

High Density Polyethylene Micro Spike® Liner



Product Data

Property	Test Method	Values				
Thickness, nominal (mm)		30 (.75)	40 (1.0)	60 (1.5)	80 (2.0)	100 (2.5)
Thickness (min. ave.), mil (mm)	ASTM D5994*	29 (.71)	38 (.95)	57 (1.43)	76 (1.90)	95 (2.38)
Thickness (lowest indiv. for 8 of 10 spec.), mil (mm)	ASTM D5994*	27 (.68)	36 (.90)	54 (1.35)	72 (1.80)	90 (2.25)
Thickness (lowest indiv. for 1 of 10 spec.), mil (mm)	ASTM D5994*	26 (.64)	34 (.85)	51 (1.28)	68 (1.70)	85 (2.13)
*The thickness values may be changed due to project specifications (i.e., absolute minimum thickness)						
Asperity Height (min. ave.), mil (mm)	GRI GM12/ASTM D7466	16 (.41)	16 (.41)	16 (.41)	16 (.41)	16 (.41)
Density, g/cc, minimum	ASTM D792, Method B	0.94	0.94	0.94	0.94	0.94
Tensile Properties (ave. both directions)	ASTM D6693, Type IV					
Strength @ Yield (min. ave.), lb/in width (N/mm)	2 in/minute	66 (11.6)	88 (15.4)	132 (23.1)	176 (30.8)	220 (38.5)
Elongation @ Yield (min. ave.), % (GL=1.3in)	5 specimens in each direction	13	13	13	13	13
Strength @ Break (min. ave.), lb/in width (N/mm)		66 (11.6)	88 (15.4)	132 (23.1)	176 (30.8)	220 (38.5)
Elongation @ Break (min. ave.), % (GL=2.0in)		350	350	350	350	350
Tear Resistance (min. ave.), lbs. (N)	ASTM D1004	23 (102)	30 (133)	45 (200)	60 (267)	72 (320)
Puncture Resistance (min. ave.), lbs. (N)	ASTM D4833	60 (267)	90 (400)	120 (534)	150 (667)	180 (801)
Carbon Black Content (range in %)	ASTM D4218	2 - 3	2 - 3	2 - 3	2 - 3	2 - 3
Carbon Black Dispersion (Category)	ASTM D5596	Only near spherical agglomerates for 10 views: 9 views in Cat. 1 or 2, and 1 view in Cat. 3				
Stress Crack Resistance (Single Point NCTL), hours	ASTM D5397, Appendix	300	300	300	300	300
Oxidative Induction Time, minutes	ASTM D3895, 200°C, 1 atm O ₂	≥100	≥100	≥100	≥100	≥100
Melt Flow Index, g/10 minutes	ASTM D1238, 190°C, 2.16kg	≤1.0	≤1.0	≤1.0	≤1.0	≤1.0
Oven Aging	ASTM D5721	80	80	80	80	80
with HP OIT, (% retained after 90 days)	ASTM D5885, 150°C, 500psi O ₂					
UV Resistance	GRI GM11	20hr. Cycle @ 75°C/4 hr. dark condensation @ 60°C				
with HP OIT, (% retained after 1600 hours)	ASTM D5885, 150°C, 500psi O ₂	50	50	50	50	50

These product specifications meet or exceed GRI's GM13

Supply Information (Standard Roll Dimensions)

Thickness		Width		Length		Area (approx.)		Weight (average)*	
mil	mm	ft	m	ft	m	ft ²	m ²	lbs	kg
30	.75	23	7	930	283.117	21,390	1,984	3,900	1,770
40	1.0	23	7	710	216.41	16,330	1,514.87	3,900	1,770
60	1.5	23	7	505	153.53	11,615	1,078	3,900	1,770
80	2.0	23	7	385	117.35	8,855	821	3,900	1,770
100	2.5	23	7	310	94.49	7,130	661	3,900	1,770

Notes:

All rolls are supplied with two slings. All rolls are wound on a 6 inch core. Special lengths are available on request. All roll lengths and widths have a tolerance of ±1%
*The weight values may change due to project specifications (i.e. absolute minimum thickness or special roll lengths) or shipping requirements (i.e. international containerized shipments).

All information, recommendations and suggestions appearing in this literature concerning the use of our products are based upon tests and data believed to be reliable; however, it is the users responsibility to determine the suitability for their own use of the products described herein. Since the actual use by others is beyond our control, no guarantee or warranty of any kind, expressed or implied, is made by Agru/America as to the effects of such use or the results to be obtained, nor does Agru/America assume any liability in connection herewith. Any statement made herein may not be absolutely complete since additional information may be necessary or desirable when particular or exceptional conditions or circumstances exist or because of applicable laws or government regulations. Nothing herein is to be construed as permission or as a recommendation to infringe any patent.

Linear Low Density Polyethylene Micro Spike® Liner



Product Data

Property	Test Method	Values			
Thickness, nominal, (mm)		40 (1.0)	60 (1.5)	80 (2.0)	100 (2.5)
Thickness (min. ave.), mil (mm)	ASTM D5994*	38 (.95)	57 (1.43)	76 (1.90)	95 (2.38)
Thickness (lowest indiv. for 8 of 10 spec.), mil (mm)	ASTM D5994*	36 (.90)	54 (1.35)	72 (1.80)	90 (2.25)
Thickness (lowest indiv. for 1 of 10 spec.), mil (mm)	ASTM D5994*	34 (.85)	51 (1.28)	68 (1.70)	85 (2.13)
*The thickness values may be changed due to project specifications (i.e., absolute minimum thickness)					
Asperity Height (min. ave.), mil (mm)	GRI GM12/ASTM D7466	16 (.41)	16 (.41)	16 (.41)	16 (.41)
Density, g/cc, maximum	ASTM D792, Method B	0.939	0.939	0.939	0.939
Tensile Properties (ave. both directions)	ASTM D6693, Type IV				
Strength @ Break (min. ave.), lb/in width (N/mm)	2 in/minute	112 (19.6)	168 (29.4)	224 (392)	280 (49.0)
Elongation @ Break (min. ave.), % (GL=2.0in)	5 specimens in each direction	400	400	400	400
Tear Resistance (min. ave.), lbs. (N)	ASTM D1004	25 (111)	36 (160)	50 (222)	60 (267)
Puncture Resistance (min. ave.), lbs. (N)	ASTM D4833	50 (222)	70 (310)	90 (400)	115 (512)
Carbon Black Content (range in %)	ASTM D4218	2 - 3	2 - 3	2 - 3	2 - 3
Carbon Black Dispersion (Category)	ASTM D5596	Only near spherical agglomerates for 10 views: 9 views in Cat. 1 or 2, and 1 view in Cat. 3			
Oxidative Induction Time, minutes	ASTM D3895, 200°C, 1 atm O ₂	≥100	≥100	≥100	≥100
Melt Flow Index, g/10 minutes	ASTM D1238, 190°C, 2.16kg	≤1.0	≤1.0	≤1.0	≤1.0
Oven Aging	ASTM D5721	60	60	60	60
with HP OIT, (% retained after 90 days)	ASTM D5885, 150°C, 500psi O ₂				
UV Resistance	GRI GM11	20hr. Cycle @ 75°C/4 hr. dark condensation @ 60°C			
with HP OIT, (% retained after 1600 hours)	ASTM D5885, 150°C, 500psi O ₂	35	35	35	35
2% Secant Modulus (max.), lb/in. (N/mm)	ASTM D5323	2400 (420)	3600 (630)	4800 (840)	6000 (1050)
Axi-Symmetric Break Resistance Strain, % (min.)	ASTM D5617	30	30	30	30

