TRELLEBORG

Note!
This page is clickable.

1. Trelleborg Waterproofing 1
2. Contact Details 2
3. Elastoseal EPDM Geomembrane System 3
4. Product Specifications 4
5. Certificate & Environment 5
6. Guide Specification 6
7. QAS - Quality Assurance 7
8. Panel Prefabrication Manual 8
9. Installation Manual 9
10. References 10
11. Material Comparisons 11
12. Samples 12

Trelleborg Waterproofing –Solutions Securing Values

Trelleborg Waterproofing offers water and weather protection systems for increased service life of buildings and other types of construction. We are part of the global industrial Trelleborg group, which is based on leading polymer technology and unique applications know-how in sealing, damping and protection for demanding industrial environments throughout the world.

Our vision is to offer innovative air-, sound- and water resistant products and systems, making it possible to save on energy and environment, as well as increasing the service life of buildings and other constructions.

Our core values guide us in making decisions and conducting business:

Customer focus All of our decisions are taken with the customer in focus. Working in partnership, we aim to add value for our customers, as well as for Trelleborg Waterproofing.

Performance "Performance" is not only about the results we achieve but how we achieve them.

Innovation We think differently and strive to apply innovative thinking and creativity to everything we do.

Responsibility We have a social responsibility and we carefully protect the positive image of our company.

Our customers should always feel that our products as well as our commitment correspond to their needs and expectations. This is achieved through quality driven team work where each single activity in combination with all other activities in our organization results in satisfied and returning customers.

Trelleborg Engineered Systems is a leading global supplier of engineered solutions that focus on sealing, protection and safety of investments, processes and individuals in extremely demanding environments.

Trelleborg Engineered Systems comprises four business segments:

Industry: precision components and systems in polymer coated materials, such as hoses, elastomer laminates and polymer-coated fabrics. Other special products, such as molded components to many different industry segments, printing blankets for the graphics industry, and industrial antivibration applications.

Infrastructure Construction: specialized solutions for infrastructure projects, for example, fender systems for harbors, tunnel seals, dredging systems, pipe seals, acoustic and vibration damping solutions for railways, bridges and buildings, and protective suits and diving suits.

Offshore: niche oriented products for offshore oil and gas extraction.

Building: Polymer and bitumen based construction products for sealing and waterproofing applications for industry and consumers.

Protection against the elements

We supply complete systems including all component parts. Our waterproof roofing membranes comprise a range that covers virtually all needs. The materials are well proven and comply with strict environmental criteria.

High-tech membranes with exceptionally long service life

It is not enough for a waterproof membrane to stay watertight, it must also be capable of withstanding frost, snow, heat and strong winds without physical or chemical changes that could shorten its intended service life. All our membranes satisfy statutory requirements and have been tested under the harshest imaginable conditions.

Every year we spend large amounts of money on research and development of

both materials and system solutions. Trelleborg membranes are the result of intensive development, often at basic research level.

They now last longer than ever; studies show that we have materials that can retain their properties for 40–50 years at a total cost which is often substantially lower than that of alternative types of roofing. That, and their minimal maintenance demand,

Trelleborg Waterproofing's commitment:

+ Scientifically designed waterproofing systems
+ Installed by trained contractors
+ Quality control plan and quality assurance checklist
+ Comprehensive warranties

= Dependable, long-lasting waterproofing with minimum maintenance demand

Protection against the elements

make our membranes very attractive and economical options for the user.

Single-ply principle and ballasted roofs

Our waterproofing systems are based on the single-ply principle, mechanically fastened or ballasted. They are much more dependable and durable than traditional roofing systems consisting of two or more glued layers.

Not just roofs

In addition to roofing, Trelleborg Waterproofing supplies a wide range of membranes and systems for waterproofing and containment. We have systems for facades, tanking, secondary containment, reservoirs and landfills.

Trained contractors

A waterproofing system is no better than its weakest link, and experience has shown that damage and leaks are usually caused by faulty installation. That is why we provide all our contractors with training on our waterproofing systems: product knowledge, application methods and quality assurance.

A safe choice

Buyers benefit from an extensive quality control plan that covers the whole process, from raw materials and manufacturing until the waterproof membrane is in place, so you can be sure that it will perform its function for many years to come.

Our warranty assurances and safety packages are among the most comprehensive on the market.

Contact Details

Trelleborg Waterproofing AB

Company Information

Trelleborg Waterproofing AB
Polymeric Membranes
P.O. Box 1004
SE-331 29 Värnamo
Sweden

Phone: +46 370 481 00
Fax: +46 370 485 00
E-mail: polymeric.membranes@trelleborg.com
Internet: www.trelleborg.com/waterproofing
Personal e-mails: firstname.surname@trelleborg.com

Visiting and delivery address:
Kävsjövägen, Norregårds Industriområde
SE-331 35 Värnamo
Sweden

Invoicing address:
Box 1088
SE-231 81 Trelleborg
Sweden

GPS coordinate:
Lat: N 57° 12' 10.45"
Long: E 14° 1' 57.50"

VAT No:	SE556739698001
Registered office:	Höganäs
Org. No:	556739-6980
Account:	SWIFT
Swift address:	ESSESESS
For domestic payment:	Bankgiro 272-9481
IBAN:	SE8050000000057461014900

General Conditions of Delivery: www.trelleborg.com/waterproofing

Elastoseal EPDM Geomembrane

A landfill is a San Francisco in miniature. Everyone knows that earth movements and large settlements will come. The question is only when and how serious. Therefore, the waterproofing layer over a landfill must be flexible enough to accommodate all movements and settlements in the substrate without rupture, irregardless of temperature, age, mechanical loads or chemical and biological influence. One material can withstand deformation better then all others. Rubber!

EPDM rubber

– a superior geomembrane in waste landfills and wastewater reservoirs.

Elastoseal EPDM Geomembrane is a vulcanised rubber sheet that belongs to the product group polyolefines. The long rubber molecules have been cross-linked to an elastic and chemically stable membrane. Strength and elasticity are not affected by high or low temperatures and physical properties are practically unchanged over decades of service, without becoming brittle, cracking or shrinking.

Viscoelastic properties

Rubber membranes have no yield point under elongation whereas thermoplastic materials become thinner, uncontrolled and will break at a low tensile force. Rubber membranes elongate in a linear fashion to maximium 300 % and can be elongated in all directions at the same time (multiaxial response). Rubber membranes are not subjected to stress cracking, whereas semicrystalline materials will break even at a low stress, in points where the surface is scratched, contains defects or exhibit other weaknesses. Stress cracking occurs already at elongations of 20-30 % of the yield point of thermoplastic materials, i.e. at 2-4 % elongation. The risk of stress cracking on thermoplastic, semicrystalline materials increase upon installation or service at low temperatures.

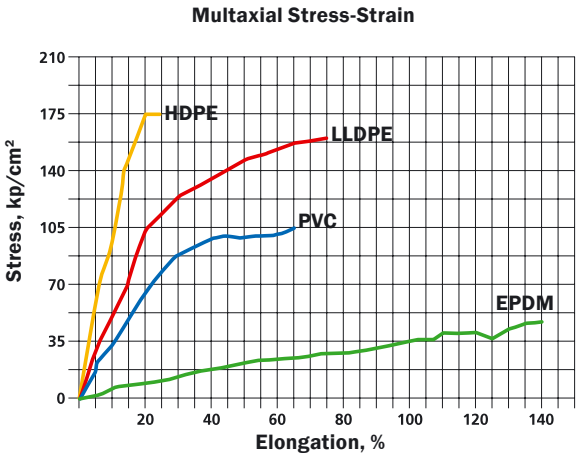
A rubber membrane has viscoelastic properties, which means that the product can withstand an almost unlimited pressure load. At low loads the elastic properties are dominating and at high loads the viscose properties dominate. The material can be deformed to extreme limits and still return to its original size and shape. The opposite is true for the semicrystalline thermoplastic materials, where a concentration of load or force results in a permanent deformation or thickness reduction. EPDM is highly resistant to microbiological attack, root penetration. EPDM resists leachates and acids, alkalies, nitrates and phosphates in solution. The membrane is UV resistant and can be installed both exposed or earth covered. The service life and performance is exceptional, as the strength and elasticity remains virtually unchanged even after decades of service.

Trelleborg Waterproofing AB
P.O. Box 1004, SE-331 29 Värnamo, Sweden
Tel: +46 370 481 00, Fax: +46 370 485 00, E-mail: polymeric.membranes@trelleborg.com

Elastoseal EPDM Geomembrane

Superior characteristics Elastoseal EPDM Geomembrane

- Elasticity and strength – irrespective of temperature the membrane will perform well under maximum working load.
- Multidimensional Strain – superior resistance to earth settlements and movements.
- Puncture resistant with full flexibilty up to the maximum tensile strength.
- Lay flat characteristics – adheres to and provides close contact to any substrate.
- Unaffected by low temperatures and fully thermally seamable even in freezing temperatures.
- Optimal surface friction characteristics – soft textured rubber surface provides high interface friction.
- Excellent UV and ozone resistance – superior service life also in exposed installations.
- High resistance to chemicals – the membrane provides chemical resistance needed in landfills, wastewater reservoirs and ponds.
- Large panels fabricated to specified sizes according to site drawings. The result is reduced field seaming and short installation times.
- The Thermobond seaming technique with hot wedge allows for maximum installation control and quality.
- The Thermobond seaming with dual hot wedge allows for conventional air channel QC testing on site.
- Can easily be adhered to substrates of concrete, wood or metal. All details and anchoring with conventional methods that are quality controlled.
- Protrusions and pipes are easily attached with prefabricated boots and hot air seaming.
- Damage is easily repaired, even after long service life and exposed installations.
- Rubber membranes have been used for over 50 years in lining applications and have the longest history of all geomembranes.
- Trelleborg has over 30 years of experience with rubber membranes in geotechnical applications.



The stress and strain response for four common geomembranes. EPDM membranes have superior multiaxial elongation properties.

Trelleborg Waterproofing AB
P.O. Box 1004, SE-331 29 Värnamo, Sweden
Tel: +46 370 481 00, Fax: +46 370 485 00, E-mail: polymeric.membranes@trelleborg.com

Elastoseal EPDM Geomembrane

Facts on EPDM Geomembranes

EPDM is a synthetic polymer developed in 1959. Over 40 years EPDM has found an ever increasing use as construction material in the automotive industry and within building and civil engineering.

EPDM is an amorphous elastomer obtained by the co-polymerization of ethylene, propylene and a nonconjugated diene monomer. EPDM is a polymer composed of saturated linear macromulecules with a paraffinic structure. Because the EPDM remains saturated after vulcanisation it resists degradation due to oxidation. The rubber compound also contains reinforcing carbon black, fillers, processing aids, antioxidants and vulcanising ingridients.

During production the EPDM is vulcanised. The long rubber molecules are joined together by chemical cross-linking, giving an elastic, chemically stable product. with negligible aging despite exposure to UV-radiation, atmosphere, chemicals, water, earth and extremes of temperature.

EPDM Membranes can be strained in all directions at the same time, and up to 300 % elongation.

		EPDM	Thermoplastic materials
At - 40° C EPDM is unaffected and flexible, thermoplastics are stiff, brittle and will crack.	-40°C	0% 300% 0%	0% 0% 0%
At + 150° C EPDM is unaffected, thermoplastics become liquids.	+150°C	0% 300% 0%	
After decades of flexing, EPDM is unaffected. Thermoplastics become thin and elongated, and eventually will crack.	**Elongations due to settlements and movements.**	0% 300% 0%	0% 40% 40%

Trelleborg Waterproofing AB
P.O. Box 1004, SE-331 29 Värnamo, Sweden
Tel: +46 370 481 00, Fax: +46 370 485 00, E-mail: polymeric.membranes@trelleborg.com

TRELLEBORG

Elastoseal EPDM Geomembrane

The Thermobond seaming technique provides a fast, easy method for producing quality thermally welded seams. All site seaming is performed with a thermal hot wedge. Details like pipe connections, penetrations, overflows and flashings are seamed with a hot air gun. The combination of an elastic, vulcanised rubber membrane, prefabricated boots, engineered details and reliable, uncomplicated thermal welding in all types of weather provides a maximum of security and a homogenous, elastic waterproofing membrane.

Thermobond seaming technique
- the obvious choise

During production, a thin layer of a thermoplastic rubber (TPE) is laminated to one side of the membrane resulting in a vulcanised EPDM membrane which can be heat seamed. This technique offers the best of both worlds: the advantage of elastomers and the advantage of thermoplastics. The combination of Elastoseal EPDM and Thermobond seaming provides the superior service life and performance of EPDM and the thermal seaming performance of thermoplastic membranes.

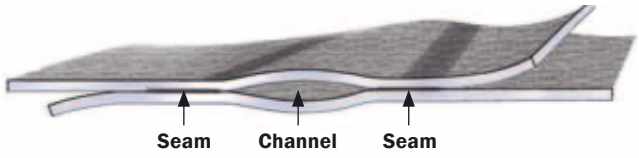
The engineered system – panels made to size

The Elastoseal Geomembranes are prefabricated, using thermal welding to form large, homogenous panels. The size of each panel is often 500 – 1500 sqm:s. The topography of the site, conditions and equipment will dictate the size and weight of each panel. Size and shape of each panel is individual, depending on shape, depth and size of the pond or water containment.

Engineered technical solutions can be prefabricated in advance in the fabrication plant, providing ready-made sections, pipe boots and special attachments.

Seams with air pressure test channels are produced with dual hot wedges. The dual wedge provides easy air pressure testing of seams both immediately after installation and after many years of service.

Prefabricated pipe boots, flashings and details are seamed with hot air guns. Quality control testing is provided by means of high pressure air lance testing.



Trelleborg Waterproofing AB
P.O. Box 1004, SE-331 29 Värnamo, Sweden
Tel: +46 370 481 00, Fax: +46 370 485 00, E-mail: polymeric.membranes@trelleborg.com

Elastoseal EPDM Geomembrane

The Elastoseal EPDM Geomembrane is a completely engineered system, where product, seaming, details, installation technique and site quality assurance guarantees a maximum of saftey and performance. The traceability from production to fabrication and finally to installation is always guaranteed.

Trelleborg Geomembrane QAS

- a waterproof quality assurance system

Organisation on the work site

Installers are always certified by Trelleborg Waterproofing AB. In every installation crew a quality manager is authorized.

Supply logistics

Deliveries to the site are controlled for quality by ensuring packing, transport, storing of material on site and control of received goods is fully documented.

Control of earth works

Before the start of a lining installation the earth work and surface quality as well as compaction is approved by the installer.

The installers quality control records

Include drawings, marking of all panels, documentation of testing and final report to ensure that all materials can be traced back to manufacture.

Trial seam QC testing

The installer controls seam quality prior to each period or shift.

Destructive QC testing

Seam samples are taken each 150-300 m on all field seams. Seam strength is recorded.

Non destructive QC seam testing

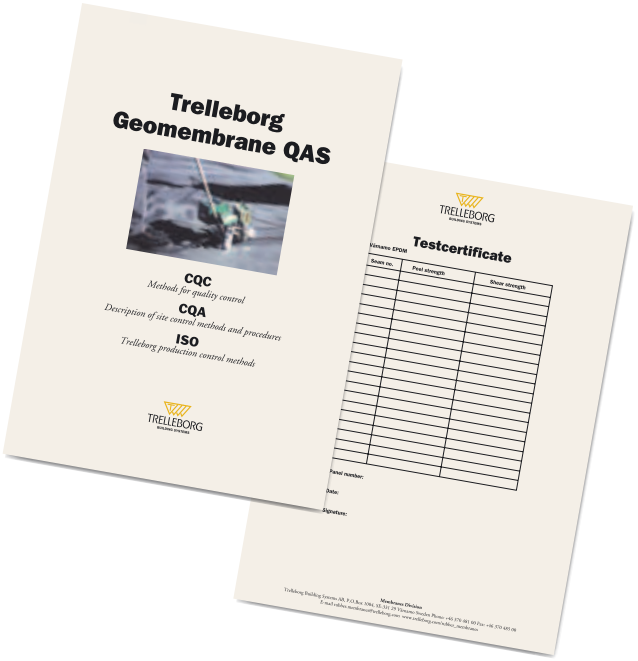
Each dual wedge welded seam is tested with air pressure. All details are tested with air lance.

Repairs and patching

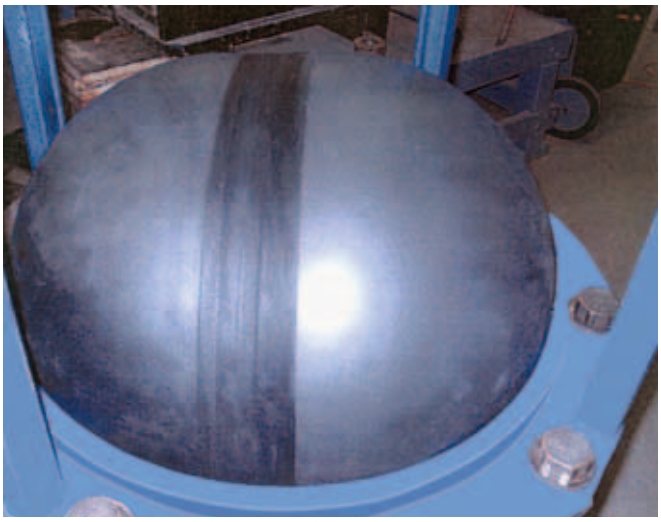
All repairs are fully documented and QC tested.

Cover materials placement

After completion of the lining installation the placement of cover soils and other geosynthetics is closely monitored to prevent damage to the membrane.



The Trelleborg QAS, fully applied, gives a complete documentation and quality control over geomebrane production and installation.



Testing of multi axial strain according to ASTM D5617, on Elastoseal membrane and Thermobond seam.

Trelleborg Waterproofing AB
P.O. Box 1004, SE-331 29 Värnamo, Sweden
Tel: +46 370 481 00, Fax: +46 370 485 00, E-mail: polymeric.membranes@trelleborg.com

Elastoseal EPDM Geomembrane

Prefabricated panels are unrolled, unfolded, positioned and seamed with automatic hot wedge welding machines, producing double tracks for air testing. The seaming speed is approx. 2-3 m/min. With 1000 sqm panels a three man crew will install 2-3 panels per day including positioning and quality testing.

Factory made pipe boots, collars or flashing details with Thermobond hot air seams.

Installation

- Elastoseal EPDM Geomembrane

1. Excavation work. Slopes should be restricted to max. 45°. Stones, roots and debris are removed and the surface should be compacted and smooth. The bottom surface shall have a positive slope to provide gas/water drainage.

2. A geotextile (500 - 800 g/sqm) or a layer of sand (3-5 cm), is applied.

3. The EPDM panel, sized according to site drawing, is supplied as a roll on a pallet. Each panel is marked with panel number, position and unfolding directions.

4. The panels are rolled out, unfolded and positioned. At sizes over 600 sqm:s a winch or fork lift is recommended. Normal panel size is 1000 sqm but sizes up to 3000 sqm:s have been used.

5. The panels are seamed with a dual hot wedge producing a seam with an air channel.

6. Each seam is tested with air pressure. Results are documented according to Trelleborg QAS.

7. The EPDM panels are placed in anchor trenches and backfilled as panel placement proceeds. Then the final beach design is constructed.

Trelleborg Waterproofing AB
P.O. Box 1004, SE-331 29 Värnamo, Sweden
Tel: +46 370 481 00, Fax: +46 370 485 00, E-mail: polymeric.membranes@trelleborg.com

Elastoseal EPDM Geomembrane

Compared to traditional thermoplastic membranes the Elastoseal EPDM Geomembrane offers a trouble free, secure installation process.

Comparison

The seam quality and speed is independent of membrane thickness. Unlike thermoplastic materials which require surface melt, Elastoseal is heated to effect a bond. With large variations in thermoplastic membrane thickness, the required energy and the correct speed of the hot wedge, can vary substantially from sheet to sheet when seaming thermoplastics.

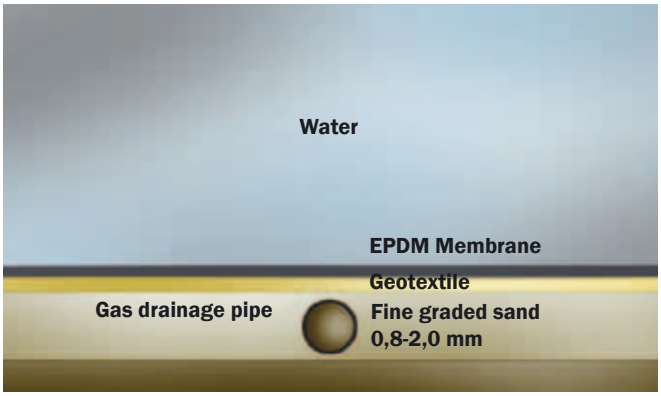
Elastoseal EPDM can be installed and seamed independent of season, with no effect on quality or workmanship. Fully seamable down to -15° C.

Elastoseal EPDM has low thermal expansion/contraction characteristics and is a flexible product that conforms to the substrate. Folds or wrinkles in the seaming area due to temperature variations are not a problem when seaming.

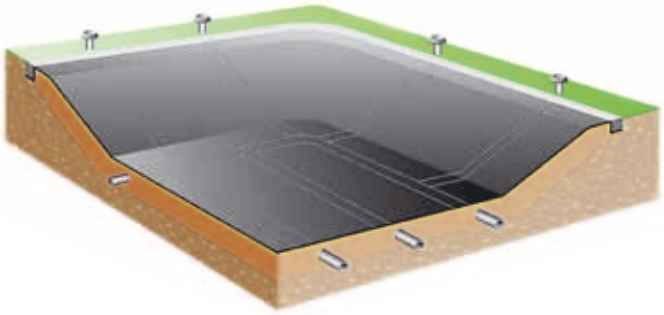
Elastoseal EPDM has a textile surface finish offering high interface friction characteristics. Earth material will stay in place on slopes up to 24-27 degrees.

Before ballasting a geomembrane, high winds often are a major problem causing uplift and damage. Unlike lighter thermoplastic membranes, Elastoseal EPDM lays flat and adheres to the soil surface preventing uplift.

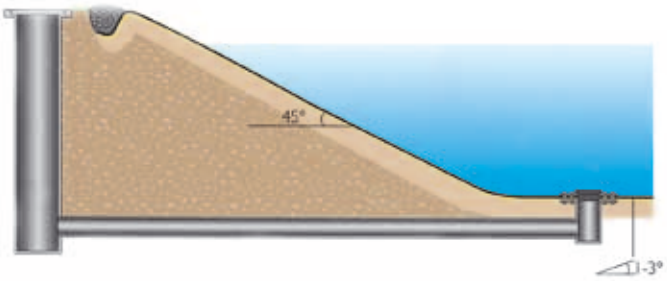
Penetrations and attachments to pipes are no problem with the Thermobond seaming technique and hot air guns. Pipe boots and collars can be made on site or factory produced in any size.



Reservoir construction.



Gas drainage pipes.



Membrane trench and pond drain pipes.

Trelleborg Waterproofing AB
P.O. Box 1004, SE-331 29 Värnamo, Sweden
Tel: +46 370 481 00, Fax: +46 370 485 00, E-mail: polymeric.membranes@trelleborg.com

Product Specifications

Trelleborg EPDM Geomembrane Products

Elastoseal T EPDM

EPDM membrane rolls for prefabrication to panels using a hot wedge.

Thickness, mm	Rollsize, width x length, m	Package	Weight, kg/m²
0,80	1,70 x 25 or 125	20 alt. 6 rolls on pallet	0,9
1,00	1,70 x 25 or 125	20 alt. 6 rolls on pallet	1,2
1,20	1,70 x 25 or 100	15 alt. 6 rolls on pallet	1,4
1,50	1,70 x 25 or 75	15 alt. 6 rolls on pallet	1,8

Elastoseal EPDM Geomembrane panels

EPDM membrane prefabricated to panels, with Thermobond splice edge for site seaming with dual track hot wedge.

Thickness, mm	Size, m²	Package	Weight, kg/m²
0,80	Specified, max 300 m²	Rolled on paper core	0,9
	Specified, max 1000 m²	Rolled on paper core	0,9
1,00	Specified, max 300 m²	Rolled on paper core	1,2
	Specified, max 1000 m²	Rolled on paper core	1,2
1,20	Specified, max 1000 m²	Rolled on paper core	1,4
1,50	Specified, max 1000 m²	Rolled on paper core	1,8

The following panels sizes are preferred on Elastoseal EPDM, irrespective of thickness. The overlap between two panels can be calculated to 200 mm.

Panel without splice edge	Panel with one splice edge 300 mm	Panel with two splice edges 300 mm	Length
1,70 m	1,95 m	2,20 m	max 125 m
3,35 m	3,60 m	3,85 m	max 70 m
5,05 m	5,30 m	5,55 m	max 70 m
6,70 m	6,95 m	7,20 m	max 70 m
8,40 m	8,55 m	8,90 m	max 70 m
10,10 m	10,35 m	10,60 m	max 70 m
11,75 m	12,00 m	12,25 m	max 70 m
13,40 m	13,65 m	13,90 m	max 70 m
15,10 m	15,35 m	15,60 m	max 70 m

Trelleborg Waterproofing AB
P.O. Box 1004, SE-331 29 Värnamo, Sweden
Tel: +46 370 481 00, Fax: +46 370 485 00, E-mail: polymeric.membranes@trelleborg.com

Product Specifications

Accessories and Components

Thermobond Splice Strip

Laminate EPDM/TPE, for hot wedge seaming. Thickness 1,50 mm.

Width, mm	Length, m	Weight kg/lin.m
150	20	0,2
300	20	0,5
450	20	0,7
600	20	0,9
900	20	1,4

Thermobond TPE 100 strip

Homogenous TPE sheet, thermoplastic, for details and connections. Thickness 2,00 mm.

Width, mm	Length, m	Weight kg/lin.m
300	10	0,7
450	10	1,1
600	10	1,4
1700	10	4,1

Thermobond Hot Melt Sealant

Homogenous TPE rod for sealing of T-splices. Diameter 4 mm. Delivered in 30 meter rolls.

Thermobond Hot Melt Strip

Homogenous TPE strip for heat seaming applications. Width 40 mm, thickness 0,7 mm. Delivered in 20 meter rolls.

Thermobond Pipe Boots

EPDM Pipe Boots with EPDM/TPE laminate flange for heat splicing to membrane. Available in 90° and 45° angel and in closed or open design. Stock sizes are Ø 50, 70, 100, 125, 150 mm.

Thermobond PE drain/overflow

Black polyethylene pipe with flange of EPDM/TPE laminate, for heat splicing to membrane. Stock sizes inner Ø 63, 75, 90, 110, 125 mm.

Cleaning Wash 9700

For cleaning of EPDM membrane. Delivered in 5 l tin.

Contact Adhesive 5000

For adhering EPDM membrane to substrates like concrete, wood etc. Delivered in 5 l bucket.

Sealant 5590

Silicone sealant for EPDM membrane. Delivered in 310 ml cartridge, 15 pcs. per box.

TRELLEBORG

Product Specifications

Elastoseal Geomembrane

Dok: 2010,04

Physical Properties	Unit	0,80 ± 0.1 mm	1,00 ± 0.1 mm	1,20 ± 0.1 mm	1,50 ± 0.1 mm	Test methods
Rolls are prefabricated into customer adapted panels.						
Thickness (nominal)	%	±10	±10	±10	±10	ASTM D5199
Hardness	°IRH	65 ± 5	65 ± 5	65 ± 5	65 ± 5	S-ISO 48
Density (Elastoseal/EPDM)	g/cm³	1.2±0.05	1.2±0.05	1.2±0.05	1.2±0.05	ASTM D792
Modulus at 100% Elongation	N/mm		> 2.8	> 3.4	> 4.2	SS-ISO 37
Mechanical Properties						
Tensile Strength	N/mm		7.5	9	11	ASTM D412/D882/SS-ISO 37
Wide Width Tensile Strength	N/mm	6.2	6,4	7,0		ASTM D4885/EN ISO 10319
Wide Width Tensile Strain	%	160	180	250		ASTM D4885/EN ISO 10319
Elongation at Break	%	320	320	320	320	ASTM D882/SS-ISO 37
Tear Resistance	N		30	40	50	ASTM D1004
Tear Resistance	N		40	50	60	SS-ISO 34
Multiaxial Stress	kPa	1100	1350	1600		ASTM D5617
Multiaxial Strain	%	130	130	130		ASTM D5617
Hydrostatic Burst	kPa	350	450	480		ASTM D751 A
Puncture Resistance						
Flat Tip Rod	N	100	140	165		ASTM D4833
Radius Rod	N	95	135	140		FTMS 101C/2065
Sharp Point	N	340	470	560		FTMS 101C/2031
Pyramid	N			111		ASTM D5494
CBR Piston	N	600	750	850		ASTM D6241/EN ISO 12236
CBR Piston Strain at Yield	%	250	250	250		ASTM D6241/EN ISO 12236
Hydrostatic Puncture Resistance	kPa	600	600	600		ASTM D5514, method B
Critical Cone Height	mm	90	90	90		ASTM D5514, method A
Low Temp Impact (-40°C)						
Impact Energy	Joule				>159	CGSB 148.1-113
Dimensional Stability	%	±1	±1	±1	±1	ASTM D1204
Brittle Point	°C	-63	-63	-63	-63	ISO 812
Hydraulic Burst	kPa			600		ASTM D3786

Trelleborg Waterproofing AB
P.O. Box 1004, SE-331 29 Värnamo, Sweden
Tel: +46 370 481 00, Fax: +46 370 485 00, E-mail: polymeric.membranes@trelleborg.com

TRELLEBORG

Product Specifications

Elastoseal Geomembrane

Physical Properties	Unit	0,75 ± 0,1 mm	1,00 ± 0,1 mm	1,20 ± 0,1 mm	1,50 ± 0,1 mm	Test methods
Properties after Ageing 4 weeks 80°C						SS-ISO 188
Tensile Strength	%	<25	<25	<25	<25	SS-ISO 37
Tensile Strain	%	<40	<40	<40	<40	SS-ISO 37
Seam Strength						
Shear Strength	kN/m			9	10	ASTM D6392
Shear Strain	%			490	571	ASTM D6392
Peel Strength	kN/m			6	6	ASTM D6392
Peel Incursion	%			<10	<10	ASTM D6392
Multiaxial Stress	kPa				2133	ASTM D5617
Multiaxial Strain	%				102	ASTM D5617
Low Temp(-40°C) Impact Resistance	Joule				>159	CGSB 148.1-113
Interface Direct Shear (Max Friction Angle)						
Sand (SW)	°			23		ASTM D5321
Lean Clay (CL)	°			14		ASTM D5321
Glacial Till (GM)	°			26		ASTM D5321
Non Woven Geotextile	°			23		ASTM D5321
Interface Direct Shear (Large Displacement)						
Ottawa Sand	°			22.7		ASTM D5321
Sandy Clay	°			17.3		ASTM D5321
Non Woven Geotextile	°			10.7		ASTM D5321
Water Vapour Permeability			98000			pr EN 1931
UV-resistance at 4500 MWs/m²						
Change in mechanical strength	%		-12			DIN 53387
Change In Elongation	%		-3			DIN 53387

Trelleborg Waterproofing AB
P.O. Box 1004, SE-331 29 Värnamo, Sweden
Tel: +46 370 481 00, Fax: +46 370 485 00, E-mail: polymeric.membranes@trelleborg.com

Product Specifications

Elastoseal Geomembrane

Chemical properties	Excellent	Moderately Resistant	Non resistant
Inorganic Salts	X		
Animal Oils	X		
Bases	X		
Organic Salts	X		
Vegetable Oils	X		
Weak Inorganic Acids	X		
Alcohols	X		
Aldehydes	X		
Amines	X		
Esters	X		
Ketones	X		
Organic Acids	X		
Ethers		X	
Phenols		X	
Mineral Oils			X
Hydrocarbons			X
Chlor (highly chlorinated water)			X

Additional requirements

Approvals

Identification

Each roll marked with product name, article- and roll number, dimensions, date of manufacture and signature.

Packing

Polyethylene-film wrapping.

