Installation Guideline

HUESKER
Ideen. Ingenieure. Innovationen.

NaBento®

1. General

These installation instructions apply to the use of all NaBento clay geosynthetic barriers (GBR-C) as sealing components in waterproofing systems for various applications. Exceptions to this guideline are possible through special regulations and approvals or suitability assessments.

NaBento is an industrially manufactured composite material consisting of outer geotextiles with a bentonite layer in between and a supporting geotextile that is frictionally bonded together by stitching.

The GBR-C is manufactured with either a roughened or smooth outer surface to ensure optimal bonding with the soil or geosynthetics it comes into contact with (IR types with a roughened outer surface, L types with a smooth outer surface). Calcium or sodium bentonite can be selected as the bentonite insert, with varying fill levels (suffix 'N' for sodium, suffix 'C' for calcium).

NaBento	Filling quantity [g/m²]	Bentonite	External appearance	Special features
L-N	4,500	Sodium	smooth	
IR-N	4,500	Sodium	rough	
IR-N (WB)	4,500	Sodium	rough	integrated root barrier to prevent root penetration, to improve resistance to drying out and the membrane protects against cement paste released from fresh concrete. The GTD is exposed to this cement paste when it comes into contact with fresh concrete.
L-C	10,000	Calcium	smooth	
IR-C	10,000	Calcium	rough	
IR-C (WB)	10,000	Calcium	rough	integrated root barrier to prevent root penetration, to improve resistance to drying out and the membrane protects against cement paste released from fresh concrete. The GTD is exposed to this cement paste when it comes into contact with fresh concrete.

The sealing effect is achieved through the absorption of water and swelling of the bentonite when subjected to load in its installed state. By combining it with other products, NaBento can be adapted to specific site conditions. For example, different geotextiles, as well as varying quantities of bentonite, can be used. In addition, variants with an integrated PE protective layer (designation '(WB)') are available to increase resistance to root penetration and drying out, and to protect against cement paste coming into contact with fresh concrete.

NaBento is manufactured by NaBento Vliesstoff GmbH in accordance with DIN EN ISO 9001-certified processes.

2. Packing, marking and transport to the construction site

NaBento is supplied in standard widths of 5.10 m or 2.55 m, rolled up to full width, fitted with a paper measuring tape and tightly packed in black PE film. Two labels in accordance with ISO 10320, containing product information and the CE mark (in accordance with DIN EN 13492 and 13493), are affixed to the packaging. The roll packaging is sealed with high-visibility adhesive tape bearing the warning 'Protect from moisture'. Each strip is marked at the start of the roll with a white imprint (e.g. 'NaBento IR-N') and is numbered consecutively on the paper measuring tape included in the roll.

The packaged NaBento rolls are stored horizontally in a dry environment at the factory, in a level, secure and covered storage area. The rolls are transported from the production site to the construction site lying flat in lorries fitted with tarpaulins. The rolls can usually be unloaded from the top or the side. The loading area must be level, dry and free of foreign objects.

The bentonite powder required for sealing the overlap areas is also transported in bags, protected from the weather. On request, special adhesive can also be supplied for shear-resistant joints at the overlaps.

Upon delivery, the rolls must be checked for any transit damage. Any damaged or unmarked goods must be reported immediately to the supplier, HUESKER Synthetic GmbH, by the person responsible on site. Further use can be made in case of minor damage after consultation with HUESKER. Minor damage to the packaging film can be sealed on site with weatherproof tape and foil.

3. Unloading, storage and transport on the construction site

The following options are available for unloading the NaBento rolls:

- Site equipment with lifting beam or with load-bearing tube, pushed into the roll core (Fig. 1).
- Transport belts (width ≥ 3.5 cm), arranged at 1/3 of the roll width from the edge. On request, the transport belts can be attached to the rolls prior to despatch from the factory. Lift carefully to avoid cutting of the straps.
- Stacker with mandrel length ≥ 2/3 of the roll width (carpet mandrel) (Fig. 2).
- Side inserts can also be used as a substitute for a crossbar, eliminating the need for a continuously inserted tube. HUESKER can provide these ball-bearing side nozzles on request (Fig. 3).

