Tech Note - Welding on Steep Slopes and Vertical Walls.

The requirement to install and weld geomembrane liners on steep slopes and vertical walls is not uncommon, however they do pose challenges that need to be overcome to ensure a safe and high-quality installation.

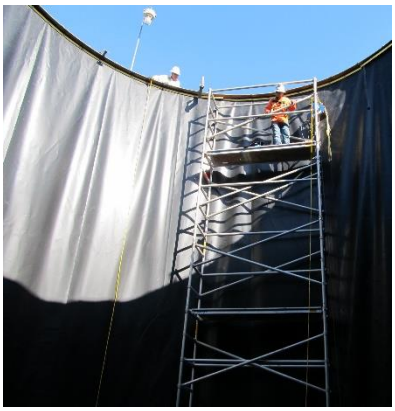
Steep Slopes:

Typically, containment systems are designed with batter slopes of 3H:1V or less to provide sufficient bank stability and for ease of construction. In some instances, due to pre-existing conditions, area constraints, local topography or to achieve required storage volumes, the impoundment is designed with steeper batter slopes of up to 1H:1V (45°).

The general principals of lining steep slopes are consistent with the methodology used on regular sloped impoundments, taking into account the depth of the impoundment, special consideration should be given to the following:

1. Construction of the subgrade becomes more difficult and may require specialized equipment. The subgrade must be stable with well compacted clay. Loosely compacted slopes may not provide the impoundment with the necessary structural stability and loose surfaces will make the liner installation much more challenging. Loose material will be displaced during the install and the surface may slump or settle unevenly.
2. All personnel access on the slope must be via geomembrane ladder, textile ladder or rope ladder. On steep slopes it is always preferable for personnel to tie off to anchor points at the top of the slope with a harness system. If vehicles or mobile equipment are used as anchors they should be locked out/immobilized while personnel are anchored.
3. The geosynthetic components of the liner system may comprise geotextile, drainage net, geocomposite and geomembrane. To deploy the geosynthetic components, it is recommended that these materials are deployed from the top of the embankment. Ropes or lifting slings should be clamped to the end of the material and pulled off the rolls with equipment or UTV's at the base of the impoundment. Dependent on the length of the slope and size of the impoundment, it may be more beneficial to install materials on the batter slope and floor sections separately.
4. Ensure there is sufficient temporary ballast (e.g. sandbags) available to secure the geosynthetic components. On steeper slopes the weight of the geosynthetic material alone can cause it to pull down the slope.
5. Best practice is always to weld upslope. Using an additional technician at the top of the slope with a rope attached to the wedge welder to take the weight of the welder should be considered. This will allow the welding technician to concentrate on guiding the welder and ensuring the correct lap is maintained. Repairs with extrusion welders also become equally challenging given the weight of the welder, but again, using the same protocols for wedge welding are usually sufficient.

Vertical Walls:



Tanks, clear wells and cut-off walls typically have vertical walls which often need lining. As with steep slopes special consideration needs to be given to:

1. All working at heights regulatory requirements MUST be followed.
2. All personnel access up the wall (above chest height) should be via elevated work platform (EWP - scissor lift or boom lift) or mobile scaffolding. All personnel must ensure fall protection (harness systems) are in continuous use while working in an elevated position.
3. The geosynthetic components of the liner system may comprise geotextile, drainage net, geocomposite and geomembrane. Deployment methodology is generally determined by the access available at the site. With vertical installations it is best to measure the section to be lined carefully and to pre-cut and pre-fabricate the panels whenever possible.
   Deployment of the geosynthetic material and/or panels can be achieved by draping the material from the outside of the wall using a telehandler or crane. Alternatively, if access is not possible from the outside of the wall, lifting the material inside from the floor can be achieved using rope and pulley systems anchored at the top of the wall. With all overhead work, appropriate PPE (safety helmets, kickboards etc.) should be worn and qualified riggers/spotters employed. Typically, it is beneficial to install materials on the wall and floor sections separately.
4. Welding up vertical walls is labor intensive. Best practice is to weld from the base up the wall. The lightest possible welding machine for the material to be welded should be used.
   In general, if an EWP is used, an operator should be operating the EWP leaving the welding technician in the basket to concentrate on the welding process. If scaffolding is used, as a minimum 2 welding technicians will be required. The first welding technician starts the weld at the floor and up the wall to pass to the 2nd welding technician. The 1st technician must then climb higher in the scaffolding to leapfrog the 2nd technician. The 2nd technician will then pass the welding machine up and this leapfrogging process is continued until the weld is completed at the top of the wall.
   In both cases, an additional technician on the floor with a rope passed through a pulley at the top of the wall and attached to the wedge welder to take the weight of the welder should be considered. This will allow the welding technician/s to concentrate on guiding the welder and ensuring the correct lap is maintained.
   Repairs with extrusion welders also become equally challenging given the weight of the welder, but again, using the same protocols for wedge welding are usually sufficient.

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