



Tektoseal® Clay+

1. General

These installation instructions apply for the use of all Tektoseal® Clay+ geosynthetic clay liners (GCL) as sealing components in lining systems, in a variety of applications. Special regulations, authorisations or appraisals may allow exceptions.

Tektoseal® Clay+ is an industrially manufactured composite material comprising outer geotextile sheets and an encapsulated bentonite layer that are securely needled together.

Sodium bentonite, in varying quantities, can be used as the bentonite layer. The sealing effect occurs through the bentonite, when installed, absorbing water and swelling under load.

Tektoseal® Clay+ contains self-sealing overlaps at the longitudinal sides. Two 25 cm stripes on the top non-woven are pre-impregnated with Sodium-Bentonite. Additional sealing works have just to be done at transversal overlaps at the beginning respectively the end of the roll.

The manufacturing processes for Tektoseal® Clay+ are certified to DIN EN ISO 9001.

2. Packaging, labelling and transport to the site

Tektoseal® Clay+ is supplied either in the standard width of 5.10 m or in fractions thereof, rolled up over its full width, equipped with a paper measuring tape and packed moisture-tight in black PE sheet with the name printed on it. Two labels are affixed to the packaging in accordance with ISO 10320. The roll packaging also includes a high visibility label with the warning 'Protect against moisture'. Each liner is continuously marked with a blue imprint on both sides of the roll (e.g. 'Tektoseal® Clay 5000+'). This continuous marking also appears on the paper measuring tape supplied with the roll.

The rolls are transported horizontally from the place of manufacture to the site on tarpaulin-covered vehicles. They can generally be unloaded from the top or side. Loading beds shall be level, dry and free of detritus.

The bentonite powder required just for the transversal overlap areas during installation is transported in bags that shall also be properly protected against the weather.

Upon delivery, the rolls shall be inspected for transport damage. HUESKER Synthetic GmbH shall be notified promptly by the site manager of any damaged or unlabelled goods. In the event of minor damage, further use may be possible following consultation with HUESKER. Minor damage to the packaging can be repaired on-site with weather-resistant adhesive tape and sheeting.

3. Unloading, storage and transport at the site

Tektoseal® Clay+ rolls can be unloaded using the following methods:

- A site vehicle equipped with a spreader bar assembly or suitably strong core pole, which is pushed through the roll core (Fig. 1)
- A forklift with a pole length $\geq 2/3$ the roll width (carpet stinger) (Fig. 2)
- Hoisting slings, each placed $1/3$ of the width in from the edge of the roll. Hoisting slings can be pre-placed on the rolls at the manufacturing plant upon request.



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- By self-unloader facility of delivery vehicle (upon request).