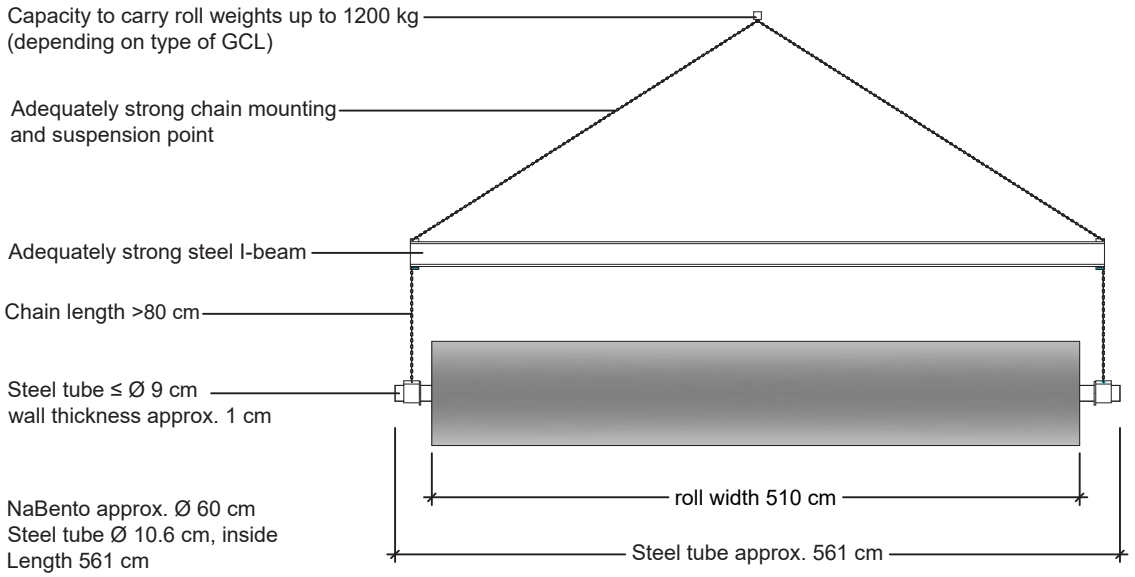

Fig. 1: Lifting traverse

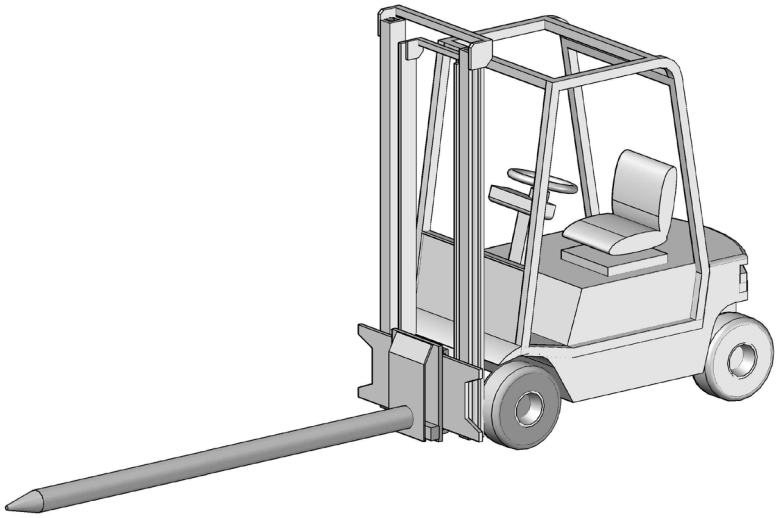

Fig. 2: Stacker with carpet mandrel

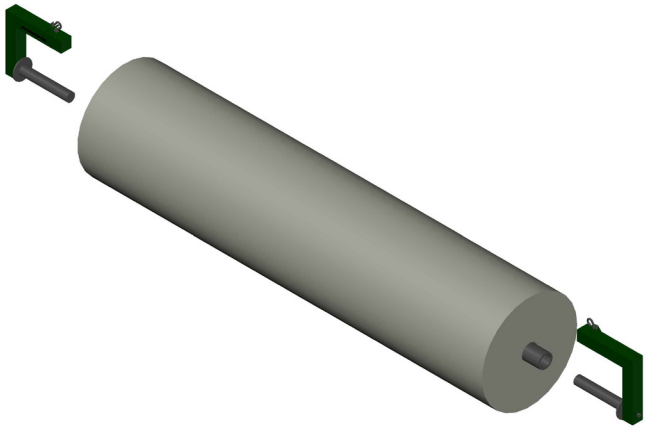

Fig. 3: Crosshead inserts

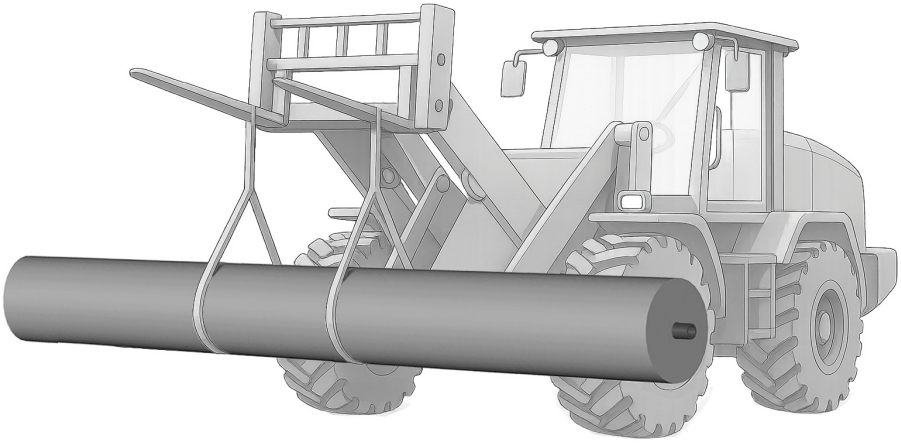

Fig. 4: Lifting slings

When unloading, there must be no damage to the rolls, which can be caused by a point or linear load (e.g. unloading with the gripper arm, rubbing of slings against the end of the roll, etc.).