These product specifications meet or exceed GRI's GM17

Supply Information (Standard Roll Dimensions)

Thickness		Width		Length		Area (approx.)		Weight (average)*	
mil	mm	ft	m	ft	m	ft ²	m ²	lbs	kg
40	1.0	23	7	710	283.47	16,330	1,514.87	3,900	1,770
60	1.5	23	7	505	216.41	11,615	1,078	3,900	1,770
80	2.0	23	7	385	117.35	8,855	821	3,900	1,770
100	2.5	23	7	310	94.49	7,130	661	3,900	1,770

Notes:

All rolls are supplied with two slings. All rolls are wound on a 6 inch core. Special lengths are available on request. All roll lengths and widths have a tolerance of ±1%
*The weight values may change due to project specifications (i.e. absolute minimum thickness or special roll lengths) or shipping requirements (i.e. international containerized shipments).

All information, recommendations and suggestions appearing in this literature concerning the use of our products are based upon tests and data believed to be reliable; however, it is the users responsibility to determine the suitability for their own use of the products described herein. Since the actual use by others is beyond our control, no guarantee or warranty of any kind, expressed or implied, is made by Agru/America as to the effects of such use or the results to be obtained, nor does Agru/America assume any liability in connection herewith. Any statement made herein may not be absolutely complete since additional information may be necessary or desirable when particular or exceptional conditions or circumstances exist or because of applicable laws or government regulations. Nothing herein is to be construed as permission or as a recommendation to infringe any patent.

High Density Polyethylene Micro Spike® Liner (Single Sided)



Product Data

Property	Test Method	Values			
Thickness, nominal (mm)		40 (1.0)	60 (1.5)	80 (2.0)	100 (2.5)
Thickness (min. ave.), mil (mm)	ASTM D5994*	38 (.95)	57 (1.43)	76 (1.90)	95 (2.38)
Thickness (lowest indiv. for 8 of 10 spec.), mil (mm)	ASTM D5994*	36 (.90)	54 (1.35)	72 (1.80)	90 (2.25)
Thickness (lowest indiv. for 1 of 10 spec.), mil (mm)	ASTM D5994*	34 (.85)	51 (1.28)	68 (1.70)	85 (2.13)
*The thickness values may be changed due to project specifications (i.e., absolute minimum thickness)					
Asperity Height (min. ave.), mil (mm)	GRI GM12/ASTM D7466	16 (.41)	16 (.41)	16 (.41)	16 (.41)
Density, g/cc, minimum	ASTM D792, Method B	0.94	0.94	0.94	0.94
Tensile Properties (ave. both directions)	ASTM D6693, Type IV				
Strength @ Yield (min. ave.), lb/in width (N/mm)	2 in/minute	88 (15.4)	132 (23.1)	176 (30.8)	220 (38.5)
Elongation @ Yield (min. ave.), % (GL=1.3in)	5 specimens in each direction	13	13	13	13
Strength @ Break (min. ave.), lb/in width (N/mm)		88 (15.4)	132 (23.1)	176 (30.8)	220 (38.5)
Elongation @ Break (min. ave.), % (GL=2.0in)		350	350	350	350
Tear Resistance (min. ave.), lbs. (N)	ASTM D1004	30 (133)	45 (200)	60 (267)	72 (320)
Puncture Resistance (min. ave.), lbs. (N)	ASTM D4833	90 (400)	120 (534)	150 (667)	180 (801)
Carbon Black Content (range in %)	ASTM D4218	2 - 3	2 - 3	2 - 3	2 - 3
Carbon Black Dispersion (Category)	ASTM D5596	Only near spherical agglomerates for 10 views: 9 views in Cat. 1 or 2, and 1 view in Cat. 3			
Stress Crack Resistance (Single Point NCTL), hours	ASTM D5397, Appendix	300	300	300	300
Oxidative Induction Time, minutes	ASTM D3895, 200°C, 1 atm O ₂	≥100	≥100	≥100	≥100
Melt Flow Index, g/10 minutes	ASTM D1238, 190°C, 2.16kg	≤1.0	≤1.0	≤1.0	≤1.0
Oven Aging	ASTM D5721	80	80	80	80
with HP OIT, (% retained after 90 days)	ASTM D5885, 150°C, 500psi O ₂				
UV Resistance	GRI GM11	20hr. Cycle @ 75°C/4 hr. dark condensation @ 60°C			
with HP OIT, (% retained after 1600 hours)	ASTM D5885, 150°C, 500psi O ₂	50	50	50	50

These product specifications meet or exceed GRI's GM13

Supply Information (Standard Roll Dimensions)

Thickness		Width		Length		Area (approx.)		Weight (average)*	
mil	mm	ft	m	ft	m	ft ²	m ²	lbs	kg
40	1.0	23	7	760	231.637	17,478	1,621.46	3,900	1,770
60	1.5	23	7	530	161.54	17,190	1,130.78	3,900	1,770
80	2.0	23	7	400	121.914	9,200	853.40	3,900	1,770
100	2.5	23	7	325	99.055	7,475	693.39	3,900	1,770

Notes:

All rolls are supplied with two slings. All rolls are wound on a 6 inch core. Special lengths are available on request. All roll lengths and widths have a tolerance of ±1%
*The weight values may change due to project specifications (i.e. absolute minimum thickness or special roll lengths) or shipping requirements (i.e. international containerized shipments).

All information, recommendations and suggestions appearing in this literature concerning the use of our products are based upon tests and data believed to be reliable; however, it is the users responsibility to determine the suitability for their own use of the products described herein. Since the actual use by others is beyond our control, no guarantee or warranty of any kind, expressed or implied, is made by Agru/America as to the effects of such use or the results to be obtained, nor does Agru/America assume any liability in connection herewith. Any statement made herein may not be absolutely complete since additional information may be necessary or desirable when particular or exceptional conditions or circumstances exist or because of applicable laws or government regulations. Nothing herein is to be construed as permission or as a recommendation to infringe any patent.

Micro Spike® Textured Geomembrane



Applications for HDPE and LLDPE Micro Spike®, textured geomembranes include projects where slope stability is critical. Micro Spike® is the only HDPE or LLDPE geomembrane that exhibits reproducible texture and friction angle values with the highest interface surface friction values in the industry. Micro Spike® is a patented product.

Agru America's structured Geomembranes are produced on state-of-the-art equipment using a flat die-cast extrusion manufacturing process as opposed to blown film extrusion. Agru America is the only manufacturer of structured and embossed Geomembranes in North America.

