

MODULO GEOBENT XP INSTALLATION GUIDELINES FOR LANDFILL LINING

Bottom Barriers

The location and the construction characteristics of a landfill must meet the conditions required to prevent polluting the ground and the underground or surface water, and ensure the efficient collection of leachate.

During the construction stage, the ground must be protected by combining a geological barrier, a waterproof lining system for the bottom and the slopes of the landfill, and a leachate collection system.

In case of landfill for inert waste, the bottom barrier system must consist of the following:

- geological barrier;
- containment barrier system made with natural materials ($s > 0.5$ m) if the geological barrier does not meet regulation standards;



GCL to reinforce the system, if necessary.

In case of landfills for non-hazardous waste, the bottom barrier system must consist of the following:

- geological barrier whose geological formation must be natural;

- containment barrier system made with natural materials ($s > 1.0$ m);
- geosynthetic clay barrier, if necessary;
- HDPE geomembrane;
- layer of drainage materials for the collection of leachate.

Sidewall Barriers

In case of landfills for non-hazardous waste, the sidewall barrier system must consist of:

- geological barrier whose geological formation must be natural;
- containment barrier system made with natural materials;
- HDPE geomembrane;
- layer of drainage materials for the collection of leachate.



Exceptionally, a thickness of less than 0.5 m may be applied in projects involving special solutions for the execution of the sidewall containment barrier system, which in any case must guarantee the same level of protection. This can be achieved easily by using a geosynthetic clay barriers either singly or in pairs.

Whatever type of barrier is used, the project stage must envisage an accurate check of the stability of the waterproofing packet.

Capping Barriers

The top covering of a landfill must meet the following criteria:

- isolation of waste from the external environment;
- minimization of water infiltration;
- maximum reduction of maintenance requirements;
- minimization of erosion phenomena;
- resistance to settling and to local subsidence.



In the case of landfills for non-hazardous waste, capping must consist of a multi-layer structure composed of the following elements from top to bottom:

- top covering layer;
- drainage layer in natural material with protection from clogging. This layer can be replaced by a geosynthetic for drainage;
- compacted mineral layer or, alternatively, a geosynthetic clay barrier;
- a gas drainage and capillary breakage layer protected from clogging;
- a leveling layer to allow the upper layers to be laid correctly.

Reclamation of Polluted Areas

Making a landfill site permanently safe is an intervention whose purpose is the final isolation of the sources of pollutants if they consist of accumulated waste and if it is not possible to remove them even by using the

best technologies available at a sustainable cost and in accordance with EU regulations.



A typical intervention project usually envisages:

- a complete investigation into all sources of contamination aimed at identifying pollutants with high and low risks for the environment;
- a comprehensive intervention which minimizes the risk of contaminant dispersion and whose first step is the selective removal of the high-risk waste;
- the coverage of all low-risk waste and contaminated ground;
- the waterproofing of areas with low-risk waste aimed at minimizing the infiltration of meteoric waters through the waste mass and at reducing the risk of contamination of the stratum below.

Subgrade preparation

The relative thinness of GCLs requires more attention to be given to subgrade preparation than should be given during the construction of a compacted clay liner. In general, the subgrade preparation specifications that are used for geomembrane installations are adequate for GCLs.

The subgrade surface should be smooth and free of vegetation, sharp-edged rocks, stones, sticks, construction debris, and other foreign matter that could contact the GCL in order to reduce puncturing actions which can affect the GCL efficiency during its working life.

The subgrade surface shall be compacted in accordance with the project specifications. At a minimum, the subgrade should be rolled with a smooth-drum compactor of sufficient weight to remove any wheel ruts, footprints, or other abrupt grade changes. Furthermore, all protrusions extending more than 12 mm from the subgrade surface shall either be removed, crushed, or pushed into the surface with a smooth-drum compactor.

Compaction of the subgrade should be in accordance with the design specifications, or, at a minimum, to the extent that no rutting is caused by installation equipment or vehicles (grade of subgrade compaction has to be min. 90% as per Proctor Modified Test).

A good technique for difficult subgrade conditions is to water the subgrade approximately one hour in advance of GCL deployment, and then smooth-drum roll the area just before GCL deployment. The exact timing of watering, rolling and deployment depends on the site-specific soils and weather conditions.

Proper CQA procedures should include a final visual inspection of the subgrade surface to identify unacceptable surface protrusions (typically larger than 12 mm), excessive rutting (typically greater than 25 mm), abrupt vertical displacement differences, or other areas that may damage the GCL during or after installation. These areas should be eliminated by removing protruding objects, smooth-drum compaction, or the placement of a protective geotextile cushion layer (min. 500 g/sq.m.) prior to installation of the GCL.