Trelleborg Waterproofing AB
P.O. Box 1004, SE-331 29 Värnamo, Sweden
Tel: +46 370 481 00, Fax: +46 370 485 00, E-mail: polymeric.membranes@trelleborg.com

Product Specifications

Elastoseal T EPDM

Physical properties	Unit	Requirement	Typical value	Test methods
Hardness	°IRH	65 ± 5	65	BS 903 A26
Modulus at 300% elongation	Mpa	5,0	6,9	BS 903 A2
Tensile Strength	Mpa	min 9,0	10,1	BS 903 A2
Elongation at break	%	min 300	405	BS 903 A2
Tear Strength	kN/m	min 30	37	BS 903 A3 C
Properties after ageing 168h/121	°C			BS 903 A19
Tensile Strength	Mpa	min 7,5	9,7	BS 903 A2
Elongation at break	%	min 300	345	BS 903 A2
Brittle point	°C	max.-40	-53	BS 903 A25
Factory seam strength				
Peel strength	N/mm	min. 2,5	3	

Physical properties	Unit	Requirement	Test methods
Thickness	mm	Nom. +15/-10 %	ASTM D 412
Tensile Strength	Mpa	min 9,0	ASTM D 412
Elongation at break	%	min 300	ASTM D 412
Tear Strength	kN/m	min 26	
Ozone Resistance 168h/40	°C	-	
Properties after ageing 670h/115	°C		ASTM D 573
Tensile Strength	Mpa	min 8,3	ASTM D 412
Elongation at break	%	min 200	ASTM D 412
Tear Strength	kN/m	min 22	ASTM D 624
Linear dimensional change	%	±2	ASTM D 1204
Brittle point	°C	max -45	ASTM D 2137
Water absorption,mass	%	+8 to -2	ASTM D 471
Weather resistance, no crack		pass	Practic G26
Factory seam strength			
Peel strength	N/mm	min. 2,5	

Additional requirements

Approvals

Approved according to FFL Directive and fulfil the requirments of ASTM 4637 -67, vulcanised rubber sheeting, and UNE 53,586-86, Elastomeros.

Thickness

Nominal ±10% (±0,1 mm).

Identification

Each roll marked with product name, article- and roll number, dimensions, date of manufacture and signature.

Packing

Polyethylene-film wrapping.

Trelleborg Waterproofing AB
P.O. Box 1004, SE-331 29 Värnamo, Sweden
Tel: +46 370 481 00, Fax: +46 370 485 00, E-mail: polymeric.membranes@trelleborg.com

Product Specifications

Chemical resistance

EPDM Membranes

General Information

EPDM rubber have a good chemical resistance to the following groups of chemicals: Anorganic salts, Animal oils, Bases, Organic salts, Vegetable oils, Weak organic acids.

In general the chemical resistance to the following groups decreases as the number of C-atomes increases: Alcoholes, Aldehydes, Amines, Esters, Ketones, Organic acids.

Arbitrary can be suggested that the chemical resistance of EPDM rubber diminishes to "Moderatly" or "Non-resistant" if the number of C-atoms of the chemical is higher than approximatly five.

The resistance to ethers and phenols can be rated as "Moderate".

EPDM rubber is not resistant to: Halogenated hydrocarbons, Hydrocarbons, Mineral oils.

Of the utmost importance for the effect of chemicals on EPDM is: The contact time, The temperature, The pressure, The concentration of the chemical.

Especially if the chemical resistance is rated "Moderatly resistant" above factors are of exeptional importance.

The resistance rating given in the following table are valid at room temperature if not other temperature is stated.

	Resistant	Moderately Resistant	Non-Resistant
Acetaldehyde		X	
Acetic acid 10-25 %	X		
Acetic acid 50-100 %		X	
Acetic anhydride	X		
Acetic acid glacial		X	
Acetylacetone		X	
Acetone	X		
Acetonitrile	X		
Acetylene			X
Acrylic acid	X		
Acrylonitrile		X	
Acrolein		X	

	Resistant	Moderately Resistant	Non-Resistant
Adipic acid	X		
Aluminium acetate	X		
Aluminium chlorate	X		
Aluminium chloride	X		
Aluminium fluoride	X		
Aluminium hydroxide	X		
Aluminium nitrate	X		
Aluminium oxide hydrate	X		
Aluminium phosphate	X		
Aluminium sulfate	X		
Allylchloride			X
Ammonia anhydrous	X		
Ammonium carbonate	X		
Ammonium chloride	X		
Ammonium fluoride	X		
Ammonium hydroxide	X		
Ammonium nitrate	X		
Ammonium ortophosphate	X		
Ammonium oxalate	X		
Ammonium sulfate	X		
Ammonium thiocyanate	X		
Amylacetate	X		
Amylalcohol	X		
Amylchloride			X
Aniline	X		
Animal oil	X		
Antimony chloride	X		
Antimony pentasuphide	X		
Antimomy trisulphide	X		
Asphaltite			X
A.S.T.M. fuel A-B-C			X
A.S.T.M. oil 1-2-3			X
Aqua regia			X
Argon	X		

Trelleborg Waterproofing AB
P.O. Box 1004, SE-331 29 Värnamo, Sweden
Tel: +46 370 481 00, Fax: +46 370 485 00, E-mail: polymeric.membranes@trelleborg.com

TRELLEBORG

Product Specifications

Chemical resistance

	Resistant	Moderately Resistant	Non-Resistant
Arsenic acid	X		
Arsenic tri-oxide	X		
Arsenic tri-sulfide	X		
Barium chloride	X		
Barium hydroxide	X		
Barium oxide	X		
Barium peroxide	X		
Barium sulfate	X		
Barium sulfide	X		
Beer	X		
Benzalchloride			X
Benzaldehyde	X		
Benzene			X
Benzene sulfonic acid - 10 %	X		
Benzoic acid	X		
Bezoylchloride			X
Benzylalcohol		X	
Benzyl benzoate	X		
Bismuth carbonate	X		
Bisulphite solution	X		
Bitumen	X		
Borax solution	X		
Boric axid	X		
Bromic acid	X		
Bromine anhydrous liquid			X
Bromo benzene			X
Butadiene			X
Butane			X
Butanol	X		
Butanon (M.E.K.)	X		
Buttermilk		X	
Butylstearate			X
Butylacetate		X	

	Resistant	Moderately Resistant	Non-Resistant
Butylalcohol	X		
Butylaldehyde		X	
Butylamine			X
Butylbenzoat	X		
Butylchloride			X
Butylene			X
Butylether			X
Butylglycol	X		
Butyloleate			X
Butyric acid		X	
Butyraldehyde		X	
Cadmium sulfate	X		
Calcium	X		
Calciumcabonate	X		
Calciumchloride	X		
Calciumcyanide	X		
Calciumhydroxide	X		
Calciumsulfate	X		
Calciumsulfide	X		
Calcium(bi)sulfite	X		
Calciumoxide	X		
Caproic acid	X		
Caprolactam 20-100 %	X		
Carbamide	X		
Carbitol	X		
Carbolic oil		X	
Carbondioxide	X		
Carbondisulfide			X
Carbonmonoxide	X		
Carbontetrachloride			X
Castor oil		X	
Cellulose acetate	X		
Cement	X		

Trelleborg Waterproofing AB
P.O. Box 1004, SE-331 29 Värnamo, Sweden
Tel: +46 370 481 00, Fax: +46 370 485 00, E-mail: polymeric.membranes@trelleborg.com

TRELLEBORG

Product Specifications

Chemical resistance

	Resistant	Moderately Resistant	Non-Resistant
Cetylalcohol	X		
Chlorine dry	X		
Chlorine wet		X	
Chlorine dioxide	X		
Chlorine water			X
Chloroacetic acid	X		
Chlorobenzene			X
Chlorodiphenyl			X
Chloroform			X
Chlorophenol			X
Chloroprene			X
Chlorsulfonic acid			X
Chronic acid 10-50 %			X
Chromium sulfate	X		
Chromium trioxide	X		
Citric acid	X		
Copper chloride	X		
Copper cyanide	X		
Copper hydroxide	X		
Copper nitrate	X		
Copper sulfate	X		
Cottonseed oil (20° C)	X		
Cottonseed oil (100° C)		X	
Cream butter	X		
Creosote oil			X
Cresol		X	
Cyanic acid	X		
Cyclohexane			X
Cyclohexene			X
Cyclohexanol			X
Cyclohexanone			X
Decalin			X
Dextrose	X		

	Resistant	Moderately Resistant	Non-Resistant
Diacetone alcohol	X		
Dibenzylether	X		
Dibutylphthalate	X		
Dichlorobenzene			X
Dichloroethylene			X
Dichloromethane		X	
Diesel oil			X
Diethanolamine	X		
Diethylamine			X
Diethylene glycol	X		
Diethylether			X
Diethylketon	X		
Diethylsebacate		X	
Dimethylamine			X
Dimethylaniline	X		
Dimethylether			X
Dimethylformamide		X	
Di-n-butylsebacate	X		
Dioctylphthalate		X	
Dioxane	X		
Diphenyl			X
Diphenylether			X
Dipropylene glycol	X		
Diphenyloxide			X
Dixan 2% solution	X		
Dowtherm A			X
Epichlorohydrin		X	
Ethane			X
Ethanolamine	X		
Ethylacetate	X		
Ethylacrylate	X		
Ethylalcohol	X		
Ethylbenzene			X

Trelleborg Waterproofing AB
P.O. Box 1004, SE-331 29 Värnamo, Sweden
Tel: +46 370 481 00, Fax: +46 370 485 00, E-mail: polymeric.membranes@trelleborg.com

TRELLEBORG

Product Specifications

Chemical resistance

	Resistant	Moderately Resistant	Non-Resistant
Ethylchloride		X	
Ethylene			X
Ethylenebromide			X
Ethylene diamine		X	
Ethylene dichloride			X
Ethylene glycol	X		
Ethylene glycoldiacetate	X		
Ethylether			X
Ethyl hexanol	X		
Ethyl mercaptan			X
Ethylene oxide	X		
Fatty acids		X	
Fatty alcoholes	X		
Ferric chloride	X		
Fluoboric acid 65 %	X		
Fluosilicic acid 50 %	X		
Formaldehyde	X		
Formaline	X		
Formic acid (<50%)	X		
Freon			X
Furfural	X		
Gallic acid		X	
Gasoline			X
Gelatin	X		
Glucose	X		
Glutamic acid	X		
Glycerol (glycerin)	X		
Glycerol monostearate		X	
Glycol	X		
Helium	X		
Heptane			X
Hexaldehyde		X	
Hexane			X

	Resistant	Moderately Resistant	Non-Resistant
Hexanol		X	
Hexylamine		X	
Hexylchloride			X
Hydrazine	X		
Hydrazine hydrate	X		
Hydrobromic acid	X		
Hydrochloric acid	X		
Hydrocyanic acid 20-90 %	X		
Hydroflouric acid 40 %		X	
Hydroflouric acid 75 %			X
Hydrogen	X		
Hydrogen peroxide 10-30%	X		
Hydrogen sulfide(dry+wet)	X		
Iodine		X	
Iron chloride	X		
Iron sulfate	X		
Iso butyl methylketon	X		
Iso octane			X
Isopropyl acetate	X		
Isopropyl alcohol	X		
Isopropylether			X
Kerosone			X
Lactic acid (milk acid)	X		
Lanolin		X	
Lauryl alcohol		X	
Lead acetate	X		
Lead arsenate	X		
Lead sulfate	X		
Linseed oil		X	
Lubrication oil			X
Magnesium chloride	X		
Magnesium hydroxide	X		
Magnesium silicate	X		

Trelleborg Waterproofing AB
P.O. Box 1004, SE-331 29 Värnamo, Sweden
Tel: +46 370 481 00, Fax: +46 370 485 00, E-mail: polymeric.membranes@trelleborg.com

TRELLEBORG

Product Specifications

Chemical resistance

	Resistant	Moderately Resistant	Non-Resistant
Magnesium silico fluoride	X		
Magnesium sulfate	X		
Magnesium sulfite	X		
Maleic acid	X		
Mercury	X		
Mercury chloride	X		
Mercury nitrate	X		
Metaldehyde	X		
Methane			X
Methanol	X		
Methylacetate	X		
Methylamine			X
Methylchloride			X
Methylene chloride		X	
Methyl ethyl keton	X		
Methyl glycol	X		
Methyl glycol acetate	X		
Methyl-isobutylketone		X	
Mineral oil			X
Mixed nitrate and sulphuric acid			X
Molasses	X		
Monochloro ethylene			X
Mono ethanol amine	X		
Naphta			X
Naphtalene			X
Nickelsulphate	X		
Nitric acid 10 %		X	
Nitric acid 65-100 %			X
Nitric acid red funning			X
Nitrobenzene		X	
Nitrogen	X		
Nitrogenoxide	X		
Nitropropane	X		

	Resistant	Moderately Resistant	Non-Resistant
Nitrotoluene			X
Octane			X
Octanol		X	
Oleic acid		X	
Oleum			X
Olive oil		X	
Oxalic acid	X		
Oxygen	X		
Ozone	X		
Palmitic acid		X	
Palm oil		X	
Paraffinic oil and wax		X	
Pentane			X
Perchloric acid		X	
Perchloro ethylene			X
Perhydrol	X		
Petroleum			X
Phenol			X
Phenylchloride			X
Phosphoric acid 20-85 %	X		
Phosphorus oxychloride	X		
Phtalic acid	X		
Phtalic acid antihydride	X		
Picric acid		X	
Potassium acetate	X		
Potassium alum. suphate	X		
Potassium borate	X		
Potassium bromide	X		
Potassium carbonate	X		
Potassium chlorate	X		
Potassium chloride	X		
Potassium chromium sulfate	X		
Potassium cyanide	X		

Trelleborg Waterproofing AB
P.O. Box 1004, SE-331 29 Värnamo, Sweden
Tel: +46 370 481 00, Fax: +46 370 485 00, E-mail: polymeric.membranes@trelleborg.com

TRELLEBORG

Product Specifications

Chemical resistance

	Resistant	Moderately Resistant	Non-Resistant
Potassium dichromate	X		
Potassium hydroxide	X		
Potassium hypochlorite	X		
Potassium Iodide	X		
Potassium nitrate	X		
Potassium permanganate		X	
Potassium phosphate	X		
Potassium sulfate	X		
Potassium sulfite	X		
Propane (liqiud and gas)			X
Propanol	X		
Propyl acetate	X		
Propyl amine			X
Propylene			X
Propylene chloride			X
Propylene glycol	X		
Propylene oxide	X		
Pyridine		X	
Salad oil		X	
Salicilic acid	X		
Seawater	X		
Silicic acid	X		
Salad oil		X	
Salicilic acid	X		
Seawater	X		
Silicic acid	X		
Silicone oil	X		
Skydrol	X		
Soap solution	X		
Sodium acetate	X		
Sodium borate	X		
Sodium(bi)carbonate	X		
Sodium chlorate	X		

	Resistant	Moderately Resistant	Non-Resistant
Sodium chloride	X		
Sodium cyanide	X		
Sodium dichromate	X		
Sodium fluoride	X		
Sodium fluo aluminate	X		
Sodium hydroxide 20-75 %	X		
Sodium hypochlorite 10-30 %	X		
Sodium iron cyanide	X		
Sodium meta phosphate	X		
Sodium nitrate	X		
Sodium nitrite	X		
Sodium peroxide	X		
Sodium orthophosphate	X		
Sodium silicate	X		
Sodium (bi) sulfate	X		
Sodium sulfide	X		
Sodium (bi) sulfite	X		
Sodium thiosulphate	X		
Soybean oil			X
Sorbic acid	X		
Starch (amylodextrin)	X		
Stearic acid		X	
Styrene			X
Sugar	X		
Sulfamic acid	X		
Sulfur 90 °C	X		
Sulfur dichloride			X
Sulfur dioxide (wet+dry)	X		
Sulfuric acid 10-75 %	X		
Sulfuric acid, fuming			X
Sulfurous acid 10-75 %			X
Sulfur trioxide		X	

Trelleborg Waterproofing AB
P.O. Box 1004, SE-331 29 Värnamo, Sweden
Tel: +46 370 481 00, Fax: +46 370 485 00, E-mail: polymeric.membranes@trelleborg.com

Product Specifications

Chemical resistance

	Resistant	Moderately Resistant	Non-Resistant
Tannic acid	X		
Tartaric acid		X	
Tetra chloro ethylene			X
Tetra hydro furan			X
Tetra hydro naphtalin			X
Toluene			X
Tributyl phosphate		X	
Trichloroethane			X
Tricresyl phosphate		X	
Tri ethanol amine	X		
Tri ethyl amine			X
Tri methyl amine			X
Tri sodium phosphate	X		
Turpentine			X
Vegetable oil and fat	X		
Vinyl acetate	X		
Vinyl chloride			X
Vinyl pyridine			X
Washing preparation (synth.)	X		
Water	X		
Wine	X		
Xylol			X
Zinc acetate	X		
Zinc dichloride	X		
Zinc sulfate	X		

Trelleborg Waterproofing AB
P.O. Box 1004, SE-331 29 Värnamo, Sweden
Tel: +46 370 481 00, Fax: +46 370 485 00, E-mail: polymeric.membranes@trelleborg.com

Elastoseal T / H, EPDM Geomembrane

Accompanying document

CE -07

0402-CPD-470302

Product Description

Elastoseal Geomembranes are polymeric geosynthetic barriers made from vulcanised EPDM rubber. The membrane is calandered in two plyes and is not reinforced. This gives unique properties when it comes to flexibility and elasticity.

Product Use

Elastoseal is used as fluid barrier in reservoirs and dams. The membrane can be used both covered or uncovered in service.

Product Standard

EN 13361 Geosynthetic barriers – Characteristic required for use in the construction of reservoirs and dams.

Product Data

Characteristic	Test method	Unit	Value
Water permeability	EN 14150	$m^3/(m^2 * day)$	$< 10^{-6}$
Tensile strength	EN ISO 527-3	Mpa	9.0
Elongation	EN ISO 527-3	%	300
Static puncture:	EN ISO 12236	kN	0,75
Weathering / UV resistance	EN 12224	%	Δ < 25
Micro organisms:	EN 12225	%	Δ < 25
Oxidation	EN 14575	%	Δ < 25
Environmental stress cracking:	EN 14576	-	NPD[1]
Leaching water soluble, properties	EN 14415	%	Δ<2
Leaching water soluble, mass	EN 14415	%	Δ<2

[1] *No Performance Determined*

Edition: 31-05-2007

Trelleborg Waterproofing AB
P.O. Box 1004, SE-331 29 Värnamo, Sweden
Tel: +46 370 481 00, Fax: +46 370 485 00, E-mail: polymeric.membranes@trelleborg.com

Certificate of Conformity

CE -07

0402-CPD-470301
0402-CPD-470302

We declare that the rubber membranes produced at our Norregård Plant, with affixed CE marking according to the European Standards EN 13956 and EN 13361 fulfils the requirement of these Standards. More detailed information about covered products and their use can be found in accompanying documents.

FPC Certifying Body: SP, Box 857, 501 15 Borås, Sweden

Manufacturer: Trelleborg Waterproofing AB
Production Unit Norregård,
Kävsjövägen
SE-331 35 Värnamo
Sweden

Trelleborg Waterproofing AB

Thomas Zipfel
PA Director

Trelleborg Waterproofing AB
P.O. Box 1004, SE-331 29 Värnamo, Sweden
Tel: +46 370 481 00, Fax: +46 370 485 00, E-mail: polymeric.membranes@trelleborg.com

Certificate & Environment

Environmental product declaration

Elastoseal T EPDM

The Company
Trelleborg Waterproofing AB
Box 1004, Kävsjövägen
SE-331 29 Värnamo

Overview
Trelleborg Waterproofing develop, manufacture and market rubber membranes and systems for waterproofing. The most common applications are commercial roofing, water reservoirs and landfills. The organisation is certified in accordance with SS EN ISO 9001:1994.

Environmental work
The work is carried out according to the environmental policy, which has been adopted by Trelleborg Waterproofing AB and the environmental management system in accordance with ISO 14001. The manufacturing organisation has a duty to report in accordance with the environmental protection act and is annually reported to the county administrative board in Jönköping.

The product

Area of use
Watertight layer in reservoirs, irrigation canals, garden ponds, landfills as well as roofs, terraces and facades.

Description
Elastoseal EPDM Geomembrane has a crosslinked polymer structure, which gives the product unique elasticity and unsurpassed ageing resistance, without problematic additives, in the most varying environmental and climatic conditions. Advanced polymer technology makes it possible to attain these qualities with thin membrane thicknesses. Long life combined with low weight and volume per installed unit gives a product very economical in resources in its whole life cycle.

Included material

EPDM polymer	30%
Carbon black	40%
Mineral oils	25%

Additives

Vulcanising agent	5%
ZnO	1%

The product does not contain chemicals from the Limitation or Allergy list issued by the National Chemicals Inspectorate.

Manufacturing
Raw materials are mixed to a compound in the form of slabs. The material is heated and calendared into two separate layers which are laminated together. After cooling, the rubber sheeting and a textile interlining are rolled up on a steel drum. The rubber is then crosslinked by vulcanising in autoclave.Thereafter the intermaterial and rubber sheeting are rolled out and separated. The textile is reused; the rubber sheeting is inspected and packaged.

Waste disposal
Paper is gathered for recycling. Other waste, approx. 20 g/m^2, goes to energy recovery and special landfill.
Environmentally dangerous waste approx. 0.7 g/m^2 goes to an authorised entrepreneur.

Discharge into water and ground
Nothing discharged into water and ground.
Cold water is circulated in the system.
Wastewater and storm water are connected to the sewer system of the municipality.

Discharge into the air
Vulcanisation fumes approx. 20 mg TVOC/m^2.

Energy
Electricity consumption approx. 1.1 kWh/m^2.

Distribution
Transport volume: approx. 400 m^2/m^3 load volume.
Production location: Värnamo/Sweden
Method of transport: Lorry, Train, Ship.

Forms of transport
From factory direct to customer as well as via retailers. The deliveries are adapted for best cost-efficiency/use of resources.

Packaging
The rubber sheeting is rolled up on a cardboard tube and packed in polythene bag. The rolls are then placed on their sides with roll support on a European pool pallet.

Trelleborg Waterproofing AB
P.O. Box 1004, SE-331 29 Värnamo, Sweden
Tel: +46 370 481 00, Fax: +46 370 485 00, E-mail: polymeric.membranes@trelleborg.com

Certificate & Environment

Environmental product declaration

The building stage
Elastoseal EPDM Geomembrane is applied to foundations of sand, geotextile, insulation or concrete. Splices are connected through heat. Loading pallets are part of the return system. Other packaging is pre-separated at source and recycled.

The usage stage

Use
No resources to maintain the watertight layer's function during use are required over and above the instructions and orders for the personnel treading upon the watertight layer. The rubber sheeting does not emit any measurable emissions.

Maintenance
The rubber sheeting does not require any maintenance apart from regular care. Any damage is repaired with the same product.

Life span
Rubber sheeting has been used in sealing systems since the end of the 40's, often in very extreme environments and climates.
At plants still in use, there is rubber sheeting which, after 50 years, fulfils its original function.

Demolition
Supplies of rubber sheeting from building demolitions must always be agreed upon.
- The sheeting must be clean of pollutants, metal parts and other foreign objects.
- The sheeting must be divided into manageable sizes and rolled up or folded together on a pallet.

Delivered material must be specified in accordance with the following:
- Supplier.
- The name of the project, the quality stamp and year of manufacture of the rubber sheeting.
- Amount in kg or m^2 per package as well as the total amount.

Residual products
The rubber sheeting's good ageing resistance makes it possible to utilise products in a number of ways after requirements in question.

Reusing
The sheeting can be used and reused in other buildings.

Recycling
If the sheeting is not too dirty, it can be ground down to powder and used as a raw product for manufacture of new rubber sheeting or as additives in plaster to increase elasticity and impact-strength. In pyrolysis plants, gaseous fuel and carbon black are obtained from rubber.

Energy recovery
The rubber sheeting's heat value 43 MJ/m^2 and mm can be obtained by combustion in waste heating plants and cement kilns.

Waste products
Leaching and emissions do not occur.

Other information
This declaration gives information for a qualitative assessment of the effect on the environment.

Trelleborg Waterproofing AB
P.O. Box 1004, SE-331 29 Värnamo, Sweden
Tel: +46 370 481 00, Fax: +46 370 485 00, E-mail: polymeric.membranes@trelleborg.com

Certificate & Environment

Elastoseal T EPDM

Qualitative record of the utilisation of resources and the effect on the environment.

Item	Part of life cycle	Type of energy	Raw materials		Emissions to		Effect on ground
			Renewable	Non-renewable	Water	Air	
1	Resources						
1.1	Raw materials/Extra materials	Electricity 0.25 kWh/m^2		EPDM 30% Carb. black 40% Min.oil 25%	No	Dust	No
1.2	Additives < 5% of 1.1			Vulc. agent 5% ZnO 1%	No	Dust	No
1.3	Recycled material			Rubber powder	No	Dust	No
1.4	Parent state for raw materials/additional materials. Sweden/EU/The rest of the world						
1.5	Production	Electricity 0,85 kWh/m^2	Cotton textile	Polymer textile	No	TVOC 20mg/m^2	Disposal waste<20g/m^2
2.	Distribution of product						
2.1	Place of production/Country, Värnamo/Sweden						
2.2	Method of transport, Lorry, Train, Ship	Diesel, Petrol, Oil, Electricity					
2.3	Distribution form	Diesel, Petrol, Oil, Electricity					
2.4	Packaging		Wood, paper	Polythene			
3	The building stage						
3.1	Building production	Electricity	No		No	TVOC	No
3.2	Building goods adaptation						No
4	The usage stage						
4.1	Use	Not applicable	No	No	No	No	
4.2	Maintenance		No	No	No	No	
4.3	Life span						
5	Demolition						
5.1	Disassembly						
6	Residual products						
6.1	Reusing						
6.2	Recycling						
6.3	Energy recovery					SO_2, CO_2	Ash
7	Waste products						
7.1	Landfill				Nej	Nej	No, no restrictions

Trelleborg Waterproofing AB
P.O. Box 1004, SE-331 29 Värnamo, Sweden
Tel: +46 370 481 00, Fax: +46 370 485 00, E-mail: polymeric.membranes@trelleborg.com

TRELLEBORG

Guide Specification

Elastoseal EPDM Geomembrane

PART 1 – GENERAL

1.1 Scope of work

This Guide Specification consists of providing and installing non-reinforced vulcanized rubber sheets made from EPDM (ethylene propylene diene monomer) and EPDM/TPO (ethylene propylene dien monomer/thermoplastic olefine) for use as Geomembranes.

1.2 References

1. ASTM D 882 – Standard Test Method for Tensile Properties of thin Plastic Sheet.
2. ASTM D 792 – Standard Test Method for determining the Specific Gravity and Density of Plastics by displacment.
3. ASTM D 1004 – Standard Test Method for determining the Intial Tear Resistance of Plastic Film and Sheeting.
4. ASTM D 4437 – Standard Practice for determining the Integrity of Field Seams used in joining Flexible Polymeric Sheeting.
5. ASTM D 4833 – Standard Test Method for index puncture resistance of Geotextiles, Geomembranes and related Products.
6. ASTM D 5199 – Standard Test Method for measuring nominal thickness of Geotextiles and Geomembranes.
7. ASTM D 5617 – Standard Test Method for multi-axial tension test for Geosynthetics.
8. ASTM D 6392 – Standard Test Method for detemining the integrity of Nonreinforced Geomembrane Seams produced using Thermo-Fusion Methods.

1.3 Submittals

A. Manufacturer´s certification that quality control data for rolls used in the fabrication of panels are in compliance with these specification requirements.
B. Manufacturer´s, Fabricators and Installer´s Qualifications.
C. Geomembrane design panel layout, termination and detail drawings.
D. Geomembrane completion "as-built" drawings showing panel numbers, seam numbers, repairs, destructive test locations, penetrations and results of non-destructive air channel testing.
E. Geomembrane Installation Certification.
F. Results of Geomembrane Installation Quality Control Tests.
G. Geomembrane Installation Warranty.

1.4 Factory Fabrication

A. The fabricator shall be an experienced firm customarily engaged in factory fabrication of EPDM or similar roll goods into large prefabricated panels by thermo-fusion and/or hot bond vulcanisation methods. The fabricator shall, if other than the manufacturer, be approved by the EPDM manufacturer.
B. Prior to factory seaming, all roll goods shall be thoroughly inspected.
C. All factory seams shall by made by means of vulcanisation or thermo-fusion methods using equipment and procedures approved by the manufacturer. Seam width shall be minimum 25 mm.
D. All factory seams shall not have any overlapping material or flaps on the top side of the panel.
E. All roll goods and seams shall be 100 % visually inspected during fabrication.
F. All seams shall be non destructivly tested by the air lance method in accordance with ASTM D 4437.
G. Each welding machine used in panel fabrication shall be tested prior to each shift by fabricating a 1,0 m long sample. A minimum of two specimens shall be taken from the sample and tested in peel in accordance with ASTM D 6392 and shall meet or exceed the values in Table 1 of these specifications.
H. The fabricator shall maintain panel fabrication QC documentation to include the following:
   1. Project number, associated panel number and size, date of fabrication.
   2. Panel numbers and all associated EPDM roll numbers with Manufacturers documentation. (ie. roll, lot and batch numbers, date of manufacture, etc.)
   3. QC documentation on all seam testing and the result and/or repair.
I. The fabricator shall provide written certification that the factory seams were inspected and tested in accordance with these specifications.
J. Each panel shall be rolled and/or folded and packaged with protective cardboard or plastic or rubber membrane wrapping with prominent and unique identification as to panel number and markings indicating direction of unrolling/unfolding to facilitate layout and positioning according to the panel layout drawings.

Trelleborg Waterproofing AB
P.O. Box 1004, SE-331 29 Värnamo, Sweden
Tel: +46 370 481 00, Fax: +46 370 485 00, E-mail: polymeric.membranes@trelleborg.com

TRELLEBORG

Guide Specification

Elastoseal EPDM Geomembrane

1.5 Construction Quality Control

A. Field inspection and testing will be performed under the provisions of this specification as a minimum.
B. Geomembrane installation by Installation Contractor shall include:
1. Visual inspection for installation damage and conformance with this specification.
2. Destructive and Non-destructive seam testing in accordance with this specification.
C. Equipment used in the performance of installation and seaming shall be in accordance with geomembrane manufacturer's recommendations and shall be maintained in optimum working condition.

1.6 Qualifications

A. Manufacturer:
The manufacturer shall have at least 10 years continous experience in the manufacture of EPDM membrane roll goods.
B. Fabricator:
The Fabricator shall be approved by the Manufacturer.
C. Installer:
The Installer shall be an approved installer for the manufacturer.

1.7 Warranties

A. Material:
Manufacturer and Fabricator to provid a written 10 year material only warranty from date of delivery, on quality of material and factory seams.
B. Installation:
Installer to provid a written 2 year installation only warranty from date of completion, on quality of workmanship.

1.8 Delivery, storage and handling

A. Packing and Shipping:
Geomembrane panels shall be packed and shipped by appropriate means to prevent damage to the material and to facilitate handling.
B. Storage and Protection
1. The site owner/general contractor shall provide on-site storage for geomembrane panels from time of delivery until installation.
2. Store and protect geomembrane panels from dirt, vandalism, UV and sun light exposure and other sources of damage. Place geomembrane panels on smooth, elevated surfaces and provid waterproof covering for all stored panels.
C. On-site handling
1. Unloading, on-site handling and storage of the geomembrane is the responsibility of the General Contractor/Installation Contractor.
2. Use only Manufacturer approved handling equipment when off-loading or moving geomembrane panels to prevent any damage.
3. Inspect and report any observed damage to the Engineer of the Site Owner.