Slightly damaged packaging of rolls should be sealed with adhesive tape and foil to make them watertight.
Before doing so, however, it must be ensured that the clay sealing sheet is not mechanically damaged or pre-swollen.
Damaged or pre-swollen mats (water content of the bentonite ⩾ 50 %) must not be installed.

Site storage must be on surfaces that are dry and level, and that will remain dry in the event of rain or increase of groundwater. The storage area must be set up on solid ground and be free of foreign objects. A maximum of up to five rolls may lie parallel on top of each other. During storage, the rolls must be kept covered with a weatherproof and UV-stable tarpaulin (protective film). Similarly, the bentonite bags must be stored in a dry and protected place.
The special adhesive must also be stored in a frost-free environment.

NaBento rolls must be transported to the respective work section without damage by means of site equipment with a lifting beam (see Fig. 1) or equipment with a roll-off device. The packaging film of the rolls must only be removed immediately before installation of the material.

To show how the unloading process from a container works, we have provided a video.
Click here to watch the video!

4. Qualification of the installation personnel, installation devices and accessories

The contracted installation personnel must have sufficient qualifications and experience with the installation of clay geosynthetic barriers. Before starting work, the installation personnel must be instructed by the site manager on the contents of these installation instructions. If the installer does not have previous experience, practical instruction can be provided by a HUESKER employee after consultation and at an agreed cost.

The installation device consists of a laying traverse (L ⩾ 6.0 m) suspended from the excavator or wheel loader with an additional pipe (Ø outside ⩽ 90 mm) or a roll-off device consisting of two ball-bearing side supports that are pushed into the steel core of the roll. Depending on the NaBento type, the laying device must have sufficient load-bearing capacity for roll weights of ⩾ 850 to 1200 kg.

The following accessories must also be provided for installation:
- For the execution of overlapping with bentonite powder:
  e.g. spreader , alternatively watering cans 10 – 15 l or buckets, shovels, trowels.

- For the execution of the overlapping with bentonite paste:
  Power generator, cable drum, drill with stirring attachment, water tank, two buckets of 50 l,
  2 – 3 buckets of 10 – 15 l, shovel, trowels.

- For the execution of the overlap with special glue:
  2 watering cans 10 – 15 l, 1 – 2 buckets 10 – 15 l, 3 paint rollers (made of fur) in 10 – 12 cm width;
  3 – 4 paint brushes, each 10 – 12 cm wide.

Further:
- Construction equipment (excavator, front-end loader), shovels, trowels, tape measure, folding rule, chalk sticks, coloured chalk line, electric/battery cutter, carpet knife incl. spare blades, broom.

5. Weather conditions for installation, protection during work interruption

Installation should be carried out in dry weather, so that the first covering of the clay liners including the overlaps with a soil layer of at least 30 cm thickness or with a minimum ballast of 5 kPa is carried out in dry conditions. At the same time, the subgrade must not have any standing water. The covering may be carried out with a water content of the bentonite of w < 50 % (determination according to DIN 18121) in the clay liner. Installation in rainy weather (e.g. drizzle) is only permissible if the above conditions are ensured by directly covering the NaBento. Furthermore, the specifications in the following sections must be taken into account.

Temporarily uncovered GBR-C, especially finished sealed overlaps, must be protected from rain with waterproof tarpaulins. The same applies to panel edges left overnight without backfill (Fig. 5). Pre-swollen mats or areas with w ≥ 50 % (see above) must not be built over; they must be replaced or covered with dry GBR-Cs.

NaBento can be installed at freezing temperatures if **dry bentonite powder** is used for the overlaps and the **backfill material is not frozen.**