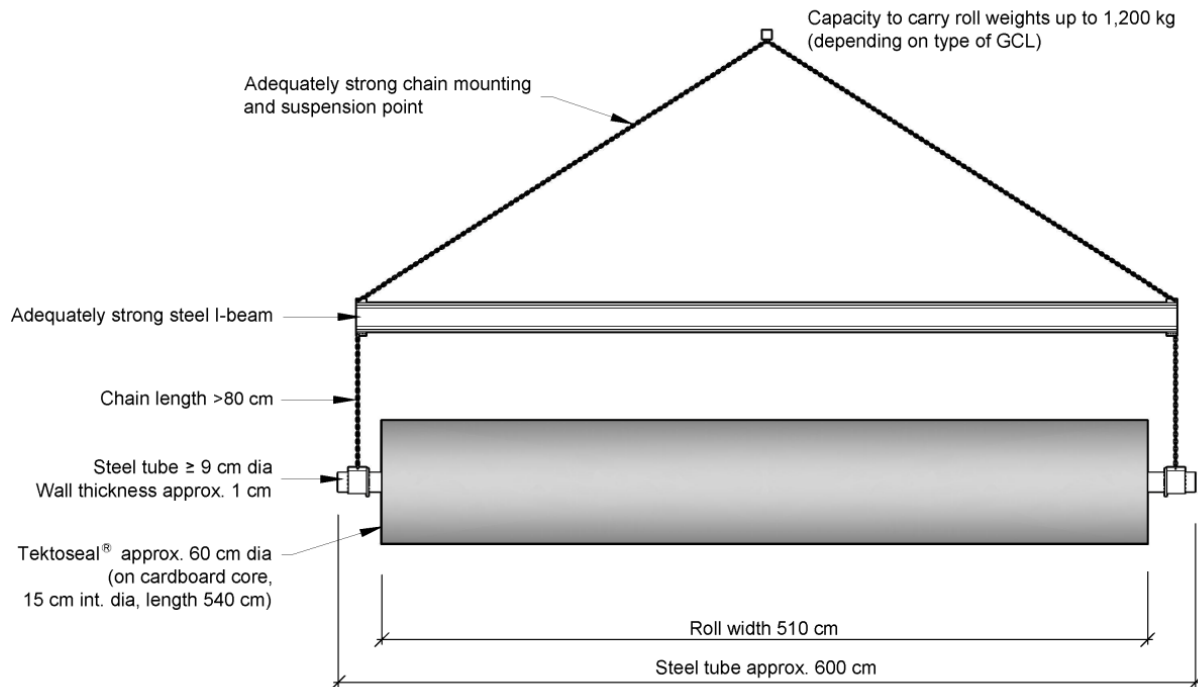


Fig. 1: Spreader bar assembly

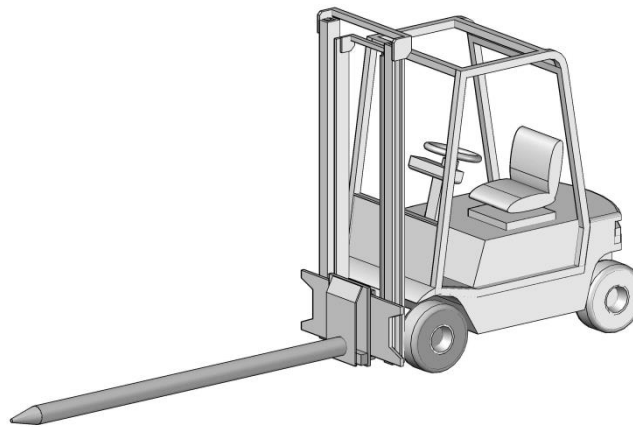


Fig. 2: Forklift with stinger

During unloading, the rolls shall be fully protected from any damage that may occur due to point or linear loads (for example, chafing on the roll ends from the hoisting slings etc.).

Minor damage to the roll packaging shall be sealed against water ingress using adhesive tape and sheeting. However, prior to the repair, it shall be ensured that the geosynthetic clay liner has not been mechanically damaged or is not pre-swollen. Damaged or pre-swollen liners (bentonite water content $\geq 50\%$) shall not be installed.

Storage at the site shall be on a dry and level surface, where rolls will also remain dry in the event of rain or a rise in groundwater levels. The storage area shall be on solid ground that is

HUESKER Synthetic GmbH

Fabrikstraße 13–15, D-48712 Gescher
Tel.: +49 (0) 25 42 / 701 - 0
Fax: +49 (0) 25 42 / 701 - 499
E-Mail: info@HUESKER.de
Internet: www.HUESKER.com

Amtsgericht Coesfeld
HRB 5256
USt.-IdNr.: DE 123785158
Geschäftsführer:
Dr. F.-Hans Grandin



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free of detritus. A maximum of five rolls can be placed parallel on top of one another. During storage, the rolls shall be kept covered with a weather- and UV-resistant tarpaulin (protective sheet). The bags of bentonite shall be similarly stored in a dry and sheltered area.

Tektoseal® Clay+ rolls shall be transported undamaged to the relevant work location using a site vehicle equipped with a spreader bar assembly (see above) or a vehicle fitted with a roll-off device. The roll packaging shall only be removed immediately before installation of the material.

4. Qualification of installation personnel, equipment and accessories

The site operatives undertaking installation of the geosynthetic clay liners shall be suitably qualified and experienced. Prior to starting work, the operatives shall be briefed by the site manager on the contents of these installation instructions. Subject to agreement and an expense allowance, an employee of HUESKER Synthetic can provide practical instruction for installers who have no prior experience.