PART 2 – PRODUCTS

2.1 Geomembrane

A. Geomembrane shall be EPDM and/or EPDM/TPO produced in rolls and fabricated into panels free of pinholes, holes, blisters, delaminations or any sign of contamination by foreign matter.
B. The EPDM Geomembrane and seams shall have the following minimum values:

TABLE 1 Membrane – Physical Properties

Property	Units	Value	Test
Nominal Thickness	*mm*	*0,80/1,00/1,50*	*ASTM D 5199*
Minimum Thickness	*mm*	*0,70/0,90/1,40*	*ASTM D 5199*
Density	*g/cm³*	*1,20 +/- 0,05*	*ASTM D 792*
Tensile Strength	*MPa*	*min. 7,0*	*ASTM D 882/ ISO 37*
Elongation at break	*%*	*min. 300*	*ASTM D 882/ ISO 37*
Multiaxial Strain at break	*%*	*min. 100*	*ASTM D 5617*
Tear Resistance	*kN/m*	*min. 30*	*ASTM D 1004*

Seam Properties

Property	Units	Value	Test
Shear Strength	*kN/m*	*min. 6,0**	*ASTM D 6392 (500 mm/min)*
Peel Strength	*kN/m*	*min. 2,0**	*ASTM D 6392 (500 mm/min)*

* or membrane break only or min 300 % elongation have been reached witout break in the seam.

Trelleborg Waterproofing AB
P.O. Box 1004, SE-331 29 Värnamo, Sweden
Tel: +46 370 481 00, Fax: +46 370 485 00, E-mail: polymeric.membranes@trelleborg.com

TRELLEBORG

Guide Specification

Elastoseal EPDM Geomembrane

PART 3 – EXECUTION

3.1 Surface Acceptance

A. The General Contractor/Installer shall remove all debris, stones etc. from the surface prior to installation of the geomembrane. Stones larger than 20 mm and other debris that could damage the membrane shall be removed. A geotextile, weight 400-800 g/sqm is recommended to install under the geomembrane for mechanical protection.
B. The surface shall be compacted, dry, smooth and free of soft wet areas with standing water. Equipment track deformations shall not be greater than 40 mm in depth.
C. Anchor Trenches: Only the amount of trench required in one day shall be excavated. Trench corners shall be rounded to avoid sharp edges. Loose soil, stones greater than 20 mm and other debris shall be removed from the upper edge of the trench that will be in contact with the membrane.
D. The Installer shall provide written acceptance for the surface on which the geomembrane is to be installed on a daily basis.

3.2 Equipment

A. Only rubber tracked low ground pressure equipment with contact pressure less than 17,5 kPa shall be used for geomembrane deployment over the geosynthetics when required.
B. Equipment used shall not damage the geomembrane or other geosynthetics by handling, trafficking or other means. Damage to the geosynthetics caused by installation proceedures shall be repaired at no cost to the site owner.
C. Direct equipment contact with the geomembrane shall be minimized. The geomembrane shall be protected by extra layer of materials, plywood or other suitable means in high traffic areas.

3.3 Placement

A. General:
1. Methods used to unroll and unfold panels shall not cause damage to the geomembrane. Damaged geomembrane shall be removed and replaced at no cost to the site owner.
2. Only those panels that can be anchored and seamed the same day shall be deployed.
3. Methods used to place and unfold the panels shall minimize wrinkles and folds.
4. Place adequate loading (ie. sand bags) to prevent uplift by wind.
5. The geomembrane shall be covered instantly after finished installation if a soil or geosyntetic cover is required.
6. Panels shall be placed as shown on the panel layout drawing.
7. Geomembrane shall be trimmed in the anchor trench to limits shown on the anchor trench detail with excess material discarded.

B. Weather Conditions
1. Do not place or seam panels at higher or lower temperatures than recommended by the manufacturer.
2. Do not place or seam panels during precipitation, in the presence of excessive moisture, in areas of ponded water or during excessive winds.

3.4 Geomembrane Field Seaming

A. Seam Layout
1. In general, orient seams parallel to line of maximum slope, ie. oriented along, not across the slope.
2. No horizontal seams shall be less than 1,0 m from toe of slope.
3. Adjacent panels shall be overlapped a minimum of 100 mm prior to field seaming.
4. Wrinkling between adjacent panels shall be minimized.

B. Seam Preparation
1. Prior to seaming, seam shall be clean and free of moisture, dust, dirt and foreign materials.
2. If required, remove surface oxidation by grinding according to manufacturer instructions.
3. Align seams with fewest possible number of wrinkles, “fishmouths”.

C. Seaming Equipment and Products
1. Approved process for field seaming are automated dual track thermo-fusion welding for all field seams or hand held thermo-fusion for patches or repairs.
2. Use only equipment and cleaning methods specifically approved by the geomembrane manufacturer.
3. Seam strength shall meet specification requirements in Part 2, Tabel 1.

D. General Seaming Process
1. Seaming shall extend to the outside edge of panels to be placed in anchor trench.

Trelleborg Waterproofing AB
P.O. Box 1004, SE-331 29 Värnamo, Sweden
Tel: +46 370 481 00, Fax: +46 370 485 00, E-mail: polymeric.membranes@trelleborg.com

Guide Specification

Elastoseal EPDM Geomembrane

2. If required, provide a firm substrate directly under seam overlap, ie. a roped hard plastic board to follow the hot wedge machine as it moves along seam.
3. Seaming procedure shall not damage underlaying geosyntetics.
4. Cut "fish mouths" or wrinkles at seam overlaps along ridge of wrinkle in order to achieve a flat overlap. Seam cut "fishmouths" or wrinkles by thermal fushion methods. Patch any portion where overlap is inadequate with oval or round patch which extends a minimum of 50 mm beyond the cut in all directions.
5. Seam shall be a minimum of 25 mm and shall be a dual track thermo-fushion weld with air channel for non-destructive testing.
6. T-seams shall be bridged according to manufacturers instruction.

E. Trial Seams
1. A trial seam shall be made on fragment pieces of EPDM to confirm seaming conditions are acceptable. The trial sample shall be a minimum 1.0 m long and 0,3 m wide with the seam centered lengthwise. Six random test pieces will be cut from the trial seam sample, each 25 mm wide. Test specimens in peel (3) and shear (3). The specimen shall not fail. The engineer or installer may order additional trial seams if required.

F. Non-destructive Seam Continuity Testing
1. Non-destructively test field seams over their full length using the pressurized air channel evaluation according to ASTM D 5820.

G. Destructive Seam Testing
1. Destructively test field seams as required by the engineer.

H. Defects and Repairs
1. Clean area to be repaired and remove all oxidation according to manufacturer approved methods.
2. For small defects, holes or cuts, repair with a patch that is round or oval in shape and extends a minimum of 50 mm beyond the edge of the defect or hole in all directions.
3. Non-destructive test all patches using Air Lance Test in accordance with ASTM D 4437.

3.5 Anchor Trench

A. The EPDM Geomembrane shall be placed into an anchor trench as shown on drawings. All excess shall be trimmed and removed from the anchor trench prior to backfilling.

B. The anchor trench shall be backfilled with the excavated trench material or select material and compacted in place after completion of the EPDM Geomembrane installation and seaming. Temporary ballast in the anchor trench will be required if backfilling cannot be completed on a daily basis.

3.6 Geomembrane Acceptance

A. The Contractor/Installer shall retain ownership and responsibility for Geomembrane until acceptance by the Site Owner or his representative. The geomembrane installation shall be accepted by the owner when:
1. Installation is completed.
2. Documentation of installation is completed.
3. Confirmation of adequacy of field seams, repairs, attachments and all associated testing is complete.

3.7 Geomembrane Cover Materials

A. The EPDM Geomembrane shall be covered with the required cover materials as soon as possible after Geomembrane Acceptance, preferably within 7 days.

B. Placement of the cover material shall not damage the geomembrane. Geotextiles are recommeded for protection of the geomembrane.

Trelleborg Waterproofing AB
P.O. Box 1004, SE-331 29 Värnamo, Sweden
Tel: +46 370 481 00, Fax: +46 370 485 00, E-mail: polymeric.membranes@trelleborg.com

QAS - Quality Assurance

Elastoseal EPDM Geomembrane

MANUFACTURING MANUAL QUALITY CONTROL AND QUALITY ASSURANCE SYSTEM

1. MATERIAL SPECIFICATION

1.1 Overview

This manual constitute a generall description of the principles for Quality Control and Quality Assurance of the production of Elastoseal EPDM Geomembrane at the plant of Trelleborg Waterproofing AB, Polymeric Membranes.
The production at the Trelleborg plant in Sweden is focused on exacting quality control throught the entire process. The production is completely traceable from a specific panel on site back to individual product data compound properties of the actual rubber mix used in production. Our operations are conducted according to ISO 9001 and ISO 14001.

1.2 Material

Elastoseal EPDM Geomembrane is calandered in two plies in vulcanised, crosslinked EPDM (Ethylene-propylene-diene-monomer) or EPDM/TPE (Ethylene-propylene-diene-monomer/Thermoplastic Elastomer of Olefine type). The crosslinked molecular structure of EPDM gives unique properties, a chemical stable product with negligiable aging over long periods of time despite exposure to the atmosphere, sunlight, UV radiation, chemical pollution, water or high- and low temeperatures. The product contains no plastizers or additives, which can evaporate or be washed out over the years. The strength and elasticity remains virtually unchanged over decades, without shrinkage, melting, hardening or cracking, and the membrane remains flexible and elastic even if the temperature varies from –50 to + 120° C.

1.3 Material Specification

Upon receipt of raw material random tests are made of the batches. Documentation of this testing is kept by Trelleborg Waterproofing AB, Polymeric Membranes.

1.4 Production Control

All test results are recorded and kept available at Trelleborg Waterproofing AB, Polymeric Membranes. Upon delivery to work site every panel is marked according to project specifications. Production Control include the following properties and are tested according to standard methods: Certificates are issued for deliveries of geomembranes for geotechnical projects:
Form QM1, QM2.

Property	Test Method	Test Frequency
Thickness	EN 1849-2	5 roll
Width	EN 1848-2	5 roll
Labelling		5 roll
Hardness	SS ISO-48	every curing batch
Tensile strength	SS ISO-37	every curing batch
Elongation at break	SS ISO-37	every curing batch
Tear resistance	SS ISO-34	every curing batch
Seam test	EN 12316-2	every curing batch

Trelleborg Waterproofing AB must be informed about request for QAS - Quality Assurance at date of order.
QAS - Quality Assurance can not be imlemented on Manufacturing and Prefabrication retrospectiverly.

Trelleborg Waterproofing AB
P.O. Box 1004, SE-331 29 Värnamo, Sweden
Tel: +46 370 481 00, Fax: +46 370 485 00, E-mail: polymeric.membranes@trelleborg.com

QAS - Quality Assurance

Elastoseal EPDM Geomembrane

PREFABRICATION MANUAL
QUALITY CONTROL AND QUALITY ASSURANCE SYSTEM

1. MATERIAL SPECIFICATION

1. Overview

This manual constitute a general description of the principles for Quality Control and Quality Assurance of the prefabrication of Elastoseal EPDM Geomembrane.

2. Non Destructive Testing

All prefabricated splices shall be controlled using the air lance continuity test.
The air lance equipment and procedures are generally outlined in ASTM D 4437 and as follows:

1. Air lance test equipment consists of a compressed air source that can deliver a continuous air nozzle exit pressure of min 350 kPa/3,5 bar to a 4,75 mm diameter nozzle on the end of a hand held lance.
2. The nozzle opening shall be directed to the edge of the seam an held a maximum of 25 mm away from the edge.
3. The rate of travel along the edge of the seam shall not exceed 12 m/min.
4. Any defect that is identified by a distinct change in sound by the air passing through an opening or obvious de-bonding due to air pressure force shall be marked for repair. The panel as such shall also be controlled visually and approved before packaging.

3. Destructive Testing

A destructive seam testing shall be performed at the beginning of every working shift or when the seam conditions for some reason changes.

1. Cut a sample of minimum 300 x 300 mm at a suitable place. The seam shall be located in the centre of the sample.
2. Test the sample in a calibrated tensiometer at a strain of 500 mm/min.
3. The pass/fail criteria are:

Seam shear = min. 6 kN/m
Seam peel = min 2,0 kN/m.
Typical value for seam peel is 3,0 kN/m.

4. Marking, Delivery, Certificates

To avoid damages during handling and transport panels is transported, packed and stored according to TWP specifications. Every panel delivered to site is marked with Manufacturer, Product Name, Thickness, Width, Length, Panel Number/Identification and Production Date. Every delivery is also followed by certificate:

QF3 Panel Listing Report.
QF1 Non-Destructive Seam Control.
QF2 Destructive Seam Control.

Trelleborg Waterproofing AB
P.O. Box 1004, SE-331 29 Värnamo, Sweden
Tel: +46 370 481 00, Fax: +46 370 485 00, E-mail: polymeric.membranes@trelleborg.com

QAS - Quality Assurance

Elastoseal EPDM Geomembrane

INSTALLATION MANUAL QUALITY CONTROL AND QUALITY ASSURANCE

1 INTRODUCTION

1.1 Overview

This manual constitute a general guide in delineating the basic construction related activities that define quality control and quality assurance for the installation of non-reinforced EPDM geomembranes. Construction Quality Control (CQC) is defined as a planned system of inspections that are used directly to monitor and control the quality of a construction project. Construction Quality Assurance (CQA), on the other hand, is a planned system of activities that provide assurance that the project is constructed as specified in the design.

1.2 Personnel

The following are the personnel that are referenced in this manual:

Owner

Project or Facility owner who is ultimatly responsible for the final install acceptance of the geomembrane installation.

Engineer

Design engineer who is responsible for the project design, planning and specifications. The engineer may also function as the project manager.

Contractor

The prime contractor for the project who is ultimately in charge and responsible for all subcontractors. The contractor may be the earthwork contractor or the geomembrane installation company.

Manufacturer

The manufacturer of the geomembrane roll goods or panels from raw materials, Trelleborg Waterproofing AB, Polymeric Membranes.

Fabricator

The Fabricator is a by Trelleborg Waterproofing AB approved company that fabricates the EPDM roll goods into large prefabricated panels, custom designed for a specific project application. The Manufacturer may also function as Fabricator.

Installer

The installer is a by Trelleborg Waterproofing AB approved subcontractor (or an approved prime contractor) for the complete installation, seaming and attachment of the EPDM panels in accordance with project specifications.

CQA Consultant

Independent third party who monitors, tests, inspects and or Inspector documents the geomembrane installation and associated geosynthetic materials. The CQA consultant usually reports directly to the Owner and is independant of the Contractor.

1.3 Geomembrane Delivery

1.3.1 Transportation and Handling

Transportation of the Geomembran is the responsibility of the Manufacturer and/or the Fabricator. The geomembrane rolls or panels are packaged and shipped in a manner that will protect them from damage. All handling on site is the responsibility of the Installer and the Installer and CQA Inspector shall verify that:

1. Only approved handling equipment is used on site that will not damage the geomembrane panels in any way.
2. The Installer´s personnel handle the geomembrane panels with care.
3. Upon delivery to the site, the Installer and CQA Inspector will conduct a thorough surface observation of all panels for defects or damage. This examination will be conducted without unrolling rolls or unfolding panels unless damage is suspected. The CQA Inspector will identify any panels which should be rejected and removed from site due to severe damage or any panels which will require minor repair.

1.3.2 Storage

The Installer and ultimately the Contractor will be responsible for the storage of the EPDM Geomembrane rolls and/or panels on site in a location that provides optimal on site transport and handling. Storage area should be protected from theft, vandalism, vehicular traffic, dirt, debris, UV exposure and other sources of damage. All panels must be placed on smooth, elevated surfaces.

2 GEOMEMBRANE INSTALLATION

2.1 Earthworks

2.1.1 Surface preparations

The Contractor will be ultimately responsible for preparing the subgrade soils in accordance with the project specifica-

Trelleborg Waterproofing AB
P.O. Box 1004, SE-331 29 Värnamo, Sweden
Tel: +46 370 481 00, Fax: +46 370 485 00, E-mail: polymeric.membranes@trelleborg.com

QAS - Quality Assurance

Elastoseal EPDM Geomembrane

tions. Prior to any Geosynthetics installation, the Installer and the CQA Inspector shall verify the following:

1. The surveyor has defined and verfied all lines and grades.
2. The Contractor has provided all CQC documentation that the supporting soils meet the density specification.
3. The surface to be lined has been rolled and compacted and that the Contractor has verified that the surface is free of irregularities, loose soil and abrupt changes in grade.
4. The Contractor has verified that the soil surface does not contain stones larger than 20 mm or debris that may be damaging to the EPDM geomembrane.
5. The Contractor has verified that there is no area of softened soils due to high water content and there is no standing water.

The Installer shall verify all of the above in writing that the surface on which the EPDM geomembrane is to be installed is acceptable. Under no circumstances shall the Installer deploy geomembrane panels in unacceptable areas. If the accepted surface becomes damaged or deteriorates, all liner installation work shall stop and the condition brought to the attention of the Contractor for repair.

2.1.2 Anchor Trenches

All anchor trenches, runouts or terminations shall be excavated by the Contractor to lines and grades shown on the drawings prior to geomembrane placement. The Installer and CQA Inspector shall inspect trench or termination construction to verify acceptability of construction in accordance with the project drawings.

Anchor trenches shall be prepared just in advance of geomembrane deployment to prevent damage to trenches.

The edges of the anchor trench in contact with the geomembrane shall be slightly rounded and free of loose soil, protrusions or debris that could damage the geomembrane.

Backfilling of the anchor trenches or runouts shall be accomplished as soon as practical after geomembrane installation and seaming. If backfilling cannot be completed at the end of each day, temporary ballast (sandbags) must be placed at the terminations.

2.2 Geomembrane Placement

2.2.1 Field Panel Identification

A field panel is the unit area of prefabricated EPDM geomembrane which will be placed and seamed in the field.

The Contractor shall ensure that each field panel is given a number or letter-number "identification code". This identification code will be agreed upon by the Engineer, Installer and CQA Inspector. The field panel identification code should be as simple as possible for cross reference to panel numbers. It is the responsibility of the Installer to ensure that each field panel is marked and referenced with the original panel number as well as the identification code.

2.2.2 Location of panels in field

The Installer shall place each panel at the location indicated on the proposed panel layout plan, as approved and/or modified. The CQA Inspector shall observe that field panels are installed at the proper location.

Each panel shall be placed one at a time and each panel shall be seamed immediately after placement, or ballasted with sand bags if required to be left overnight.

Each panel shall be installed with overlaps shingled down gradient to allow for drainage in the event of precipitation. Orientation of overlaps will also be placed in the direction of prevailing winds if the wind conditions are over 7 m/sec.

The Installer shall record the location, identification code and date of installation for each field panel on an as-built drawing and shall submit this documentation to the CQA Inspector no later than the following day.

2.2.3 Weather Conditions

Geomembrane placement shall not proceed at ambient temperatures below -15° C or above +30° C unless approved by the Engineer. It should be noted that EPDM can be installed and seamed at temperatures down to -15° C if required due to location and construction schedule.

Geomembrane placement shall not be performed during any type of precipitation, in the presence of surface moisture or ponded water, in the presence of winds exceeding 11 m/sec.

The CQA Inspector shall observe that above conditions are not present during placement and that surface soils have not been damaged by weather conditions.

2.2.4 Placement Method

The Installer will ensure that the following procedures are followed:

1. Deployment equipment does not damage the geomembrane or the supporting soil.
2. Personnel working on the geomembrane do not smoke, wear damaging shoes or engage activities that could damage the geomembrane.

Trelleborg Waterproofing AB
P.O. Box 1004, SE-331 29 Värnamo, Sweden
Tel: +46 370 481 00, Fax: +46 370 485 00, E-mail: polymeric.membranes@trelleborg.com

QAS - Quality Assurance

Elastoseal EPDM Geomembrane

3. The method used for unroll/unfold the panels does not cause any damage to the geomembrane or soil surface.
4. Temporary ballast does not damage the geomembrane.
5. Adequate protection against wind uplift is provided and that there is no possibility of damage due to wind action.

The CQA Inspector will observe each panel after placement for damage and will advise the Contractor which panels should be rejected or repaired. Damaged panels that can not be repaired will be marked, recorded and removed from the site.

2.3 Geomembrane Field Seaming

2.3.1 Seam Layout

The Installer shall provide the Engineer with a seam layout drawing which is consistent with the proposed panel layout plan.

Seams shall be oriented parallel to the direction of maximum slope, i.e. oriented along, not across the slope.

Seams shall be minimized in corners and odd-shaped geometric locations.

Horizontal seams shall not be allowed on a panel less than 1,0 m from the toe of slopes greater than 10 %. For slopes less than 10 % this requirement does not apply.

A seam numbering system using adjacent panel numbers shall be used for identification and recording of each seam on CQA documentation and as-built drawing.

2.3.2 Seam Equipment and Products

Manufacturer approved processes for field seaming the Elastoseal EPDM and for repair are thermo-fusion welding. All welding equipment shall have accurate temperature monitoring devices to ensure proper measurement of the weld temperature at the point of surface fusion.

All field seam thermo-fusion welds shall be of the dual track type to allow for an air channel used in non-destructive air pressure testing.

All repair or small area welds shall be by hand held hot air or hot wedge and hand roller with silicone roll.

Only Manufacturer approved cleaning solutions or grinding methods shall be used to clean seam areas of dirt, debris or oxidation.

The Installer shall provide a calibrated field tensiometer for the field testing of completed trial welds and destructive samples.

2.3.3 Seam Preparation

The Installer shall verify the following:

1. Prior to seaming, the seam overlaps are a minimum of 100 mm, properly aligned and free of wrinkles.
2. The seam area is free of any moisture, dust, dirt, sand or debris of any nature.
3. The seam area is free of surface oxidation.
4. Ambient temperatures are between -15° C and + 30° C and wind velocity is below 7 m/sec.
5. The surface below the EPDM is smooth and non yielding. In the case of soft or rough surfaces, a roped seaming board (i.e. conveyor belt, wood- or plastic board) may be required below the seam area.

2.3.4 Trial Seam or Trial Welds

Prior to actual production seaming, the Installer shall make trial seams on pieces of EPDM to verify that seaming equipment and conditions are acceptable and will produce a field seam which meets project specifications. Each trial seam shall be assigned a number and the test results recorded in appropriate documentation and witnessed by the CQA Inspector.

Trial seams shall be performed for each welding machine to be used and by each operator.

A passing trial weld seam must be made prior to the beginning of each seaming period, typically at the start of the day and after lunch.

The trial seam sample shall be approximately 1,0 x 0,3 m with the seam centered lengthwise.

Six specimens, each 25 mm in width and 150 mm in length shall be cut from the trial seam using the 25 mm die coupon cutter. Three of the specimens shall be tested in shear and three shall be tested in peel on the field tensiometer. Both the inside and outside seams of a dual track shall be tested. All shear and peel test specimen shall either meet the project specifcations or give break in the membrane or exceed 300 % elongation of the membrane without break in the seam.

The CQA Inspector shall observe the trial seam procedures and shall verify field tensiometer results. Trial seam samples shall be marked with the seamers intials, identification, date and conditions and retained by the CQA Inspector.

2.3.5 Production Seaming of Panels

After approval of the Trial Weld Seams, production seaming on the deployed panels will commence. All production seams will be non-destructively tested and each completed seam shall be labeled with proper identification.

If required, a firm substrate will be provided by roping

Trelleborg Waterproofing AB
P.O. Box 1004, SE-331 29 Värnamo, Sweden
Tel: +46 370 481 00, Fax: +46 370 485 00, E-mail: polymeric.membranes@trelleborg.com

QAS - Quality Assurance

Elastoseal EPDM Geomembrane

or placing a strip of conveyor belt material or wood/plastic board directly under the seam area.

Wrinkles or "fish mouths" at the seam overlap will be eliminated prior to seaming by pulling the EPDM smooth. Seaming will extend to the outside edge of panels to be placed in the anchor trench.

The CQA Inspector will observe the seaming process for complience with specifications.

2.3.6 Non-Destructive Seam Continuity Test

The Installer shall non-destructively test all field seams over their full length using an air pressure test (for dual track seams), an air lance test or other approved method. The purpose of the non-destructive test is to check the continuity of the seams. Continuity testing must be completed as the seaming progresses and not at the completion of all field seaming.

The CQA Inspector will observe the continuity testing to verify proper equipment and method, review report documentation and observe outcome of all testing.

2.3.6.1 Air Pressure Testing for Dual Track Seams

The following procedure apply for all production seaming using the dual track thermo-fusion process. The proceedures described below shall be followed by the Installer and shall be verified by the CQA Inspector.

In general, follow the proceedures outlined in ASTM D 5820 – Pressurized Air Channel Evaluation of Dual Seamed Geomembranes and the following.

Equipment shall be comprised of the following

1. Manual or Motor Driven air pump capable of generating up to 350 kPa/3,5 bar pressure.
2. A hose with quick connects and valve to isolate pump from test once air pressure is achieved in seam.
3. Pressure gage capable of indicating pressure in 5 kPa/0,2 bar increments within the test range.
4. A sharp hollow needle, diameter 1,5-2,0 mm, that can be injected witout loose of pressure to one end of the air channel.
5. Hot Air Gun or mechanical clamps to seal both ends of the air channel.

The following procedures shall be followed.

1. Seal both ends of the air channel to be tested.
2. Insert the needle and connect the air pressure indicator to the needle assembly.
3. Connect the air pump to the air pressure gage with a flexible hose and quick connect.
4. Pressurize the air channel to 150 kPa/1,5 bar (min 1,4 – max 1,6 bar) and remove the flexible hose.
5. Allow the air pressure to stabilize and observe that the entire channel is inflated.
6. With a pressure of approx. 150 kPa/1,5 bar stabilized in the air channel, record the pressure. After 2 minutes, record the pressure again. If the differance between the two readings is more than 40 kPa/0,4 bar, the seam will require retesting.
7. If the pressure drop is greater than 40 kPa/0,4 bar (failure) check all seals for air leaks and retest.
8. If the pressure drop is still unacceptable after retest of the apparatus and checking for air leaks, locate the failed area and repair. Perform retesting.

2.3.6.2 Air Lance Continuity Testing

Air Lance testing will only be performed on seams that cannot be tested using the air pressure techniques outlined in 2.3.6.1 above. The proceedures shall be followed by the Installer and the CQA Inspector will observe the Installer's work as needed to verify proper procedure and reporting. The air lance equipment and procedures are generally outlined in ASTM D 4437 and as follows:

1. Air lance test equipment consists of a compressed air source that can deliver a continuous air nozzle exit pressure of min 350 kPa/3,5 bar to a 4,75 mm diameter nozzle on the end of a hand held lance.
2. The nozzle opening shall be directed to the edge of the seam an held a maximum of 25 mm away from the edge.
3. The rate of travel along the edge of the seam shall not exceed 12 m/min.
4. Any defect that is identified by a distinct change in sound by the air passing through an opening or obvious debonding due to air presssure force shall be marked for repair.

2.3.7 Destructive Seam Testing

Destructive seam tests shall be performed at selected locations as appropriate to the project and at locations selected by the Engineer and the CQA Inspector. The purpose of this tests is to evaluate the mechanical bond strength of the seam area. Seam destructive testing shall be performed as the work progress and not at the completion of the project.

1. Location and Frequency: The location of seam cut outs will be randomly selected and at generally proposed intervals of between 150 and 300 m of seam length. The Installer will cut the samples and this will be observerd

Trelleborg Waterproofing AB
P.O. Box 1004, SE-331 29 Värnamo, Sweden
Tel: +46 370 481 00, Fax: +46 370 485 00, E-mail: polymeric.membranes@trelleborg.com

QAS - Quality Assurance

Elastoseal EPDM Geomembrane

by the CQA Inspector.

2. Size of samples: A sample size of minimum 0,3 x 0,3 m shall be cut with the seam centered lengthwise. Additional samples may be required for third part independant lab testing and owner archives if required by the specifications and the CQA Inspector. Thus a total length of seam sample may be 1,0 m for destructive testing. Final determination of sample sizes will be determined at the beginning of the project and agreed by all parties.

3. Holes in the geomembrane resulting from destructive sampling will be immidiately repaired and tested for continuity by air lance.

4. Sample identification: The destructive sample shall be marked as a D/S sample number with identification as to adjacent panels, seam number, date etc. as required on the QC form.

5. Field Testing: The sample collected for Installer testing shall be tested as follows: Ten specimens of 25 mm width will be cut with a coupon cutter die and press. Five alternate specimens will be tested in peel and shear. Testing will be accomplished on a calibrated field tensiometer at a strain rate of 500 mm/min.

6. Pass/Fail Criteria: The minimum acceptable strength values are as follows:

Seam Shear **min. 6,0 kN/m**
Seam Peel **min. 2,0 kN/m**

The seam test is approved if the above values have been fulfilled or if the parent material break or if elongation at break is min. 300 % without break in the seam.

Four out of five specimens meeting the above criteria will constitute a passing destructive test.

If the seam sample fails the test, the following procedure shall be followed: Take additional samples approximately 3,0 m on either side of the failed sample and test as above. Each of this samples must pass. Continue the procedure until a passing result is obtained and repair the seam length between passing destructive sample areas.

2.4 Defects and Repairs

All seams and non-seams areas of the EPDM Geomembrane shall be thoroughly examined by the Installer for obvious defects, holes, blisters or damage caused during installation. Identification of the defect or damaged area will be made by marking on the geomembrane panel or seam and indicating same on the CQA documents as to location, type of repair, date.

2.4.1 Repair Procedures

Several procedures exist for the repair of Elastoseal EPDM Geomembrane and the manufacturer directions must be adhered to for effective repair. The final decision as to appropriate repair procedure will be agreed upon between the Engineer, Installer and CQA Inspector.

1. Patching. Patching is used to repair large holes, tears, destructive cut-outs, fishmouth repair or any defects that are found to be suspect.

2. Cap Strip. Cap Strips of the EPDM material (Elastoseal or Thermobond strips) are usually 150 mm in width and are used to repair long lengths of defective seam area or suspected seam area.

3. All surfaces to be repaired must be clean, dry and free of oxidation.

4. All patches shall extend a minimum of 50 mm beyond the edge of the defect and shall have rounded corners. Small patches shall be round or oval in shape.

5. The repair procedures, materials and equipment shall be as recommended and approved by the manufacturer and as approved by the Engineer and CQA Inspector.

2.4.2 Repair Verifications

Each repair shall be non-destructively tested by the air lance method in accordance with section 2.3.6.2. Repairs that pass the air lance method will be considered passed and an indication of an adequate repair. Failed tests will require the repair to be redone and retested.

The Installer must document all repairs and submit the documentation as well as the as-built drawings indicating repair locations to the CQA Inspector. Each repair must be numbered, marked on the panel, logged on the panel or seam repair form and noted as to pass/fail results. The CQA Inspector will visually observe non-destructive tests as required to verify proper procedure and documentation.

3. CERTIFICATIONS

Certificates verifying the control, Form QI1: Non-destructive Seam Evaluation Report, QI2: Destructive Seam Evaluation Report,QI3: Panel Placement Report, shall be presented during or after installation. Additionally the installer shall also record the location and identification number of each panel on an “as-built” drawing.

Trelleborg Waterproofing AB
P.O. Box 1004, SE-331 29 Värnamo, Sweden
Tel: +46 370 481 00, Fax: +46 370 485 00, E-mail: polymeric.membranes@trelleborg.com

QAS - Quality Assurance

Elastoseal EPDM Geomembrane

Enclosure - Quality Documentation Forms

QM1	Test Records – Manufacturing, Physical Properties every 5 roll
QM2	Test Records – Manufacturing, Physical Properties every curing batch
QF1	Non - Destructive Seam Control
QF2	Destructive Seam Control
QF3	Panel Listing Report
QI1	Non-Destructive Seam Evaluation Report
QI2	Destructive Seam Evaluation Report
QI3	Panel Placement Report

Trelleborg Waterproofing AB
P.O. Box 1004, SE-331 29 Värnamo, Sweden
Tel: +46 370 481 00, Fax: +46 370 485 00, E-mail: polymeric.membranes@trelleborg.com

TRELLEBORG

QAS - Quality Assurance

Form QM 1

Elastoseal EPDM Geomembrane

Certificate – Manufacturing Quality Control

Physical Properties – Test Frequency every fifth roll

Project		**Date**	
Number and date of delivery notes			
Product			
Product number			
Roll size, w x l, m		**Quantity**	

Roll number	Thickness mm	Width mm	Label	Roll number	Thickness mm	Width mm	Label

We hereby certify above test results

Date: ……………………...……………………………...