Micro Spike® surface texture



US Patent - No. 6,203,741 and 6,132,845

Comparative properties for Design Consideration

Blown film co-extruded textured surfaces vs. Micro Spike® structured textured surfaces

Design Consideration	Blown film co-extruded	Micro Spike® structured
Consistent core thickness	no	yes
Consistent surface texture	no	yes
Consistent asperity height	no	yes
Consistent interface friction	no	yes
Affect on mechanical properties	yes	no
Affect on stress crack potential	yes	no
Reduction in CQA program costs (less testing required)	no	yes



The calendared structured liner manufacturing process allows production of the only textured liner with a consistent core thickness, resulting in unchanged mechanical properties from that of smooth sheet. The consistent surface structuring or texture gives Micro Spike® Geomembranes reproducible friction angle values with efficiencies of over 95%.

***Representative Large Scale Interface Shear Values – ASTM 5321
landfill cap loading conditions***

Soil/Micro Spike® Surface	P	LD
Coarse Sand	34°	34°
Glacial Till	37°	32°
Silty Sand	32°	28°
Non Woven GT	32°	17°

Micro Spike® geomembranes are manufactured to meet or exceed current industry standards including GRI GM 13 (HDPE) and GRI GM 17 (LLDPE) test values, frequency of testing and functional requirements. Micro Spike® textured Geomembranes have smooth edges to allow for high quality thermal fusion welding between adjacent sheets. All Agru Geomembrane material is rolled on solid plastic pipe cores to ensure ease of installation without damage to the rolled material.

Micro Spike® textured HDPE and LLDPE geomembrane has a decided advantage over blown film textured geomembrane:

Reliability: Micro Spike's® reproducible friction angles gives the design engineer the confidence that he has designed a system that will be built to meet or exceed the project design requirements.

Cost Savings: Micro Spike® is competitively priced with value added advantages including consistent core thickness and texture which reduces installation costs, on-site quality control and third party quality assurance costs.

Consistent Material: The structured “Micro Spikes” are totally integrated with the Geomembrane.

Highest Tensile Values: Agru's LLDPE Micro Spike® has a 400% Elongation at Break (HD 350%), in an industry where the standard is only 250%* (HD 100%*). Our calendared Structured Manufacturing Process produces a consistent core thickness, resulting in the highest tensile values available in the industry.

*Tensile elongation values from GRI GM 13 & 17

High Interface shear: Exceptional shear resistance between soil and geotextile components allows flexibility and stability during protective cover material placement. The textured asperity height is not only consistent but higher than competitive textured products.



Why specify or use anything else!

Agru Worldwide has over 20 years experience with Geomembranes and 50 years experience with Thermoplastic Extrusion. Agru offers a wide range of concrete protective liners (Sure Grip), pipe, fittings, sheet stock, billet and solid rod.

1. Requirements and Fields of Application

The Problems with Old Neglected Deposits

AgruLock is a HDPE system developed for the construction of vertical cut off walls.

Vertical cut off walls mainly serve as a safe containment of polluting liquids which seep from old neglected deposits, landfills or industrial areas such as leaking storage basins.

Environmental pollution as a result of this emissions often lead to irreparable contamination of soil and groundwater.

Vertical barriers without HDPE panels have insufficient im-permeability to such pollutants.

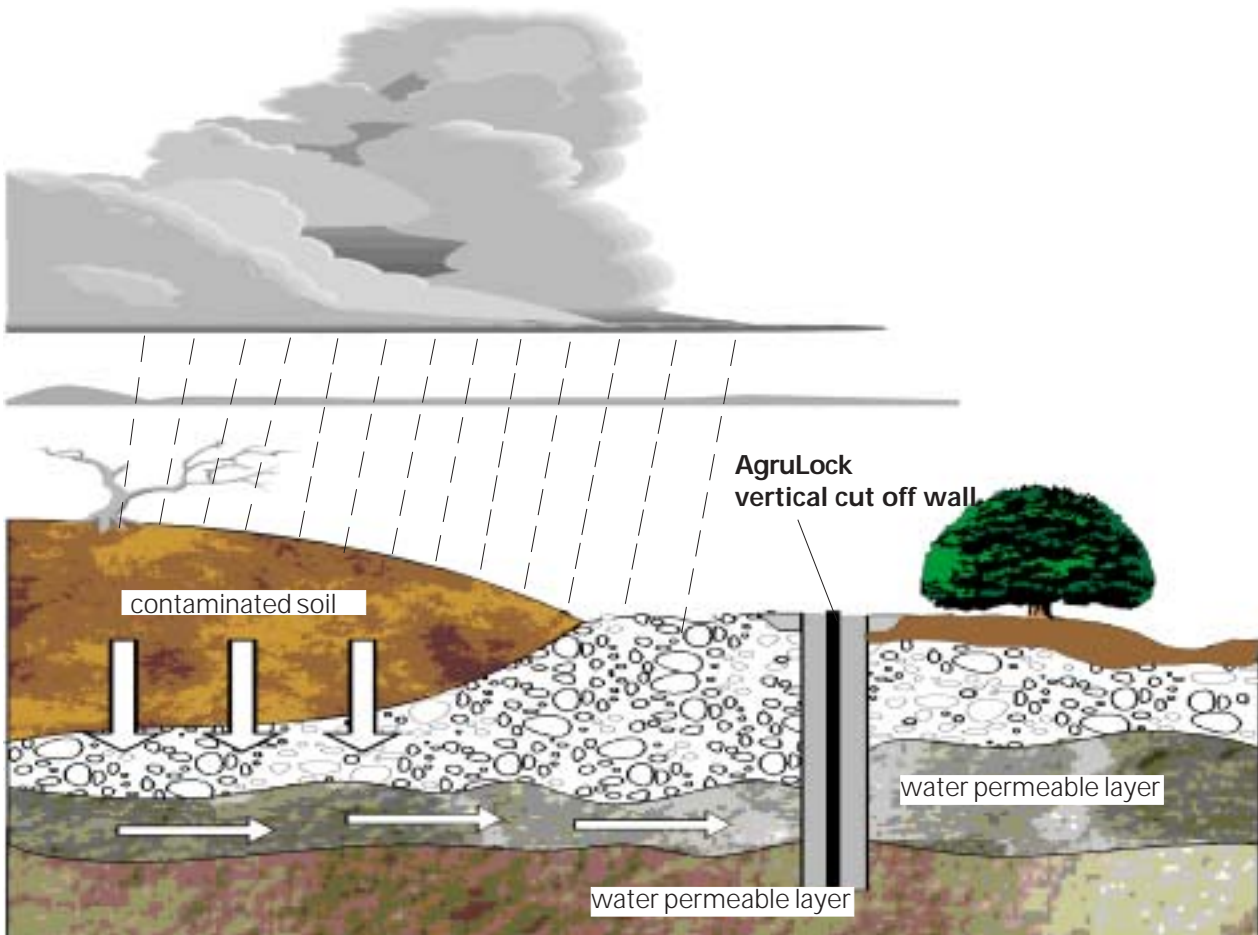
With regard to present technical standards, vertical cut off walls with integrated AgruLock HDPE panels meet the demands for:

- ❑ long lasting impermeability
- ❑ chemical and biological resistance
- ❑ high mechanical strength
- ❑ high flexibility which is necessary for construction work and for ground settlement
- ❑ well-tried installation techniques
- ❑ long service life
- ❑ economic efficiency

The AgruLock System (HDPE liner + lock profiles) has proved its superior performance and suitability many times on projects located all over the world.