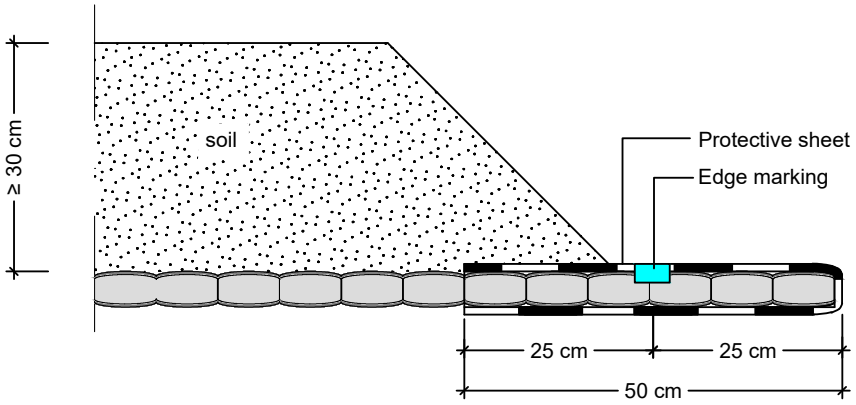

Fig. 5 Temporary edge protection

6. Subgrade requirements

The subgrade shall be a wide-graded sand-gravel mixture or finer, adequately compacted, and free of foreign material and standing water. The subgrade surface must be sufficiently firm and level so that installation equipment does not create significant ruts deeper than 5 cm. The compacted surface must not have height variations caused by protruding individual grains or roller marks exceeding 3 cm. Similarly, voids must be avoided and, if necessary, filled by sprinkling sand. Ruts in the subgrade caused by the installation equipment must be smoothed out before installation continues and, if necessary, recompacted. Footprints are evidence of insufficient compaction.

If the formation of the subgrade surface as described above is not possible, a sand layer or a suitable protective non-woven material should be installed between the subgrade and NaBento after consultation with HUESKER.

7. Principles of laying and arrangement of overlaps

The following principles must be taken into account when laying NaBento, or already in the laying plan:

- For slopes steeper than 1:5, we recommend laying in the direction of fall. A deviation from this is allowed in flatter areas.
- When unrolling, the panels must be positioned parallel to each other, free of folds and stresses, while observing the overlaps (see section 8).
- Unwinding is slow, controlled and with constant steering of the roll edges, so that adjusting the panels is minimized (Fig. 6.).

- All overlaps are to be roof-tiled in the direction of drainage.
- All overlaps must be wrinkle-free, clean and free of foreign matter. If necessary, the overlap area must be cleaned.
- If transverse overlaps are required on longer slopes that have slopes steeper than 1:3, design safety measures to prevent slippage during construction may need to be used. These may be small intermediate anchor trenches or berms. With a correspondingly larger overlap, it is also possible to nail the underlying lane that will later be covered.
- For slopes steeper > 1:3, HUESKER should be consulted prior to installation. In this case, the stability must be verified during all construction stages.
- T-joints are to be staggered by 1.0 m (Fig. 7). Cross-joints are not permitted.
- In low points, minimize the number of cross overlaps.
- During each working day, only as many panels may be laid as can be covered with soil, in accordance with Section 10. Areas not covered with soil must be secured, with foils, against precipitation. Care must be taken in the edge areas to ensure that no water can penetrate between the film and GBR-C or below the GBR-C.
- The GBR-C may not be driven on directly (more details in section 10.2).

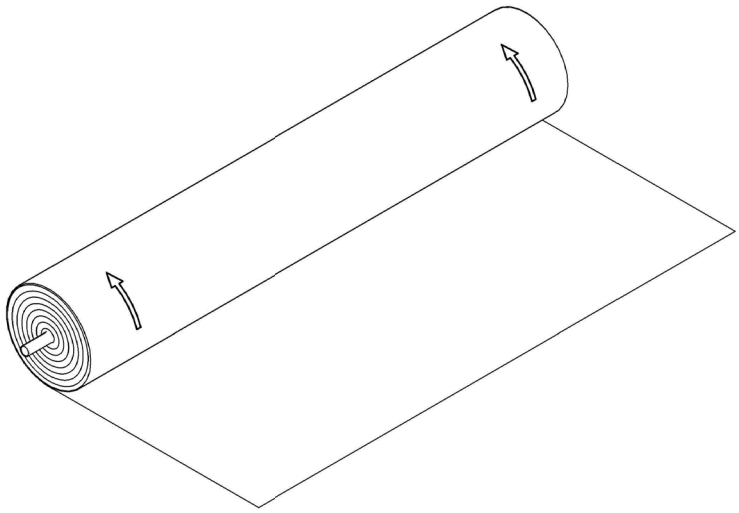

Fig. 6: Unwinding direction

8. Overlaps, marking, cutting and sealing

Caution in making panel connections is critical to the quality of the entire seal. The prerequisites for tight overlaps are the level and firm subgrade, clean and tightly overlapping connection surfaces, and proper sealing.

The overlaps of NaBento are at least 25 cm (Fig. 7). The longitudinal overlaps (parallel to the panels) have no roughness layer and are protected on the top and bottom of the roll with a 25 cm wide light-colored marking strip (IR types only). Cross overlaps (transverse to the unwinding direction) must be marked at a distance of 25 cm from the edge of the roll. Sharp multi-purpose knives or cordless cutters are suitable for cutting the rolls.