Signature: ……………………………………...……………

Quality Manager

Trelleborg Waterproofing AB
P.O. Box 1004, SE-331 29 Värnamo, Sweden
Tel: +46 370 481 00, Fax: +46 370 485 00, E-mail: polymeric.membranes@trelleborg.com

TRELLEBORG

QAS - Quality Assurance

Form QM 2

Elastoseal EPDM Geomembrane

Certificate – Manufacturing Quality Control

Physical Properties – Test Frequency every curing batch

Project		**Date:**
Number and date of delivery notes		
Product		
Roll size, w x l		**Quantity:**
Tested rollnumber		**Curing batch No:**

Test Results

Property	Unit	Test Method	Result
Hardness	IRH	SS ISO-48	
Tensile Strength	MPa	SS ISO-37	
Elongation at break	%	SS ISO-37	
Tear resistance	kN/m	SS ISO-34	
Seam Strength	N/mm	EN 12316-2	

We hereby certify above test results

Date: ……...……...

Signature: ……...……

Quality Manager

Trelleborg Waterproofing AB
P.O. Box 1004, SE-331 29 Värnamo, Sweden
Tel: +46 370 481 00, Fax: +46 370 485 00, E-mail: polymeric.membranes@trelleborg.com

QAS - Quality Assurance

Form QF 1

Elastoseal EPDM Geomembrane

Certificate – Prefabrication Quality Control
Non-destructive Seam Control

Air lance continuity test according to ASTM D4437.
Test Frequency: every seam on every panel.

Project		**Date:**
Number and date of delivery notes		
Product		
Roll size, w x l		**Quantity:**
Tested rollnumber		**Curing batch No:**

We hereby declare that during the air lance continuity testing of all seams no defect was detected.
The panel was also controlled visually and approved before packaging.

We hereby certify above test results

Date: ……...……...

Signature: ……...……
Quality Manager

Prefabication Company
Name and address

TRELLEBORG

QAS - Quality Assurance

Form QF 2

Elastoseal EPDM Geomembrane

Certificate – Prefabrication Quality Control
Destructive Seam Control

Destructive seam test according to ASTM D6392.
Test Frequency: beginning of every working shift or when the seam conditions changes.

Sample size 300 x 300 mm, Machine strain rate 500 mm/min
Pass/fail criteria: Seam peel min. 2,0 kN/m, Seam shear min. 6,0 kN/m
or Break in membrane
or 300 % elongation before break at shear test

Specimen number	Peel strength	Shear strength	Break in membrane in shear test	Elongation exceeding 300 % in shear test

We hereby certify above test results

Date: ……...……...

Signature: ……...……
Quality Manager

Prefabication Company
Name and address

TRELLEBORG

QAS - Quality Assurance

Form QF 3

Elastoseal EPDM Geomembrane

Certificate – Prefabrication Quality Control

Panel Listing Report

Project		**Date**
Product		

Panel number	Roll numbers in this panel			
	Roll no.	Roll no.	Roll no.	Roll no.

We hereby certify above test results

Date: ……...……...

Signature: ……...……

Quality Manager

Prefabication Company

Name and address

Installer:

TRELLEBORG

QAS - Quality Assurance

Form QI 1

Elastoseal EPDM Geomembrane

NON - DESTRUCTIVE SEAM EVALUATION REPORT

Project name		
Contractor		
Seam type	Dual track	
	Single track	
Weather		
Temperature		
Seam Number		
Seam Length		
Date seamed		
Time seamed		
Installer		

Legend

Repair needed

Repair complete

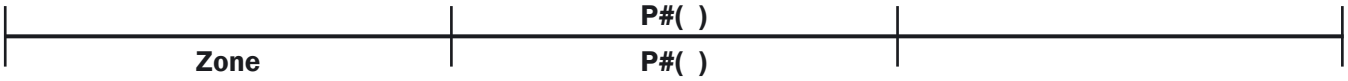
Repair tested

Repair Approved

Destructive sample

Cap Strip Repair

Quality Assurance Summary Seam Detail (Show Dimensions)



Air Pressure – Dual Track Seam							
Zone	Length	Pressure Start	Pressure End	Time Start	Time End	Pressure Loss	P/F

Air/Vacuum – Single Track Seam				
Zone	Length	Air Lance/Vacuum	P/F	Action

Seam Repairs					
Repair No	Defect Type	Repair Date	Repair Type	Approved by	Comments

Installer:

TRELLEBORG

QAS - Quality Assurance

Form QI 2

Elastoseal EPDM Geomembrane

DESTRUCTIVE SEAM EVALUATION REPORT

Project name	
Membrane type	
Date tested	
Machine type	
Seam Sample No	
Installer	
Date seamed	
Weather, Temperature	

Quality Assurance Summary

Peel Adhesion		
Specimen Number	**Load N/m**	**Fail Mode**
Average		

Bonded shear strength		
Specimen Number	**Load N/m**	**Fail Mode**
Average		

Seam Qualified ☐

Seam Disqualified ☐

Notes: _____

_____

Installer:

TRELLEBORG

QAS - Quality Assurance

Form QI 3

Elastoseal EPDM Geomembrane

PANEL PLACEMENT REPORT

Project name: _____

Date	Time	Panel Number	Repairs Yes/No	Repairs Number	Repairs Repaired	Repairs Tested	Size L x W	Area m²
Total area								

Comments: _____

_____

_____

Completed by: _____ (Signature) (Date)

Checked by: _____ (Signature) (Date)

Prefabrication Manual

Elastoseal T EPDM system

1. Introduction

This Manual describes the methods for prefabrication of Elastoseal T EPDM membrane to large custom designed panels. The Manual constitutes the performance and standard of work to be followed by prefabricators approved by Trelleborg Waterproofing AB.

2. Products

Elastoseal T EPDM

Membrane with 36 mm Thermobond splicing edge.

Thickness mm	Width mm	Length mm	Weight kg/mm²	Weight/ roll kg
0,80	1700	25 or 125	0,92	39 or 196
1,00	1700	25 or 125	1,15	49 or 244
1,20	1700	25 or 100	1,38	59 or 293
1,50	1700	25 or 75	1,73	98 or 221

Thermobond Splice Strip

Hot air spliceable splice strip for connections and details.

Splice Strip for Geomembranes			
Thickness mm	Width mm	Length m	Weight/roll kg
1,50	150	20	6,0
1,50	200	20/4 0	9,0
1,50	300	20	12,0
1,50	450	20	18,0
1,50	600	20	24,0
1,50	900	20	37,0
1,50	1600	20	64,0

The standard width for making connections between panels is 200 mm for geomembrane.

Thermobond Hot Melt Sealant

TPE tread for adjusting difference in level and sealing at T-joints. Diameter 4 mm, length 30 m.

Thermobond Hot Melt Strip

TPE strip for adjusting difference in level and sealing T-joints. Thickness 0,70 mm, width 40 mm, length 20 m.

Thermobond Pipe Boot

Boot for pipe penetrations equipped with TPE flange for heat welding to Elastoseal EPDM. Diameter 50 to 150 mm and available in closed or open type.

Trelleborg Waterproofing AB
P.O. Box 1004, SE-331 29 Värnamo, Sweden
Tel: +46 370 481 00, Fax: +46 370 485 00, E-mail: polymeric.membranes@trelleborg.com

Prefabrication Manual

Elastoseal T EPDM system

3. Preparations

Before the start of the prefabrication the following items must be available for review, information and control:

- Construction documents i.e. drawings and specifications for the project, details included.
- Handling instructions from manufacturer of splicing machinery.
- Specified materials and quantities according to shipping documents and labels.

4. Requirements

The prefabrication shall be performed using following facilities and assets:

- A clean and even substrate of adequate size.
- Access to electricity for splicing machines.
- 40 mm silicon roll for hand splicing details.
- Guiding device for wedge machine. This can be a trench or profile made of metal or wood.
- Handling equipment for lifting and unrolling membrane before splicing. Preferably possible to turn 180 degrees. The possibility to turn the roll makes roll positioning more efficient.
- Handling equipment for packing panels on cores or folding on pallet after splicing.
- Brass wire brush for cleaning wedge and pressure wheels.
- Measuring equipment like tape measure, marking chalk and a pair of scissors for cutting.
- Equipment for non-destructive and destructive splice controls.

Trelleborg Waterproofing AB
P.O. Box 1004, SE-331 29 Värnamo, Sweden
Tel: +46 370 481 00, Fax: +46 370 485 00, E-mail: polymeric.membranes@trelleborg.com

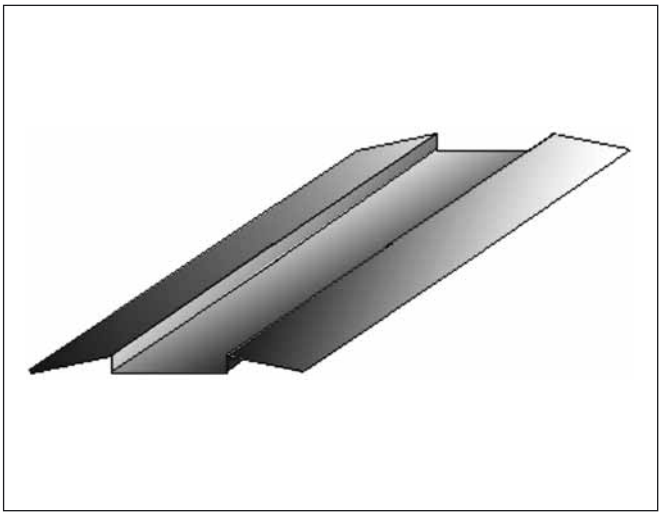
Prefabrication Manual

Elastoseal T EPDM system

Splicing machinery

It is important to use the splicing machinery recommended by us to assure proper welding and a good quality.

Leister Twinny adapted with prefabrication kit are used for splicing Elatoseal T. Leister Twinny with 50 mm rolls set up for prefabrication without test channel is Trelleborg article 55999021.



To assure proper steering during prefabrication we recommend the use of a guidance track. The measurement of the track itself should be approx. 250 x 25mm.

Leister Triac are used for splicing details like pipe boots or T-joints. Leister Triac with 40 mm nozzle is Trelleborg article 5599902.

Leister Varimat is used for splicing Thermobond strip to Elastoseal T.

Trelleborg Waterproofing AB
P.O. Box 1004, SE-331 29 Värnamo, Sweden
Tel: +46 370 481 00, Fax: +46 370 485 00, E-mail: polymeric.membranes@trelleborg.com

Prefabrication Manual

Elastoseal T EPDM system

5. Materials handling

Check materials as verified by specifications, shipping documents and product labels. Damaged or missing goods shall be reported immediately. The material shall be stored in their original packaging in a dry, frost free environment protected from dust.

6. Membrane positioning

The positioning of the membrane is easier if the membrane is put in unrolling equipment that can be moved around.

Unroll the first lengthway in required length with the grey Thermobond edge facing upwards, centred in the guiding trench.

Position the second lengthway so that the overlap is aligned with the markings on the membranes that equal 70 mm overlap.

Stretch the membranes so that wrinkles are kept to a minimum.

- We recommend that the ready panel is installed on site so that the Thermobond edge of Elastoseal T is facing towards the substrate. This is the opposite side facing upwards as during prefabrication.
- Keep the membrane free from sharp objects at all time and do not walk on surfaces that shall be spliced together.
- It can give better efficiency during prefabrication if two guiding tracks are being used and that the panels are being folded in between. Much of the prefabrication time lies in material handling so material logistic is a key factor.

Trelleborg Waterproofing AB
P.O. Box 1004, SE-331 29 Värnamo, Sweden
Tel: +46 370 481 00, Fax: +46 370 485 00, E-mail: polymeric.membranes@trelleborg.com

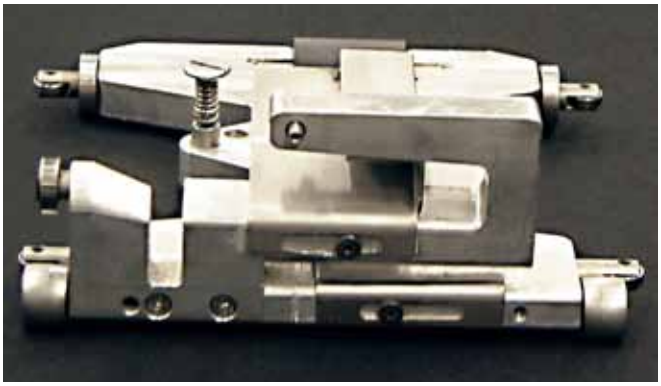
Prefabrication Manual

Elastoseal T EPDM system

7. Splice machine settings

The splicing of the Elastoseal T shall be made with a Leister Twinny that is adapted with a preconfection kit. This equipment have been tested and approved. Other type of machinery might give insufficient heat and pressure.

Prefabrication kit



The prefabrication kit is mounted underneath the Twinny. It is very important that the lower pressure wheel isn't in contact with the driving wheel (the lower black wheel). The machine must pull itself forward in the membrane. The membrane overlap should be adjusted in the machine so that the overlap is set to approx. 38 mm.

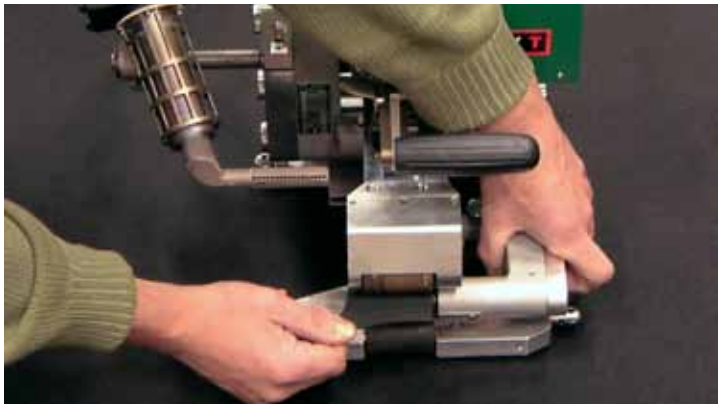
Speed and temperature

The Leister Twinny shall be set to the maximum temperature that is 560°C and the speed of approx 2,5 m/min.

Pressure

The pressure shall be set so that a pressure of approx 250 N is achieved. Our recommendation for adjusting pressure is:

1. Cut a piece 50x50 mm of the membrane that shall be spliced.
2. Lower pressure wheels over one layer of the material.
3. Increase pressure to the rolls until the material is compressed but still can be retracted from the machine without to much effort (sideways).
4. Control the pressure by lowering the wheels at the Thermobond edge. The cross knurled pressure wheels shall then leave a noticeable mark in the TPE but not deform.



Trelleborg Waterproofing AB
P.O. Box 1004, SE-331 29 Värnamo, Sweden
Tel: +46 370 481 00, Fax: +46 370 485 00, E-mail: polymeric.membranes@trelleborg.com

TRELLEBORG

Prefabrication Manual

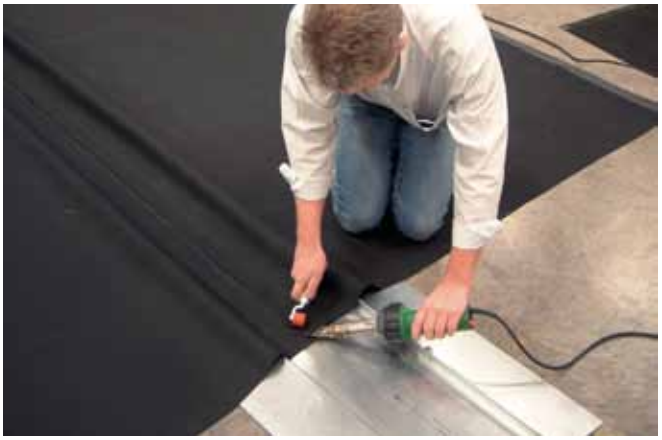
Elastoseal T EPDM system

8. Splicing Elastoseal T

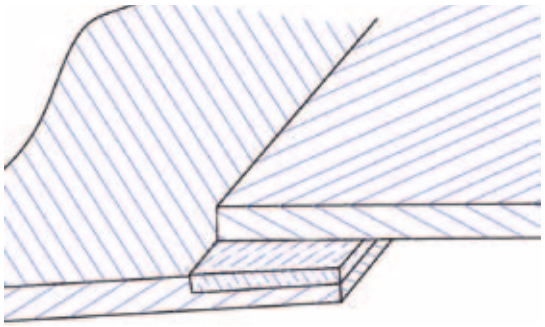
Place the Leister Twinny in position and insert the membrane. Stretch and hold the two layer of membrane when the machine starts.

Always control and steer the machine as the splicing goes on. Sometimes the machine needs to be slowed down manually to avoid separation between the membranes.

The hot wedge doesn't close the splice where it has started. Therefore the splice at the starting point shall be torn open until full strength is noted.



Splice the flap by hand alternatively cut this part of the membrane away.



If an Elastoseal T roll shall be spliced cross another Elastoseal T joint the difference in level must be adjusted with hot melt sealant before making this T-joint. It shall also be pressed together after the machine has passed.

◊ Note that a Thermobond seam doesn't reach full strength until the material has cooled down.

Trelleborg Waterproofing AB
P.O. Box 1004, SE-331 29 Värnamo, Sweden
Tel: +46 370 481 00, Fax: +46 370 485 00, E-mail: polymeric.membranes@trelleborg.com

Prefabrication Manual

Elastoseal T EPDM system

9. Splicing Thermobond splice strip

Connections for field splicing shall be made with Thermobond splice strip.

Mark out a 50 mm overlap on the panel and position the Thermobond strip.

The Thermobond splice strip shall be welded with Leister Varimat.

If the Thermobond splice strip must be prolonged this is done by overlapping the strips minimum 40 mm with the TPE facing upwards and splicing them together with Leister Triac. The difference in height must be levelled with Hot melt sealant where the strip should be spliced to a panel. The width of the hot melt sealant should be min. 50 mm.

If the Thermobond strip is applied transverse to the membrane lengthway this creates a T-joint. The diffrence in level must be evened out with Hot melt sealant before bringing on the Thermobond strip as previous described. This areas shall be pressed with pressure roll after the splicing machine passes and re-heats the Hot melt sealant.

Prolonging of Elastoseal T

There are some alternative approaches for prolonging Elastoseal T and to cross splice. If the roll are to short one alternative is to store it and use it where convenient. This brings high efficiency in the prefabrication. If cross splicing must be done we recommend the following methods:

1. Overlap the short ends of an Elastoseal T 40 mm and place a Thermobond Hot Melt Strip between the membranes. Insert the overlap in a Hotbond press with a temperature of 180°C and press for approx 15 seconds.

2. Place the short ends of the Elastoseal T butt jointed and seam a Thermobond splice strip as a cover strip. Exaggerate the width and cut the edge away. Make sure that the TPE side of the splice strip is facing the right direction.

For both of these methods the difference in level at T-joints must be adapted with Hot Melt Sealant.

Trelleborg Waterproofing AB
P.O. Box 1004, SE-331 29 Värnamo, Sweden
Tel: +46 370 481 00, Fax: +46 370 485 00, E-mail: polymeric.membranes@trelleborg.com

Prefabrication Manual

Elastoseal T EPDM system

10. Quality control

Non destructive testing

The prefabricated splices shall be controlled using the air lance continuity test. The air lance equipment and procedures are generally outlined in ASTM D 4437 and as follows:

1. Air lance test equipment is a compressed air source that continuously delivers an exit pressure of minimum 350 KPa (3,5 Bar) thru a hand held lance with a nozzle diameter of 4,75 mm.
2. The nozzle opening shall be directed to the edge of the seam and held a maximum 25 mm away from the edge.
3. The testing speed shall not exceed 12 m/min.
4. Any defect that is identified by a distinct change in sound shall be marked for repair. The panel as such shall also be controlled visually and approved before packaging.

Destructive testing

A destructive seam testing shall be performed at the beginning of every working shift or when the seam conditions for some reason changes. The seam must have cooled down to approx 20°C before testing.

1. Cut a sample of minimum 300x300 mm with the seam located in the centre of the sample.
2. Pull the sample so that the seam is tested by shear force.
2. The break of the sample shall always occur in the membrane beside the seam.

Typical value while testing the seam in a tensiometer at 500 mm/min are : Seam shear 6,0 N/mm seam peel 2,0 N/mm. A shear test should always give a break in the membrane and not an adhesion break.

11. Package and transport

To protect the splice areas from moisture and contamination the packages shall not be opened until the material shall be prefabricated.

Prefabricated panels can either be folded into a package and put on a pallet alternatively be folded and rolled around a pipe or tube. Regardless what methods that are being used the package shall be wrapped with some kind of protection material to prevent mechanical damages during transportation.

Another critical aspect is that sufficient documentation and information shall follow each package. This documentation shall inform about:

1. Project name and panel identification for traceability and quality control.
2. Unfolding and /or unrolling direction.

12. Defects and repairs

From experience we know that most damages occur due to careless handling of the material. If damage does occur these can be repaired with Thermobond splice strip.

1. Measure and mark out the size of the repair patch needed. The patch of Thermobond strip must be at least 50 mm larger than the actual damage in all directions. The corners of the patch shall be rounded.
2. Splice the patch of Thermobond splice strip using a hand held Leister Triac and a silicone pressure roll.

If the material has been exposed to sun for more than 12 hours before repairing the membrane must be grinded before splicing! This can also be the case if material has been lying in the open indoors for a longer period of time. If uncertainty are at hand a test splice shall be performed followed by destructive splice testing as described above.
Note that the membrane must be completely dry before repairing.

All rolls delivered are marked with roll number as identification. This gives traceability and roll number shall always be noted while handling claims.

13. Technical guidance

The technicians of Trelleborg Waterproofing provide training and guidance regarding prefabrication of Elastoseal T.

Trelleborg Waterproofing AB
P.O. Box 1004, SE-331 29 Värnamo, Sweden
Tel: +46 370 481 00, Fax: +46 370 485 00, E-mail: polymeric.membranes@trelleborg.com

Installation Manual

Elastoseal EPDM Geomembrane

Introduction

This Installation Guidelines Manual provides procedures for the installation of the Elastoseal EPDM Geomembrane System in landfill capping and waterproofing applications. It also give general guidance on design and site preparation for water containment projects.

The Manual is not a document describing The Trelleborg Quality System QAS. For information on the Trelleborg QAS see the specific QAS manual.

In general, the lining installation contractor takes responsibility for the installation according to specifications for the geomembrane and other geotechnical products. Professional project site surveys, design and construction considerations, site drawings, soil and earth analyses etc. is of major importance for the proper function of a water containment or landfill capping. This is the responsibility of the site owner and the design engineer, as quality and measurements of excavations are the responsibility of the general contractor or excavating contractor on the site.

This guidelines manual describes the installation of the Elastoseal EPDM Geomembrane System and gives general guidance to the installer on aspects that must be checked and observed to avoid problems with the final water reservoir or landfill capping.

Before the start of any installation or commitments on performance are made, a physical inspection of the site should be made. It is important that the site owner and design engineer investigate soil quality and stability, excavation surface quality, ground water level and variations, presence of gases in the soil, risk of cavities and settlements and that the excavation size conforms to drawings and panel specifications.

The Elastoseal EPDM Geomembrane System should only be installed by an installer approved by Trelleborg Waterproofing AB and according to design specifications, current local code of practice and CQA requirements. The Installer shall inspect and approve the site before the start of any installation.

Designing with Geomembranes

Site considerations

A thorough analysis of the site should be done by a professional geotechnical engineer. The presence and flow of groundwater and surface water in different seasons must be understood, and the stability of substrates under all seasons and weather conditions must be verified. Presence of contamination and gas generation must be evaluated and designed for as well as the risk of settlements due to earth movements or dissolving/collapsing of organic materials in the earth.

Soil type

The lining design is dependant on soil characteristics, which must be well defined. The geotechnical engineer must evaluate soil type and quality, slope angel stability, compaction, requirements for protective geotextiles, aspects of stability. Any wet areas in the bottom surface of the excavation must be drained before deployment and seaming of panels. The risk of dissolving earth fractions, like content of lime have to be considered.

Ground Water Level

The minimum depth to groundwater as well as groundwaters´ seasonal fluctuation must be evaluated. If the level is higher then the bottom level of the reservoir, the membrane will be subjected to hydrostatic pressure. Also, when the groundwater level is rising, air and gas will move upwards, which will cause gas accumulation and ballooning of the membrane. The above groundwater/gas considerations must be designed for by the site owner and design engineer.

Trelleborg Waterproofing AB
P.O. Box 1004, SE-331 29 Värnamo, Sweden
Tel: +46 370 481 00, Fax: +46 370 485 00, E-mail: polymeric.membranes@trelleborg.com

TRELLEBORG

Installation Manual

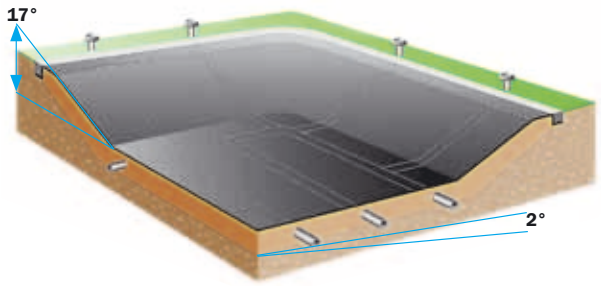
Elastoseal EPDM Geomembrane

Reservoir Specifications

Accurate design drawings specifying depth, size and shape of the reservoir should provided and must include slopes and perimeter details, anchoring and attachments to concrete or other structures. Construction design should be specified, including geomembrane and other geosynthetic materials for drainage of gas and water, protection and cover stability. Pipes and penetrations shall be specified, and water distribution from pipes, over exposed liner or earth surfaces should be protected.

Bottom slopes

The bottom of the excavation of any reservoir must have a positive slope of minimum 1-2%. This is to allow gas to evacuate along the bottom liner to side slopes and vents. Any areas with a negative slope can result in gas traps, causing ballooning of the membrane. Such balloons can very well rise above the water level.



Embankment slopes

Stability of embankments is a fundamental issue, and shall be considered by geotechnical engineers. It is recommended that interface friction is measuered using soil material from the actual site and the EPDM membrane, geotextile or other geotechnical product in contact with the soil. A general rule is that slopes should not be steeper than 3H :1V. Most soil slopes will become unstable when steeper then 2 H :1 V (26,5°).

Embankment crest

The embankment crest is often the point where liners are exposed to the maximum of stress and mechanical abuse. The soil surface on the crest and 1 meter down the slope shall be smooth and free of any stones or debris. A slope of 2° from the reservoir is recommended for drainage. The crest must be wide enough for an anchoring trench width min 0,5 meter, and for safe work by men and machines when anchoring the liner. Its further advised that a running length of 1,0 meter from crest to edge of anchor trench be used.

Water Level

The water level in the reservoir must be controlled to prevent overtopping and waves. An overflow pipe or spillway must be used to avoid overfilling. On small backyard ponds a minimum distance between water level and embankment crest of 0,2 m can be accepted, but in larger reservoirs minimum 0,5 m distance should be required by the design engineer.

Soil Cover

The risk of soil slippage down the slope of a reservoir should be considered by the geotechnical engineer, when an earth covered liner is designed. Geogrid nets and water drainage layers are often used for increased stability of slopes.

Typical interface direct shear data for the Elastoseal EPDM is:

EPDM to sand 23°
EPDM to clay 14°
EPDM to Glacial Tile 26°
EPDM to geotextile 23°

The above is a general guidance only. Actual design data should be derived with materials from the site. For proper

Trelleborg Waterproofing AB
P.O. Box 1004, SE-331 29 Värnamo, Sweden
Tel: +46 370 481 00, Fax: +46 370 485 00, E-mail: polymeric.membranes@trelleborg.com

TRELLEBORG

Installation Manual

Elastoseal EPDM Geomembrane

drainage of water during melting periods, the soil layer must be over 1 meter in thickness in sub arctic areas. The depth of the soil cover must also take into consideration cold climates and maximum frost depth in order to provide stability.

Geotextiles and other Geosynthetics

Geotextiles are generally recommended to provide smooth substrates and for protection of the liner during installation and service. The weight should be minimum 270 g/sqm, but up to 800 g/sqm is often used. A geotextile provides for a more stable substrate than thick sand layers. Additionally, other geosynthetics such as geonets for drainage may be required.

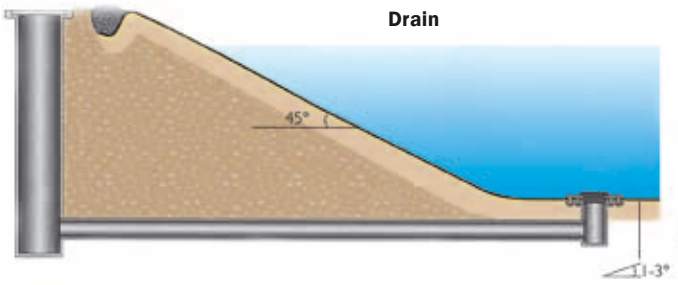
Drainage

Drainage of water and gas is perhaps the most critical problem which must be addressed when designing a reservoir. A large number of installations suffer unnecessary and often disastrous problems with water and gas under the lining system. Whenever water flows or gas is possible under the liner or variations in ground water level is expected the drainage of water and gas must be considered and designed for.

Drainage of ground water

Some actions that can provide water drainage:

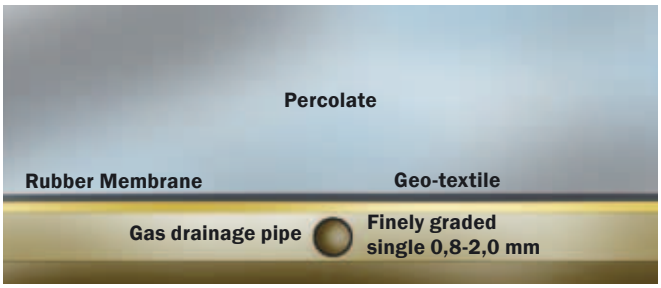
- Always slope the bottom surface 1-2% towards the embankments and control grades so that no that no negative slope can be found.
- Provide a layer of min 10 cm permeable sand under the liner.
- Provide permeable Geonets under the liner.
- Provide drainage piping under the liner.



Drainage of gas

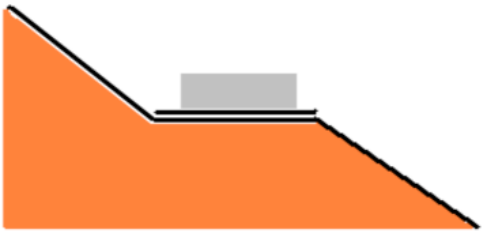
Some actions that can provide gas evacuation:

- Always slope the bottom surface 1-2% towards the embankment, control grades so that no spots with negative slope can be found.
- Use Geotextiles, Geonets or Geocomposites for gas transmission.
- Drainage piping under the liner.
- Provide gas vents on top of slopes.



Terracing

Terracing of slopes should be considered and is often recommended for safety reasons. On long slopes and slopes with seaming parallel to the slope terracing is necessary.



Trelleborg Waterproofing AB
P.O. Box 1004, SE-331 29 Värnamo, Sweden
Tel: +46 370 481 00, Fax: +46 370 485 00, E-mail: polymeric.membranes@trelleborg.com

Installation Manual

Elastoseal EPDM Geomembrane

Elastoseal EPDM installation
Earthworks

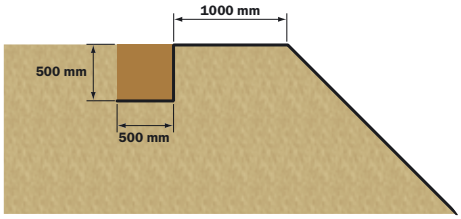
Site layout
Approved installation layout shall be available prior to beginning, with panel size, positioning details and numbering. It is recommended that the site is visited of the work, and that free access to the site and unloading/storage and transport is provided.