AgruLock Fields of Application

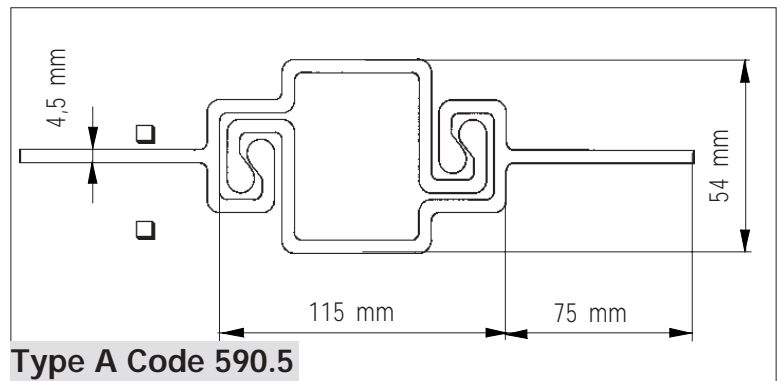
- ❑ safe containment of contaminated soil
- ❑ enclosure of seepage
- ❑ landfill gas barriers
- ❑ civil and hydraulic engineering
- ❑ barrier against backpressure from groundwater at constructions below water tables



2. AgruLockProfile-Types:

Special Features of Type A

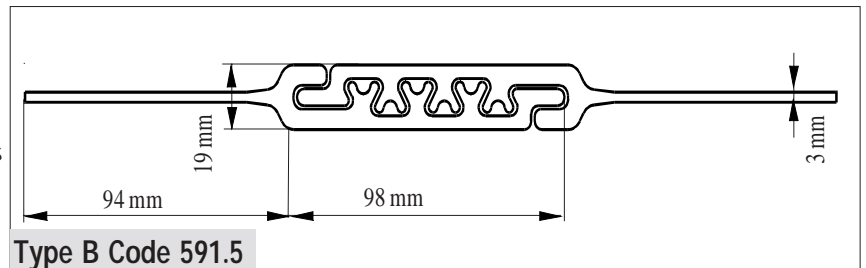
- outstanding high horizontal elongation of the interlock
- robust design
- easy downfeed into each other
- possibility of filling the hollow with a special sealing compound
- identical male and female profile
- horizontal separation load: > 25kN/ m run of interlock



AgruLock Profile Type A

Special Features of Type B

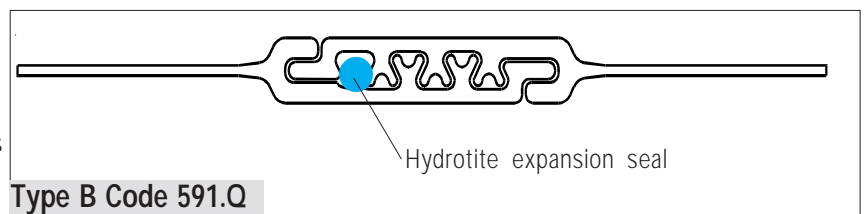
- horizontal separation load: > 45 kN/m run of interlock
- flat design
- easy downfeed into each other
- identical male and female profile
- delivered as straight strips or on rolls



AgruLock Profile Type B

Special Features of Type B.Q

- the insertion of a Hydrotite expansion seal makes the interlock watertight
- horizontal separation load: > 37 kN/m run of interlock
- flat design
- easy downfeed into each other
- identical male and female profile
- delivered as straight strips or on rolls

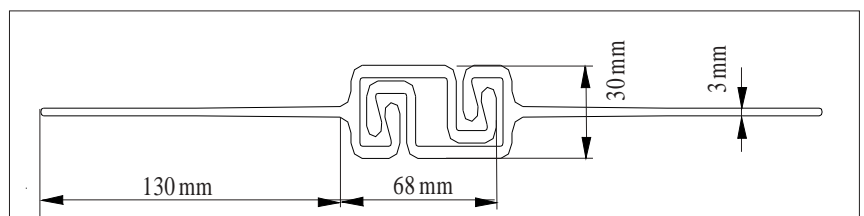


AgruLock Profile Type B with Hydrotite expansion seal

Special Features of Type C

combines advantages of Type A with Type B

- flat design - delivery on rolls
- horizontal separation load: 20 kN/m run of interlock
- identical male and female profile
- high elongation of the lock
- hollow can be filled (sealing compound)
- robust design
- easy downfeed
- weldable with common fusion machines (no adoption required)



The AGRULOCK profiles are available in different lengths - according to project demands.

Form of delivery: straight strips (Type A/ B) on rolls (Type B)

Specification

The AgruLock cut off wall consists of AGRU HDPE liners in conjunction with AgruLock profiles which are lowered into a bentonite slurry wall. AGRU Kunststofftechnik offers three different profile types in order to provide the optimum solution for each individual project.

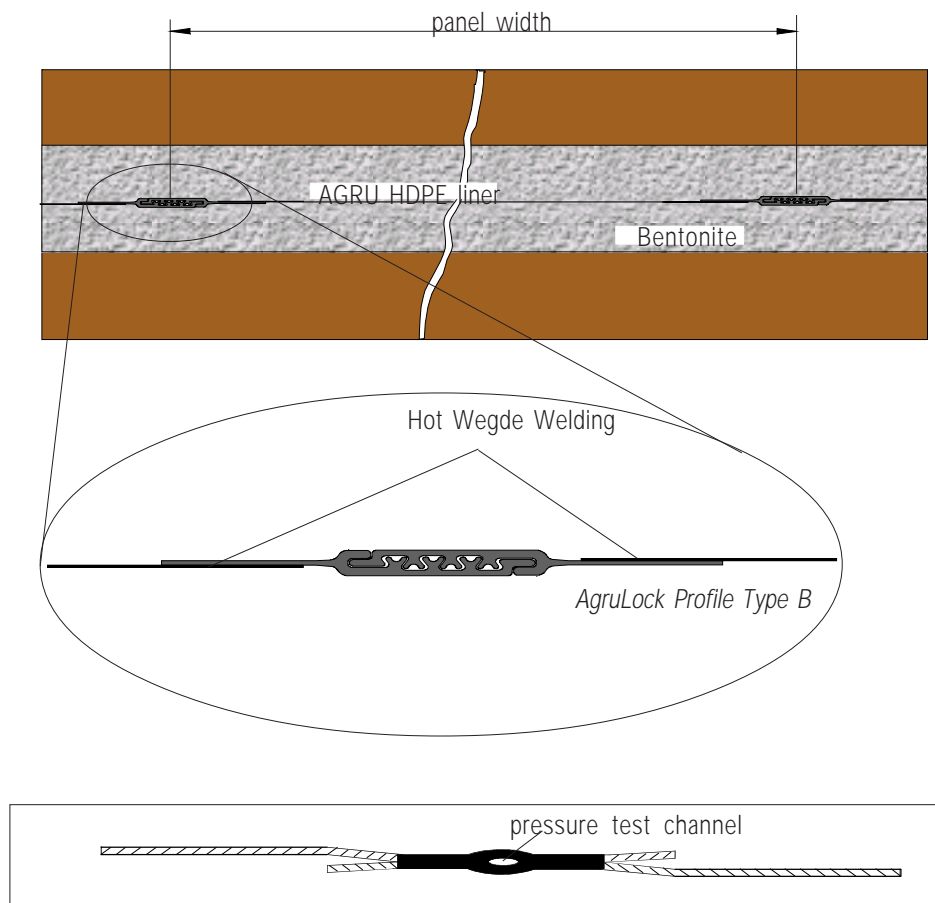
Installation Technique

The individual panels, consisting of a liner and two AgruLock profiles is to be prefabricated on site.