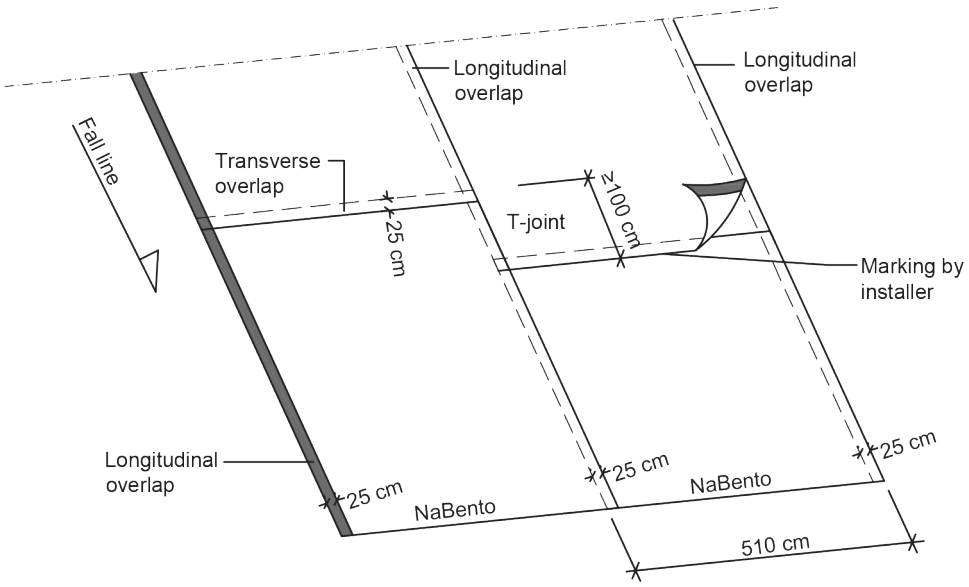

Fig. 7: View of the NaBento overlaps

8.1. Overlaps with bentonite powder/paste

The overlaps are usually sealed with bentonite powder or paste.

The overlaps to be sealed must be free of soil residues and loose particles. The bentonite powder is applied onto the lower NaBento membrane, as shown in Fig. 8a. The powdered bentonite can be scattered by hand and spread with a trowel, or applied using a sports ground spreader. The use of watering cans, with their spouts cut in half to provide a correspondingly large outlet cross-section, has also proven effective. The supplied bentonite powder is sufficient to apply a quantity of 700 g/m² over a width of approx. 10 cm to the longitudinal and transverse overlaps.

The bentonite paste is mixed from 3 – 4 weight parts of water with the addition of 1 part bentonite (drill with stirring attachment). The finished, viscous paste can be applied using a pump with a slotted nozzle or by hand (with a shovel and trowel).