Surface preparations
The Contractor will be ultimately responsible for preparing the subgrade soils in accordance with the project specifications. Prior to any Geosynthetics installation, the Installer shall verify the following:

1. The surveyor has defined and verified all lines and grades.
2. The excavation size, depth and slopes are in accordance with design drawings.
3. The Contractor has verified that the supporting soils meet the density specification.
4. The surface to be lined has been rolled and compacted and that the surface is free of irregularities, loose soil and abrupt changes in grade.
5. That the soil surface does not contain loose stones larger than 20 mm or debris that may be damaging to the EPDM geomembrane.
6. That there is no area of softened soils due to high water content and there is no standing water.
7. That compaction of the earth around pipes and structures is in accordance with design requirements.

If the accepted surface becomes damaged or deteriorates, all liner installation work shall stop and the condition brought to the attention of the Contractor for repair.

Anchor Trenches
All anchor trenches, runouts or terminations shall be excavated according to design and to lines and grade shown on the drawings prior to geomembrane placement. Anchor trenches shall be prepared just in advance of geomembrane deployment to prevent damage to trenches. The edges of the anchor trench in contact with the geomembrane shall be slightly rounded and free of loose soil, protrusions or debris that could damage the geomembrane. Up to a reservoir depth of 10 meter, and slope maximum 3V:1H, the trench size should be 50 x 50 cm with a horizontal crest platform of 100 cm. In the case of deeper reservoirs, increase this sizes of the trench with 10 cm for every 5 meter of increased depth. Backfilling of the anchor trenches or run outs shall be accomplished as soon as practical after geomembrane installation and seaming. If backfilling cannot be completed at the end of each day, temporary ballast (sandbags) should be placed at the terminations. The trench should be machine compacted after backfilling.



Trelleborg Waterproofing AB
P.O. Box 1004, SE-331 29 Värnamo, Sweden
Tel: +46 370 481 00, Fax: +46 370 485 00, E-mail: polymeric.membranes@trelleborg.com

Installation Manual

Elastoseal EPDM Geomembrane

Geomembrane Installation

Product Information

The Trelleborg Elastoseal EPDM Geomembrane System provides an engineered system where all products and methods are designed for an installation meeting the highest expectations on quality and performance. Only Trelleborg products and methods that are authorized by Trelleborg are to be used in the geomembrane installation. Each panel delivered to site is marked with product identification, panel number and a sketch, where position of unrolling and directions of unfolding the panel are indicated.

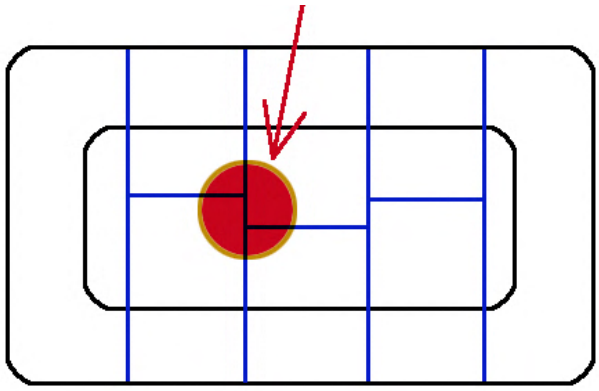
Delivery, storage and handling

In most cases panels are delivered to site in 2 meter wide rolls, rolled on a plastic or iron pipe, and strapped on a pallet. Care should be taken not to damage rolls with forklifts or during handling. Rolls should be left on pallets until they are used, with transport cover sheets in place. Keep the panels covered and protect them from sun exposure. Sunlight will result in a surface oxidation of rubber. This oxidation must be removed by machine grinding when splicing TPE directly against an EPDM surface. Panel to panel seaming is not affected, but repairs, cross splicing and seaming a pipe boot to the membrane will be affected.

Panel layout

A field panel is the unit area of prefabricated EPDM geomembrane which will be placed and seamed in the field. Panels should have an oversize of min. 2% in length and width compared to drawings of the reservoir, to allow for slack and folds occurring during installation. Each field panel is given a number or letter-number "identification code". The field panel identification code should be as simple as possible for cross reference to panel numbers, or be the same as panel numbers.

A site panel layout plan shall be available, showing the position and seaming of each panel. Panels shall be designed and positioned to avoid double cross joints (i.e. 4 sheets meeting at one point). All seams shall run parallel to the slope of the excavation. In corners or irregular shaped reservoirs this is not always possible, but panel design shall restrict seam angles exceeding 45° across the slope.



Geomembrane Placement

The Installer shall ensure that each field panel is marked and referenced with the original panel number as well as the identification code. Each panel shall be placed at the location indicated on the panel layout plan.

As a general guidance an installation crew of 3 men can position panels up to 800 – 1000 sqm in size, provided they have machines for unrolling the panel.

Each panel is placed one at a time and each panel is seamed immediately after placement, or ballasted with sand bags if required to be left overnight. An EPDM panel is very flexible, a useful technique for moving and position the panel to the correct position is to pump the panel up and down, which will create an air cushion under the panel. Three men can move a 1000 sqm panel several meters in any direction using this technique.

Wrap the sheet around a wood stick and wear gloves when pulling the panel out.

If left overnight it is recommended to fold over seam

Trelleborg Waterproofing AB
P.O. Box 1004, SE-331 29 Värnamo, Sweden
Tel: +46 370 481 00, Fax: +46 370 485 00, E-mail: polymeric.membranes@trelleborg.com

TRELLEBORG

Installation Manual

Elastoseal EPDM Geomembrane

areas 0,5 meter, for protection of the surface to be seamed the next day.

Each panel is to be installed with overlaps shingled down gradient to allow for drainage in the event of precipitation. Orientation of overlaps will also be placed in the direction of prevailing winds if the wind conditions are over 7 m/sec. The Installer shall record the location, identification code and date of installation for each field panel on an as-built drawing.

Geomembrane placement shall not proceed at ambient temperatures below -15° C or above +30° C unless approved by the design engineer. Elastoseal EPDM can be installed and seamed at temperatures down to -15° C if required due to location and construction schedule.

Geomembrane placement shall not be performed during any type of precipitation, in the presence of surface moisture or ponding water, or in the presence of winds exceeding 11 m/sec.

The Installer shall ensure that the following procedures are followed:

1 Deployment equipment does not damage the geomembrane or the supporting soil.

2. Personnel working on the geomembrane do not smoke, wear damaging shoes or engage in activities that could damage the geomembrane.

3. The method used for unroll/unfold the panels does not cause any damage to the geomembrane or soil surface.

4. Temporary ballast does not damage the geomembrane.

5. Adequate protection against wind uplift is provided and that there is no possibility of damage due to wind action.

Trelleborg Waterproofing AB
P.O. Box 1004, SE-331 29 Värnamo, Sweden
Tel: +46 370 481 00, Fax: +46 370 485 00, E-mail: polymeric.membranes@trelleborg.com

Installation Manual

Elastoseal EPDM Geomembrane

Geomembrane Field Seaming

Seams shall be oriented parallel to the direction of maximum slope, i.e. oriented parallel to and not across the slope.

Seams shall be minimized in corners and odd-shaped geometric locations. Horizontal seams shall not be allowed on a panel less than 1,0 m from the toe of slopes greater than 10 %. For slopes less than 10 % this requirement does not apply.

A seam numbering system using adjacent panel numbers shall be used for identification and recording of each seam.

Manufacturer approved processes for field seaming the Elastoseal EPDM and for repair are thermo-fusion welding. All welding equipment shall have accurate temperature monitoring devices to ensure proper measurement of the weld temperature at the point of surface fusion.

All field seam thermo-fusion welds shall be of the dual track type to allow for an air channel used in non-destructive air pressure testing.

All repair or small area welds shall be by hand held hot air gun or hot wedge and hand rolled with a silicone roll.

Only Manufacturer approved cleaning solutions or grinding methods shall be used to clean seam areas of dirt, debris or oxidation.

Seam Preparation

The seam overlaps shall be a minimum of 100 mm, properly aligned and free of wrinkles. The seam area shall be free of any moisture, dust, dirt, sand or debris of any nature and free of surface oxidation.

The surface below the EPDM must be smooth and non yielding. In the case of soft or rough surfaces, a roped seaming board (i.e. conveyor belt, wood- or plastic board) may be required below the seam area.

Trial Seam or Trial Welds

Prior to actual production seaming, trial seams on pieces of EPDM shall be made to verify that seaming equipment and conditions are acceptable and will produce a field seam which meets specifications. The correct speed, heat setting and machine setting should be established for the specific weather and wind conditions of the site.

Trial seams are performed for each welding machine to be used and by each operator.

A passing trial weld seam must be made prior to the beginning of each seaming period, typically at the start of the day and after lunch.

The trial seam sample shall be approximately 1,0 m x 0,3 m with the seam centered lengthwise.

Both the inside and outside seams of a dual track thermo-fusion seam shall be tested. All shear and peel test specimens shall either break in the membrane or exceed

Trelleborg Waterproofing AB
P.O. Box 1004, SE-331 29 Värnamo, Sweden
Tel: +46 370 481 00, Fax: +46 370 485 00, E-mail: polymeric.membranes@trelleborg.com

Installation Manual

Elastoseal EPDM Geomembrane

300 % elongation of the membrane without break in the seam.

Production Seaming of Panels

After approval of the Trial Weld Seams, production seaming on the deployed panels will commence. All production seams will be non-destructively tested and each completed seam shall be labelled with proper identification. As an example, a typical welding speed, using a Leister Twinny welder, at an ambient temperature of 15 – 23° C, clouded conditions and wind speed not exceeding 6 m/s, is 2 m/min with the machine set at 400° C. If required, a firm substrate must be provided by placing a strip of conveyor belt material or wood/plastic board directly under the seam area.

Wrinkles or "fish mouths" at the seam overlap shall be eliminated prior to seaming by pulling the EPDM smooth. Seaming will extend to the outside edge of panels to be placed in the anchor trench. Note that the hot wedge will not seam the first 0,2-0,3 meter of each seam, this part must be seamed with a hot air gun and roller.

Non-Destructive Seam Continuity Test

The Installer shall non-destructively test all field seams over their full length using an air pressure test (for dual track seams), an air lance test or other approved method. The purpose of the non-destructive test is to check the continuity of the seams. Continuity testing must be completed as the seaming progresses and not at the completion of all field seaming.

The following procedure is used for all production seaming using the dual track thermo-fusion process. In general, follow the procedures outlined in ASTM D 5820 – Pressurized Air Channel Evaluation of Dual Seamed Geomembranes and the following:

Equipment shall be comprised of the following
1. Manual or Motor Driven air pump capable of generating up to 350 kPa/3,5 bar pressure.
2. A hose with quick connects and valve to isolate pump from test once air pressure is achieved in seam.
3. Pressure gauge capable of indicating pressure in 5 kPa/0,2 bar increments within the test range.
4. A sharp hollow needle, diameter 1,5-2,0 mm, that can be injected without loss of pressure to one end of the air channel.
5. Hot Air Gun or mechanical clamps to seal both ends of the air channel.

Trelleborg Waterproofing AB
P.O. Box 1004, SE-331 29 Värnamo, Sweden
Tel: +46 370 481 00, Fax: +46 370 485 00, E-mail: polymeric.membranes@trelleborg.com

Installation Manual

Elastoseal EPDM Geomembrane

Procedure:

1. Seal both ends of the air channel length to be tested.
2. Insert the needle and connect the air pressure indicator to the needle assembly.
3. Pressurize the air channel to 150 kPa/1,5 bar (min 1,4 – max 1,6 bar) and shut off the pump.
4. Allow the air pressure to stabilize and observe that the entire channel is inflated.
5. With a pressure of approx. 150 kPa/1,5 bar stabilized in the channel, record the pressure. After 2 minutes, record the pressure again. If the difference between the two readings is more than 40 kPa/0,4 bar, the seam will require retesting.
6. If the pressure drop is greater than 40 kPa/0,4 bar (failure) check all seals for air leaks and retest.
7. If the pressure drop is still unacceptable after retest of the apparatus and checking for air leaks locate the failed area and repair. Perform re-testing.

The Air Lance testing will only be performed on seams that cannot be tested using the dual track air pressure techniques. The air lance equipment and procedures are generally outlined in ASTM D 4437 and as follows:

Air lance test equipment consists of a compressor that can deliver a continuous exit pressure of min 350 kPa/3,5 bar to a 4,75 mm diameter nozzle on the end of a hand held lance.

1. The nozzle opening shall be directed to the edge of the seam an held a maximum of 25 mm away from the edge.
2. The rate of travel along the edge of the seam shall not exceed 12 m/min.

Trelleborg Waterproofing AB
P.O. Box 1004, SE-331 29 Värnamo, Sweden
Tel: +46 370 481 00, Fax: +46 370 485 00, E-mail: polymeric.membranes@trelleborg.com

TRELLEBORG

Installation Manual

Elastoseal EPDM Geomembrane

3. Any defect is identified by a distinct change in sound by the air passing through an opening or obvious de-bonding due to the air pressure force. Defects shall be marked for repair.

Cover Material

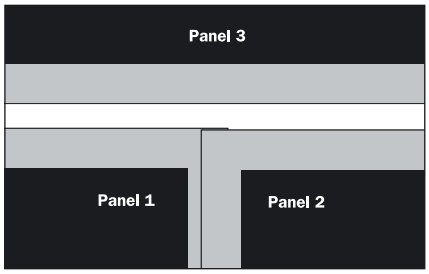
Cover material must be placed with care and in accordance with the design specification, avoiding damages to the membrane. The EPDM surface shall be protected with geotextile or fine sand layers, min 0,5 m in thickness.

Details

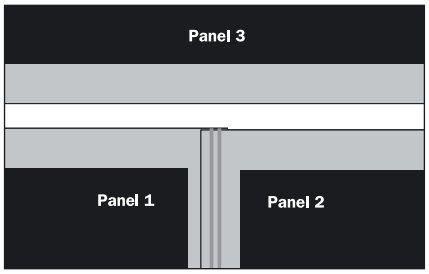
In general the EPDM membrane shall not be cut or split unless absolutely necessary. Whenever a cut is made, there is an increased leakage risk. EPDM rubber membranes conform to irregular substrates like no other membrane type, and can be folded in corners like a serviette without risk of cracking even, if exposed to the atmosphere.

T – Joints between panels

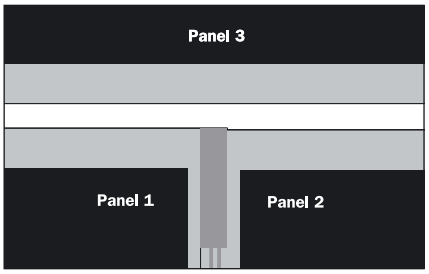
Panels should run over the entire width of a reservoir whenever possible. When the width of the excavation exceeds 60 meter it is necessary to make T-joints between panels at the bottom surface. A T-joint is produced as follows:



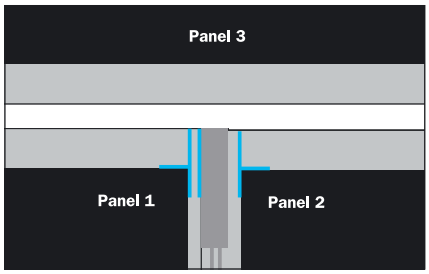
1. Position panel 1 and 2.



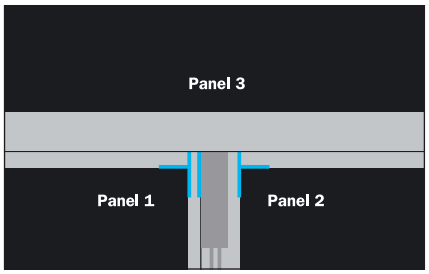
2. Seam panel 1 and 2 with dual hot wedge.



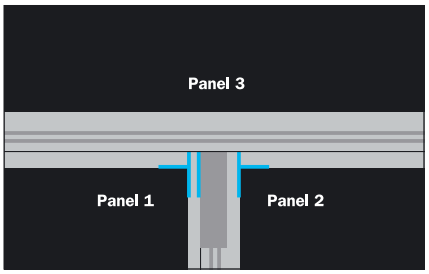
3. Using a hot air gun, seam the full surface of the flap.



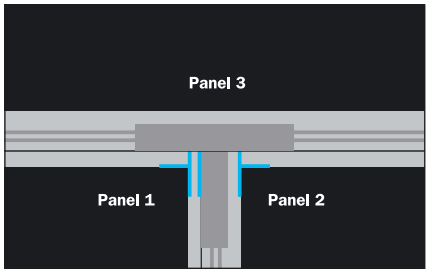
4. Level the height differances with Hot Melt Sealant and Hot air Gun.



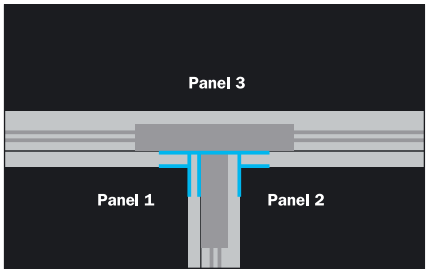
5. Position panel 3.



6. Seam the panel with dual hot wedge.



7. Seam entire surface of panel 3 overlapping flap with hot air gun.



8. Seal the edges of panel 3 with Hot Melt Sealant.

Warning: Use Hot Melt Sealant and not Sealant 5590. Sealant 5590 is based on silicone, no hot air or wedge seaming is possible on a siliconized surface.

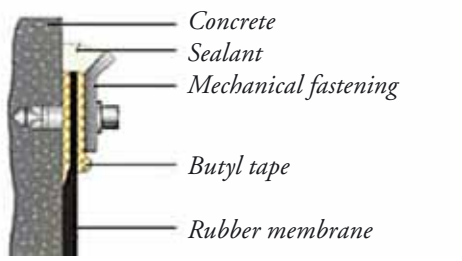
Trelleborg Waterproofing AB
P.O. Box 1004, SE-331 29 Värnamo, Sweden
Tel: +46 370 481 00, Fax: +46 370 485 00, E-mail: polymeric.membranes@trelleborg.com

Installation Manual

Elastoseal EPDM Geomembrane

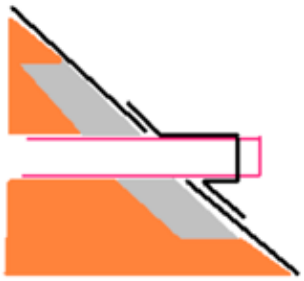
Batten Connection to concrete structures

The soil around all concrete structures must be thoroughly compacted and stabilized. Depending on the design data, fasten the membrane using a stainless- or aluminum bar using butyl tape 9060 and silicone sealant 5590 for water-proofing. Fixings should be made with maximum 0,3 m c/c. Adhering the membrane partially with paste adhesive 3300 or contact adhesive 5000 will improve stability of the installation.



Pipe Penetration

Factory made Thermobond pipe boots for seaming with hot air guns are available in most sizes. Soils around pipes shall be stabilized by compaction or concrete reinforcement. Grind the EPDM surface with rotating grinding machine and heat splice the seam. Cut corners 45 °. Apply sealant 5590 around edges. The boots are then bonded to the pipe according to design detail provided.

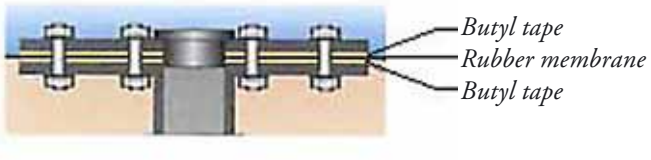


Drains

A concrete base is required for stable construction of inlet/outlet pipes in the bottom surface. The EPDM membrane is mechanically clamped to a drain pipe fastened in the concrete base or attached to the concrete base by batten.

Corners

Prefabricated corners are rarely used in EPDM geomembrane applications, inside angels are usually folded like a serviette. If a concrete outside corner design is necessary Thermobond pre-moulded corners and Thermobond 2 mm sheet, in TPE material suitable for hot air seaming, are available.



Defects and Repairs

Several procedures exist for the repair of Elastoseal EPDM geomembrane. Manufacturer directions must be applied to for effective repairs.

1. Patching. Patching is used to repair large holes, tears, destructive cut-outs, fishmouth repair or any defects that are found to be suspect.
2. Cap Strip. Cap Strips of Thermobond strips are usually 150 mm in width and are used to repair long lengths of defective seam area or suspected seam area.
3. All surfaces to be repaired must be clean, dry and grinded for oxidation.
4. All patches shall extend a minimum of 100 mm beyond the edge of the defect and shall have rounded corners.

Trelleborg Waterproofing AB
P.O. Box 1004, SE-331 29 Värnamo, Sweden
Tel: +46 370 481 00, Fax: +46 370 485 00, E-mail: polymeric.membranes@trelleborg.com

Installation Manual

Elastoseal EPDM Geomembrane

Small patches shall be round or oval in shape.
5. The repair procedures, materials and equipment shall be as recommended by Trelleborg Waterproofing AB.

Quality Assurance System

Installations are always tested by the installer regarding non-destructive seam integrity, as described above. A panel design drawing "as built" and test certificates on air channel testing is always provided by the installer.

In case the Trelleborg Waterproofing QAS System is contracted full documentation and records on quality control in production, prefabrication and installation as well as records on the installation for long term tracebility shall be provided.

To enable the Trelleborg Waterproofing QAS System to be applied smoothly it is essential, that

- The QAS requirement is specified when order is placed with Trelleborg Waterproofing and prefabricator.
- That the Site Owner, General Contractor or Excavation Contractor, whoever is the direct partner, have appointed a quality manager, who is the receiver of the test results and follow the installation on a daily basis.

The following documentation shall be provided by the installer (For detailed information, see the Trelleborg Waterproofing Quality Assurance System Specification):

Membrane Production Records

QM1 Physical Properties of membranes
QM2 Physical Properties of membranes

Prefabrication Records

QF1 Air Lance testing of seams
QF2 Destructive testing of seams
QF3 Panel listing report

Installation Records

QI1 Non-destructive seam test
QI2 Destructive seam test
QI3 Panel placement report
"As built" drawing

Destructive seam testing can be made by Trelleborg Waterproofing or on site by the use of a testing rig.

Trelleborg Waterproofing AB
P.O. Box 1004, SE-331 29 Värnamo, Sweden
Tel: +46 370 481 00, Fax: +46 370 485 00, E-mail: polymeric.membranes@trelleborg.com

Installation Manual

Elastoseal EPDM Geomembrane

Damage considerations

The following typical damages to liners have to be considered in design and installation.

Mechanical damages

The stress and subsequent puncture caused by rocks, machines, inferior preparation of soil surfaces, light weight geotextiles are common reasons for failures.

Settlements and movements

Although EPDM has superior properties and multidimensional elasticity the risk of collapsing structures and materials dissolving must be considered.

Gas uplift

Gas is a constant issue and a difficult problem to solve after installation of the liner. Always provide gas drainage if conditions on the site are questionable.

Cover soil slippage and slides

Consider interface friction properties of soil and geomembrane in design and construction to prevent surface slides and damage.

Trelleborg Waterproofing AB
P.O. Box 1004, SE-331 29 Värnamo, Sweden
Tel: +46 370 481 00, Fax: +46 370 485 00, E-mail: polymeric.membranes@trelleborg.com

Installation Manual

Elastoseal EPDM Geomembrane

Rough substrates

Concern about quality of surfaces and precautions during installation is necessary to avoid punctures. Use of geotextiles or fine grain soil is advisable.

Wind uplift

All membrane edges must be carefully and adequately anchored under earth. During installation loading with sand bags and follow up on weather reports are essential. The picture shows a broken geo pipe after a 5000 sqm membrane up lift in strong winds. Long term ballast design must be considered for long slopes left exposed.

Weather limitations

Installation and seaming of panels can not continue with rain or intermittent showers. Stop seaming under these conditions, or the quality of the installation will be jeopardized. Also stop installation at wind speeds over 11 m/sec.

Wave and ice action

Side slopes of reservoirs must be protected by armour if excessive wave and ice damage may occur.

Traffic

Driving on the liner surface is not permitted and will damage the membrane. A minimum of 30 cm of soil cover is necessary for occasional traffic and 60 cm for sustained traffic by vehicles. Light weight, wide track vehicles should be used over soil covered geomembranes. They are commonly referred to as low ground pressure (LGP) tracked vehicles.

Trelleborg Waterproofing AB
P.O. Box 1004, SE-331 29 Värnamo, Sweden
Tel: +46 370 481 00, Fax: +46 370 485 00, E-mail: polymeric.membranes@trelleborg.com

Installation Manual

Elastoseal EPDM Geomembrane

Safety

When designing and installing a pond, reservoir or other water containment or conveyenace project safety during installation and during the service life of the installation must be considered.

People and animals must be protected. Examples of precautions are:

- Fences around reservoir or impoundments.
- Intermediate sections or benches built in to reservoir slopes. This is important when slopes exceed 3H:1V.
- Access to ladders and float devices.
- Animal access ramps.

Elastoseal installation equipment

An indicative list of equipment and tools include the following items:

- ✓ Scissors, knives with hooked blades.
- ✓ Tape measures/wheels.
- ✓ Chalk line.
- ✓ Rubber squeegee for water removal.
- ✓ Rags.
- ✓ Markers suitable for rubber.
- ✓ Silicone handrollers.
- ✓ Hot Air Guns, type Leister Triac or similar.
- ✓ Dual Hot Wedge thermal fusion machine, type Leister Twinny.
- ✓ Generator and cables.
- ✓ Compressor and air lance for testing of seams.
- ✓ Grinding Machine and Grinding Discs.
- ✓ Ropes or straps for unrolling panels.
- ✓ Tractor, winch or 4-wheel drive LPG vehicle for pulling out panels
- ✓ Air Pump, needle and other equipment for continuous air pressure testing of seams.
- ✓ Board or conveyer belting for support over wet areas.
- ✓ Sump pumps for water removal.
- ✓ Sand bags/ballast.
- ✓ Spreader bar/lift assembly for large rolls.
- ✓ Gloves for protection when pulling and waving membrane panels.

Trelleborg Waterproofing AB
P.O. Box 1004, SE-331 29 Värnamo, Sweden
Tel: +46 370 481 00, Fax: +46 370 485 00, E-mail: polymeric.membranes@trelleborg.com

Installation Manual

Elastoseal EPDM Geomembrane

Trelleborg EPDM Geomembrane Products

Elastoseal T EPDM

EPDM membrane rolls for prefabrication to panels using a hot wedge.

Thickness, mm	Rollsize, width x length, m	Package	Weight, kg/m²
0,80	1,70 x 25 or 125	20 alt. 6 rolls on pallet	0,9
1,00	1,70 x 25 or 125	20 alt. 6 rolls on pallet	1,2
1,20	1,70 x 25 or 120	15 alt. 6 rolls on pallet	1,4
1,50	1,70 x 25 or 75	15 alt. 6 rolls on pallet	1,8

Elastoseal EPDM Geomembrane panels

EPDM membrane prefabricated to panels, with Thermobond splice edge for site seaming with dual track hot wedge. Elasoseal Panels are available in thickness 0,80, 1,00, 1,20 and 1,50 mm. Length of panels are max. 70 m. Delivered rolled on paper cores width 2,0 m.

The following panel size alternatives are available

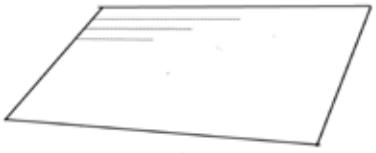
Standard size panels

Thermobond site seaming edges along panel length.
Width. 5,3 / 10,3 / 15,3 m.
Length: 25,0 or 50,0 m

Thermobond site seaming edges along all panel edges.
Width: 5,3 / 10,3 / 15,3 m
Length: 25,3 or 50,3 m

Customized panels, size and shape according to specifications. Maximum size 1000 m²

Prefabricated according to specifikation.



Prefabricated according to specification, Thermobond site seaming edges along pane length/roll direction.

Prefabricated according to specification, Thermobond site seaming edge along all panel edges.

Trelleborg Waterproofing AB
P.O. Box 1004, SE-331 29 Värnamo, Sweden
Tel: +46 370 481 00, Fax: +46 370 485 00, E-mail: polymeric.membranes@trelleborg.com

Installation Manual

Elastoseal EPDM Geomembrane

Accessories and Components

Thermobond Splice Strip

Laminate EPDM/TPE, for hot wedge seaming. Thickness 1,50 mm.

Width, mm	Length, m	Weight kg/lin.m
150	20	0,2
200	20	0,3
300	20	0,5
450	20	0,7
600	20	0,9
900	20	1,4

Thermobond Hot Melt Sealant

Homogenous TPE rod for sealing of T-splices. Diameter 4 mm. Delivered in 30 meter rolls.

Thermobond Hot Melt Strip

Homogenous TPE strip for heat seaming applications. Width 40 mm, thickness 0,7 mm. Delivered in 20 meter rolls.

Thermobond Pipe Boots

EPDM Pipe Boots with EPDM/TPE laminate flange for heat splicing to membrane. Available in 90° and 45° angel and in closed or open design. Stock sizes are Ø 50, 70, 100, 125, 150 mm.

Thermobond PE drain/overflow

Black polyethylene pipe with flange of EPDM/TPE laminate, for heat splicing to membrane. Stock sizes inner Ø 63, 75, 90, 110, 125 mm.

Cleaning Wash 9700

For cleaning of EPDM membrane. Delivered in 5 l tin.

Contact Adhesive 5000

For adhering EPDM membrane to substrates like concrete, wood etc. Delivered in 5 l bucket.

Sealant 5590

Silicone sealant for EPDM membrane. Delivered in 310 ml cartridge, 15 pcs. per box.

Thermobond TPE 100 strip

Homogenous TPE sheet, thermoplastic, for details and connections. Thickness 2,00 mm.

Width, mm	Length, m	Weight kg/lin.m
300	10	0,7
450	10	1,1
600	10	1,4
1700	10	4,1

Trelleborg Waterproofing AB
P.O. Box 1004, SE-331 29 Värnamo, Sweden
Tel: +46 370 481 00, Fax: +46 370 485 00, E-mail: polymeric.membranes@trelleborg.com

TRELLEBORG

Elastoseal Geomembrane References

Public Company Coal Mines Kolubara, Lazarevac, Serbia

Lignite coal is the major source of energy in Serbia, used for coal fired electric power plants. The 600 square kilometre Kolubara open pit is the largest supplier of lignite coal in the Republic. In order to expand the coal field it was in the year 2000 decided to move 5 kilometres of a major river. The Kolubara River meanders north – south through the centre of the of the Kolubara coal basin and has a maximum flood of Q = 650 cubic meters/second. Combinations of compacted clay-liner (CCL) and highly extensible EPDM geomembrane with geotextile protection were chosen to satisfy design requirements. At the completion, approx. 100 000 sqm:s of EPDM geomembrane, 200 000 sqm:s of geotextile was installed along with over 265 000 m2 of CCL to provide the requisite hydraulic seepage barrier. The EPDM liner installation was completed in March 2007 and the new river bed was opened in the autumn of 2007.

THE KOLUBARA RIVER DISPLACEMENT, LAZAREVAC, SERBIA.

Owner: Public Company Coal Mines Kolubara
Designer: Jaroslaw Cerni Institute, Belgrade
Contractor: Neshvyl Ltd, Belgrade

Technical data

Installation: April 2006-March 2007
Liner: 1,0 and 1,2 mm Elastoseal EPDM Geomebrane
Area: 98 000 m2
Splicing: Thermobond Dual track seam

Kolubara River Displacement Scheme and Design Consideration

The Kolubara river dislocation scheme was a very complex project. The scope and complexity largely overcomes classic hydro technical tasks related to minor redirection of watercourses for the following reasons:

1. Due to excavation of large areas of the open pit mines to depths of over 20 meters, the dislocation of the watercourse is drastic from its original route.
2. The dislocated riverbed will be in very close proximity to the future open pit mines and had to be designed to prevent seepage into the open pit area.
3. The watercourse had to be dislocated along the open pit mine contours and the river bed sections had to stable geotechnically.
4. The watercourse had to be designed for maximum flood and protect riparian lands from flooding.
5. The displaced river had to be designed to be stable as regards bed and banks erosion during maximum flood 650 m2 per second.
6. The displaced watercourse had to be designed to flow over waste soil deposit areas, reclaimed land and through variable geological strata and sedimentary layers, some of which are highly permeable.