Prefabrication works include the cutting of the specified dimensions of the HDPE liners and profiles and welding them together using hot wedge welding or hot air welding.

The installation depth normally corresponds to that depth where water impermeable ground layers occur.

Hot wedge welding machines of the type that creates a pressure test channel enable the welder to test and document the tightness of the seam. Additionally peel tests should be performed to assure the mechanical strength of the bonds. Hot wedge welding is a well-tried joining method. It has been successfully used for the installation of HDPE liners in waste disposal.



The connection between HDPE liner and AGRULOCK profile is carried out by means of hot wedge welding which provides a pressure test channel between two welded seams

The Advantages of AgruLock Vertical Cut Off Walls

- lasting tightness
- impermeable to pollutants
- high chemical and biological resistance
- high mechanical strength
- high flexibility which is necessary for the construction works and for ground settlements
- control function
- well-tries installation techniques
- long service life
- economic efficiency
- ease of fabrication
- up to 7000 mm wide panels means less elements to be installed
- material uniformity of profile and liner

- rigidity of the profile
- the profile provides excellent lateral guidance for a trouble free insertion of the panels
- spacious design allowing sufficient tolerances during installation
- Type A+C: the installed profile can be filled with special sealing compounds
- Type B: possibility of sealing with a Hydrotite expansion seal

The Material - Polyethylene

Only the highest quality raw material is used for the production of AGRU HDPE liners and the AgruLock profile. Strict and complete quality control programs assure the consistent high quality of AGRU products.

Property	Test Method	Unit	Guide Value
Density	ISO 1183	g/cm ³	0,94
MFR (190/5)	ISO 1133	g/10 min	0,6- 1,60*
Heat Reversion	DIN 16726 (120°C / 2 h)	%	≤ 4,0
Tensile Strength at yield	ISO 527	N/mm ²	> 16
Elongation at yield	ISO 527	Yield %	> 9
Modulus of Elasticity	DIN 53457	N/mm ²	650

Data sheets acc. ASTM are available on request.

The data in this table are approximate values and based upon results of the internal inspection and data of raw material supplier. The results can slightly differ from the indicated mean values in longitudinal and transverse direction and due to different nominal thicknesses. In any case requirements relating to a special project (tender documents) have to be agreed with AGRU.

Independent of the indicated test standards, internal tests and data on test certificates are generally carried out in accordance with the appropriate test procedures according to ÖNORM (Austrian Standard) resp. DIN (German Standard).

AGRU assumes no liability in connection with the use of this data. The specifications on this sheet are subject to change without notice.

effective as of March 1999

3. Installation Guideline

Transportation and Storage

The AgruLock profiles are delivered to the construction site in form of straight strips. The HDPE liners are transported on rolls, protected with a PE-film.

Both the profiles and the liner materials should be stored on even, stone free areas, using a layer of geotextile if necessary, to prevent damage.

The maximum stack height should not exceed 5 rolls.

When transporting, moving or storing the liners, point loads which could cause damage should not be applied.



Storage of AgruLock profiles and AGRU HDPE liners in front of the welding tent



Prefabrication of the HDPE panels (AGRU HDPE liner + 2 AgruLock profiles) in a welding tent to maintain steady welding conditions

Prefabrication of HDPE Panels

After the liners are unrolled and cut to the required length, two AgruLock profiles have to be welded to both sides of each liner.

The use of a hot wedge welding machine that creates two welded seams and a pressure test channel according to DVS 2225 for the testing of the integrity of the welds is recommended.

The strength of the welds should be tested by peeling according to DVS 2225 part 2.

To facilitate the installation, all prefabrication works may be performed on site under workshop conditions by using a suitable welding tent or covered area.

Installation Equipment

Normally it is useful to construct a concrete boundary where the trench is to be excavated. The boundary serves as a guide to the excavation and it stabilizes the trench edges and improves personnel access. A grab-bucket conveyer is then used to excavate the trench to the specified depth. The width of the grab corresponds to the width of the trench. The bentonite slurry is pumped into the trench during the excavation in order to support the trench walls. For that purpose a pipe or a tube can be fixed directly on the grab.



Concrete boundary of the trench - the installation frame in the background, the installation drum in the foreground

Lowering Equipment

For the lowering of AGRU HDPE liners in conjunction with the AgruLock profiles, two well-tried devices are available.

The prefabricated panels can either be lowered by means of a frame or a drum.



AGRU HDPE liner + 2 welded AgruLock profiles on the mobile drum

If the drum is used for the panel installation, weight has to be attached to the liner to facilitate a smooth downfeed. Furthermore the weight keeps the panel in a vertical position. For this purpose the liner must be jammed between two steel bars at the side to be lowered. Afterwards the designated weight is mounted to the flat steel bars using screws or bolts.



Clamping of the HDPE panel with steel bars over the whole panel width



Raising the installation frame with the AgruLock panel attached

When the frame is used for the installation of the liner elements, the dead weight of the frame provides the required downfeed weight. Both, the lower and the upper edge of the panel are to be jammed between steel bars. The prefabricated panels are fixed onto the steel grid frame which is lowered into the bentonite slurry wall.

The vertical cut off wall is constructed this way by installing the panels piece by piece.

The use of the frame is restrictive as this method should only be use during calm weather conditions.

After welding and testing of the weld, the HDPE liner with the AgruLock profiles is rolled up on the drum core.

Afterwards the drum is placed in front of the trench which is already filled with bentonite.

The AgruLock cut off wall is built by fitting the AgruLock profile into the profile of the panel already installed.



Downfeed of the panel using a drum with an electric drive unit



If the installation is carried out by using the steel frame, the HDPE panels are fixed on the frame after welding the profiles to the liner. Afterwards the panels are installed by means of a crane and a centering construction.

The centering construction (steel rods or sheet metal fixed on the frame at right angles to the frame) assures that the frame stays in the middle of the trench during the downfeed procedure.

After the drum or the frame installation the AgruLock panels are to be hung until the bentonite slurry is cured sufficiently.

Downfeed of the AgruLock panels and subsequent hanging until the bentonite is cured

*Lowering procedure with
the drum*



*Insertion of the
AgruLock panel
into the profile
already installed*



Insertion prior to reaching the desired depth - The straps which were used for rolling up the panel are used for hanging the liners afterwards.



