



TUNNEL LINING SYSTEMS

AGRUFLEX LINER + EASYFIX SYSTEM



agru

Worldwide Competence
in Plastics





Worldwide competence in plastics

AGRU Kunststofftechnik GmbH is a family-owned, highly productive enterprise headquartered in Austria with worldwide activities. These include the production and sales of high-quality thermoplastic polymer products.

The extensive experience in the production of geosynthetic liners for a wide range of applications enables AGRU to offer tunnel lining systems out of high-quality materials, to assist and support its customers and partners with service and know-how.

The ISO 9001:2008 quality management system ensures high-quality products. The AGRU product range is continuously expanded and improved.

WORLDWIDE COMPETENCE



AGRU tunnel liners

- High-grade resins
- Specially selected raw material
- Perfect mechanical properties
- No toxic fumes in case of fire
- High flexibility
- Easy to install
- Good weldability
- Long service life





IN TUNNEL LINING





Tunnels with AGRUFLEX

Blasted or bored tunnel constructions.

It is impossible to imagine tunnel construction (cut-and-cover, drilling-and-blasting, as well as tunnel boring) without AGRU tunnel liners. The liner protects the structure from infiltration of water, aggressive soils and root penetration.

Water affects the tunnel with its explosive effect during its frost and ice formation. Water spots, dripstones made by lime diffusion and concrete corrosion are prevented by the use of AGRU tunnel liners.

Maintenance work is significantly reduced and therefore interruptions can be avoided.

AGRUFLEX TUNNEL LINERS



Polyolefins

The coextruded tunnel liner out of VLDPE is produced by flat die calendaring. The liner has a black base layer and bright coloured signal layer.

The application of VLDPE with its excellent flexibility guarantees a perfect adjustment to the tunnel structure, an easy installation and leak-tight joints between the polyolefin tunnel liners.

The material has an excellent resistance to aggressive soil and mountain water.

Conventional construction

- Shotcrete layer
- Sealing with AGRU thermoplastic liners
- Reinforced inner concrete shell

Installation

Step 1:

The geotextile used for protection and drainage weighs typically up to 1000 g/m² and is attached to the tunnel wall by discs. The discs are arranged in a special grid.

Step 2:

AGRUFLEX tunnel liners are fixed onto the discs by hot gas welding or by means of the AGRU Easyfix system (Velcro effect).

Step 3:

The joining of the AGRUFLEX tunnel liners is done with hot wedge welding according to DVS 2225 and tested regarding tightness. Manual hot gas welding combined with extrusion welding is used for patches and waterstop profiles.

