

Method Statement waterproofing works

Lining of ponds, canals and tanks for industrial, agriculture and environmental purpose with prefabricated membranes

General

Ponds and canals have an enormous economical and technical importance in agriculture, public water supply, supply of electric energy, industry and environment.

Its functions depends strongly on durable and reliable waterproofing.

Movements of structures, settlements of underground and grounds, permeable to water can impair the function of such facilities.

Waterproofing membranes as flexible waterproofing are adjustable to such movements and secures, that the complete content of ponds and canals can be supplied to its purpose.

The significant advantage of flexible waterproofing are, compared to other sealing system, the low costs for installation and maintenance.

Depending to kind of structure, the loosely laid membrane can either be fully exposed, or protected with ballast layers.

This method statement describes the installation(*) of Sikaplan® Trocal® and Mipoplast® waterproofing membranes (*installation = supply, unrolling, positioning, fixing and overlap-welding of pre-manufactured waterproofing membranes)

Purpose

Agriculture:

- irrigation canals
- irrigation pools
- fish-hatching ponds
- salinas
- protective dams/dykes

Public water supply:

- supply canals to purification plants
- rainwater retention pools
- settling pools
- process water pools

Hydroelectric power supply:

- up-/downstream canals
- pools for pumped storage - scheme
- dams

Industry:

- process water-storage pools
- fire pool / sprinkler systems

Environment:

- retention basins for oil tank yards
- pools for liquid manure

Artificial lakes:

- biotopes
- swimming lakes



Construction requirements

The main planning criterions for pit- and pond lining are:

- purpose of structure
- waterproofing lining fully exposed or ballasted
- capacity, hydraulic conditions, waterflow
- kind, quality and temperature of water
- topographical conditions
- waterproofing substrate
- climatic conditions (wind/temperature/rainfall)
- measurements of structure
- groundwater level and natural sources

annex structures:

- inlets/outlets
- emergency-overflows, spillways
- pump sumps
- valve shafts
- locks

Project specification

In order to avoid any kind of damages of the installed waterproofing membrane and to assure its proper function as waterproofing, following requirements to the substrate should be fulfilled:

- the structure should be designed to minimise movement of the structure, due to temperature, settlement and contraction
- reinforcement bars in concrete structures should be min. 20mm below surface
- all metal elements, used as part of waterproofing should be stainless, or anticorrosive (i.e. cast iron, V2A, V4A steel quality)
- soils and planum should be compacted (Proctor value min.95%) and smooth
- water pressure, as well as vapour pressure from substrate on membrane, should be avoided with sufficient drainage system and ventilation pipes under the waterproofing lining
- the surface of substrate should be smooth to avoid punctures of membrane under influence of hydrostatic pressure

Preparation works

Materials stockyard

A secured area (i.e. storage hall, or open ground) to store rolls of membranes, geotextiles and all its required auxiliary products with accessibility to lifting and carrying equipment to secure logistic from stockyard to installation site, should be available close to installation site. Membranes should be stored weathering protected. Defined quantities of waterproofing membranes and geotextiles should almost be available from stockyards, in order to prevent work interruptions due to lack of material.

Installation equipment

Depending to requirements, supply and install all equipment for membrane installations, i.e.:

- movable working platforms for linings of high rising walls
- movable unrolling hooks
- mobile hydro-pneumatic movable working platform, or cranes
- illumination equipment, if works has to be performed in the dark
- power supply with 380V/220V to installation area to drive welding equipment
- equipment, to lift membrane and geotextile rolls on working platforms, i.e. with light hydraulic cranes
- ventilation equipment for works in closed tanks

General

Representatives of waterproofing contractors should have the possibility of site inspection in the beforehand, in order to get impression for quotations and preparations of works to be performed.

Electric power (110/220V/380V), clean water and ev, compressed air (5 - 10bar/1000 - 1500l/min.) should be available on site. The access to site should be in a proper size to pass all required machinery's, equipment, tools and products for waterproofing works (i.e. manholes into tanks). The access of unauthorised persons should not be allowed to avoid punctures of installed waterproofing lining. The labours of waterproofing contractors should be advised, that the access onto the installed membrane is allowed in soft and no sharp edged shoes (i.e. shoes with soft rubber soles) only. Smoking and open fires should not be permitted within installation site.