Handling and Storage

The survival of the roll of GCL in good condition depends on a number of aspects, the main areas of damage appear to take place while the GCL is being unloaded stored and handled at the site where it has to be installed.

On arrival at the site the rolls will be either on a flat bed lorry, or truck, or in a container. Unloading is best carried out by a fork lift truck equipped with a carpet boom. The carpet boom is inserted into the core of the roll and simply lifted clear of the vehicle.

However, a fork truck is not always available at the site, in which case a heavy duty steel pipe should be used. The pipe is pushed through the core of the GCL roll, leaving about 50 cm or so, protruding from each end of the roll core. The lifting slings from each end of the spreader bar are attached to the ends of the pipe and the roll lifted vertically using a front end loader or back hoe.

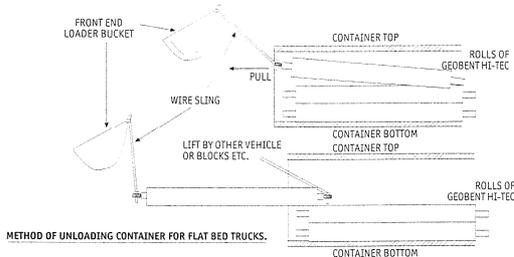


If the rolls have travelled any distance it may be that the ends of the individual rolls have moved together during the journey and the pipe at this end cannot be extended beyond the end of the core. If this is the case, or if the GCLs have been delivered by container, then the individual rolls should be offloaded, by sliding the heavy duty pipe up the centre of the core as far as possible, attach a wire rope at this end and lift the end clear of the rolls underneath, then back off the front end loader from the roll to be lifted, just half a meter or so, to slide the roll a short distance (40 cm approx) then lower the end of the roll push the pipe the rest of the way through the core so that the sling can be attached at both ends and the lift completed.

If the rolls are in a container this method must be used to move the GCL rolls to the door of the container where they can be properly lifted.

The lifting equipment must be as shown in the diagram, or similar, there are some variations, the main objective in having a spreader bar is to keep the lifting slings clear of the end of the rolls to avoid damage. The main items of the lifting equipment are a

swivel hook, or eye bolt from the bucket of the front end loader, or back hoe, to a double wire sling. The ends of each sling going from the swivel to each end of the spreader bar as shown. The spreader bar then has a short sling from each end to the ends of the pipe.



The swivel on the crane is useful in turning the roll so that it can be unrolled from the top of the roll with the stencilling uppermost so that the marks for the overlap can be used.

The forks of a fork lift should never be used, under any circumstances, to unload GCL rolls, this would incur heavy damage to the roll.

Modulo Geobent XP should be stored under covering a clean dry building if at all possible and clear of the ground, with their original wrapping left intact until ready to install. If a building is not available the rolls of GCL should be left in their original wrapping and stored off the ground on pallets or some other support and then covered with tarpaulin, or plastic sheet, to ensure that the GCLs are not subject to any inclement weather or water damage.

Modulo Geobent XP should also be carefully handled when being deployed from storage to their position around the landfill just prior to installation. Even though these liners are very forgiving of any minor damage, they should be treated with the same respect as any other liner or geotextile.

Anchor Trench and Runout

The recommended anchor trench is usually dug by a small back hoe about min. 1,5 m back from the top of the side slope (depending on the inclination and length of the slope, the distance could also be higher in order to ensure a proper anchorage of

geosynthetics). This gives the liner or multiple liners a short run out before being locked into the anchor trench.

The size of the anchor trench depends on the number of liners and length and inclination of the slope, but is usually about 60-80 cm wide by 60-80 cm deep although this can vary as mentioned.



The end of the liner should be placed into the anchor trench when the roll is being situated on the slope. Once the liner is in position the end of the liner should be down the side of the anchor trench and across the bottom, do not bring the liner up the other side of the anchor trench as this configuration would hold water and reduce the effectiveness of the anchor trench. Any excess liner should be folded in the bottom of the trench.

Once the GCL is in position the anchor trench should be filled in with the earth previously removed and compacted in two lifts, if possible, using the wheels of the back hoe, or a small roller if available.

The anchor trench should always be dug, prepared and completed before the GCL installation begins.

Liner placement

As each roll is moved from storage to its location for installation, all information from the roll should be recorded and filed by the on-site CQ officer or the person in charge.

Modulo Geobent XP should be brought from storage using the lifting device and spreader bar, as previously described, so that the GCL roll is properly supported and can be

easily unrolled from the supporting pipe, or bar. The GCL should be carried in this way to avoid damage. Never drag or roll into position ready for placement.



When Modulo Geobent XP is being placed on a steep slope it might be more convenient to attach the end of the GCL in the anchor trench and roll the GCL down the slope by passing a lifting pipe through the core of the roll attach a rope at each end and ease the roll down the slope by hand, instead of pulling the liner off the supporting bar, this is always difficult if the slope is too steep.