The installation equipment may, for example, comprise a placing beam with an additional core pipe, fitted to an excavator or front-end loader, which is then pushed through the roll core (150 mm internal diameter). Depending on the type of Tektoseal® Clay+ used, the placing assembly shall have the capacity to lift roll weights ≥ 800 -1200 kg.

The following accessories are also required for installation:

- For applying bentonite powder at overlaps:
either a (sports ground) spreader or 10–15 ltr watering cans or buckets, shovels, trowels
- For applying bentonite paste at overlaps:
generator, cable drum, drill fitted with an agitating device, water container, two 50 ltr tubs, 2 or 3 10–15 ltr buckets, shovels, trowels

Additional equipment:

- Site vehicle (excavator, front-end loader), electric/battery-powered cutter, shovels, trowels, measuring tape, folding rule, chalk, coloured chalk line, carpet knife incl. spare blades, broom



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5. Weather conditions for installation, protection in the case of work stoppages

Installation shall be carried out in dry weather to enable the geosynthetic clay liners, including overlaps, to be covered with at least 30 cm of soil or a minimum load of 5 kPa in dry conditions. In addition, the subgrade shall be free of any standing water. Covering-up may be carried out provided that the bentonite water content within the GCL is $w < 50\%$ (in accordance with DIN 18121). Tektoseal® Clay+ shall be installed in wet weather (e.g. showers) only where the aforementioned conditions are ensured by immediate covering-up of the liner. The guidelines in the following sections shall also be observed.

Liners that have not been covered up, particularly overlaps, shall be protected against rain using waterproof tarpaulins. The same applies for the edges of liners that remain uncovered overnight (Fig. 3). Pre-swollen liners or areas with $w \geq 50\%$ (see above) shall not be covered up, but replaced or covered by dry GCLs.

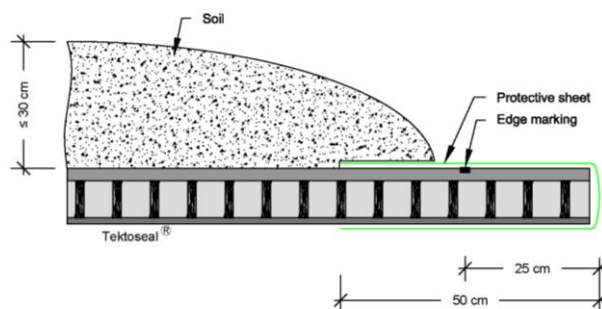


Fig. 3: Temporary edge protection

Tektoseal® Clay+ can be installed at frost temperatures provided that dry bentonite powder is used for the transversal overlaps and the covering material is not frozen.

6. Subgrade requirements

The subgrade shall consist of mixed granular soils (e.g. a well-graded sand-gravel mix (rounded gravel or crushed material)) or finer and shall also be sufficiently compacted and free of foreign matter (roots, stones $> 63 \text{ mm}$, construction debris) and standing water. The subgrade surface shall be level and solid enough to prevent significant rutting by installation machinery. Furthermore, the rolled surface shall not display any protrusions caused by individual pieces of gravel or rutting that is greater than 3 cm. Any rutting on the subgrade caused by the placing machinery shall be smoothed out and if necessary compacted before installation work continues. Footprints are a sign of insufficient compaction.

If the subgrade surface cannot be prepared as described above, a layer of sand or a suitable protective nonwoven material shall be placed between the base and Tektoseal® Clay+ following consultation with HUESKER Synthetic.



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7. Basic principles of installation and arrangement of overlaps

The following principles shall be observed during installation of Tektoseal® Clay+ or, prior to this, at the installation planning stage:

- We recommend downhill installation on earthwork slopes steeper than 1:5. This is not mandatory for flatter areas.
- During unrolling, the liners shall be positioned parallel to one another, untensioned and free of folds, while maintaining the required overlaps (see Section 8). The Tektoseal® Clay+ shall not scrape against the base during this process.
- The unrolling process shall be carried out slowly and in a controlled manner, with continuous guiding of the liner edges so as to prevent any need for subsequent adjustment (Fig. 4).
- The woven layer shall be at the bottom, the nonwoven layer at the top.
- The overlaps shall be formed in the direction of drainage, based on the roof tile principle.
- All overlaps shall be clean and free of folds and foreign matter. The overlap area shall be cleaned if necessary.
- Where transverse overlaps are needed on longer earthwork slopes that have areas steeper than 1:3, suitable provision shall, where necessary, be made in the design, for measures to prevent sliding during the construction phase. These may take the form of small intermediate anchor trenches or berms. Where accordingly larger overlaps are specified, nailing of the lower, subsequently covered sheet is also possible.
- HUESKER Synthetic shall be consulted in all cases where steep earthwork slopes > 1:3 are involved. In such cases, the stability of all construction conditions shall be verified.
- T-joints shall be staggered by 1 m (Fig. 5); cross joints shall not be permitted.
- The number of transverse overlaps shall be kept to a minimum at lower points.
- Only the number of liners that can be covered with soil in accordance with Section 10 shall be installed on any given workday. Areas that are not covered with soil shall be protected by sheeting against precipitation. Care shall be taken at the edges to prevent any infiltration of water between the sheeting and the GCL or below the GCL.
- Vehicles shall not pass directly over the GCL. See Section 10 for further details.



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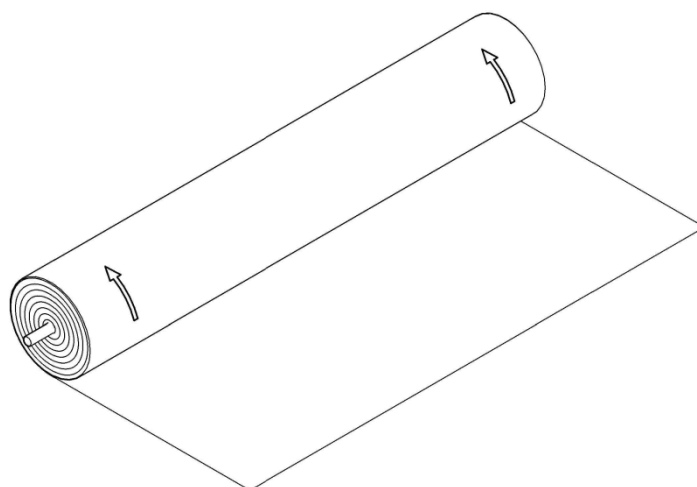