Substrate conditions

General

Wet substrates to be lined membranes are acceptable for installation. Running and ponding waters should be removed and maintained dry (i.e. drainage pipes or well system), prior to sheet membrane installation until completion of waterproofing works.

Substrates

a.) new concrete structures:

The surface of substrate shall be smooth (steel trowel finish, resp. first class formwork quality) and edges shall be chamfered. The slope shall be $\geq 2.00\%$. Any projections in cementitious substrate must be removed by chiselling and be grinded afterwards; nails and wires must be removed. Honeycombed concrete must be chiselled and reprofiled with repair mortar. Water infiltration's through cracks of concrete structures, or along steel elements shall be sealed, either with waterproofing mortar, high pressure injection of fine-cement suspension. Throughout waterproofing measurements against hydrostatic pressure from outside, see our sep. system description of groundwaterproofing of structures. The aggregate-diameter of plasterings and mortar screeds shall not exceed 0 - 4mm.

The whole surface shall be throughout cleaned by using of high pressure water. Ponding water shall be removed and the whole surface must be dried off, by using of compressed air.

b.) refurbishment of existing concrete structures

Old linings, as well as hollow plasterings and screeds shall be removed. Larger cracks and honeycombs in structure shall be chiselled and reprofiled with repair mortar. Water infiltration's shall be sealed, either with waterproofing mortar, or high pressure injection of fine-cement suspension. New plasterings and screeds shall be applied on sandblasted substrates, its aggregate diameter shall not exceed 0 - 4mm and its surface must be steel-trowel finished. Edges shall be chamfered. The whole surface shall be throughout cleaned by using of high pressure water. Ponding water shall be removed and the whole surface must be dried off, by using of compressed air.

c.) excavated soils / dam fill

The excavated soil, or dam fill must be compacted to Proctor value min. 95%. Crushed stones on compacted soil surface on slopes shall be removed. In order to allow proper dewatering under waterproofing membrane on bottom, the soil shall be sloped to $\geq 4.00\%$ and covered with a filter layer of fine gravel (dia. $\leq 4\text{mm}$ / thickness 5cm). The drainage system as well as ventilation must be fully functioning (no ponding water on surface visible). Layout of rodent protection over drainage pipes, ventilation pipes, and at waterproofing terminations in form of wire mesh strips (material: galvanised steel, dia. $\geq 1.0\text{mm}$, mesh width $\leq 15\text{mm}$). The wire mesh shall be fixed with i.e. herring nails into the soil and covered with fine gravel.

Material requirements

Geotextiles

The geotextile to be installed on prepared substrate have the function of a cushion layer to protect the membrane against puncturing, as well as drainage layer to lead seepage waters to bottom area.

The geotextile should be material compatible to PVC and PO membranes as well as cementitious substrates), such as Polypropylene non woven fabric with needed, or thermal cured endless fibre (chemical cured fibre are not allowed).

Physical properties:

- Unit weight: $>500\text{g/m}^2$ as per NF.G 38013
 - Thickness: $>4.00\text{mm}$ as per NF.G 38012
 - Tensile strength: $>500\text{N}/50\text{mm}$ as per DIN 53857/2
 - Elongation: $>80\%$ as per DIN 53857/2
 - Perforation: CBR $>1600\text{N}$ as per DIN 54307
 - Water permeability: $4 \times 10^{-3}\text{m}/\text{sec}$ as per NF.G 38016
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Pre-manufactured waterproofing membrane	<p>The waterproofing material, similar to Sikaplan®, Trocal® and Mipoplast® membranes, should consist of calendered (laminated), or extruded membrane on base of plastified Polyvinilchloride (PVC-p), or Polyolefine (PO).</p> <p>Physical properties should comply to the requirements as per DIN 16726 for polymeric waterproofing membrane and according to product data sheets to Sikaplan®, Trocal® and Mipoplast® membranes.</p>
Protection layers	<p>The installed waterproofing membrane shall be protected against mechanical damage by overlay of protection layers on installed membrane where required:</p> <p>The protection layers should be made of geotextiles, geocomposites, or protection sheets</p> <p>The protection sheet shall be loose laid and overlapped at edges with min. 100mm on installed membrane. The overlaps shall be welded by using of heat welding machine (either manual welding, or automatic welding).</p> <p>The protection sheet material, similar as Sikaplan® 30 Protection Sheet shall consist of calendered (laminated) membrane on base of plastified and unreinforced Polyvinilchloride, thickness not less than 3.00mm.</p>
Fixing elements	<p>Waterproofing membranes to be installed into concrete structures should be fixed with fixing elements at all corners, peripheries and terminations, where the installed membrane is unprotected.</p> <p>Fixing elements should be made of PVC-(for PVC-membranes), or PO - (for PO-membranes) laminated metals, similar to Sika® - Trocal® PVC-, or PO - laminated metals, to be cut and folded to profiles in metal workshop.</p> <p>Alternatively, profiled, or unprofiled Aluminium strips, supplied by others may be used.</p>
Installation procedure	
General	<p>The installation procedure of waterproofing membrane in ponds, pools, or canals depends on:</p> <ul style="list-style-type: none"> -chosen waterproofing system (exposed / ballasted) -project design -chosen membrane type and its fixing method <p>The following installation instructions are divided in single operations, applicable according to kind of each project. The operation-sequences should be defined according to project design and its specifications.</p>
Waterproofing terminations with PVC-/PO-laminated metal profiles at vertical concrete substrates:	<p>Unrolling and positioning of geotextile protective layer, to be fixed with PVC-/PO-laminated metal profile and loose hanging at wall. Mounting of PVC-/PO-laminated metal profile (cut to size 165mm x 2000mm, two times- folded / mounting holes ø 5mm in distance of 150mm). The top level of profile should be placed min. 50cm above max. water level. Between each profile should be a gap of 5mm. The profiles should be fixed with countersunk screws (dia. 4.5mm/lenght 16.5mm, stainless steel) and dowels into substrates. The gaps between profile elements should be covered with 20mm-adhesive tapes.</p>
Waterproofing terminations in form as membrane end, loosely laid and ballasted in peripheral-trench on dam crest:	<p>Unrolling and positioning of geotextile protective layer, loosely laid in trench and provisional ballasted (i.e. with stones, or sandbags) at opposite edge of trench. Loosely layout of hot air welded waterproofing membrane (slope waterproofing) into trench. The installed membrane in trench shall be ballasted with unreinforced concrete, or compacted sand/round-gravel</p>
Linear fixings at edges with PVC-/PO-laminated metal angles at vertical concrete substrates	<p>Unrolling and positioning of geotextile protective layer, to be fixed with PVC-/PO-laminated metal angle and loosely hanging at wall. Mounting of PVC-/PO-laminated metal angles (cut to size 200mm x 2000mm, single folded 100mm x 100mm - angle / mounting holes ø 5mm in distance of 150mm). Between each profile should be a gap of 5mm. The profiles should be fixed with countersunk screws (dia. 4.5mm/lenght 16.5mm, stainless steel) and dowels into substrates. The gaps between profile elements should be covered with 20mm-adhesive tapes.</p>

Waterproofing details at penetration in walls (flanges supplied by client)

The surface of steel should be smooth, clean and free of oil and fat. Creation of sealing rings (two pcs. each penetration), made of waterproofing membrane in size according to flange (half - rings, if size of flange exceed standard roll width / in general: the size of penetration should not exceed 1500mm). Cut opening in waterproofing membrane, which size should be equal to the size of penetration and the roll length equal to wall height. Overlapping seams should be terminated at outer edge of flange and intersectioned to butt-seams. Hot air welding of prepared sealing rings congruent at penetration opening of waterproofing membrane on both sides of membrane. The location of bolts signed on welded membrane and cut of bolt holes with the aid of a punch-knife (diameter of punch-knife equal to bolt diameter). The prepared waterproofing, incl. welded sealing rings should then be slipped over the base flange and be mounted according to step. Mounting of pressure flange afterwards (the membrane should not be waved and sealing rings not fishmouthed in the pressure flange).