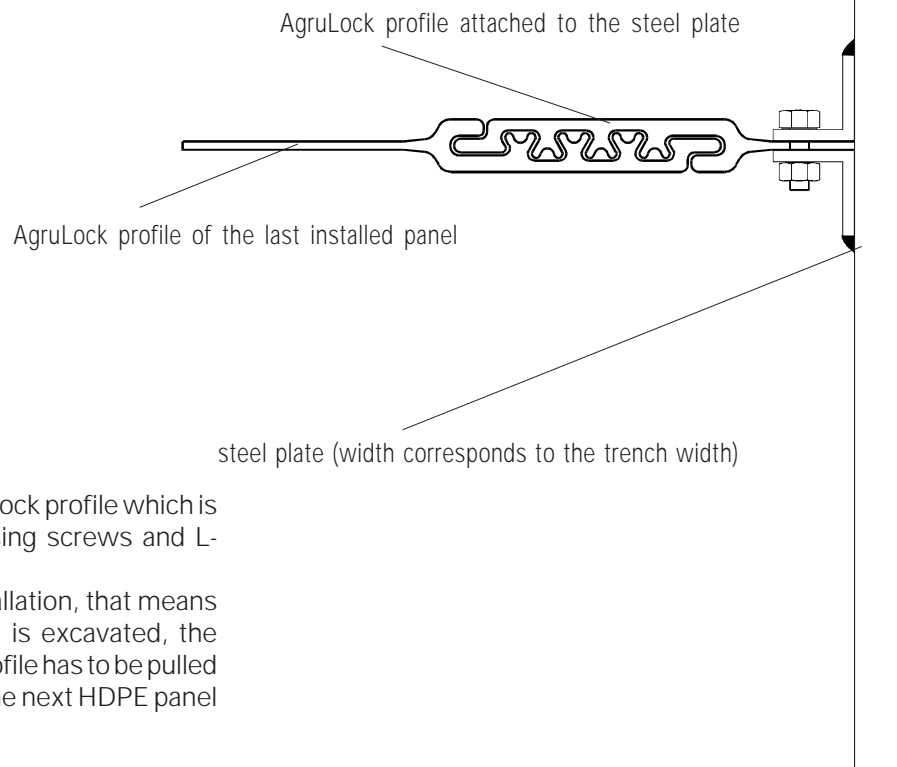
The AgruLock profile makes an easy insertion possible.

If Type B with the hydrotite is used, the expansion profile should be put into the designated recess of the profile prior to installation.

Partition of the Cut Off Wall

Normally the bentonite slurry is not cured when the next sector of the trench is excavated. In this case it is possible to insert the following panel without resistance.

If the interruption of the installation works lasts longer than the maximum curing time of the bentonite slurry, the last installed panel section has to be sealed.



This is done by inserting a AgruLock profile which is screwed to a steel plate by using screws and L-profiles.

Prior to continuation of the installation, that means before the next trench section is excavated, the steel plate with the AgruLock profile has to be pulled out of the trench. Afterwards, the next HDPE panel can be installed.

Device for the partition of the cut off wall

4. Permeability Values

**Exemplary permeability calculation
using 5 m wide panels in a 0.6 m wide
trench:**

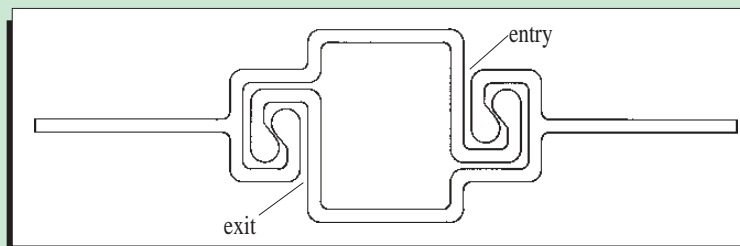
**AgroLock Type A + AGRU HDPE
Liners**

As the liner is watertight, percolation is only possible at panel joints. Therefore the permeability values depend on the lock profile geometry as well as on the permeability coefficient of the bentonite.

1. Elongation of the path of percolation through the AgroLock profile:

elongation of path of percolation	350 mm
normal path of percolation through the wall	<u>600 mm</u>

factor f_1 (with/ without AgroLock) $600/ 950 = 6,3 \times 10^{-1}$



2. Split for leakage 2 mm in a distance of 5000 mm:

split permeable	2 mm
HDPE liner non permeable	<u>5000 mm</u>

factor f_2 $2/ 5000 = 4 \times 10^{-4}$

Total Factor $f_1 \times f_2 = 6,3 \times 10^{-1} \times 4 \times 10^{-4} = 2,5 \times 10^{-4}$

**permeability factor of a vertical sealing wall without HDPE Liner and
AgroLock** $k_f \leq 1 \times 10^{-10} \text{ m/s}$

Composite Diaphragm with HDPE Liner and AgroLock

permeability factor $k_f = 1 \times 10^{-10} \text{ m/s} \times 2,5 \times 10^{-4}$

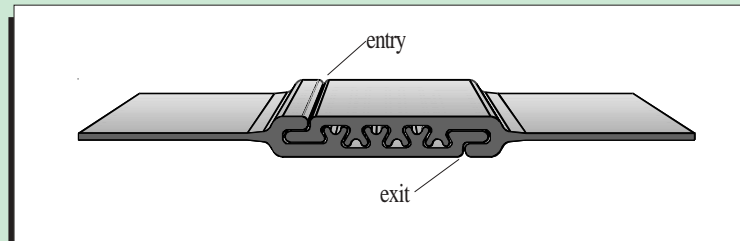
$= 2,5 \times 10^{-14} \text{ m/s}$

Exemplary permeability calculation using 5 m wide panels in a 0.6 m wide trench: AgruLock Type B + AGRU HDPE Liners

1. Elongation of the path of percolation through the AgruLock profile:

elongation of path of percolation 220mm
normal path of percolation through the wall 600 mm

$$\text{factor } f_1 \text{ (with/ without AgruLock)} \quad 600/ 820 = 7,3 \times 10^{-1}$$



2. Split for leakage 2 mm in a distance of 5000 mm:

split permeable 1 mm
HDPE liner non permeable 5000 mm

$$\text{factor } f_2 \quad 1/ 5000 = 2 \times 10^{-4}$$

$$\text{Total Factor} \quad f_1 \times f_2 = 7,3 \times 10^{-1} \times 2 \times 10^{-4} = 1,46 \times 10^{-4}$$

permeability factor of a vertical sealing wall without HDPE Liner and AgruLock
 $k_f \leq 1 \times 10^{-10} \text{ m/s}$

Composite Diaphragm with HDPE Liner and AgruLock

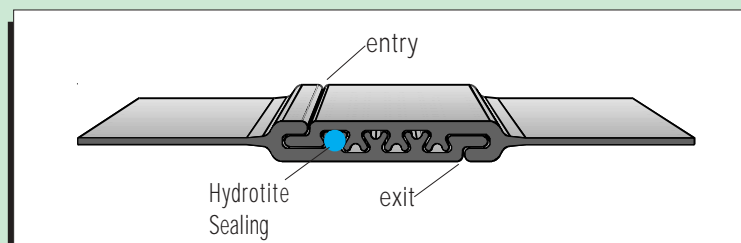
$$\text{permeability factor} \quad k_f = 1 \times 10^{-10} \text{ m/s} \times 1,46 \times 10^{-4} = \underline{\underline{1,46 \times 10^{-14} \text{ m/s}}}$$

The unique feature of AgruLock Type B is that it can be made completely watertight.