Fig. 4: Direction of unrolling

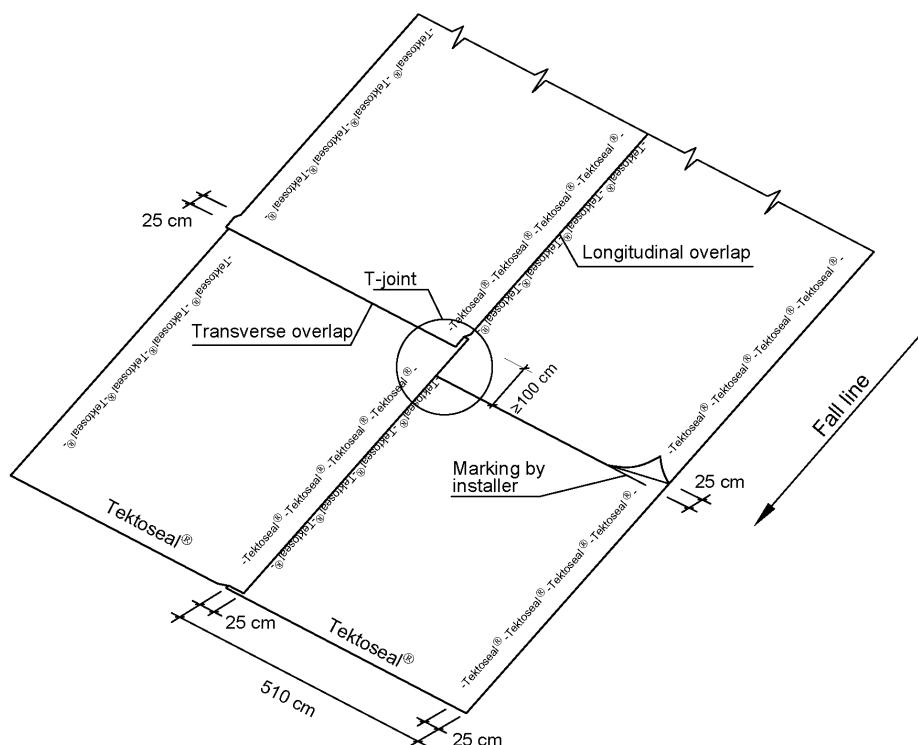


Fig. 5: Illustration of joints between Tektoseal® Clay+ liners

8. Overlaps, marking, cutting and sealing

The careful formation of joints between liners is essential for the overall sealing quality. Properly sealed overlaps depend on a flat and solid subgrade, clean and tightly overlapping surfaces at joints and good sealing practice.

Tektoseal® Clay+ longitudinal overlaps are self-sealing and 25 cm wide (Fig. 5, 6a). Additional bentonite sealing is not required here. The width of the longitudinal overlaps (along the length



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of the liner) is marked on the upper surface of the liner by blue Tektoseal® Clay+ lettering 25 cm from the edge. A correct overlap is automatically achieved by positioning the overlapping liner along the bottom edge of the lettering on the lower liner.

Transverse overlaps are not self-sealing (along the ends of the liner) and shall be marked 25 cm from the end of the liner. Sharp multi-purpose knives or battery-operated cutters are suitable for cutting liners.