Final design of the river bed and banks included three types of sections for the approx. 5 km:s of the new Kolubara watercourse. Included was also a 120,000 sqm lake, which will serve as a recreational and ecological feature to help improve the area devasted by mining. The lake was constructed over an old ash waste disposal pit, the bottom being lined with a 1 m thick CCL up to elevation 84 m. The steeper upper slopes of the lake were lined with EPDM geomembrane with protection geotextiles and overlain with crushed stone (300<D<500) armor protection. (Figure 1.)

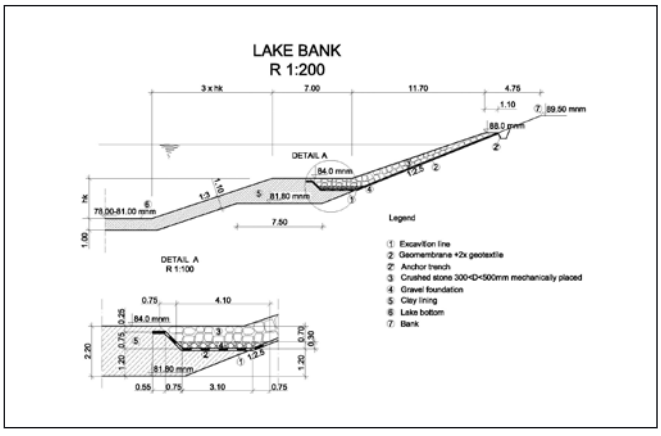


Figure 1. Typical lake bank section with anchor bench CCL/ EPDM tie-in at the 84 m elevation.

TRELLEBORG

Elastoseal Geomembrane References

Public Company Coal Mines Kolubara, Lazarevac, Serbia

The Canal lining design were made in three types of channel cross sections depending of substrate soil. Canal Type 1 were designed for excavation through original ground containing high porous gravel layers that require effective seepage control. This section require crushed stone armor (300<D<500 mm) protection over the upper protection geotextile on the 3H:1V side slopes. (Figure 2.)

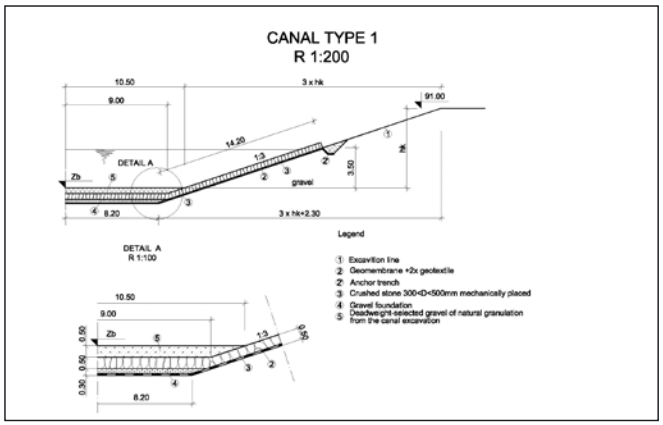


Figure 2. Typical Canal Type 1

The Canal 2 type is designed for reaches constructed through waste soil that will be susceptible to differential settlement. The section is a composite lining with the geomembrane placed over the 1,0 m thick CCL base layer. A ballast layer is used over the geosynthetics to prevent uplift as well as protection. To prevent scour of the soil ballast layer at high flood conditions, crushed stone erosion control "belts" are placed fully across the canal section at 100 meter intervals. (Figure 3.)

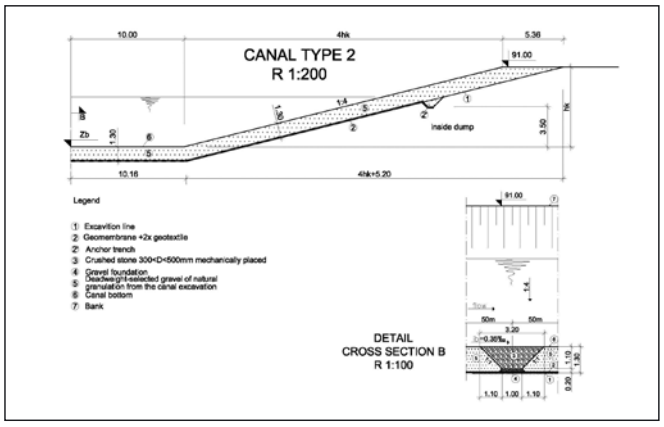


Figure 3. Typical Canal Type 2

Canal Type 3 is designed as 1,2 m thick CCL layer only for reaches that are not susceptible to potential settlements. The requisite 1,3 meter of ballast is still required to protect the CCL and for erosion control.

Geomembrane and Geomembrane/CCL Composite

In channel sections were not only erosion control was necessary an Elastoseal EPDM membrane was used. EPDM was selected for a variety of design considerations including the following:

- Highly extensible for differential settlements (> 300 % yield with no yield point).
- Highly effective moisture barrier (low wvt rate, historical use).
- Proven historical use in canals and large water containment projects (> 50 years).
- Long design life requirement.
- Thermally weldable for factory fabrication (effective QC procedures).
- Large custom panel fabrication (full cross channel width panels, large area coverage).
- Thermally weldable for field installation and QC.
- Proven QAS procedures and methodology.
- High conformance to subsoil irregularities.
- High puncture resistance.
- Construction stress resistance (i.e. ballast placement with 300<D<500 mm stone).
- Construction during cold winter months (< 0° C).
- Requirements for rapid, efficient installation (Project time constraints).
- Local (regional) fabrication and support.

Large Scale Site Performance Testing

The design and the method of placing large stone with heavy equipment and equipment travel necessitated a field loading test. Prior to approving design and and methods a 20 m by 30 m test section on the lake bank was made. On top of the 1,0 mm EPDM and 350 g/sqm geotextile top and bottom of the membrane the placement of the stone layer with a 50 ton loader took place. After the placement all stones were removed and the EPDM membrane and the geotextiles were inspected. No geotextile damage or puncturing of the EPDM was noted in the trial.

Site performance test

Elastoseal Geomembrane References

Public Company Coal Mines Kolubara, Lazarevac, Serbia

Fabrication and installation of the Geomebrane

Prefabricated panel sizes were determined by the location and cross section of the river banks. Layout drawings of each section were first made and approved so that each panel number is located in its precise location on the river section.

For the river banks the size of the panels varied between 12 to 15 m width by 50 to 67 m length. The length was determined by full canal section width so that only longitudinal cross channel seams were used. This allowed for full double fusion field seams an QC air channel testing across the new river section. The lake bank section required panels 20 to 35 m in width by 50 m in length.

The prime contractor scheduled incremental canal sections for preparation of earth works, lining installation and cover soil placement at a one week basis. Immediately after positioning the cross canal seams were made by dual track thermal fusion bonding with air channel for testing. All field seams were tested with air pressure direct after seaming. In addition all subgrade preparation, panel placement procedures, welding, testing and reporting was accomplished in accordance with Trelleborg QAS procedures and under full third party CQA observation.

Construction Quality Control and Assurance

The fully designed and implemented Trelleborg Quality Assurance System was made a part of the contract documents and utilized to the full extent on the Kolubara project. The QAS was comprehensive and included quality procedures from original roll goods manufacture through cover soil or aggregate placement.

The QAS included the following:

QC Manufacture of rollgods, QC Fabrication of panels, QC CCL Material and Placement, QC Subgrade Preparation, QC Panel Placement and Thermal Fusion Field Seaming and QC Cover Soils and Aggregate Placement.

Implementation of the QAS in the field and at the fabrication plant was carried out by the third party consulting organisation CIP, Institute for Transportation, Belgrade.

River bed with bridge

Panel Placement

Thermal fusion seaming

TRELLEBORG

Elastoseal Geomembrane References

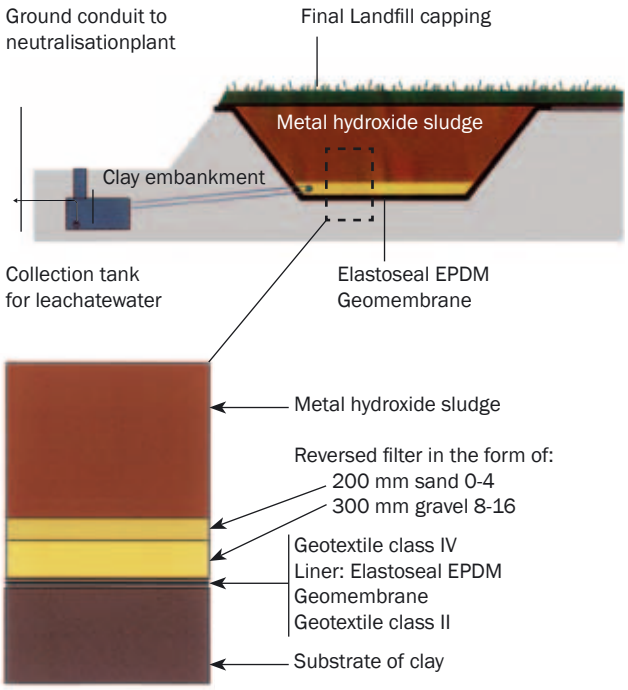
Avesta Polarit, Avesta, Sweden

Bottom lining of landfill site

AvestaPolarit in Avesta manufactures stainless steel. A residual product from this is metal hydroxide sludge, containing environmentally hazardous substances such as chromium. This must, in accordance with EU directive (1999/31/EC), be dumped in a class 1 landfill site which has the most stringent restrictions. In order to satisfy the requirements of the landfill directive, AvestaPolarit looked for a liner that is and will remain: completely watertight, resistant against chemicals, resistant to UV radiation and with very long service life.

On the basis of these premises, Elastoseal EPDM rubber membrane was chosen as liner. The dumping of the metal hydroxide sludge takes place in an open reservoir with a bottom liner of Elastoseal EPDM. When the landfill site is filled, after 4-5 years, it is planned to be covered with Elastoseal. This capping is simply performed, as the membrane can be spliced throughout its service life. After capping, the sludge will be fully encapsulated up to a pipe conduit which leads away the leachate water. This leachate water is treated using a 'reverse filter', where the water passes through layers of sand and gravel which bind larger particles before the water leaves the landfill site. After final treatment in a neutralisation plant, the water can be released into the nearby river Dalälven.

Bottom liner at landfill site, Avesta, Sweden.
Owner: AvestaPolarit Contractor: Hedbergs Tak



Technical data	
Installation	June, 2001
Liner	1.2 mm Elastoseal EPDM Geomembrane
Area	7,100 m^2
Prefabricated panels	2 at 13.8 x 66 m, 5 at 15.9 x 66 m
Installation time	7 days with 3 men
Splicing	Thermobond dual track seams
Seaming speed	2-3 m/min

Elastoseal Geomembrane References

Boliden Bergsöe, Landskrona, Sweden

Capping fire waste

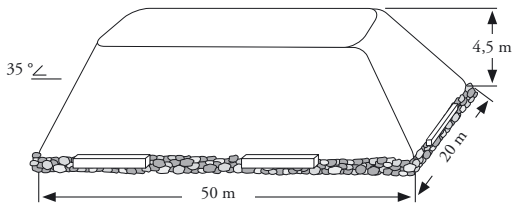
In summer 2001, lightning struck one of the buildings at Bergsöe in Landskrona. A large number of scrapped car batteries were being stored there pending recycling. The lightning strike caused the building, to catch fire as considerable heat was generated. Extinguishing was carried out by smothering with large volumes of sand. Mopping up of the fire took several months.

After the fire, there remained just 6,000 tonnes of sand mixed with 45% toxic lead oxide. The fire waste was to be stored on an open asphalt surface.

Boliden Bergsöe is situated near the coast, and there was a significant risk of strong winds whipping up a cloud of lead-mixed sand, known as diffuse dusting. There was also a risk of rainwater carrying toxic substances down into the ground. These problems required an immediate solution. It was decided to encapsulate the fire waste with a membrane so that water and wind could not release the hazardous substances in the time it would take to process the waste.

The Boliden Group has already used rubber membranes in landfill sites with good results and, following internal recommendations, an Elastoseal rubber membrane was chosen. This provides a flexible liner which conforms to all substrates, without the formation of air pockets. The covering is tightly sealed and provides a secure storage area. Covering fire and industrial waste is often quite sufficient in locations where water cannot rise up and dissolve the waste from underneath.

Capping fire waste, Landskrona, Sweden.
Owner: Boliden Bergsöe. Contractor: Scandinavian Terra Tec AB.



Technical data	
Installation	March, 2002
Liner	1.2 mm Elastoseal EPDM Geomembrane
Area	1,610 m^2
Prefabricated panels	3 psc. measuring approx. 37 m^2 each.
Installation time	8 hours for 2 men
Splicing	Thermobond dual track seam
Seaming speed	2-3 m/min

TRELLEBORG

Elastoseal Geomembrane References

Gnosjö Municipality, Gnosjö, Sweden

Secure long-term closure

At the end of the 1960s there was an extensive surface treatment industry in Gnosjö, Sweden. This industry resulted in emissions of heavy metals and cyanides, and large stores of metal hydroxide sludge were established. The problems were remedied by Gnosjö Municipality collecting and assuming responsibility for the handling of industrial waste from the entire area. During this perod, a total of 1500 tonnes of hydroxide waste and arsenic were collected. At this time Gnosjö Municipality was granted permission to build landfill sites with only asphalt as the bottom layer, but wisely considered that the waste was so toxic that asphalt would not provide sufficient security. Instead, they looked for a material that would guarantee safe, long-term storage, and found the solution in a rubber membrane.

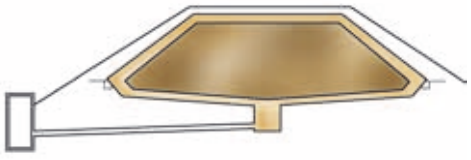
Industrial waste closure, Gnosjö, Sweden.
Owner: Gnosjö Municipality

Benefiting Trelleborg knowledge

The bottom drains from the landfill site run to a closed concrete well. The idea was that this would be used to store leachate water for detoxification. However, it has become evident that hardly any leachate water at all emerges from the sludge that was dewatered before being dumped. The well has instead turned into a good opportunity to check that the membrane remains leakproofed and that no groundwater or rainwater leaks in through it. Sixteen years later, the landfill site is still completely tight, maintenance-free and only requires occasional checking.

Trelleborg has more than 30 years' experience of using rubber membranes as geomembranes. During this time, we have developed products that retain their physical properties for an extremely long time. We know that a material's service life is determined by the strength of the material's chemical bonds, as well as the external circumstances affecting the material. Elastoseal EPDM Geomembrane is fully cross-linked and stable. This makes Elastoseal the diamond among liners.

Technical data	
Installation	1984
Liner	1.5 mm Värnamo Butyl
Area	2,000 m²
Splicing	Hotbond



Elastoseal Geomembrane References

Ljungby Municipality, Ljungby, Sweden

Bredemad's waste station

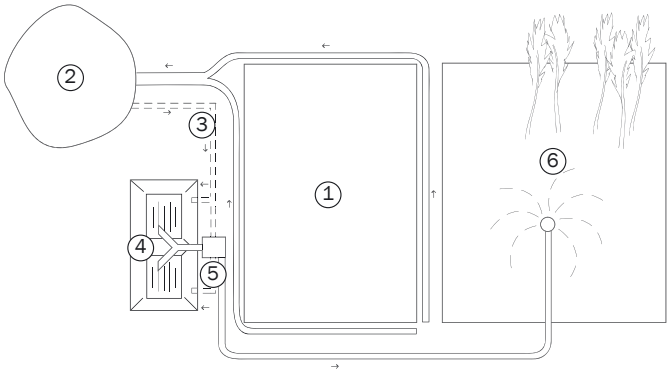
Ljungby Municipality has decided to extend its environmental undertaking by collecting, and treating locally, all leachate water which comes from the existing landfill site at Bredemad's treatment plant. In order to do this, the municipality has commissioned the construction of a new 40,000 m^3 leachate reservoir with a sealing layer comprising 14,000 m^2 Elastoseal EPDM Geomembrane.

In the new leachate reservoir, the leachate water will be stored temporarily in order to be used for irrigating energy forest, when the season allows. The reservoir has been built with two separate compartments so that emptying and treatment can take place in one of the tanks, while the other tank receives all the leachate water. Under the surface of the membrane are eight drainage pipes for the groundwater.

The leachate water is pumped from the new leachate water reservoir to a newly planted energy forest covering 7.5 hectares. The energy forest absorbs the heavy metals and, after felling, the timber is burned in the municipality's district heating power plant, where the contaminants can be dealt with.

Bredemad's waste station, Ljungby.
Client: Ljungby Municipality Ground
Contractor: Mark & Miljö i Ljungby AB.
Membrane installer: Tak & Membranteknik i Värnamo AB.

Bredemad Leachate water reservoir



Comprehensive plan of the waste station:

1. Landfill surface
2. Old leachate water collection associated with two ditches around the landfill site.
3. Pipe to new leachate water tank.
4. New leachate water tank measuring 40,000 m^3 with a bottom sealing layer comprising 14,000 m^2 Elastoseal EPDM Geomembrane.
5. Pump housing and pipe to energy forest.
6. 7.5 hectare energy forest.

Technical data	
Installation	June 2001
Liner	1.0 mm Elastoseal EPDM Geomembrane
Area	14,000 m^2
Prefabricated panels	5.9 x 90 m
Installation time	3 weeks with 3 men
Splicing technique	Thermobond with channel splices
Spicing speed	2-2.5 m/min

TRELLEBORG

Elastoseal Geomembrane References

Rangsells, Umeå, Sweden

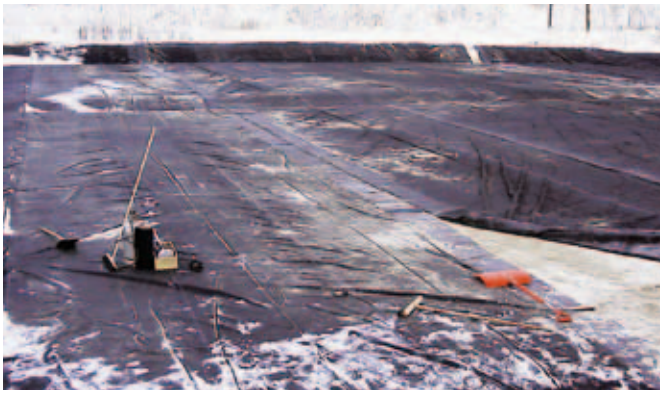
Composting area

During January 2002, Elastoseal EPDM Geomembrane was installed at Dåva Ecocycle Station in Umeå. The membrane will operate as a bottom liner for an area set aside for the mixing and storage of organic material, classified as non-hazardous waste.

The compost material is first mixed before being placed on an open area. Under the compost material are layers of chipped wood and chipped tyres. These materials are used because it is desirable for the compost material to come into contact with as much air as possible, at the same time as leachage water is drained away effectively.

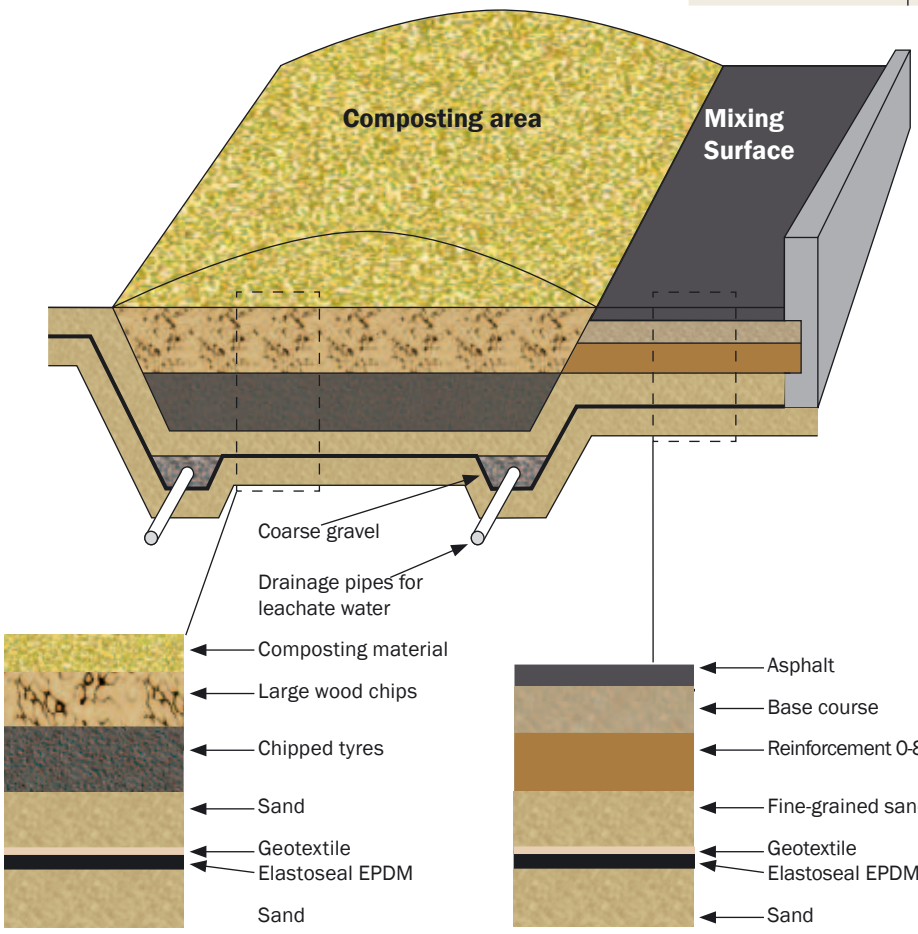
Adjacent to the compost, a 500 m² tank was installed which receives leachate water for reuse.

One of many factors which resulted in Elastoseal being chosen as the liner for this project, instead of e.g. polyethylene or Bentonite, is that the installation was carried out in the middle of the coldest Swedish winter. The rubber membrane, unlike many other lining materials, can be spliced and remains flexible at temperatures as low as –15° C.



Composting area at Dåva Ecocycle Station in Umeå, Sweden. Owner: Ragnsells. Contractor: Åke Larsson Grävare AB.

Technical data	
Installation	January, 2002
Liner	1.0 mm Elastoseal EPDM Geomembrane
Area	8,600 m²
Installation time	8 days for 4 men
Splicing	Thermobond dual track seam
Seaming speed	2-3 m/min



TRELLEBORG

Elastoseal Geomembrane References

Umeva, Umeå, Sweden

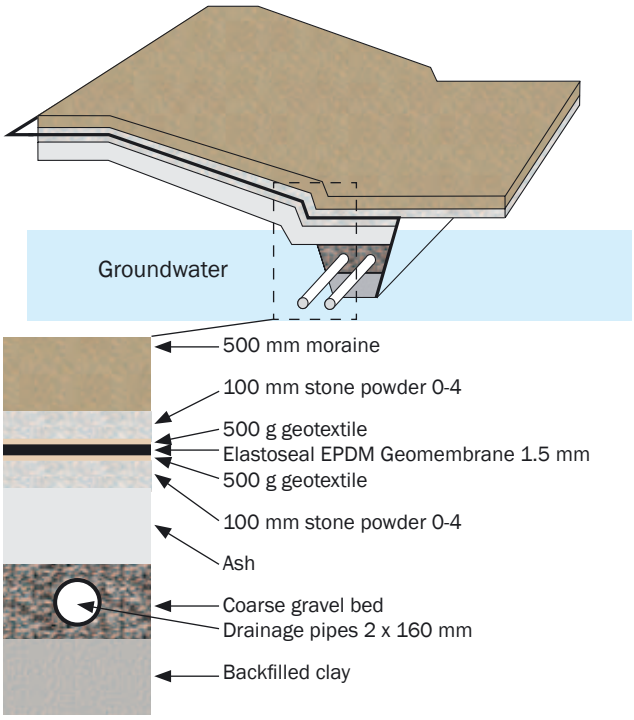
Perimeter capping at industrial landfill site

In order to create an environmentally sustainable solution, Umeva has decided to cover the existing industrial landfill site at Dåva. As the landfill site is 160.000 m² in size, the covering process will take place in stages. During the first stage, which was carried out in April 2002, Elastoseal EPDM Geomembrane was installed. This rubber membrane was used to cover the slopes at the landfill site.

The installation commenced with a 2 metre deep ditch being excavated around the slopes that were to be covered. Double drainage pipes were laid in this ditch in order to drain the water away.

The rubber membrane follows the vertical surface on the outside of the drainage system up to ground level, where the slope begins at an incline of 1:4. Elastoseal EPDM Geomembrane has excellent friction properties as the membrane is soft and has a patterned surface. This gives high friction with a low risk of sand and earth landslides. In order to facilitate future capping, the contractor made preparations by inserting splicing strips on the upper part of the membrane at this early stage. These can be used for splicing when the time comes to cover the top of the landfill site.

Perimeter capping at Dåva industrial landfill site in Umeå, Sweden. Owner: Umeva. Contractor: Åke Larsson Grävare AB.



Technical data	
Installation	April, 2002
Liner	1.5 mm Elastoseal EPDM Geomembrane
Area	5,600 m²
Installation time	12 days for 4 men
Splicing	Thermobond dual track seams
Seaming speed	2-3 m/min

TRELLEBORG

Elastoseal Geomembrane References

Åsele Municipality, Åsela, Sweden

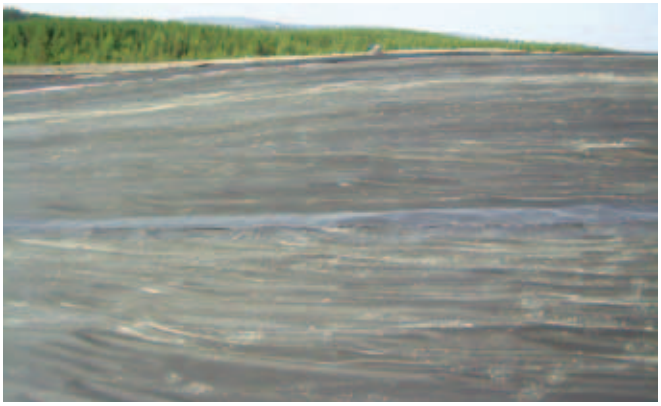
Landfill Capping

In 2001, Åsele Municipality decided to improve the storage of waste at the municipality's 28,000 m² landfill site through capping. The landfill has been used for a long time for dumping waste from: industry, construction/demolition, households and digested sludge.

The membrane alternatives which Åsele Municipality evaluated prior to capping were clay liner and Elastoseal EPDM Geomembrane. During the evaluation, it was found that clay liner would not provide adequate protection. As the landfill site contains a great many different types of waste which are deteriorating, there will be major movements and settlement for many years to come. A GCL liner would crack and leak with lost surface runoff as a consequence. It was also considered that the waste was so porous that it would be impossible to compact soil on top in such a way a clay liner would hydrate properly. The location of the site also meant that a clay liner would be a labour-intensive and expensive alternative. Extensive earthwork would be required in order to create slopes for water runoff.

Following the evaluation, the Elastoseal EPDM Geomembrane was the best alternative as it is a completely tight rubber membrane whose elasticity can withstand ground movements and conforms to the substrate.

The installation at Åsele landfill site was carried out in the summer of 2002. The work proceeded extremely efficiently as the rubber membrane had been prefabricated in 18 panels tailored to drawings.



Landfill Capping, Åsele, Sweden. Owner: Åsele Municipality. Contractor: Åke Larsson Grävare.

Technical data	
Installation	July, 2002
Liner	1.0 mm Elastoseal EPDM Geomembrane
Area	28,000 m²
Prefabricated panels	The area is divided up into panels, the largest panel measuring 1,840 m²
Installation time	16 working days with 6 men
Splicing	Thermobond dual track seam
Seaming speed	2-3 m/min

Geomembrane References

TRELLEBORG

Sweden

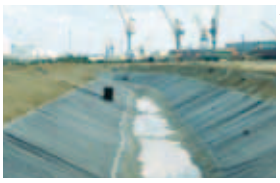
1969 Swedish Agricultural College, Lövsta, Sweden
Manure pit. 12.000 m²

1972-73 Swedish farmers, 105 jobsites, Sweden
Manure pit. 46.000 m²

1974 Bredåkra Gård, Ronneby, Sweden
Manure pit. 400 m²

1975 Swedish Agricultural College, Lövsta, Sweden
Manure pit. 15.000 m²

1976 Värnamo gummi, cooling water, Värnamo, Sweden
Industrial reservoir. 2.000 m²



1979 Supra, for gypsum slurry, Landskrona, Sweden
Canal. 28.000 m²

1979 Lambohov, Linköping, Sweden
Hot water tank. 2.800 m²

1983 Kallax Airport, Luleå, Sweden
De-icing surface. 2.000 m²

1984 Boliden Kemi, store acids, Helsingborg, Sweden
Chemical storage. 5.500 m²

1984 Gnosjö Kommun, store hydroxide waste, Gnosjö, Sweden
Chemical storage. 2.000 m²

1985 Ragn Sells AB, Högsbytorp, Sweden
Chemical storage. 1.500 m²

1987 SAS Headquarter, Frösundavik, Sweden
Ornamental lake. 4.000 m²

1989 The Globe Hotel, The Globe Sportsarena, Stockholm, Sweden
Ornamental lake. 2.200 m²

1990 Kristinelunds Slott, Helsingborg, Sweden
Ornamental lake. 1.700 m²

1990 ABB Hafo, cooling water, Järfälla, Stockholm, Sweden
Industrial reservoir. 7.000 m²

1990 Stripa Research, Mine for Clay Technology, Sweden
Tank closed. 220 m²

Sweden

1991 Flädje Golfcourse, lining under green, Vessigebro, Sweden
Golf course. 2.400 m²

1991-93 The Botanic Garden, Gothenburg, Sweden
Garden Ponds. 600 m²

1992 Värnamo Golf Club, Näsbyholm, Värnamo, Sweden
Golf course. 800 m²

1992 Boliden AB, Rönnskärsverken, Skellefteå, Sweden
Waste Deposit Cap. 15.000 m²

1992 Leto AB, Värnamo, Sweden
Waste Deposit. 300 m²

1993 Kikås, Mölndal, Sweden
Lechate Reservoir. 14.000 m²

1993 Araslövs Golf Club, Araslöv, Sweden
Golf course. 1.400 m²

1993 Stockholms Golf Club, Kevinge, Sweden
Golf course. 1.150 m²

1993 Fryxellska skolan, Sunne, Sweden
Ornamental lake. 240 m²

1993 Museum Fjärilshuset, Haga, Stockholm, Sweden
Ornamental lake. 600 m²

1994 City park, Linköpings kommun, Linköping, Sweden
Ornamental lake. 900 m²

1994 Skånebränneriet, Kristianstad, Sweden
Waste water reservoir. 19.000 m²

1994 University of Stockholm, Tovetorp, Sweden
Waste deposit. 1.900 m²

1994 Dala Airport, Borlänge, Sweden
Waste water reservoir. 1.600 m²

1995 Götaströms Golfbana, Skillingaryd, Sweden
Golf Course. 2.000 m²

1996 Kemira Kemi, store acids, Helsingborg, Sweden
Chemical storage. 5.000 m²

1996 Märsta Kommun, city park, Märsta, Sweden
Garden ponds. 2.000 m²

1996 E4 Väderstad, Mjölby, Sweden
Road dam. 4.000 m²

1996 E4 Gåsagård, Hamneda, Sweden
Road dam. 1.550 m²

1996 Stora Torget, Pajala, Sweden
Pond. 250 m²

1996 Vejnan Cemetary, Dalarna, Sweden
Pond. 400 m²

1996 Nytorget, Nyköping, Sweden
Pond. 100 m²

1996 Wolf site pond, Skansen, Stockholm Sweden
Zoo Park. 200 m²

1996-97 Citypark, Katrineholm, Sweden
Ponds. 600 m²

1997 Vasaparken, Västerås, Sweden
Pond. 600 m²

Geomembrane References

TRELLEBORG

Sweden

1997 Gräsåsens Deposit Station, Östersund, Sweden
Waste Deposit. 3.000 m²

1997 Ericsson AB, Kumla, Sweden
Pond. 900 m²

1997 Trädgårdsföreningen, Linköping, Sweden
Ornamental lake. 1.600 m²

1997 Borealis AB, Stenungsund, Sweden
Waste water reservoir. 1.600 m²

1997 Bear site pond, Skansen, Stockholm, Sweden
Zoo Park. 320 m²

1997 Odensbacken, Örebro, Sweden
Waste water reservoir. 2.400 m²

◀ **1997 Boliden AB, Kristineberg, Sweden**
Waste water reservoir. 6.000 m²

1997 Kattarps Soptipp, Östra Göinge, Sweden
Waste water reservoir. 2.100 m²

1997-98 The University, Umeå, Sweden
Ornamental lakes. 2.200 m²

1998 Cemetary, Lidköping, Sweden
Ornamental lake. 500 m²

1998 The Botanic Garden, Gotland, Sweden
Pond. 150 m²

1998 Cemetary Skogskyrkogården, Kungsbacka, Sweden
Pond. 100 m²

1998 Museum Fjärilshuset, Haga, Stockholm, Sweden
Pond. 350 m²

1998 Roundabout Värmdövägen, Stockholm, Sweden
Pond. 600 m²

1998 Stadsparken, Lidköping, Sweden
Ornamental lake. 1.400 m²

1998 Jörn, Skellefteå, Sweden
Pond. 500 m²

1998 Tom Tits Experiment, Södertälje, Sweden
Pond. 800 m²

1998 The Harbour, Mönsterås, Sweden
Pond. 100 m²

1998 Valstadsskolan, Gamleby, Sweden
Pond. 500 m²

1998 Västernordskolan, Skärholmen, Sweden
Pond. 100 m²

1998 Skansenskolan, Kalmar, Sweden
Pond. 100 m²

1998 Park, Uppsala, Sweden
Pond. 600 m²

1998 Cemetary Norra Kyrkogården, Kalmar, Sweden
Pond. 500 m²

1999 Ecological village, Kullön, Vaxholm, Sweden
Ornamental lake. 2.100 m²

1999 Astra Zenica, Södertälje, Sweden
Ornamental lake. 1.800 m²

1999 Agustenborg, Malmö, Sweden
Surface water ponds. 1.500 m²

◀ **2000 Brunnsparken, Ljungby, Sweden**
Surface water ponds. 10.900 m²

Sweden

2000 Sunninge Sund, Bro, for Vägverket, Uddevalla, Sweden
Road dam. 3.500 m²

2000 The Water Lily Pond, Ramlösaparken, Helsingborg, Sweden
Pond. 100 m²

2000 Börje Andersson, Ljusegren, Skillingaryd, Sweden
Pond. 150 m²

◀ **2000 Flickorna Lundgren, Skäret, Arild, Sweden**
Pond. 150 m²

2000 Vägverket, Road 45, Sunne, Sweden
Road Ditch. 5.000 m²

2000 Bldg 13, Onkologen, Lund Hospital, Lund, Sweden
Ornamental pond. 850 m²

2000 STAPP AB, 25 sites totally, Sweden
Shooting ranges. 9.700 m²

2001 Bjäre Golfclub, Båstad, Sweden
Golf course pond. 4.500 m²

◀ **2001 Bredemad Waste Deposit, Ljungby, Sweden**
Leachate Reservoir. 13.900 m²

◀ **2001 Avesta Sheffield, Avesta, Sweden**
Industrial Waste Pond 7.000 m²

2001 Alsterbro Water Purification Plant, Nybro, Sweden
Reed beds. 1.700 m²

2001 Forshaga Municipality, Sweden
Leachate Reservoir. 5.000 m²

2001 Jäkneberget, Västerås Municipality, Sweden
Ornamental ponds. 1.000 m²

2001 Arvid Nilsson Vägarbeten, Torsby, Sweden
Road Dam. 1.000 m²

2001 Östby Water Purification Plant, Kramfors, Sweden
Reservoir. 2.000 m²

2001 Farstorps Farm, Eslöv, Sweden
Pond. 700 m²

2001 Tyresö Municipality, Tyresö, Sweden
Ornamental Ponds. 2.000 m²

2001 Hultsfred, Sweden
Ornamental Ponds. 2.200 m²

2001 STAPP AB, appprox. 15 ranges, Sweden
Shooting ranges. 16.300 m²

2001 Municipal Landfill, Vänersborg, Sweden
Leachate Reservoir. 6.000 m²

2002 Dåva Kretsloppsanläggning, Umeå, Sweden
Landfill, bottom liner. 8.600 m²

2002 Mörebyggen, Kalmar, Sweden
Crayfish farming. 6.000 m²

◀ **2002 Dåva Industrial Lanfill, ditch area, Umeå, Sweden**
Landfill capping. 5.600 m²