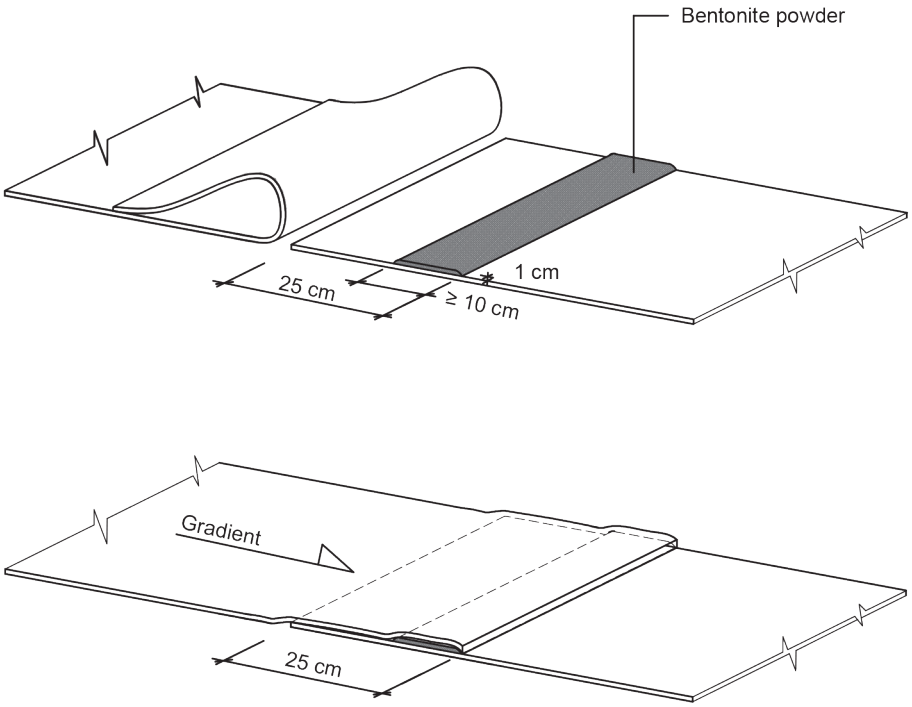

Fig. 8a: Design of the overlap with bentonite powder or paste

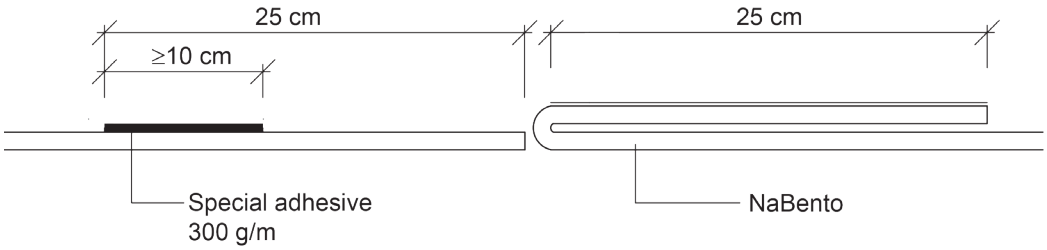

Fig. 8b: Execution of the overlap with special adhesive

To obtain a shear-resistant seal in the overlap area, special adhesive (Fig. 7b) can be applied (approx. 300 g/m) and to a width of approx. 10 cm. The sealing strip must be covered by folding back the upper NaBento layer. Do not walk on the overlap areas as per Section 8.

9. Pipe and structure connections

Pipe penetrations (see Fig. 9), are formed by an additional NaBento fitting piece (square with side length = Ø pipe plus 120 cm), arranged above the NaBento sheet. The pipe support must be solid and settlement-free, cavities should be filled with earth-moist sand-bentonite mixture, and the filling must be compacted.

Initially, the GBR-C will be routed up to the pipe, with upwards routing recommended. The pipe position is marked on the panel with a cross-shaped slot, aligned in the fall line, and is pre-drawn, moistened and cut. The slot must not be larger than the pipe diameter. The slotted NaBento is slid over the pipe.

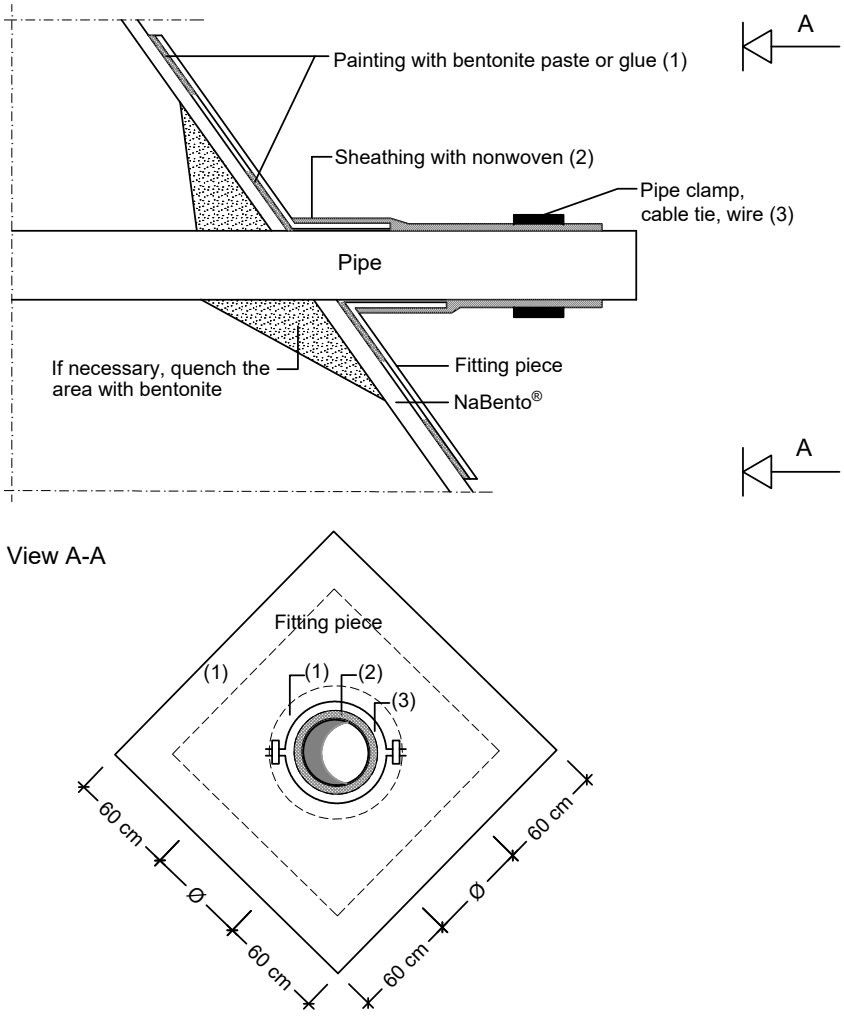

Fig. 9: Pipe connection

Similarly, proceed with the fitting piece. The cross-shaped cut must be made parallel to the edges of the fitting pieces. The additional piece is attached diagonally to the direction of the slope, see Fig. 9. By twisting the fitting piece by 45°, the “cut tongues” would cover the slots of the lower NaBento layer. The fitting piece must fit tightly around the pipe.

