrete working joints both in horizontal and vertical directions so that the best hydraulic performance of the product is ensured. The joint ribbon must be centered with regard to the structure and must be installed with a distance of not less than 75 mm from the outer margin of the wall on a homogeneous and smooth surface.



Transportation of a BENTOFIX® BFG 5000 maxi liner.



Unrolling of BENTOFIX® membrane on a base.



Vertical fixing of BENTOFIX®.



Vertical fixing of BENTOFIX® against a concrete face.



Steel reinforcement being placed in front of BENTOFIX®.



Waterproofing site with BENTOFIX®.



Sealed pipe penetration with BENTOFIX®.



Pouring of concrete over BENTOFIX®.

Further information on **Bentofix®** sealing systems are available through our website or from our:

- **corporate brochure**
- **application related brochures:**
  - Landfill engineering
  - Groundwater protection
  - Civil Engineering
  - Hydraulic Engineering
- **application related flyers and technical flyers with project specific solutions**



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