Mounting of support steel sheets over openings of expansion joints in walls

One sided mounting of PVC-/PO-laminated metal sheets (size 200mm x 2000mm / fixing-holes, dia. 5mm, distance 150mm), alternatively stainless steel sheets. The one-sided fixings should be done with countersunk screws with dowels (dia. 4.5mm / 16.5mm length / stainless steel). Between the metal sheets should be a gap of 2 - 3mm, which should be covered with 20mm adhesive tape.

Installation of waterproofing membrane at concrete walls:

Unrolling and cut to size of waterproofing membranes (size according to wall-height, incl. overlength for adjustments and overlaps). Positioning of membranes (length in vertical direction) in respect of membrane overlap (min. 50mm) and fixing at terminations and edges according to chosen fixing method:

a.) PVC-coated metal profile:

Hot air welding of waterproofing membrane on PVC-coated metal profiles

b.) Aluminiumprofile:

Fixing of membrane ends with aluminium profiles (size 30mm/40mm x 2000mm, two times folded 45°, with mounting holes dia. 5mm in distance 150mm), to be fixed with screws and dowels (dia. 4.5mm/length 16.5mm / stainless steel). Horizontal linear fixings all 2.00m with aluminium strips in membrane overlaps required, if wall height exceeds 4.00m (size 4mm x 20mm x 2000mm, edges rounded, fixing holes dia. 5mm in distance 150mm, with countersunk screws and dowels dia. 4.5mm / length 16.5mm / stainless steel).

c.) Aluminiumstrip:

Fixing of membrane ends with aluminium strip (size 4mm/20mm x 2000mm, edges rounded, with mounting holes dia. 5mm in distance 150mm), to be fixed with countersunk screws and dowels (dia. 4.5mm/length 16.5mm / stainless steel). Horizontal linear fixings all 2.00m with aluminium strips in membrane overlaps required, if wall height exceeds 4.00m. Overhanging membrane end at waterproofing termination to be downfolded and hot air welded onto waterproofing membrane.

Installation of waterproofing on slopes (substrate: compacted soil):

Unrolling and positioning of geotextile protective layer, loosely laid, 100mm overlapped and provisional ballasted (i.e. with stones, or sandbags). Loosely layout, positioning of waterproofing membrane under aid of unrolling equipment until peripheral trench on bottom or on bench and hot air welding of overlaps (overlap min. 50mm). The installed membrane in lower trench should be ballasted with unreinforced concrete, or compacted sand/round-gravel.

Mounting of periphery fixing on bottom:

a.) with PVC-/PO-laminated metal profile (incl. prestressing of vertical waterproofing):

Preparation of PVC-/PO-laminated metal sheet (size 200mm x 2000mm / angled to 100mm x 100mm / fixing holes in both shanks, dia. 5mm in distance of 150mm). Loose layout of PVC-/PO-laminated metal angles with gap of 5mm between each element (gaps to be covered with 20mm adhesive tapes) on wooden beam at wall (the thickness of wooden beam should be approx. 1% of wall height). Hot air welding of vertical waterproofing membrane on vertical shank of PVC-/PO-

laminated metal profile. For the prestressing procedure (stretching of vertical waterproofing membrane), the wooden beam should afterwards be laid on vertical shank of the hanging PVC-/PO-laminated metal angle, firmly pressed to the wall and weighted to bottom. Fixing of weighted angle with countersunk screws (dia. 4.5mm / length 16.5mm / stainless steel) and dowels into substrate.

b.) with aluminium strips (without prestressing of vertical waterproofing):
Fixing of vertical waterproofing (100mm apart from membrane ends) with aluminium strip (size 4mm/20mm x 2000mm, edges rounded, with mounting holes dia. 5mm in distance 150mm), to be fixed with countersunk screws and dowels (dia. 4.5mm/length 16.5mm / stainless steel).