All areas, especially around the pipe, should be liberally covered with bentonite. Finally, the pipe including the fitting piece is sheathed or covered with nonwoven fabric and tied down with pipe clamps, cable ties or wires. The edges of the fitting piece should be made like overlaps. Vertical perforations are to be carried out in the same way.

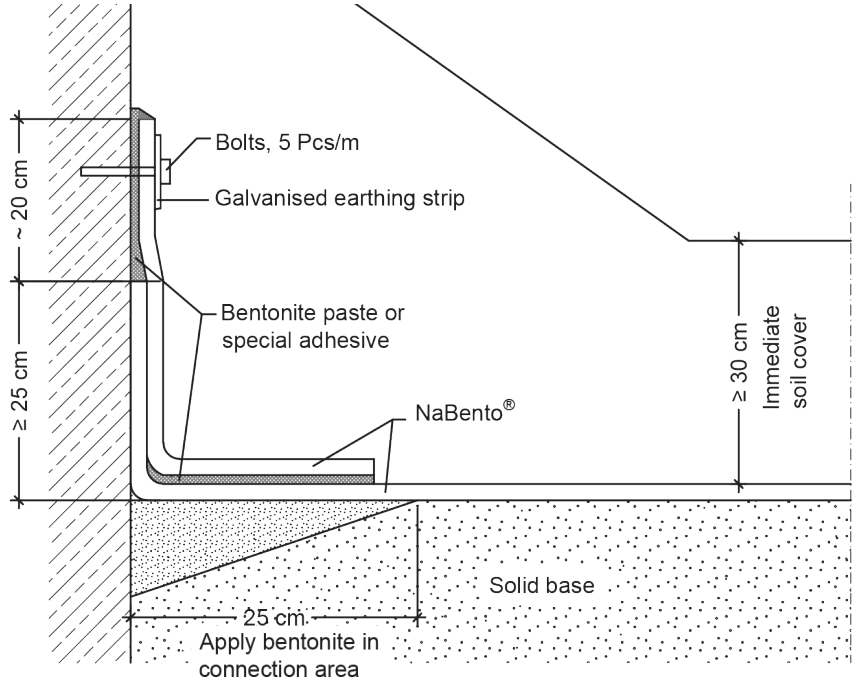

Fig. 10: Structure connection

Structural connections are made as shown in Fig.10, with an additional GBR-C strip. Using the same principle, the NaBento can also be connected directly to the structure. Where possible, the GBR-C should run above the elevation of the drainage layer or the maximum water table.

Areas of pipe and structure connections must be covered with soil immediately after construction, so that their positional stability is ensured.

10. Soil cover

10.1 Permissible maximum grain size and soil layer thickness

The soil must be covered with suitable fill material at least 30 cm thick. For mineral drainage layers, the maximum grain size is limited to 16 mm. For a larger coefficient of uniformity U ⩾ 5 and ⩽ 15, the maximum grain size can be extended up to 32 mm. From U ⩾ 15 the use of a wide graded grain size 0/63 is possible. The grading curve should be straight rather than convex (rising steeply towards the end). The use of different grain sizes (see above) is possible after consultation with HUESKER or it must be proven in object-related tests. However, preference should be given to fine-grained soils. Geotextile protection layers may be required. A soil layer of ⩾ 30 cm must be placed on top of the laid NaBento within one day. Further cover requirements i.e. frost impact, drying out of the soil should be taken from the respective applicable codes. According to the German RiStWAG guideline, for example, a minimum cover of 80 cm is recommended.

10.2 Installation of the soil

- The NaBento material must not be driven over.
- It is carried out in the pre-head process and in the direction of the overlaps. (Displacement and impurities of the connections would be avoided in this way).
- In the process of soil placement, the soil thickness must be ⩾ 30 cm before driving on the GBR-C. Preferably, use a construction site machine with low soil pressure (e.g. excavator with crawler track). Sharp turning maneuvers and abrupt starting and braking must be avoided.
- Existing anchorage trenches are backfilled first.
- When backfilling, the drop height of the soil is limited to 50 cm; the dumping of larger soil masses onto the GBR-C must be prevented.