◀ **2002 Boliden Bergsöe, Landskrona, Sweden**
Landfill capping. 1.600 m²

Geomembrane References

TRELLEBORG

Sweden

2002 Mälarö Golfclub, Ekerö, Stockhom, Sweden
Golf Course Pond. 2.260 m²

2002 Västerviks Stadspark, for Västerviks Kommun, Sweden
Ornamental Lake. 2.500 m²

2002 STAPP AB, 13 ranges, Sweden
Shooting ranges. 6.650 m²

2002 Åsele Municipal Landfill, Åsele, Sweden
Landfill capping. 28.000 m²

2002 Kemira Kemi, Helsingborg, store acids, Sweden
Reservoir Cover. 3.100 m²

2002 Ljungby Kommun, Ljungby, Sweden
Road ditch. 1.800 m²

2002 Tveta, Södertälje, Sweden
Capping. 9.000 m²

2002 Rveingehed, STAPP AB, 4 ranges, Sweden
Shooting ranges. 1.620 m²

2003 Övreskog Landfill, Ulricehamn, Sweden
Leachate reservoir. 25.000 m²

2003 Örkeljunga Golfclub, Örkeljunga, Sweden
Golf coarse pond. 1.160 m²

2003 Strandkyrkogården, Stockholm, Sweden
Cemetary pond. 1.500 m²

2003 Hammarby Sjöstad, Stockholm, Sweden
Ornamental ponds. 2.000 m²

2003 Kv. Vitberget, Skellefteå, Sweden
Ornamental ponds. 2.900 m²

2003 Gansca deposit, Sundsvall, Sweden
Leachate pond. 1.000 m²

2003 Gässlösa deposit, Borås, Sweden
Leachate pond. 1.200 m²

2003 STAPP AB, 39 ranges, Sweden
Shooting ranges. 15.040 m²

2003 Boliden AB, Skelleftehamn, Sweden
Waste water pond. 1.500 m²

2003 Luleå Wastedump, Luleå, Sweden
Leachate reservoir. 5.000 m²

2004 Kungsholmen, Stockholm, Sweden
Ornamental pond. 1.000 m²

2004 STAPP AB, 21 ranges, Sweden
Shooting ranges. 11.010 m²

2004 Djupdalen, Karstad Energi AB, Karlstad, Sweden
Aeration pond. 4.800 m²

2004 STAPP AB, 39 ranges, Sweden
Shooting ranges 15 040 m²

2004 Boliden AB, Skelleftehamn, Sweden
Waste water pond 1 500 m²

2004 Luleå Wastedump, Luleå, Sweden
Leachate reservoir 5 000 m²

2004 Djupdalen, Karstad Energi AB, Karlstad, Sweden
Aeration pond. 4.800 m²

2004 Upplands Väsby, road E4, Stockholm, Sweden
Ornamental ponds 4 500 m²

2004 Road crossing, Vinslöv, Sweden
Ground water protection 2 500 m²

2004 Landfill Uddeholm, Borås, Sweden
Capping 3 000 m²

Sweden

2004 Saltängen, Västerås, Sweden
Pond 1 760 m²

2004 STAPP AB, 21 ranges, Sweden
Shooting ranges 11 010 m²

2004 Landfill, Hovgården, Uppsala, Sweden
Sludge ponds 3 200 m²

2005 Aitik, Gällivare, Sweden
Pond 1 000 m²

2005 Ragnsells, Högsbytorp, Stockholm, Sweden
Waste ponds 1 500 m²

2005 Sakab, Kvarntorp, Kumla, Sweden
Waste pond and ditches 3 000 m²

2005 Bullermyren, Borlänge, Sweden
Pond 935 m²

2005 Allevägen, Fryele, Värnamo, Sweden
Backyard pond 100 m²

2005 STAPP AB, Halmstad range, Sweden
Shooting ranges 1 650 m²

2005 STAPP AB, Kalixfors, Halmstad, Umeå, Säve, Sweden
Shooting ranges 2 400 m²

2005 STAPP AB, Umeå, Sweden
Shooting ranges 2 100 m²

2005 STAPP AB, 7 sites, Sweden
Shooting ranges 1 885 m²

2005 Stora Holm Halkbana, Gothenburg, Sweden
Pond Lining 2 000 m²

2005 Åre Municipal, Åre, Sweden
Ponds 2 000 m²

2005 Västerby Farm, Vänge, Uppsala, Sweden
Urine Manure Pit 1 200 m²

2005 Åkerby Farm, Åkerby, Uppsala, Sweden
Urine Manure Pit 1 600 m²

2005 Troxhammars Golf, Skå, Sweden
Golf Pond 3 500 m²

2005 Wapnö Farm, Falkenberg, Sweden
Ensilage capping 6 000 m²

2005 SSAB, Oxelösund, Åle deposit, Sweden
Waste capping 14 000 m²

2005 Bäckaskogs Castle, Sweden
Ornamental Pond 400 m²

2005 Outo Kumpo, Avesta, Sweden
Slurry Pond 8 500 m²

2005 Isover, Vrena, Nyköping, Sweden
Industrial waste ditches 3 000 m²

2005 Mariefred Municipal, Mariefred, Sweden
Reed beds 3 100 m²

2005 Furuvuksparken, Gävle, Sweden
Zoo pond 600 m²

2005 Cray Fish Pond, Mörebyggen, Kalmar, Sweden
Fish Farming 1 400 m²

2005 Stenungsund Municipalty, Stenungsund
Leachate pond 1 100 m²

2006 Blaiken Mine, Lycksele
Emergency Pond 2 500 m²

2006 Avesta Sheffield. Avesta
Sludge Ponds 14 000 m²

Geomembrane References

TRELLEBORG

Sweden

2006 Svensk Tryckhjutning AB, Vimmerby, Sweden
Cooling Water pond 2 000 m²

2006 SSAB, Oxelösund, Åle deposit, Sweden
Slurry Pond 8 000 m²

2006 STAPP AB, 5 ranges for Fortifikationsförvaltningen, Sweden
Shooting ranges 1 900 m²

2007 Marieberg köpcentrum, Örebro, Sweden
Ornamental ponds 660 m²

2007 Visby Gotland, GGK Golfclub, Sweden
Golf pond 4 000 m²

2007 Vaggeryds Travbana (Trotting raceway), Sweden
Ornamental pond 4 000 m²

2008 Vankiva Avfallsanläggning, Hässleholm, Sweden
Landfill pond 300 m²

2007 Landfill Öjersjö, Gothenburg, Sweden
Waste sorting area 7 400 m²

2008 Silverstone AB, Gjuterigatan, Ljungby, Sweden
Landscape pond 1 150 m²

2007 SSAB, Oxelösund, Åle deposit, Sweden
Waste enveloping 42 000 m²

2008 Brändkläppens Avfallsanläggning, Boden, Sweden
Landfil capping 3 000 m²

2008 Industrial Landfill Semla, Fagersta, Sweden
Landfill pond 2 200 m²

2007 Långbro dammen, Stockholm, Sweden
Ornamental pond 2 500 m²

2007 Bld 14, Helicopter flottiljen, Linköping, Sweden
Closed tank 200 m²

2007 Landfill Månsemyr, Orust, Sweden
Leachate pond 5 600 m²

2007 Österleden/Brillinge, Uppsala, Sweden
Ornamental pond 1 200 m²

2008 Skrubba Landfill, Tyresö, Stockholm, Sweden
Landfill capping 25 000 m²

2008 K-Rauta parking area, Laxfiskevägen, Partille, Sweden
Spill water tank 1 100 m²

2008 OKB Nuclear Power Station, Oskarshamn, Sweden
Water Tank 200 m²

2008 Landfill Häradsudden, Kimstad, Norrköping, Sweden
Leachate pond 17 700 m²

2008 Skogslyckan cemetary, Växjö, Sweden
Irrigation Pond 1 000 m²

2008 SSAB, Oxelösund, Ålö deposit stage 6, Sweden
Waste enveloping 24 000 m²

2008 Kallmoraberget, Norberg, Sweden
Waste Deposit 10 300 m²

2008 Gerdmans, Markaryd
Landscaping pond 4 200 m²

Sweden

2008 Hammarby Sjöstad, Kanalvägen, Stockholm, Sweden
Canal 730 m²

2008 SSAB, Borlänge, Svavelgärdet deposit, Sweden
Waste deposit 4 200 m²

2008 Lövsta Landfill, Stockholm, Sweden
Landfill Capping 7 300 m²

2008 STAPP AB/Häradsö, Strängnäs, Sweden
Shooting ranges 570 m²

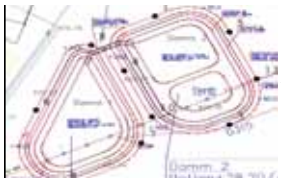
2008 SSAB, Oxelösund, Ålö deposit stage 7, Sweden
Waste enveloping 37 000 m²

2008 Outo Kumpu AB, Nyby, Torhälla, Eskilstuna, Sweden
Waste Deposit 7 100 m²

2008 Aittik Mine, Aittik, Sweden
Waste area 1 600 m²

2008 Norrbro, the Royal Castle, Stockholm, Sweden
Bridge Tanking 1 400 m²

2008 Djupdalens Deponi, Karlstad, Sweden
Landfill 600 m²



2008 Storskogens Deponi, Oskarshamn, Sweden
Landfill pond 2 000 m²

2008 Roma Kretsloppsanläggning, Roma, Gotland, Sweden
Ponds 950 m²

2008 Storskogens Deponi, Oskarshamn, Sweden
Landfill pond 2 000 m²

2009 Fågelmyra Avfallsanläggning, Borlänge, Sweden
Landfill ponds 6 000 m²

2009 Wahlsta Gård, Bettna, Hallstahammar, Sweden
Bathing pond 300 m²

2009 Månsemyr deponi, Ellös, Orust, Sweden
Landfill bottom liner 10 000 m²

2009 Bergslagsvägen, Grimsta, Stockholm, Sweden
Surface water pond 2 700 m²

2009 Moose park, Isaberg, Hestra, Sweden
Pond 400 m²

2009 Outo Kumpu AB, Nyby, Torshälla, Sweden
Industrial Waste deposit 6 000 m2

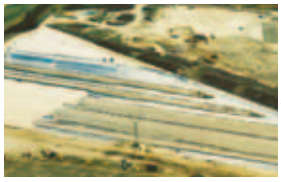
Denmark

1967 Brønderslevs Stadshopital, Brønderslev, Denmark
Fire fighting pond. 500 m²

1968 Limfjordtunneln, Aalborg, for Esso Chemicals, Denmark
Road Tunnel. 80.000 m²

1979 Samsöfarmen, Samsö, Denmark
Manure pit. 2.500 m²

1983 Nordsöcentrat, Hirtshals, Denmark
Zoo Park. 2.000 m²



1985 Maglehöjparken, Fredriksund, bitumen pollutions, Denmark
Earth Capping. 900 m²

1991 St Lyndelse Losseplads, Sandholt, Fyn, Denmark
Waste Deposit. 43.000 m²

Geomembrane References

TRELLEBORG

Denmark

1998 St Lyndelse Losseplads, Sandholt, Fyn, Denmark
Waste Deposit Cap. 5.000 m²

2000 Resevoir, Slaggdepot, Holstedbro, Denmark
Waste Deposit. 460 m²

2001 Superfos AS, Vipperød, Denmark
Industrial tank. 530 m²

2001 Marcia-Böge A/S, Denmark
Ornamental pond 2 500 m²

2008 Lysholt Parken, Ringvej/Fertinvej, Vejle, Denmark
Road landscaping 2 250 m²

Finland

1969 Saima Canal, Finland
Canal. 1,600 m²

1971 Agronom Lundström, Åbo, Finland
Manure Pit. 600 m²

1986 Mini-Soumi, Ahtäri, Finland
Ornamental lake. 3.500 m²

Norway

1970 Pigfarm, Kapp, Norway
Manure pit. 600 m²

1976 Kalnes Jordbrukskole, Östfold Fylke, Norway
Manure pit. 2.600 m²

1994 Alfaset Gravlund, Anleggsgartner Tronslien, Norway
Cemetary ponds. 750 m²

1995 Haslum Kirkegård, Öivind, Kofstad, Norway
Cemetary ponds. 370 m²

1995 Vallersund Gård, Vallersund, Norway
Ponds. 900 m²

1999 Lindum Ressurs og Gjennvinning, Drammen, Norway
Food waste Composts. 1.000 m²

2000 Liestranda, Drammen, for NGI, Norway
Vacuum consolidation. 2.400 m²

2009 Holmemkollen Ski Resort, Oslo (one panel), Norway
Snow production pond 2 480 m²

Iceland

1990 Reykjavik, Iceland
Fish farming tanks. 500 m²

Poland

2000 Cracow Golf Academy, Cracow, Poland
Golf Course. 4.000 m²

2004 Orlen Co, Plock, Poland
Fire Fighting Pond 7000 m²

2006 Konstancin, Warsaw, Poland
Landscape pond 7000 m²

Hungary

2000 Mariavölgy, Hungary
Golf Course 5000 m²

2001 Jánd Municipal, Jánd, Hungary
Landfill capping. 1.000 m²

2001 Hosszuhegyi AG, Sükösd, Hungary
Waste water reservoir 3 000 m²

Hungary

2001 Residintial Office, Pusztaszabocls, Hungary
Waste water reservoir 1 500 m²

2001 DRV Rt, Agard, Hungary
Waste water reservoir 2 000 m²

2002 Education Center, Kecskemet, Hungary
Pond 3 000 m²

2003 Apc, Hungary
Landfill Capping 5 300 m²

2003 Diluted dung reservoir, Nyirbator, Hungary
Manure Pit 8 660 m²

2003 Skanzen, Hungary
Pond 1 600 m²

2003 Pesti ut, Budapest, Hungary
Pond 1 200 m²

2004 PISEC timber yard, Zahony, Hungary
Fire fighting pond 1 060 m²

2004 Diluted dung reservoir, Nyirbator, Hungary
Manure Pit 5 600 m²

2005 Borota, Hungary
Manure Pit 1 730 m²

2005 Mátramindszent, Hungary
Manure Pit 2 020 m²

Serbia

1997 Retenzija C.S. Sava, Retenzija, Neshyl Ltd, Serbia
Waste water reservoir. 6.000 m²

2003 Highway pond, Belgrade Ring Road, Serbia
Road conveyance 5 000

2004 Fish Farm, Belgrade, Serbia
Fish Farming 800

2006 KOLUBARA Coal Mine, men made river, Serbia
Water conveyance 98 000

Slovenia

2009 Avce hydropower station, village Avce, Slovenia
ornamental pond 2 300 m²

Yugoslavia

1998 Belgrade, Yugoslavia
Waste water reservoir. 6.000 m²

Bosnien & Herzegovina

2008 Open pit coal mine, Arcelor Mittal, Buvac, Prijedor, Bosnien & Herzegovina
Canal lining 20 700 m²

Czech Republic

2003 Private garden, Praque, Czech Republic
Pond. 770 m²

2003 Aquagard jezirko, Praque, Czech Republic
Pond. 1,840 m²

2005 Ypsilon Golf, Czech Republic
Golfpond 6 400 m²

2006 Farm, ZD Krasna Ves, Lining and Floating roof, Czech Republic
Manure Pit 5 000 m²

Geomembrane References

TRELLEBORG

Spain

1995 Sacyr, Bullas-Murcia, Spain
Irrigation reservoir. 29.600 m²

1995 Communidad De Regentes Pico De La Tienda, Jumilla-Murcia, Spain
Irrigation reservoir. 13.700 m²

1996 Agrifusa, Alhama de Murcia, Spain
Irrigation reservoir. 14.300 m²

1996 Emuasa, Embalse Contraparada-Murcia, Spain
Irrigation reservoir. 28.700 m²

1996 Sixto Pers Calopa, Los Urrutias, Murcia, Spain
Irrigation resevoir. 33.100 m²

1996 Cefusa, Pliego, Murcia, Spain Irrigation reservoir. 13.700 m²

1996 Halcon Foods SA, Campos del Rio, Murcia, Spain
Irrigation resevoir. 14.300 m²

1996 Explotaciones Agricolas Duran SAT 4813, Mazarron, Murcia, Spain
Irrigation reservoir. 25.800 m²

1996 Cefusa, Cancarix, Albacete, Spain
Irrigation reservoir. 16.700 m²

1996 Lorenzo Fernandez Navarro, Librilla, Murcia, Spain
Irrigation reservoir. 13.200 m²

1996 Cdad. De Regentas Del Trasvase, Tajo-Segura, Calasparra, Murcia, Spain
Irrigation reservoir. 41.000 m²

1996 Communidad Regantes San Victor, Fortuna, Mur., Spain
Irrigation reservoir. 23.800 m²

1996 Gines Navarro Construcciones SA, Alguazas, Mur., Spain
Irrigation reservoir. 22.400 m²

1998 Ctra. Abalat km 115 Alcira-Valencia, Spain
Irrigation reservoir. 25.300 m²

1998 Torrevieja Kartagena Orihuela - Alicante, Spain
Irrigation reservoir. 58.000 m²

1999 Explotaciones Agricolas Bigastrenses SAT 7112 Torremendo - Alicante, Spain
Irrigation reservoir. 3.800 m²

1999 Alquileres Murcia SA, Los Valientes - Murcia, Spain
Irrigation reservoir. 10.000 m²

1999 Agroman, Calasparra - Murcia, Spain
Irrigation reservoir. 7.900 m²

1999 Explotaciones Agricolas la Halconera SL Cieza - Murcia, Spain
Irrigation reservoir. 9.000 m²

1999 Jose M Guillamon Blaya, Sucina, Murcia, Spain
Irrigation reservoir. 6.400 m²

1999 Finca El Olmillo SA, Fuentealamo, Albacete, Spain
Irrigation reservoir. 12.200 m²

1999 Cefusa, Cancarix, Albacete, Spain
Irrigation reservoir. 5.300 m²

1999 Agricola Aguilena S.A.T. 1.179, Paraje "Collado Tortuoso" Aguilas, Murcia, Spain
Irrigation reservoir. 97.500 m²

Spain

1999 Explot. Agricolas la Perdiz y Teconsa Urbana SA San Miguel de Salinas, Alicante, Spain
Irrigation reservoir. 8.900 m²

1999 Pedro Perez Zapata y Hnos. CB. Alhama de Murcia, Murcia, Spain
Irrigation reservoir. 7.800 m²

1999 Cdad. Regantes Tajo-Segura Sangonera la Seca Sangonera la Seca, Murcia, Spain
Irrigation reservoir. 37.200 m²

1999 Agrios Peca SA, Finca el Carril Alhama, Murcia, Spain
Irrigation reservoir. 6.600 m²

1999 Transformaciones y Explotaciones Agricolas SA, Librilla, Murcia, Spain
Irrigation reservoir. 32.000 m²

1999 SAT No 6715 "El Kajalindran", Finca lo Ajauque-Fortuna, Spain
Irrigation reservoir. 11.200 m²

1999 Finca los Charcos, TM de Tobarra, Albacete, Spain
Irrigation reservoir. 8.000 m²

1999 Sat No 1930 Aguas De Campix, Alhama, Murcia, Spain
Irrigation reservoir. 10.500 m²

2000 Union Agricola del Sureste SAT No 2114, Raiguero de Bonanza, Alicante, Spain
Irrigation reservoir. 6.000 m²

2000 Superior Fruticola SA, Aguilas, Murcia, Spain
Irrigation reservoir. 13.000 m²

2000 Exploitaciones Agricolas la Perdiz, Finca la Dehesa, Orihuela, Alicante, Spain
Irrigation reservoir. 19.100 m²

2000 SAT No 1930 Aguas de Campix, Paraje Boquera de Campix, Al Hama de Murcia, Spain
Irrigation reservoir. 10.900 m²

2000 Explotaciones Agricolas Integradas SA, TM de Corvera, Murcia, Spain
Irrigation reservoir. 8.300 m²

2000 Communidad de Propietarios San Bruno, Algorfa, Spain
Irrigation reservoir. 7.200 m²

2000 Agricola Ascoy SL, Cieza-Murcia, Spain
Irrigation reservoir. 55.100 m²

2000 Cooperativa Monte Pilones SCL, Alhama de Murcia, Murcia, Spain
Irrigation reservoir. 11.300 m²

2000 Soldive Espana SL, Finca "Balsares" Altet, Alicante, Spain
Irrigation reservoir. 8.700 m²

2000 Jose M Guillamon Blaya, Santomera, Murcia, Spain
Irrigation reservoir. 10.400 m²

2000 Agrios Peca SA, Finca Puerto Limon, Alhama, Murcia, Spain
Irrigation resevoir. 10.700 m²

2001 Finca los Parrales CB, Jumilla, Murcia, Spain
Irrigation reservoir. 6.600 m²

2001 CDAD de Regantes la Acequia del Campo, Cehegin - Murcia, Spain
Irrigation reservoir. 42.900 m²

2001 Jesus Frco.Egea Garre CB, Torrepacheco, Murcia, Spain
Irrigation reservoir. 5.100 m²

Geomembrane References

TRELLEBORG

Spain

2001 Hidrogosa SL, Lorca-Murcia, Spain
Irrigation reservoir. 12.300 m²

2002 Azaraque SA, Alhamra de Murcia, Spain
Irrigation reservoir. 18.700 m²

2002 Victorino Melo Acha, Vasconcillo Gumiel de Hizan, Burgos, Spain
Irrigation reservoir. 5.000 m²

2002 Finca Dehesa del Rey, Baza, Granada, Spain
Irrigation reservoir. 14.500 m²

◀ **2002 Intersa, Molina de Segura, Murcia, Spain**
Irrigation reservoir. 19.600 m²

2002 Invernaders y Complementos SA, Los Canovas, Fuente de Alamo, Murcia, Spain
Irrigation reservoir. 10.900 m²

2002 FCC Construcciones SA-EMCOFA SA, La Grandella, Lleida, Spain
Irrigation reservoir. 9.800 m²

2002 Generalitat de Valencia/SARCO, Spain
Irrigation reservoir. 54.000 m²

◀ **2002 Embalse regulador de Riego "El Morron", Villena Alicante, Spain**
Irrigation reservoir. 55.000 m²

2003 Comunidad de Bienes Rosa Fluxia CB, Totana, Spain
Irrigation resevoir. 3.700 m²

2003 Bodegas Basconcillos SL, Gumiel de Hizan, Burgos, Spain
Irrigation resevoir. 5.000 m²

2003 Mas Jalec-Els Hostalestes de Balenya, Barcelona, Spain
Pond. 4.200 m²

2004 Hotel Golf Can Rafel, Cervello, Barcelona, Spain
Ornamental pond. 2.300 m²

2004 Finca los Verdugales, La Aranda, Avila, Spain
Irrigation reservoir. 2.040 m²

2005 Sarco SA, de la Muela-Alhama de Murcia, Murcia, Spain
Irrigation reservoir 32 000 m²

2005 Bases, Isidro, Mahon, Menorca, Spain
Irrigation reservoir 5 500 m²

◀ **2005 Batea, Tarragona, Spain**
Irrigation reservoir 48 700 m²

2006 Campo de Golf Maioris, Lluhmajor, Baleras, Spain
Golf Course 27 000 m²

Belgium

◀ **1999 Bassin nautique de Durbuy, Durbuy, Belgium**
Ornamental fishpond. 3.800 m²

2001 Costermans, Berlaar, tomato farm, Belgium
Irrigation reservoir. 5.000 m²

2002 Doorsnede Bekken, Belgium
Landfill capping. 1.000 m²

◀ **2002 Crematorium Uccle, Belgium**
Pond. 1.000 m²

2002 Carrefour
Fire fighting pond. 7.500 m²

◀ **2003 Carrefour**
Fire fighting pond. 8.000 m²

2003 ACOR, Belgium
Manure pit. 1.900 m²

Belgium

◀ **2003 Wiekeworst, Belgium**
Irrigation pond. 3.800 m²

◀ **2003 Zoerse, pond for biological purification of water, Belgium**
Water purification pond. 2.000 m²

◀ **2003 Seneffe Castle, Belgium**
Ornamental pond. 9.000 m²

◀ **2004 Renders, Malle, 2 biogas tanks+ urine storage pond, Belgium**
Biogas plant. 3.400 m²

◀ **2004 BARKA, tomato glasshouse production, Belgium**
Irrigation reservoir. 8.000 m²

◀ **2004 Gerto, Rijkevorsel, 2 ponds, Belgium**
Floating roof. 4.000 m²

◀ **2004 Dejaeghere, Langemark, Belgium**
Irrigation reservoir 7 900 m²

◀ **2005 Tomato glashouse farm, Belgium**
Irrigation reservoir 10 000 m²

◀ **2005 ACOR, Rollegem, Belgium**
Irrigation reservoir 3 500 m²

◀ **2005 Puurs Arboretum, Belgium**
Tree garden 1 500 m²

2005 Nobis Farm, Belgium
Irrigation reservoir 5 500 m²

2005 VCST, Industrialzone Schurhovenveld, Sint-Truiden, Belgium
Fire Fighting Pond 700 m²

◀ **2005 Aquafin Pulderbos, bt Deckx, Belgium**
Water purification pond 2 500 m²

Geomembran References

Belgium

2005 IMWO Invest, Belgium
Overflow pond 1 000 m²

2006 BIOSS, Budingen, Belgium
Biogas plant 1 300 m²

2007 Volvo truck dealer de Groothe, Zwevezele, Belgium
Ornamental pond 1300 m²

2007 Verdonck Tomatofarm, Onze lieve Vrouw Waver, Belgium
Irrigation reservoir 4 000 m²

2007 Aldi Erpe, Belgium
Fire Fighting Pond 1 200 m²

2007 Botanical garden, Eeklo, Belgium
Irrigation Pond 600 m²

2007 DRAFIL, Herseaux, Belgium
Irrigation Pond 1 000 m²

2008 Trois vent Gembloux, Belgium
Irrigation Pond 2 350 m²

Luxemburg

2002 Mr Jan Stenbeck, Luxemburg
Ornamental lake. 3.000 m²

France

1980 Comurhex, Narbonne, France
Waste water reservoir. 80.000 m²

1986 Comurhex, Narbonne, France
Waste water reservoir. 40.000 m²

Italy

1973 Piancavallo Winter Sport Hotel, Piancavallo, Italy
Ornamental lake. 25.000 m²

2007 Agricola Stelle di Marenna di Pepi Massimilliani, Grosseto, Italy
Ornamental pond 250 m²

2007 Sig. Calugi Candido, Fucecchio FI, Italy
Ornamental pond 1 135 m²

Italy

2007 Circolo Golf Maremma, Grosetto (PI), Italy
Golf Pond 640 m²

2008 Monika Burner, Loc. Fontelinda, Pomonte-Scansaro, Italy
Pond 490 m²

2009 Beach area, San Benedetto del Tronto, Italy
Slurry reservoir 13 500 m²

Great Britain

1979 Agricultural basin, Cowes, Isle of Wight, Great Britain
Irrigation reservoir. 7.000 m²

1984 ERDGAS Ltd, Belfast, Great Britain
Fire fighting pond. 2.500 m²

1984 Morrison Bridge Reservoir, Moosmoran, Great Britain
Waste water reservoir. 30.000 m²

1997 Rhinefield House Hotel, Hampshire, Great Britain
Ornamental Pond. 2.000 m²

2000 Castle-Royale Golf Club, Maidenhead, Great Britain
Golf Course. 4.500 m²

2001 Rookwood Golf Club, Horsham, Sussex, Great Britain
Golf Course. 20.000 m²

2001 Michael Caine, (the mowiestar), Leatherhead, Surrey, Great Britain
Ornamental Pond. 1.100 m²

Ireland

1980 Amdahl, Swords, Ireland
Fire fighting reservoir. 2.200 m²

1981 Tibbotstown Reservoirs, Ireland
Water reservoir. 2.200 m²

1984 Electric Supply Board, Moneypoint, Ireland
Floating cover. 14.000 m²

Germany

1991 Moorflether, Hower, Flinkenrieker Hauptdeich, Hamburg, Germany
Embankment lining. 7.300 m²

1992 Stillhorner, Hower, Klutjenfelder Hauptdeich, Hamburg, Germany
Embankment lining. 12.100 m²

1993 Klutjenfelder, Overwerder Hauptdeich, Hamburg, Germany
Embankment lining. 12.400 m²

1994 Haulander, Harburger, Aue, Gauerter, Klutjenfelder Hauptdeich, Hamburg, Germany
Embankment lining. 7.300 m²

1995 Buschwerder, Reiherstieg, Zollenspieker, Pollhorn, Overwerder Hauptdeich, Hamburg, Germany
Embankment lining. 8.900 m²