Waterproofing details at penetration in slabs (flanges supplied by client):

The surface of steel should be smooth, clean and free of oil and fat. Creation of sealing rings (two pcs. each penetration), made of waterproofing membrane in size according to flange (half - rings, if size of flange exceed standard roll width / in general: the size of penetration should not exceed 1500mm). Cut opening in waterproofing membrane, which size should be equal to the size of penetration and the roll length equal to wall height. Overlapping seams should be terminated at outer edge of flange and intersectioned to butt-seams. Hot air welding of prepared sealing rings congruent at penetration opening of waterproofing membrane on both sides of membrane. The location of bolts signed on welded membrane and cut of bolt holes with the aid of a punch-knife (diameter of punch-knife equal to bolt diameter).

Mounting of support steel sheets over openings of expansion joints in slabs:

One sided mounting of PVC-/PO-laminated metal sheets (size 200mm x 2000mm / fixing-holes, dia. 5mm, distance 150mm), alternatively stainless steel sheets. The one-sided fixings should be done with countersunk screws with dowels (dia. 4.5mm / length 16.5mm / stainless steel) Between the metal sheets should be a gap of 2 - 3mm, which should be covered with 20mm adhesive tape.

Installation of horizontal waterproofing on concrete slab:

Unrolling and cut to size of waterproofing membranes (size according to required length on bottom, incl. overlength for adjustments and overlaps). Positioning of membranes (roll-length in longitudinal direction) in respect of membrane overlap (min. 50mm) and hot air welding at edges. Provisional ballast of unrolled waterproofing membrane (i.e. with sandbags).
The prepared waterproofing, incl. welded sealing rings for pipe penetrations in slab should be slipped over the base flange. Mounting of pressure flange afterwards (the membrane should not be waved and sealing rings not fishmouthed in the pressure flange). Afterwards, hot air welding of all seam overlaps.

Installation of waterproofing on bottom (substrate: compacted soil/fine gravel layer):

Unrolling and positioning of geotextile protective layer, loose laid, 100mm overlapped and provisional ballasted (i.e. with stones, or sandbags). Loose layout, positioning of waterproofing membrane under aid of unrolling equipment until peripheral trench on bottom and hot air welding of overlaps (overlap min. 50mm). hot air welding of installed membrane on waterproofing of slope. The installed waterproofing membrane should be provisional ballasted (i.e. with sandbags) unless definite ballast is installed.

Heat welding procedure for membrane overlaps

Heat weldings of membrane overlaps should be performed with automatic heat welding machines, details with hand held heat welder and pressure roller (supplied by others).

The membrane surfaces to be welded should be clean, dry and free of fat or oil. Fat or oil shall be cleaned with dry and white cotton rags and Sika®-Trocal Cleaner 2000 (solvent-free cleaner for PVC membranes), or Sika®-Trocal Cleaner L 100 for PO-membranes.

Prior to any welding works, the welding parameters (speed, temperature and pressure of rollers) shall be adjusted at the automatic welding machine and tested at separate membrane specimen.

Clamp membrane overlaps at membrane end into welding machine, insert welding nozzle into overlap and start machine self-traction. Lead the machine at hand held along overlap. This welding procedure shall be performed without interruption until other end waterproofing membrane.