Tools for handling GCL

Modulo Geobent is very easy to install and the only hand tools needed are a sharp utility knife to cut and fit the GCL around protrusions or into corners. Although the GCL can be easily moved by hand it is sometimes more comfortable when laying large areas, to use broad nosed "mole grips", as used by sheet metal workers. The liner can be held quite comfortably with these grips and the liner easily maneuvered.

GCL should first be installed on the slope section. This will accommodate water run off and drainage in case of inclement weather. It will also avoid any of the GCLs being covered by standing water and spoiling the liner. This can also be avoided by covering the GCL with backfill material or the flexible membrane as soon as possible.

The amount of Modulo Geobent laid in any one day must be limited to the amount that can be covered by the flexible membrane (HDPE liner) or cover material by the close of

work. In this way there is no GCL exposed to the weather before the start of the next working day. At the end of each day, or close of work, the GCL must be completely covered with the exception of the leading edge which should be covered by a light plastic sheet (the plastic cover from the rolls can be used), this plastic sheet should then be held in position by weighting it down in some way. If backfill is being used this can be placed over the plastic. The following day at commencement of work the plastic protective cover can be quickly removed to expose a clean dry edge so that installation of the liner can continue from this overlap.

In the case of heavy rain or other forms of inclement weather the installation of the GCL should be suspended and any exposed GCL should be covered immediately.

GCL seaming

Once the first roll of MODULO GEOBENT has been placed in position, progressive liners should be placed with overlapping seam 15-20 cm longitudinally over the previous GCL; the ends of the liner should overlap at the cross seam by 30-40 cm.

These amounts of overlap can be changed to suit the situation. Sometimes on a landfill cover it may be necessary to increase the overlap to allow for differential settlements that may occur, or on a landfill liner the high surface temperatures in a hot summer may cause some slight shrinkage of the GCL.

Under normal circumstances Modulo Geobent XP should be overlapped as above and to the markings stencilled for convenience on the upper surface of the liner. At the corners of the landfill the GCL should be trimmed to fit, always ensuring that the overlapping seams are parallel to the slope.

It is imperative that all overlapping seams are clean and that a good contact is made between the two overlapping seams of the GCL.

No additional bentonite is requested for overlap seaming whenever confining pressure acting on GCL is 10 kPa minimum. If not, suggested amount of bentonite is one 25 kg bag every 2-3 rolls.

GCL damages handling

Modulo Geobent XP is forgiving in the way of minor faults and damage; however, great care should be taken in the handling and deployment of these GCLs to ensure that no damage will occur.

If there is any damage due to unforeseen circumstances the damage is very easy to repair and should be carried immediately. On the flat surfaces of the Landfill the GCL can be repaired by placing a patch of good GCL material over the damaged area, the patch should extend for about 40-50 cm all round the damage.

The patch should be held in position by carefully placing a substantial amount of backfill material by hand over the patch to ensure the patch will not be disturbed.

If the GCL is under an HDPE liner or some other flexible membrane the repair patch should be placed under the GCL by passing the patch through the liner's damaged portion and opening the patch under the GCL. This method should also be used on landfill side slopes loose bentonite can also be used on this type of repair for further advantage. If the damage is excessive the liner should be replaced.

GCL covering

All GCLs should be covered as soon as possible in the construction of a landfill liner, either by the flexible membrane and then the backfill material, or working cover. However on steep slopes this cannot always be done right away. The steep side slopes are difficult to cover with loose material depending on the angle and the type of material being used to cover the liner.

The needle-punching system used for the production of Modulo Geobent XP helps to confine the sodium bentonite by restricting the swelling of the bentonite clay and acting as a form of confining stress, improving the

hydraulic conductivity of the liner without loss or movement of the bentonite.



The GCL can therefore stand in place with the only cover being the flexible membrane. During construction of the landfill liner the GCL should not remain uncovered by the flexible membrane for any longer than is necessary, and should not be laid too far ahead of the flexible membrane.

When the product is used on a landfill cap as a single liner great care must be taken covering the GCL with the required amount of cover soil or backfill material. If possible the cover material must be placed by the bulldozer or front end loader and spread in the direction of the overlapping GCL.

Pipe penetrations

Any pipes or vents that have to pass through the landfill composite liner, and therefore the GCL must be properly sealed around the GCL prior to the installation of the flexible membrane.

The method is to wrap a short collar of GCL around the pipe and sliding it into the subgrade and then covering the area round the pipe with sodium bentonite in powder or granules the whole is then covered by a patch fitted round the pipe.

This type of methods used on any penetration or protrusion through the liner.

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