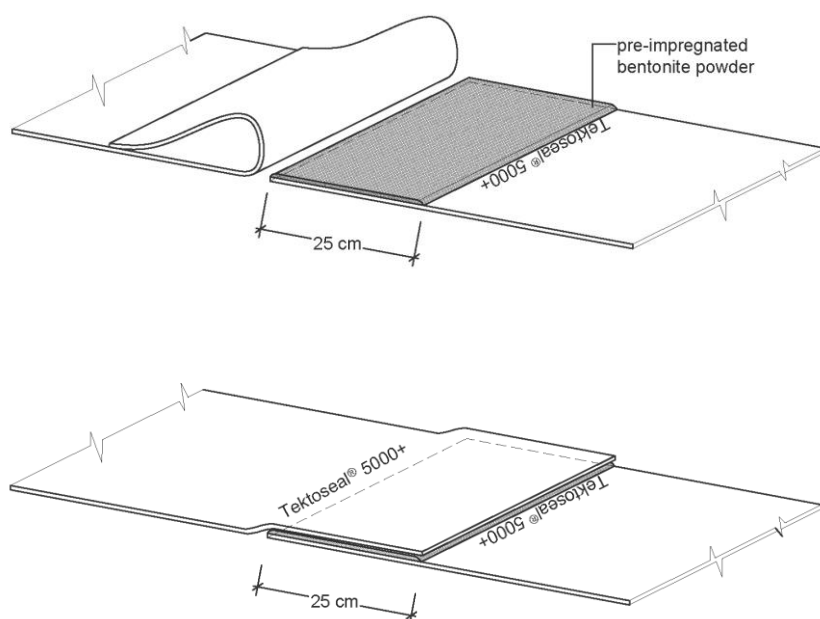


Fig. 6a: Formation of longitudinal self-sealing overlaps

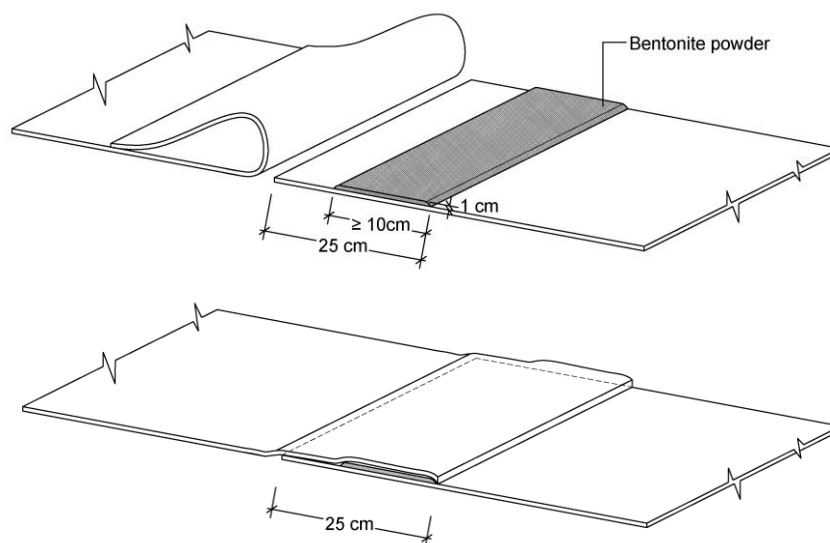


Fig. 6b: Formation of transversal overlap using bentonite powder or paste



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8.1. Transversal overlaps using bentonite powder/paste

As a rule, transversal overlaps shall be sealed using bentonite powder or paste. The overlaps to be sealed shall be free of soil or other contaminants. Bentonite powder shall be applied to the lower Tektoseal® Clay+ liner as shown in Fig. 6b above. Bentonite in powder form can be applied manually and spread using a trowel or applied with a sports ground spreader, 10 cm in width and 1 cm in height. Watering cans with the spout cut off to enlarge the opening and increase the flow cross-section are also an established method.

Bentonite paste is prepared by adding 1 part bentonite to 3-4 parts water (by weight) and mixing using a drill fitted with an agitating device. The thick, finished paste can be applied manually (with shovel and trowel) or by using a pump with a slotted nozzle. The use of bentonite paste is preferred in windy conditions as powder may blow away. The overlapped area shall be covered by folding down the upper Tektoseal® Clay+ layer.

9. Junctions with pipes and structural fabric

Pipe penetrations (see Fig. 7) shall be formed using an additional Tektoseal® Clay+ backing patch (square with side length = pipe diameter plus 120 cm) placed over the Tektoseal® Clay+ liner. The pipe bedding shall be solid and settlement-free. Any cavities shall be filled with an earth-moist sand-bentonite mix, which shall be pressed in and compacted.

The GCL shall first be carried up to the pipe, with uphill installation as the recommended method. The position of the pipe shall then be marked on the liner and a cross-shaped incision in the line of the slope shall be marked, dampened and cut. This incision shall be no larger than the diameter of the pipe. The Tektoseal® Clay+ liner with the incision shall then be pushed over the pipe.

The same procedure shall then be applied to the backing patch. The cross-shaped incision shall be cut parallel to the edges of the backing patch. This shall then be placed over the pipe diagonally to the line of the slope, as shown in Fig. 7. Oblique installation of the backing patch at an angle of 45° ensures that the flaps of the incision cover the incision in the underlying Tektoseal® Clay+ layer. The backing patch shall be fitted tightly around the pipe.



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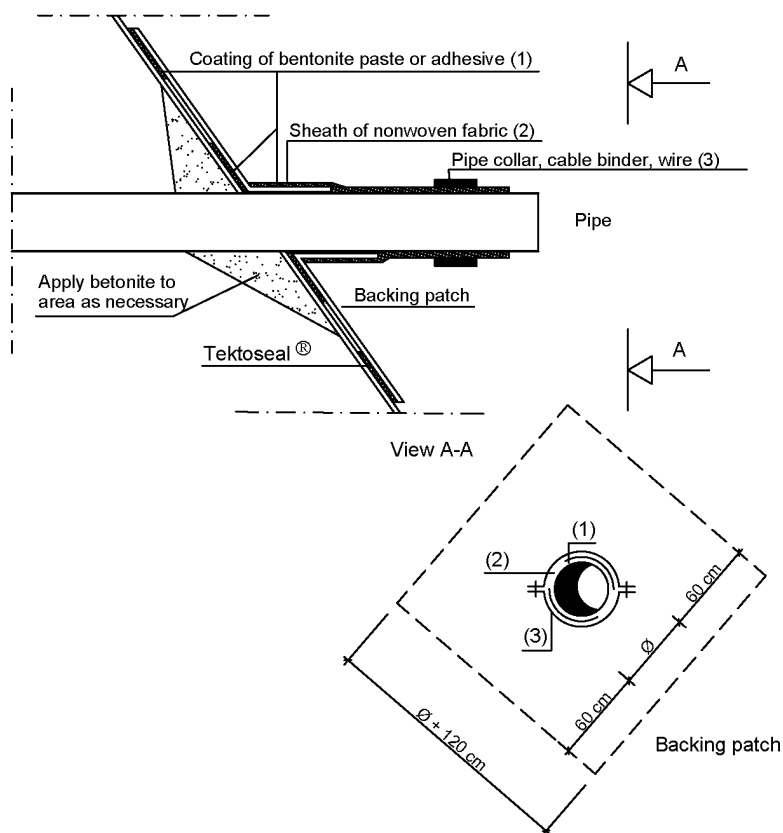