1996 Zollenspieker, Cranzer, Veddel Nord Hauptdeich, Germany
Embankment lining. 16.500 m²

1997 Ochsenwerder, Entwerder, Ness, Moorwerder, Neuer Altenwerder, Pollhorner, Krauerler, Reiherstieg, Gauerter Hauptdeich, Hamburg, Germany
Embankment lining. 37.400 m²

Geomembrane References

TRELLEBORG

Germany

1998 Altenwerder, Pollhorner, Moorwerder, Kraueler, Pollhornweg, Gauerter, Pollhornbogen, Schweensand, Hower/Warwischer, Spadenländer Obergeorgswerder, Zollenspieker Hauptdeich, Germany
Embankment lining. 64.700 m²

1999 Funfhauser, Kretsander, Kaltehofe, Lauenbrucher, Altenwerder, Ruschorter Hauptdeich, Hamburg, Germany
Embankment lining. 22.000 m²

2001 Altengammer, Neuengammer, Muggenburger, Bostelbeker. Moorburger Hauptdeich, Germany
Embankment lining. 23.100 m²

2002 Muhlenberger Loch, Germany
Embankment lining. 9.300 m²

2003 Nesspriel, Hahnöfersand, Muhlenbergloch, Germany
Embankment lining 8 500 m²

2004 Muhlenberger Loch, Nesspiel, Nordteil Finkenwerder, Germany
Embankment lining 7 100 m²

2005 Moorburger, Germany
Embankment lining 1 700 m²

2006 Muggenburger, Borstelbecker, Airbus Gelände, Germany
Embankment lining 2 500 m²

Austria

1999 Josef Duben, Wienerstr 62, Ziersdorf, Austria
Pond. 300 m²

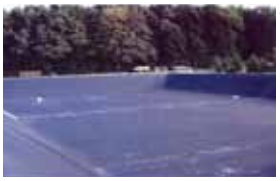
2001 Biotop 7091 Breitenbrunn, Austria
Pond 650 m²

2002 Kalte Kuchl, 2263 Rohr im Gebirge, Austria
Pond 1040 m²

2003 Biotop Schwager, 3350 Haag/NÖ, Austria
Pond 730 m²

2006 OMV Tankanlager Auerstahl, Austria
Pond 1100 m²

Switzerland



2006 Agriculture pond, Switserland
Pond 4700 m²

The Netherlands

2003 Vitens Waterauthority, Leuwarden
Ornamental Pond 1 500 m²

Russia

2003 Chernoluchje Community, Omsk; Russia
Garden pond 470 m²

Lithuenia

2007 20 pits, Lithuenia
Manure pits 11 600 m²

2008 25 pits, Lithuenia
Manure pits 14 500 m²

Kenya

1978 Teremuka Farm, Nakuru, Kenya
Irrigation reservoir. 7.000 m²

Kenya

1979 Hellsgate, Lake Naivasha, Kenya
Irrigation reservoir. 5.000 m²

1986 UNEP Headquarters, Nairobi, Kenya
Ornamental lake. 400 m²

1992 Safari Park Hotel, Nairobi, Kenya
Garden pond. 200 m²

Etiophia

2004 University, Awasa, 8 ponds, Etiophia
Waste water ponds. 10.000 m²

2006 University, Awasa, Etiophia
Waste water ponds 24 000 m²

Iran

1981 Esfahan Canal extension, Iran
Canal. 260.000 m²

2004 Karaj Municipalty, Karaj, Iran
Ornamental lake 3 000 m²

2004 Pegah Diary Products, Shiraz, Iran
Waste water pond 7 000 m²

2005 Semnan, Iran
Landfill 3 000 m²

2006 Sahranavard, Damavand, Iran
Irrigation pond 8 000 m²

2008 Karaj public park, Karaj, Iran
Ornamental pond 3 500 m²

Iraq

1982 100 small ponds by Rasmussen & Schöitz, Iraq
Portable water reservoirs. 60.000 m²

Syria

1983 Upper Salhabiyah Main Canal, Raqqa, Syria
Canal. 350,000 m²

Qatar

1995 Ras Abu Fontas B, Qatar
Desalination reservoir. 25,000 m²

Marocco

1983 Mohamedia, Soc. Nationale de Produits Petroliers, Morocco
Brine water reservoir. 34.000 m²

Pakistan

1984 UNICEF, Islamabad, Pakistan
Portable water reservoirs. 40.000 m²

1996 Chasma Dam Hydropower Project for Hyundai, Pakistan
Canal. 42.800 m²

Libya

1994 Benghazi, Aqua Bio System, Libya
Fish farming tanks. 6.100 m²

Saudi Arabia

1980 Binladin Landscaping, Jeddah, incl floating cover, Saudi Arabia
Water reservoir. 800 m²

Geomembrane References

The Caribbean

2002 Cul de Sac reservoir, Castries, St. Lucia, The Caribbean
Irrigation reservoir. 24.000 m²

2004 Cul de Sac reservoir, Castries, St. Lucia, The Caribbean
Irrigation reservoir. 30.000 m²

Australia

2008 Albany treated waste water dam 2, Albany, Australia
Canal 1 550 m²

2008 Avenue Reserve, Warnboro, Rockingham, Australia
Ornamental pond 2 700 m²

2008 Ellenbrook, Perth, Australia
Irrigation Lake 14 500 m²

2008 Islands residential development, North Cooge, WA, Australia
Rainwater tank 1 200 m²

USA

2008 STAPP Boston, USA
Shooting Ranges 920 m²

TRELLEBORG

Material Comparisons

Geomembranes

Property	Elastoseal EPDM	HDPE	LLDPE	CSPE reinforc.	PVC	PP-R reinforc.	PP	GCL
Water Tightness	A	A	A	A	A	A	A	B
UV resistance	A	B	D	A	D	A	A	NS
Service life	A	B	C	A	D	A	A	B
Cold temperature impact	A	C	B	B	D	B	B	NS
High temperature resistance	A	B	D	B	D	A	A	NS
Flexibility	A	D	B	C	B	C	B	D
Elasticity	A	D	D	C	D	D	C	NA
Tensile strength	C	A	B	A	C	A	B	D
Chemical resistance	B	A	B	B	C	B	B	C
Resistance to hydrocarbons	D	B	C	D	C	C	C	D
Stress crack resistance	A	D	B	A	B	A	A	NA
Yield point	A	D	C	B	C	B	B	NA
Plasticiser content	A	A	A	A	D	A	A	NA
Root resistance	A	A	A	B	B	A	A	D
Rest, to microbiological attack	A	A	A	A	C	A	A	B
Puncture resistance	B	C	B	B	B	B	B	C
Surface friction	A	D	D	B	B	B	B	B
Slope stability	A	C	B	B	A	B	B	D
Thermal stability	A	C	B	A	C	A	B	A
Dimensional stability	A	D	D	A	B	A	B	A
Multiaxial strain	A	D	C	C	B	C	B	D
Resistance to settlements	A	C	B	C	A	C	B	D
Seamability	A	C	B	B	B	A	B	C
Seamability at cold temp.	A	D	D	B	D	B	A	NS
Seam strength	A	A	A	A	B	A	A	D
Seam testing	A	A	A	B	A	B	A	NA
Ease of installation	A	C	C	B	A	B	B	A
Permeability	B	A	B	B	C	B	B	B
Environmental properties	A	A	A	B	D	A	A	A
Repairability	B	C	B	D	C	B	B	NA
Details, design and installation	B	D	C	B	B	C	B	C
Conformance to substrate	A	D	C	B	B	C	B	B

A=Excellent	B=Good	C=Fair	D=Poor	NS=Not Stated	NA=Not Applicable

*) A GCL is not a geomembrane, but a natural sodium bentonite clay between two geotextiles, properly hydrated under soil cover (Confining stress)

Trelleborg Waterproofing AB
P.O. Box 1004, SE-331 29 Värnamo, Sweden
Tel: +46 370 481 00, Fax: +46 370 485 00, E-mail: polymeric.membranes@trelleborg.com

Material Comparisons

COMPARATIVE PROPERTIES FOR BARRIER APPLICATIONS

Vulcanized Elastoseal EPDM Geomembrane and HDPE Geomembrane

Thermal expansion/contraction

HDPE has a high coefficient of thermal movements and is a rigid type of membrane during moderate to high temperature differentials, such as from day to night, winter to summer. Increased outdoor temperature will cause waves in the liner due to expansion and stress due to contraction. Such continual flexing cause problems, which could lead to stress cracking and that the liner is pulled out of anchoring trenches. It also cause a major splicing problem on site and could cause site splice quality problems.

EPDM is extremely flexible, will not when used as a geomembrane have any of above problems.

Stress cracking

Stress cracking is a brittle fracture phenomenon. It is a fundamental property of crystalline HDPE and can occur at stresses that are only 30-40 % of the yield stress.

Stress cracking occurs primarily at the seams of HDPE, at stress concentrations and thickness irregularities. Thickness irregularities can be caused by thickness variations in membrane, by scratches, abrasions or grinding and at overlaps or cap strips.

EPDM is a stable, elastic product, which can be stressed and elongated two dimensional at any time during its lifetime without cracking for above reasons.

UV – resistance

HDPE have a restricted natural UV resistance. By adding 2-3 % carbon black UV-resistance is improved.

EPDM have by nature a high content (1/3 by weight) of carbon black, which always give excellent UV-resistance.

Seam strength

Welding HDPE is a sensitive, precise operation, and there is a very narrow heat range available for the welding. This heat window varies within the sheet, with outdoor temperature and variations in equipment. Therefor control of seams, check systems and skill of labours are critical for membrane performance.

EPDM are spliced with thermal welding methods giving reliable results independent of outdoor temperature or material variations. The seams are as elastic as the membrane and can easily be tested for continuity and mechanical strength by non destructive and destructive methods.

Rigidity

HDPE sheets exhibit a high degree of rigidity in both cold and warm temperatures. This make proper installation difficult, especially corners, pipe boots, flashings, overflows and penetration details. The attempt to use a rigid material in a flexible application result in basic design, engineering and installation problems.

EPDM is not only flexible at any temperature, but also elastic, will retain its length and shape after elongation. The membrane will adopt to any shape, substrate or movement with large stress forces.

Yield point

HDPE have a significant yield point, the material will flow uncontrollable at its weakest point when under stress. The yield point occurs at elongations of only 10-20 %, despite the fact that the membrane can have elongation at break as high as 700 %.

EPDM have no yield point, will always elongate up to its break elongation of approx. 400 %.

Installation

HDPE is produced in a standard size roll, size can be 7 m x 100 m, as an example. This roll can not be folded and waste during installation is significant. Heavy equipment can be needed for positioning and unrolling.

EPDM can be prefabricated to panels of 800-1500 sqm:s, each panel with measures to fit exactly into the excavation of the reservoir, and the flexible membrane can easily be transported and positioned on site, by small work crews.

Site seaming

HDPE have a coefficient of expansion of approx. 0,18 % per degree Celsius. The membrane is stiff and therefor this expansion creates wrinkles when loose laid before splicing. For example: a 100 meter long HDPE membrane is loose laid in the morning with a temperature of +10° C and spliced midday when the membrane have reached a temperature of +80° C.

The HDPE membrane have increased in length by almost 1,3 meter and the entire length differance occurs as wrinkles in the edge. Besides providing a poor appearence, this results in severe stresses in the region between the exposed membrane and the membrane that is below the liquid level, which expands very little. This high liner expansion places limitations on when seaming can be done.

EPDM does not create wrinkles since the membrane has a low coefficient of expansion and is an extremely flexible product.

Trelleborg Waterproofing AB
P.O. Box 1004, SE-331 29 Värnamo, Sweden
Tel: +46 370 481 00, Fax: +46 370 485 00, E-mail: polymeric.membranes@trelleborg.com

Material Comparisons

Friction angle

Increased landfill capacity can be realized by taking advantage of the higher friction angles provided by EPDM. When the volumetric difference is multiplied by an average compacting factor and then multiplied by the aniticipated dumping charge per cubic meter, the increased revenue this will generate will save substantial amounts.

HDPE have a typical friction angle of approx. 16-18 degree.

EPDM have, due to its structured surface, a typical friction angle of approx. 24-27 degree. This gives the designer the possibility to design a construction with rather high slope surroundings to create a reservoir or similar that can contain a higher volume on the same land surface.

Splicing performance and speed

HDPE has a tendency to variate in thickness on membranes delivered. This creates problems to find the correct splice speed and energy consumption since the splicing method consists from melting the two splice edges together. The installer can not on site adjust these parameters and the splice result is questionable.

EPDM is vulcanised or thermal welded. The splices have the same elasticity and flexibility as the membrane itself. Thickness variations are of no importance when using this splicing methods.

Substrates

HDPE demands high compaction and a smooth and flat surface due to its rigidity, thermal expansion and the risk for stress cracking.

EPDM is a fully elastic membrane with exceptional good properties for irregular surfaces. The membrane conform to any irregularity and movements and settlements in the underground over the years does not cause problems.

Comparison of EPDM vis a vi HDPE

Typical properties

Measurements		
	HDPE	**EPDM**
Thickness, most frequent	1,50 mm	1,00 mm
0,80 mm	not used	available
1,00 mm	available	available
1,20 mm	available	available
1,50 mm	available	available
2,00 mm	available	available but not used
2,50 mm	available	not used
Rollwidth	5 - 10 m	1,7 m (1,3 - 3,0 m)
Rolllength	50-200 m	20-125 m
Prefabricated to specified size	No	Yes, max. 1500 sqm;s

Physical properties		
	HDPE	**EPDM**
Density	0,94 (Will float on water)	1,15
Tensile strength at break	30,0 Mpa	10,0 Mpa
Elongation at break	700 %	400 %
Tensile strength, yield point	0,5 Mpa	no yield point
Elongation, yield point	15 %	no yield point
Thermal movements	significant	ignorable
Low temperatue brittleness, ASTM D746	- 70 C	- 50 C
Carbon black content	2 - 3 %	35 - 40 %
Environmental Stress Crack Resistance, ASTM D 5397	200 (Value of time to failure under load of 30 % yield stress of membrane)	Not exposed to stress crack (Non polar material)

Trelleborg Waterproofing AB
P.O. Box 1004, SE-331 29 Värnamo, Sweden
Tel: +46 370 481 00, Fax: +46 370 485 00, E-mail: polymeric.membranes@trelleborg.com

Material Comparisons

Comparison of EPDM vis a vi HDPE Geomembrane

Chemical resistance		
1=resistant 2=moderatly 3=nonresistant		
	HDPE	EPDM
Hydrocarbons	2	3
Anorganic salts	1	1
Animal oils	1	1
Bases	1	1
Organic salts	1	1
Vegetable oils	1	1
Weak anorganic acids	1	1
Alcoholes	1	1
Aldehydes	1	1
Amines	1	1
Esters	2	1
Ketones	3	1
Organic acids	2	1
Ethers	3	2
Phenoles	2	2
Mineral oils	1	3

Installation and splicing		
	HDPE	EPDM
Splicing - type	Fusion or extrusion	Fusion
Splicing - quality standard	Difficult operation, sensitive to external factors, weather and temperature	Uncomplicated operation sensitive only to wet weather
Membrane character	Rigid, unflexible	Flexible, conform to irregular shapes
Effective permanent elongation installed on site	3 - 8 %	50 - 75 %
Effective puncture resistance	Restricted (Crystalline material, can only absorb stress in one direction)	Excellent (Absorb substantial irregularities in substrate)
Repairbility	Restricted	Fair
Effect of high temperatures (Exposed black surfaces reach 80°-100°C under the sun in hot climates)	Severe loss of physical properties	No significant change of physical properties

Other characteristics		
	HDPE	EPDM
Price indication - membrane (HDPE 1,5 mm - EPDM 1,0 mm)	100 %	150 %
Price indication - installed lining (HDPE 1,5 mm - EPDM 1,0 mm)	100 %	125-130 %

Trelleborg Waterproofing AB
P.O. Box 1004, SE-331 29 Värnamo, Sweden
Tel: +46 370 481 00, Fax: +46 370 485 00, E-mail: polymeric.membranes@trelleborg.com

Material Comparisons

COMPARATIVE PROPERTIES FOR BARRIER APPLICATIONS

Vulcanised Elastoseal EPDM Geomembrane and PVC Geomembrane

Durability and UV resistance

EPDM is a synthetic rubber material that is a stable elastic product designed for decades of outdoor exposure to the elements and inert to the effects of buried environments containing microorganisms. The high carbon black content of 35-40 % guarantees UV weatherability beyond the normal life of many containments requiring exposed membranes.

PVC contains plasticizers, normally phthalates such as DEHP and Di-butyl phthalates, for flexibility. The plasticizers will diffuse and evaporate from the membrane over time, depending on the compound quality of the PVC, but the process is always ongoing. When the plasticizer is consumed the membrane will revert, during a short time interval, to a brittle, hard product with poor mechanical properties and with a total loss of elongation. PVC is sensitive to heat, sunlight and microorganisms and only buried applications can be recommended.

Organic compounds in contact with PVC can result in microbiological degradation of the membrane and there is a risk of migration when in contact with other plastic materials and concrete.

Due to the loss of plastcizers PVC is also exposed to weight loss and shrinkage over time.

Substrates

EPDM is a fully elastic membrane with exceptional elongation properties for irregular surfaces. The membrane conforms to any irregularity and movements or settlements in the subgrade even after years of service.

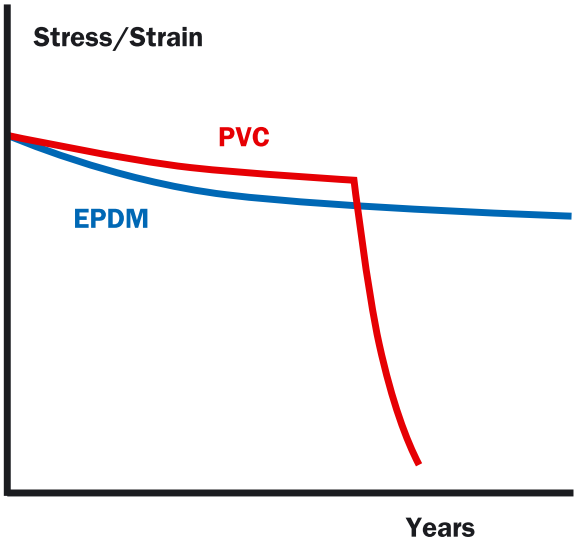
Unreinforced PVC in thickness 0,50 - 1,00 mm is very susceptible to puncture due to rocks, sharp stones or rough substrates. PVC membranes must be protected with geotextiles or protective soil layers for guaranteed long time performance.

Inteface friction angle

EPDM membranes with a textured surface have a typical friction angle of 24-27 degrees with most soil types. This gives the designer the possibility to design a construction with steeper slopes or to create a reservoir or capping that can contain a higher volume on the same land surface. Increased water storage or landfill capacity can realized. Increased slopes provides increased capacity that will generate more revenue.

PVC on the other hand has a smooth surface with low surface friction. Typical interface friction angles are approx. 16-18 degrees and the risk of slippage of cover soils and slope stability must be considered by designers.

Stress/Strain properties of EPDM and PVC membranes after long periods of aging



Trelleborg Waterproofing AB
P.O. Box 1004, SE-331 29 Värnamo, Sweden
Tel: +46 370 481 00, Fax: +46 370 485 00, E-mail: polymeric.membranes@trelleborg.com

Material Comparisons

Low temperature environments

EPDM is not affected by low temperature extremes, even if exposed. It remains flexible and can be installed and seamed at below freezing temperatures. Low temperature resistance is to -50° C, thus applications in extreme northern climates is acceptable.

PVC has a limited resistance to low temperatures. The membrane will become stiff and brittle, with increased susceptibility to tear and puncture. The best quality PVC can have a brittle point of -25°C, but in most cases the effective low temperature resistance is restricted to -17° C.

Cost effectivness and compatibility with Landscaping designs

EPDM provides a cost effective product and system. Panels are prefabricated to between 800 and 1500 sqm:s, with custom sizes to fit exactly into the excavation of the reservoir. The flexible membrane can easily be transported and positioned on site, by small working crews. Installation of single panel projects, up to 2000 sqm:s in size, can be made by owner or general building/excavating contractor.

PVC is prefabricated to large panels with similar methods, but 0,75-1,00 mm PVC is not as durable and resistant to installation stress, will not take as much abuse from rough installation surfaces, In addition protection from environmental degradation will require a minimum 50 cm of soil cover. EPDM can be installed exposed to the atmosphere and will not be damaged by placement of landscaping rock directly on the membrane.

The Environmental concern

EPDM membranes are environmentally friendly, chemically stable and contain no dangerous additives or plasticizers which could be released.

EPDM can be recycled, by grinding and reusing the elastomeric components, which can then be mixed into new EPDM rubber compounds.

PVC is a chlorinated product containing UV stabilizers and plasticizers. In summary, PVC is regarded as an environmental problem because:

- Chlor organic chemicals are generally dangerous for our environment. They cause “green house” effects, they destroy the ozone layer in the atmosphere, they are cancer ous, they have caused poisoning by PCB and they are not broken down by the nature. The production of PVC raw materials are regarded as environmentally questionable. PVC contains phthalates, plasticizers which is proven to be cancerous. PVC can cause dioxin damages and some contains heavy metals. Also chlorinated aromatic hydrocarbons, which is dangerous for human health.

Trelleborg Waterproofing AB
P.O. Box 1004, SE-331 29 Värnamo, Sweden
Tel: +46 370 481 00, Fax: +46 370 485 00, E-mail: polymeric.membranes@trelleborg.com

Material Comparisons

COMPARATIVE PROPERTIES FOR BARRIER APPLICATIONS

Vulcanized Elastoseal EPDM Geomembrane and Geosynthetic Clay Liner (GCL)

Durability and Aging

EPDM is a synthetic rubber material that is a stable elastic product designed for decades of outdoor exposure to the elements and inert to the effects of buried environments containing microorganisms. The high carbon black content of 35 – 40 % guarantees UV weatherability beyond the normal life of many containments requiring exposed membranes.

GCL's are not designed nor intended for exposed conditions. In fact, a GCL must be installed carefully on a firm, stable substrate and must be provided with a 1,0 m minimum cover to establish required confining stress during the bentonite hydration process. Without proper installation with requisite compacted soil, a GCL will not provid a long term barrier to fluid migration.

Low Temperature Environments

EPDM is not affected by low temperature extremes, even if exposed. It remains flexible and can be installed and seamed at below freezing temperatures. Low temperature resistance is to - 50° C, thus applications in extreme northern climates is acceptable.

GCL's have been used in extreme northern climates, however they must be installed and covered above 0° C ambient due to the stiffness at cold temperatures and the bentonite moisture content (freezing). Again, due to the bentonite component, GCL's are susceptible to low temperature brittelness, especially at the seam areas. The GCL must be buried below the frost depth which could be over 1,5 m in northern climates.

Thougness, Conformability and Effectivness

EPDM has a working strain to over 400 % and conforms readily to placement of overburden materials and installation over rough substrates without puncture. The rubber surface texture provides excellent friction resistance to prevent soil sliding on the surface as well as superior adherence to the subsoils (outstanding lay flat characteristics). As an elastic material, EPDM will retain its length and shape after elongation and thus will adapt to any shape or substrate movement (localized subsidence) without rupture.

A GCL, on the other hand, has no working strain as bentonite has no tensile strength. GCL's must be placed and hydrated under load (cover soils unit weight). Once in place, a GCL can not be subjected to movement as in settlements or local subsidence as this will cause cracking and destroy the barrier function. GCL seam areas are overlaps only with no mechanical strength. Soil movements and subsidence as in a landfill will cause the seam area to separate again destroying the barrier function.

Interface Friction Considerations with Soil and Slope Stability

EPDM, due to its rough texture surface, inherent soft rubber surface properties and surface conformability provides a high interface friction angle when tested against a varity of soils. Friction angles in the range of 25 to 30 degress are not uncommon. Thus, steeper covered slopes are possible with EPDM.

GCL's also have intial high surface friction characteristics with soils. However, once the GCL bentonite is fully hydrated under load and on a slope, stability of the slope cover soils is dependent on the stitch bonding which holds the two geotextile layers in a GCL together (hydrated bentonite has very low shear strength). Over time and under stress, the stitch bonding will creep resulting in pullout of the fibres and slope failure. Thus slopes with GCL's should be limited to 1V : 5H (11 degrees) or less.

Installation and Field Seaming

EPDM is supplied in large prefabricated panels that lay flat with little or no wrinkles. The panels up to 1500 sq.meters in size can be custom fabricated to fit the shape of the installation reducing waste. Seaming can be accomplished very easily and quickly by the contractor using conventional thermal welding methods with little or no restriction as to installation temperature (a big advantage for northern cold climates). The seams are easily tested for continuity and mechanical strength by non destructive and destructive methods.

GCL's can be supplied only in large rolls up to 5 m in width with no possibility for custom panel fabrication. Seams are not mechanically attached and provide no tensile strength. The seam area overlap is "sealed" by spreading bentonite by hand or spreader. The placement method is dependent on hand labor and can result in highly variable amounts of bentonite or missed areas with no bentonite. There is no method for field testing the seam effectiveness.

Trelleborg Waterproofing AB
P.O. Box 1004, SE-331 29 Värnamo, Sweden
Tel: +46 370 481 00, Fax: +46 370 485 00, E-mail: polymeric.membranes@trelleborg.com

Material Comparisons

Attachment to Structures

EPDM is easily bonded to concrete, wood and block using either solvent or waterbased adhesive systems. The EPDM rubber surface texture conforms readily to the rough concrete surface allowing intimate bonding contact as well as ease of mechanical attachment by conventional methods.

GCL's do not conform to surfaces such as concrete due to its stiff surface fabric texture and can not be permanently adhered to these sufaces with adhesives or mechanical attachment methods.

Field Repair Procedures

EPDM is easily repaired by conventional thermal seaming or by using tape seam patches even after many years of service in an exposed application.

A GCL can only be repaired by placing a loose patch with bentonite and only prior to placing the required cover soil. A GCL can not be repaired once it is hydrated and in fact hydration of the GCL prior to placement of cover soils will require removal of the GCL.

Compatibility with Adjacent Materials and Environments

EPDM, due to its rubber properties and toughness, is not affected by the placement on or under materials such as large stone or block and can be placed with fresh concrete. Aquatic plants and root systems do not penetrate EPDM and water quality of a pond or reservoir is not affected.

GCL's must be placed on smooth compacted substrates. Cover soils must be free of large stone and debris. Root systems will penetrate the nonwoven geotextile layer of a GCL, thus compromising the barrier function. The compatibility of the bentonite with contained or migrating fluids must be carefully considered and tested as the bentonite may not hydrate properly as in an aqueous environment.

Seaming Comparison

EPDM is easily seamed in the factory or field using conventional thermal fusion welders and is independent of temperature and material variations. Once thermally welded, the seams are as strong as the parent material with full tensile strength and elasticity. Large factory panels reduce the amount of field seams required.

GCL rolls are only overlapped and provided with a "bead" of dry bentonite to form a seal once hydrated under load. These seams are approximately every 5 m resulting in a large quantity of labor intensive field seams. These seam areas, however, have no tensile strength and will separate easily during construction (espacially on slopes) and due to soil movement (settlements) after placement.

Summary

A GCL is by definition not a geomembrane. Geomembranes, like EPDM, is designed for complete watertightness, a GCL will always allow water to penetrate. In fact GCL's were developed to replace a compacted clay liner (CCL) as a secondary barrier to a primary geomembrane and thus should always be used in association with a geomembrane system where required. However, GCL's are also beeing marketed as isolation barriers in projects that should be restricted to geomembranes.

GCL's are a relatively new type of product, with little practical experience, espacially the textile technique. GCL's found its first use at the end of the 80-es. Rubber based geomembranes, first with the polymer butyl and later, form the early 70-es, with EPDM, have been used since the 1940-es.

GCL's must be based on sodium bentonite, which swells more than calcium bentonite under load.

The installation of GCL's present a large technical problem and must often be regarded as un-controlable. The product may not be exposed to cold temperatures or moisture before placement and coverage. The substrate must be 100 % smooth, i.e. a 4 mm sharp stone is not acceptable. The GCL roll must be covered with soil the same day it is positioned, otherwise the hydration process will start without load, the product must be replaced and scrapped. If the GCL become dry it will shrink and crack. When re-hydrated the GCL will return to its original function as a barrier, but the cracks will remain.

EPDM membranes can be installed at any time of the year, even in cold climates, and the installation quality can be secured and documentated.

Trelleborg Waterproofing AB
P.O. Box 1004, SE-331 29 Värnamo, Sweden
Tel: +46 370 481 00, Fax: +46 370 485 00, E-mail: polymeric.membranes@trelleborg.com

Material Comparisons

Summary

A GCL is by definition not a geomembrane. Geomembranes, like EPDM, is designed for complete watertightness, a GCL will always allow water to penetrate. In fact GCL´s were developed to replace a compacted clay liner (CCL) as a secondary barrier to a primary geomembrane and thus should always be used in association with a geomembrane system where required. However, GCL´s are also beeing marketed as isolation barriers in projects that should be restricted to geomembranes.

GCL´s are a relatively new type of product, with little practical experience, espacially the textile technique. GCL´s found its first use at the end of the 80-es. Rubber based geomembranes, first with the polymer butyl and later, form the early 70-es, with EPDM, have been used since the 1940-es.

GCL´s must be based on sodium bentonite, which swells more than calcium bentonite under load.

The installation of GCL´s present a large technical problem and must often be regarded as un-controlable. The product may not be exposed to cold temperatures or moisture before placement and coverage. The substrate must be 100 % smooth, i.e. a 4 mm sharp stone is not acceptable. The GCL roll must be covered with soil the same day it is positioned, otherwise the hydration process will start without load, the product must be replaced and scrapped. If the GCL become dry it will shrink and crack. When re-hydrated the GCL will return to its original function as a barrier, but the cracks will remain.

EPDM membranes can be installed at any time of the year, even in cold climates, and the installation quality can be secured and documentated.

Design Consideration and Ultimate Performance		
	Barrier Material	
	EPDM	GCL
Resistance to sunlight (UV)	*4*	*1*
Resistance to Cracking (all causes)	*4*	*2*
Resistance to heat (hot, Arid Climate)	*4*	*1*
Resistance to Chemical Environment	*4*	*2*
Ease of Panel Installation	*3*	*4*
Field Seam Quality	*4*	*2*
Repairability	*3*	*0*
Ease of Attachment to Structures and Pipes	*4*	*1*
Low Temperature Installation	*4*	*1*
Conformance to all Substrates	*4*	*3*
Resistance to Rupture due to Puncture	*3*	*2*
General Lay Flat Characteristics	*4*	*3*
Resistance to Installation Damage	*3*	*3*
Resistance to Installation Wrinkles	*4*	*3*
Resistance to Soil Slippage (Surface friction)	*4*	*4*
Resistance to Soil Movement (Settlements)	*4*	*1*
Design Strain – All Directions (Multiaxial)	*4*	*1*
Long Term Slope Stability	*3*	*1*
Overall Long Term Durability	*4*	*3*
Overall comparative rating	**3,7**	**2,0**
Ratings		
4=Excellent; 3=Good; 2=Fair; 1=Poor; 0=not possible/not applicable		

Trelleborg Waterproofing AB
P.O. Box 1004, SE-331 29 Värnamo, Sweden
Tel: +46 370 481 00, Fax: +46 370 485 00, E-mail: polymeric.membranes@trelleborg.com