A Hydrotite sealing is inserted in a groove (supplied) during installation.

The Hydrotite material expands thus providing a watertight seal when fully hydrated.

Furthermore the material of the sealing is unaffected by chemical attack and it has a built in activation delay which prevents the sealing from swelling during installation works.



Exemplary permeability calculation using 5 m wide panels in a 0.6 m wide trench: AgruLock Type C + AGRU HDPE Liners

As the liner is watertight, percolation is only possible at panel joints. Therefore the permeability values depend on the lock profile geometry as well as on the permeability coefficient of the bentonite.

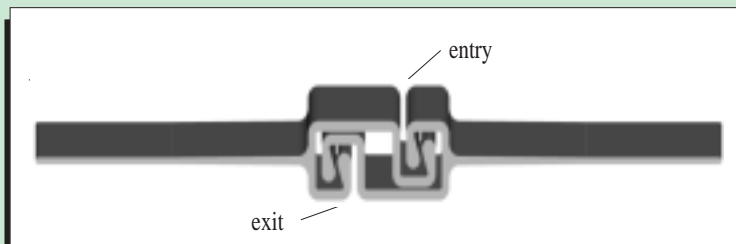
By Filling with adequate sealants as e.g based on water-expansive PU



1. Elongation of the path of percolation through the AgruLock profile:

elongation of path of percolation	200 mm
normal path of percolation through the wall	<u>600 mm</u>

factor f_1 (with/ without AgruLock) $600/ 800 = 7,5 \times 10^{-1}$



2. Split for leakage 1,5 mm in a distance of 5000 mm:

split permeable	1,5 mm
HDPE liner non permeable	<u>5000 mm</u>

factor f_2 $1,5/ 5000 = 3 \times 10^{-4}$

Total Factor $f_1 \times f_2 = 7,5 \times 10^{-1} \times 3 \times 10^{-4} = 2,25 \times 10^{-4}$

permeability factor of a vertical sealing wall without HDPE Liner and AgruLock $k_f \leq 1 \times 10^{-10} \text{ m/s}$

Composite Diaphragm with HDPE Liner and AgruLock

permeability factor $k_f = 1 \times 10^{-10} \text{ m/s} \times 2,25 \times 10^{-4}$

$= 2,25 \times 10^{-14} \text{ m/s}$

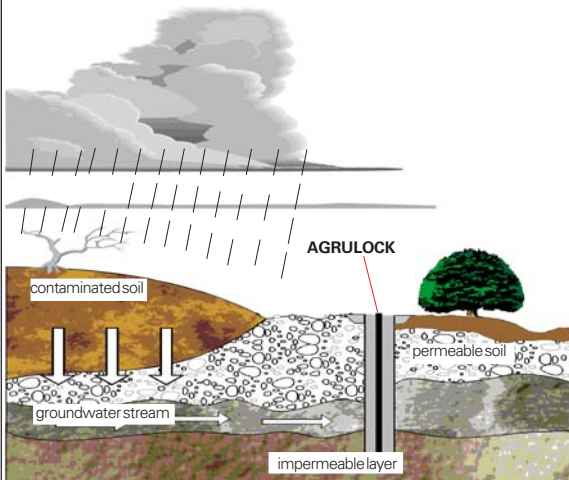
NEW INNOVATION- Cut Off Wall

AGRULOCK - VERTICAL SEALING

AGRULOCK Vertical Sealing System

Sealing of cut off walls by bentonite only gives certain permeation reduction but no permeation stop. Using AGRU LOCK system a laminar permeation stop is achieved and percolation only is possible at panel joints for which the AGRU LOCK design has elongated percolation path. AGRU LOCK Systems are installed where contaminated groundwater streams needs to be stopped or treated by "gate & fence" systems but also for construction sites where the groundwater table has to be kept constant at low level.

Function



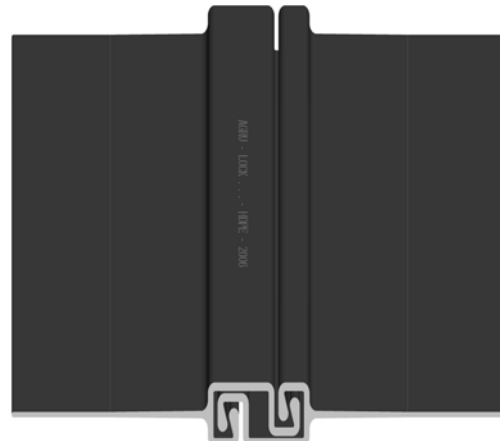
Type C- Evolution

in close corporation with installers of AGRULOCK System based on the patented LOCK Type A, an evolution was made to implement two important design criterions:

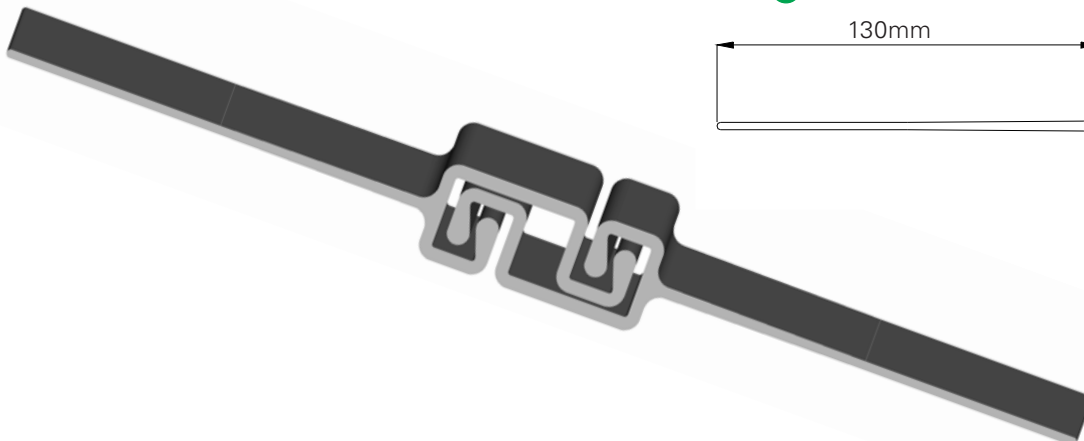
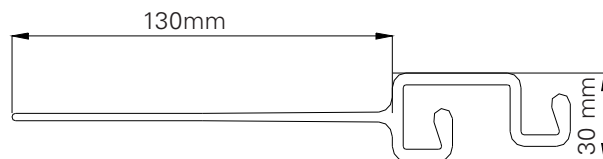
The new AGRULOCK C-Evolution gives the advantage to supply it in rolls up to 45m, that means taylormade to the customer requirements. The 130mm welding section of the profile ensures weldability with any common hot wedge welding machine.