Fig. 7: Pipe connection

All areas, especially the area around the pipe, shall be generously covered with bentonite. The pipe and backing patch shall then be sheathed in nonwoven fabric and secured with pipe collars, cable binders or wire. The edges of the backing patch shall be treated in the same way as overlaps.

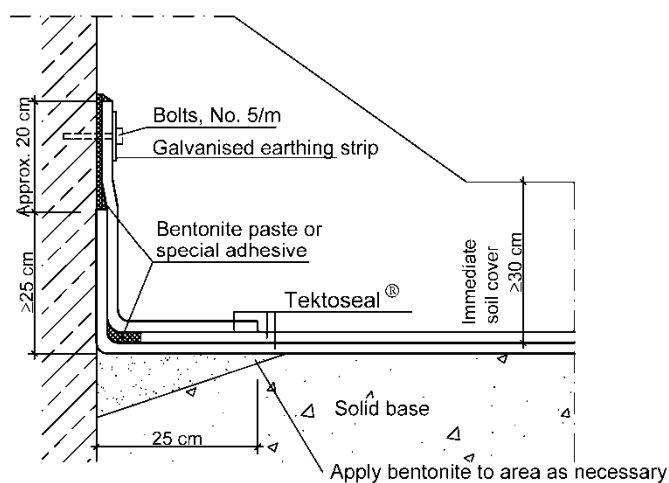


Fig. 8: Junction with structures



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Junctions with structures shall be formed as shown in Fig. 8 using an additional strip of GCL. The Tektoseal® Clay+ liner can also be connected directly to the structure using the same principle. Where possible, the GCL shall be carried above the level of the drainage layer or maximum water table.

To rule out the risk of displacement, junctions with pipes and structural fabric shall be covered with soil immediately after their formation.

10. Soil cover

10.1. Largest permissible grain size and soil layer thickness

The soil cover shall comprise a min. 30 cm layer of suitable backfill material. In the case of mineral drainage layers, the maximum grain size shall be limited to 16 mm. The maximum grain size can be increased to 32 mm where a higher coefficient of uniformity ($U \geq 5$ and ≤ 15) prevails. Where $U \geq 15$, utilisation of widely graded, 0/63 gravel is possible. Depending on the designated use, the water permeability shall be checked where 0/63 mm is used. The use of other grain sizes (see above) may be possible following consultation with HUESKER Synthetic or shall be verified by means of project-specific tests. Precedence shall, however, be given to fine-grained soils. Geotextile protection layers may be required in some cases.

A minimum daily soil layer ≥ 30 cm shall be placed on the installed Tektoseal® Clay+.

The applicable standards and regulations shall be consulted in respect of any further cover requirements (impact of freezing, drying out of soil). For example, a minimum cover of 80 cm is recommended by RiStWAG (German Guidelines for Roadbuilding Works in Water Protection Areas).

10.2. Soil placement

- No vehicles shall pass directly over Tektoseal® Clay+.
- The end-tipping procedure, with placement in the direction of the overlaps, shall be adopted (Fig. 9). (This avoids displacement and contamination of the joints between liners).
- During soil placement, the thickness of the soil layer shall be ≥ 30 cm before the GCL can be trafficked. Preference shall be given to construction vehicles exerting low ground pressure (e.g. wide-tracked excavator). Sharp turns and abrupt starting and stopping shall be avoided.
- Existing anchor trenches shall first be filled.
- The height of fall of dumped soil shall not exceed 50 cm; as a general rule, larger volumes of soil shall not be dumped on the GCL.