Widths of membrane overlaps should in no cases be less than 50mm

Seam control and seam sealing:	All welded seams, incl, seams of details (terminations, edges, corners, penetrations, etc.) should be approved visually on its watertightness by using of screw driver (size 5), or with the aid of hand welding machine. A throughout welding rope at seam edges must be visible on PVC membranes. Interrupted welding rope could be the sign of capillaries in welded seam and must be rectificated with hand welding machine and pressure roller. Complex details of seam overlaps at details may be checked with vacuum bell testing kit (supplied by others) and soap solutions.
Cleaning of membrane surface:	The surface of waterproofing membrane should be cleaned by throughout rinsing with clear water after completion of approval of watertightness.
Recommended installation tools and machineries	<p>Welding machines (available from www.leister.com):</p> <p>Automatic (= self driver with adjustable speed and temperature, overlaps clamped):</p> <ul style="list-style-type: none"> - Leister Twinny S, el. self propelled single seam welding machine with double traction <p>Semi-automatic (= self driver with adjustable speed and temperature):</p> <ul style="list-style-type: none"> - Leister Triac Drive, el. self propelled single seam welding machine with single traction for welding of waterproofing membranes in narrow area. <p>Manual welding (= hand-held welder with adjustable temperature and hand-held pressure roller):</p> <ul style="list-style-type: none"> - Leister Triac, el., driven by hand pressure and with hand held pressure roller <p>Testing kit for seam control of patches (available from www.herzgbh.de):</p> <ul style="list-style-type: none"> - translucent vacuum bell with rubber lips, reverse flow valve and manometer - el. vacuum pump, portable
Inspection and acceptance of completed waterproofing works	Prior to further protection works, representatives from waterproofing contractor and from client should inspect the completed works. The inspection should be recorded in written report to be signed by both parties.
Protection requirements	<p>a.) exposed waterproofing: Ballast elements (i.e. prefab concrete), placed on waterproofing membrane, requires geotextile protective layer. It is recommended to install (edge welding on installed waterproofing membrane) second layer of waterproofing membrane on slopes, or at wall in the range of min. and max. water level, were the membrane is most exposed to UV-light, water, algae-attack and ice. It is recommended to install geocomposite protective layer (to be anchored behind peripheral trench), covered with vegetation layer and plants on crest until max. water level, in order to protect the waterproofing membrane against various kinds of punctures (i.e. animals, vandalism's, etc.).</p> <p>b.) protected waterproofing (fully ballasted with concrete layer): Loose layout of geotextile protection layer and polyethylene foil (alternatively geotextile, faced with polyethylene foil) on installed waterproofing membrane. Application of protection mortar, thickness min. 5cm (alternatively distance holder for reinforcement bars). The membrane shall be additional (linear) protected against vertical formwork for construction joints.</p> <p>c.) protected waterproofing (fully ballasted with sand/gravel layer): Loose layout of geotextile protection layer on installed waterproofing membrane. Application of sand / gravel, compacted, thickness min. 30cm.</p>

Approval of watertightness

Besides the control of welded seams, the facility should be filled with water stepwise. The watertightness should be controlled by measurement of water table for water loss at each testing step. Thus allows rough localisation of ev. leaks in waterproofing membrane. The drainage pipes should be controlled in shafts for "unnatural" high waterflow.

Installation Limits

Installation works shall be performed by Sika® - approved membrane installers only

The chemical compatibility of other plastic materials, supposed to be in permanent contact with the specified membranes should be approved, prior to installation works. Incompatibility requests separation layer between the concerned products in form of geotextiles > 500g/m².

Some membrane are not UV-stabilised and shall not be installed at structures, permanent exposed to weathering, neither shall it be stored exposed to direct sun.

Membrane installation works should not be performed at ambient temperatures below + 5°C.

Quality control

All waterproofing products shall be subjected to standardized quality control system as follows:

- quality control of materials, delivered to stockyard on site, such as conformity of quantity and quality of material, incl. control of stock
- professional logistic from stockyard to installation site (careful handling)
- inspection of substrates, prior to waterproofing works
- inspection of professionalism of waterproofing contractor on site
- throughout control of watertightness of welded seams
- final inspection of completed works, prior to further concreting works

Standardized quality control system is available of separate sheet forms

Health and Safety Information

Protective Measures	Not required Local regulations must be observed. Fresh air ventilation is recommended, when working in closed rooms
Important Notes	Recommendation: material is recyclable. Disposal according to local restrictions Detailed health and safety information as well as detailed precautionary measures e.g. physical, toxicological and ecological data can be obtained from the safety data sheet of products.
Legal Notes	The information, and, in particular, the recommendations relating to the application and end-use of Sika products, are given in good faith based on Sika's current knowledge and experience of the products when properly stored, handled and applied under normal conditions. In practice, the differences in materials, substrates and actual site conditions are such that no warranty in respect of merchantability or of fitness for a particular purpose, nor any liability arising out of any legal relationship whatsoever, can be inferred either from this information, or from any written recommendations, or from any other advice offered. The proprietary rights of third parties must be observed. All orders are accepted subject to our current terms of sale and delivery. Users should always refer to the most recent issue of the Product Data Sheet for the product concerned, copies of which will be supplied on request.



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