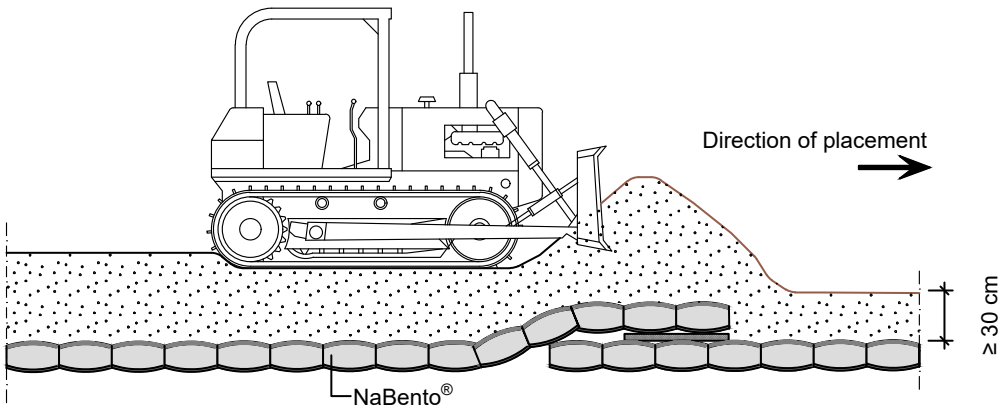

Fig. 10: Direction of soil placement

Caution: Areas that are frequently drive on during the construction phase (such as frequently travelled construction roads, i.e. not only for paving) require a sand protection layer of ⩾ 10 cm on the NaBento with a total cover of ⩾ 80 cm. In case of deviations from this, the protective measures must be coordinated with HUESKER. If necessary, a field test is sufficient to prove the paving damage in case of lower layer thicknesses or deviating grain distributions.

11. Repairs

If NaBento, that have already been laid is damaged, the corresponding areas can be repaired with an additional GBR-C piece using the principle of overlaps (Section 9). In addition, care must be taken to ensure that the damaged area is sufficiently exposed and cleaned, if necessary.

12. Concluding remarks

12.1 Stability

The internal shear strength of NaBento is very high due to the stitching, therefore external friction surfaces are decisive for stability almost without exception. In the case of embankments, the stability for such sliding surfaces should be verified during the planning phase. This applies in particular to steep slopes with inclination > 1:3. HUESKER can provide corresponding evidence and proposed solutions upon request.

12.2 Anchorage trench

For slopes steeper than 1:4, the introduction of NaBento into an anchorage trench (anchorage length ⩾ 60 cm, trench depth ⩾ 30 cm, trench width ⩾ 30 cm) behind the top of the slope is recommended for design reasons. Alternatively, ground anchors can be used. For slopes steeper than 1:3, a veneer stability check is strongly recommended.

GBR-C anchorages are not used to support scheduled tension forces. They are used only for securing during the laying phase. The absorption of these forces is reserved for a reinforcement element (e.g. a Fortrac geogrid).

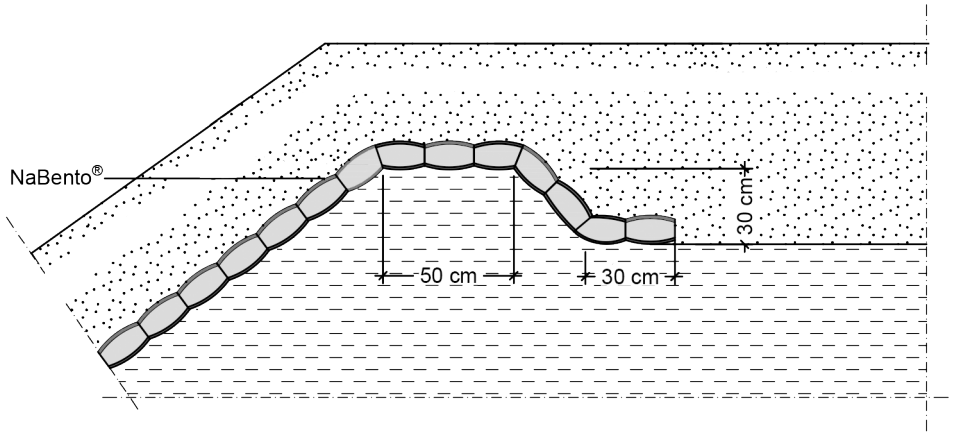

Fig. 11: Structural anchorage trench

13. Other

The aforementioned requirements for storage annd installation are necessary for the functional efficiency of the GBR-C NaBento and must be complied with.

For application-related advice and object-specific situations not covered by these installation instructions, HUESKER will be pleased to assist you.

The information contained in these installation guideline corresponds to our latest findings. We reserve the right to make changes in the interest of technical progress. Warranty claims cannot be derived from this information.

You can find the technical data of NaBento in the respective data sheet. We assume a warranty for the existence of these values only for the time of delivery. We accept no liability for a change in values due to environmental influences and/or improper processing.

HUESKER Synthetic GmbH

Fabrikstrasse 13–15
48712 Gescher, Germany
Tel.: + 49 (0) 25 42 / 701 - 0
Fax: + 49 (0) 25 42 / 701 - 499
Mail: info@HUESKER.de
Web: www.HUESKER.de