Special Features of the new Type

- ❑ horizontal separation load: > 15 kN/m run of interlock
- ❑ outstanding high horizontal elongation properties of the interlock
- ❑ taylormade profile length
- ❑ designed for tough working conditions
- ❑ easy and simple assembling at construction site
- ❑ possibility of filling the box section with a special sealing compound
- ❑ identical male and female profile
- ❑ made of HDPE
- ❑ Installation is possible with frame or coiling drum



easy and fast welding of the new Locktype



NEW INNOVATION- Cut Off Wall AGRULOCK - VERTICAL SEALING

Installation Procedure



A special equipped Excavator dig the cut off wall. A steel frame along the trench assist as alignment device.



To stabilize the cut off wall during the excavation process the bentonite slurry is permanently pumped into the trench.



The fabricated panels are transported to the actual installation section by a coil trailer and fixed to the insertion frame.



Installation frame for the insertion of the panel into the cut off wall



Then the panel is lowered down the trench by interlocking to the previous set panel. Those gives you after completion the barrier.





AGRU AMERICA T-LOCK INSTALLATION GUIDE

Agru America T-Lock is a High Density Polyethylene (HDPE) extruded anchoring system designed to provide an embedded attachment for HDPE liner. Agru America T-Lock is designed to embed in any face of new cast-in-place or precast concrete construction and can be fabricated to maneuver around shapes and corners.

Any thickness of HDPE liner can be welded to Agru America T-Lock. If unexpectedly high tensile loads are experienced by the liner, the liner is designed to yield before the T-Lock will yield or pull out of the concrete. The T-Lock Profile is detailed in Figure 1.

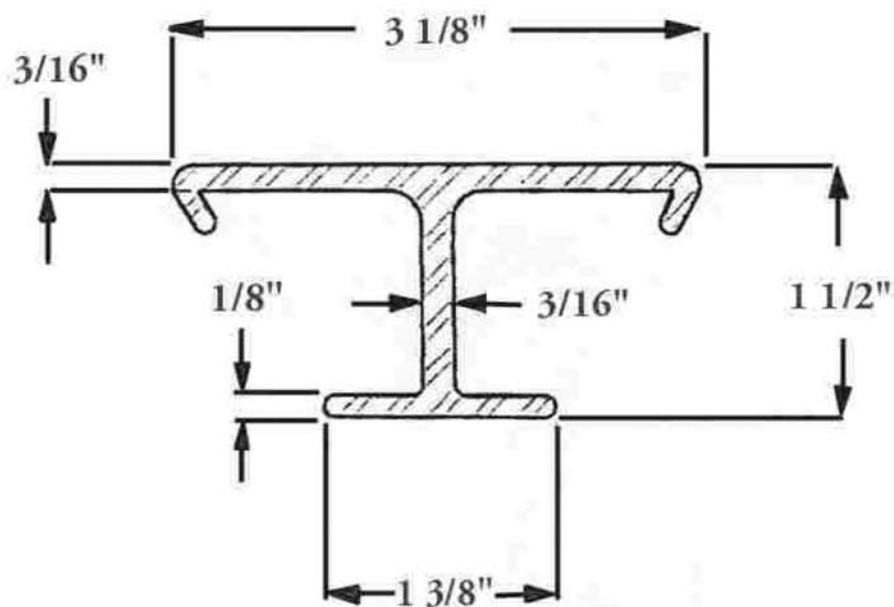


Figure 1- Agru America T-Lock

Attachment of the HDPE Liner to T-Lock is performed by grinding the T-Lock and the HDPE Liner and then extrusion welding the HDPE Liner to the T-Lock.

Proper installation techniques must be observed to ensure a secure embedment of the T-Lock and a sound weld to the HDPE Liner.



T-LOCK INSTALLATION

T-Lock must be cut and butt-welded together to fit corners and shapes. This cutting and welding, if performed correctly, will provide continued support for the HDPE Liner and secure a seal. Corners and “T” connections can be supplied prefabricated.

ATTACHMENT OF T-LOCK TO FORMS

Agru America T-Lock is attached to the inside of a concrete form with finishing nails prior to concrete placement (Figure 2). The finishing nails should be 1 inch or smaller. The nails must be driven flush with the back of the T-Lock to allow for their easy removal when the forms are wrecked. The T-Lock should be attached sufficient points to ensure a flush fitting with the form.

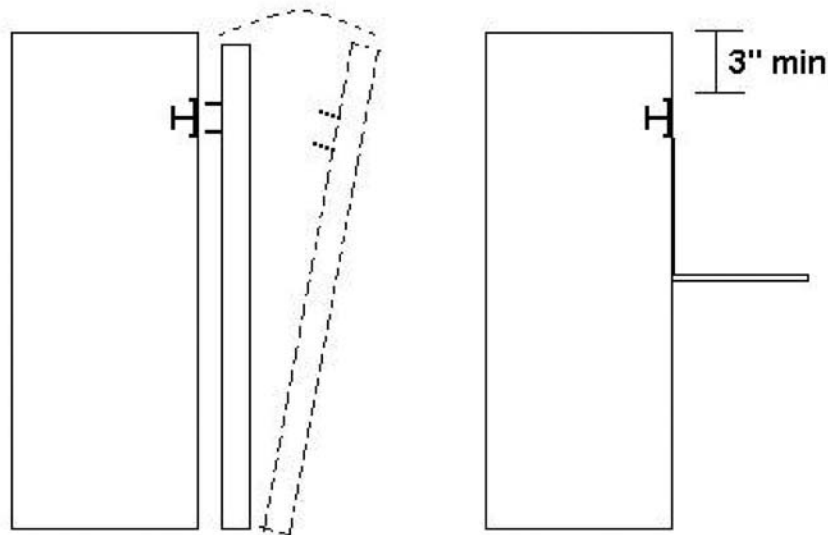


Figure 2

EMBEDMENT OF THE T-LOCK

The concrete surrounding the T-Lock should be vibrated to ensure that there are no void spaces in the concrete adjacent to the T-Lock.

After the concrete has set and the forms are wrecked, the finishing nails can be removed. If concrete gets between the T-Lock and the form, it should be chipped away to reveal the face of the T-Lock. Any sharp edges that are created by the chipping back of the concrete must be beveled to prevent possible cutting or puncturing of the liner.



HEAT FUSION WELDING OF T-LOCK

The recommended method of burr-welding T-Lock is a heat fusion welding method which yields a continuous strip of material. The following is a list of tools and procedures required to perform the heat fusion welding method.

Welding Tools

110 V Leister Triac with Welding Mirror Attachment

-or-

Any Double Sided Butt-Welding Hot Plate

Welding Procedures

1. Cut the ends of the T-Lock to be welded. These cuts should be square and smooth with no nicks or gouges in the surface.
2. Clean ends with a clean cotton cloth to remove dirt, water, grease and other foreign materials.
3. Insert clean and pre-heated welding mirror plate between ends and bring the ends firmly in contact with the mirror plate while achieving an even melt pattern over the cut face of the T-Lock. Allow the ends to heat and soften until a melt bead of approximately 1/8" appears.
4. Remove the mirror plate from between the two pieces of T-Lock and bring the melted ends together. Apply enough pressure to produce a 1/8" roll-back bead.
5. Allow the joint to cool.