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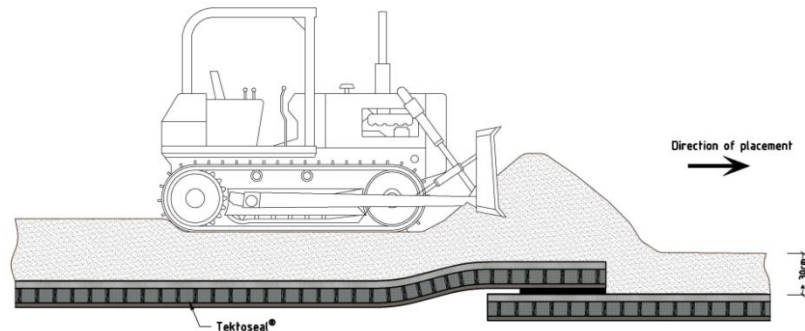


Fig. 9: Direction of soil placement

Note: Areas that are driven over frequently during the construction phase (such as busy site roads, i.e. not only those used for installation) require a total cover of ≥ 80 cm over the Tektoseal® Clay+. In the event of any deviation from this rule, suitable protective measures shall be agreed with HUESKER Synthetic. A trial area may suffice to check for any installation damage resulting from insufficient layer thicknesses or deviating grading curves.

11. Repairs

Where previously installed Tektoseal® Clay+ liners are damaged, the relevant areas can be repaired using an additional piece of GCL, based on the overlap principle.

12. Concluding remarks

12.1. Stability

The internal shear strength of Tektoseal® Clay+ is extremely high due to an innovative needle-punching process; as such, stability is virtually always dictated by the existence of potential external sliding surfaces. For earthwork slopes, due consideration shall be given at the design stage to the stability of such sliding surfaces. This particularly applies to steep slopes with an inclination of $> 1:3$. Upon request, HUESKER Synthetic can carry out the relevant checks and propose solutions.

12.2. Anchor trenches

On earthwork slopes steeper than $1:4$, it is recommended, for structural reasons, that Tektoseal® Clay+ be carried into an anchor trench behind the crest of the slope (Fig. 10) (anchor length ≥ 50 cm, trench depth ≥ 30 cm, trench width ≥ 30 cm). This anchorage is mandatory for inclinations steeper than $1:3$. See Section 12.1. Alternatively, ground anchors can also be used.

Rather than serving to accommodate the design tensile loads, anchorage of the GCL is only intended to protect against sliding during the installation phase. Reinforcing elements (such as the Fortrac® geogrid) shall be specified to accommodate the design tensile loads, e.g. induced by cover soil.



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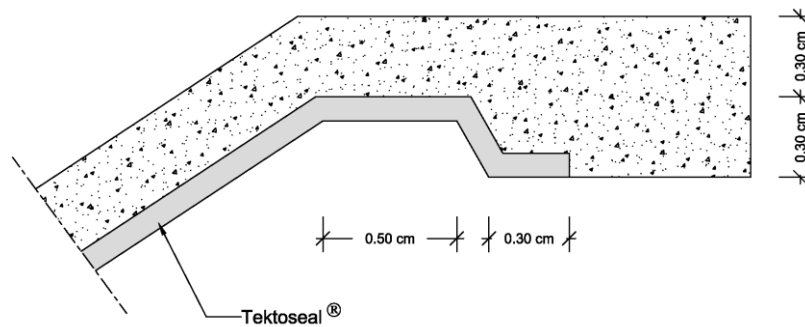


Fig. 10: Structural anchor trench

13. Miscellaneous

The above storage and installation requirements are necessary to ensure the proper performance of Tektoseal® Clay+ GCL and shall be observed in all cases.

Please do not hesitate to contact HUESKER Synthetic for application- and project-specific advice regarding situations not covered by these installation instructions.

The details provided in these installation instructions are based on our latest findings. We reserve the right to make amendments in line with technical advances. No liability may be construed and no claims shall be accepted in respect of the information presented in this document.

The technical data on Tektoseal® Clay+ is set out in the relevant data sheet. The data has a 95% confidence level. We only provide a guarantee for the achievement of these values at the time of delivery. No liability shall be accepted for changes to the values resulting from environmental impacts and/or improper application.