DRILLED TUNNEL CONSTRUCTION

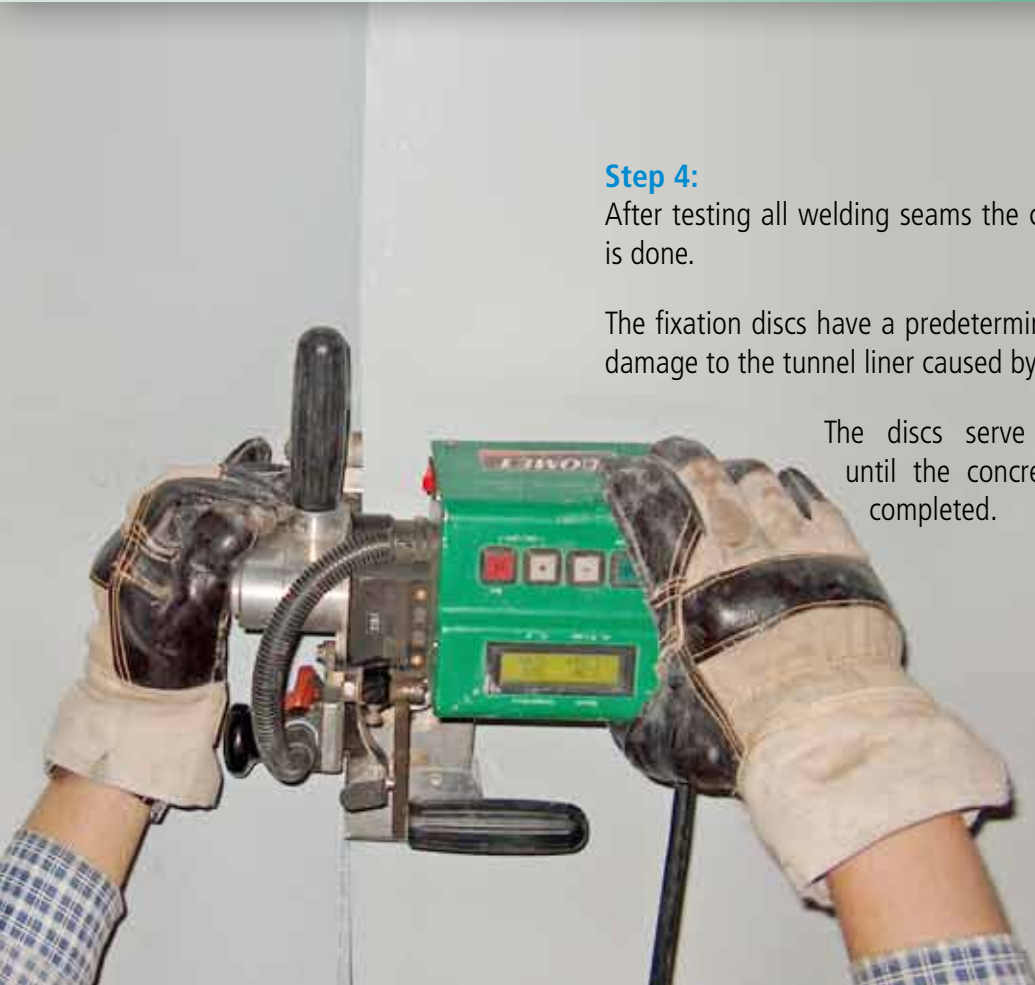


Step 4:

After testing all welding seams the concreting of the inner shell is done.

The fixation discs have a predetermined breaking point to avoid damage to the tunnel liner caused by settlements.

The discs serve as a temporary fixation until the concreting of the inner shell is completed.



Advantages of Easyfix

- Conform to ZTV-ING, DS 853 and RVS-8T
- No influence of the liner's mechanical properties caused by adhesive bonding
- Installation with semi-automatic formworks
- Flexible installation methods
- Up to 40 % timesaving for installation by easy and exact placement of the tunnel liner
- Liner widths up to 4 m

Easy The AGRU Easyfix system

In comparison to the conventional method, discs and strips backed with Velcro are attached to the shotcrete in a certain pattern.

Beginning at the tunnel floor the (fabric backed) liner is then attached to the tunnel walls. It has to be ensured that sufficient pressure is put onto the Velcro areas.

Later adjustments of the liner are possible with this installation method.

EASY INSTALLATION WITH





THE EASYFIX SYSTEM



Installation methods

Disc / profile

The fabric backed tunnel liner is attached to the discs / stripes (3 - 5 pcs/m²) applying sufficient pressure. This very simple handling and positioning makes a fast installation possible.

Hot air mounting system

Both geotextiles are thermally bonded by using a hot air bar mounted onto the scaffolding. The rollers guarantee the pressure necessary for joining.

Hot melt joint by tubbing construction

The hot melt adhesive is put between the concrete shell and the geotextile of the tunnel liner. The turning adhesive bar and the rollers are fixing the tunnel liner to the tubbing shell.





Tunnels with AGRUFLEX

Cut-and-cover tunnel constructions are usually easier to install in comparison to bored tunnels. Tunnel liners and geotextile are directly placed onto the already finished outside shell of the tunnel. Neither a complex installation of the liners nor overhead work is required.

The cut-an-cover method enables a fast installation, independent from the lead time of concreting. In individual cases also HDPE or LLDPE liners are used.



AGRUFLEX TUNNEL LINERS



Installation

Step 1: The protection geotextile typically weighs up to 1000 g/m² and is attached to the fabricated concrete shell.

Step 2: The AGRUFLEX tunnel liner is placed onto the protection geotextile.

Step 3: The welding of single liners is done by hot wedge welding according to DVS 2225. Manual hot gas welding combined with extrusion welding is used for joining smaller areas and waterstop profiles.

Step 4: An additional protection geotextile is placed onto the AGRUFLEX tunnel liner after all joints are tested and all components are installed.

Step 5: As last step one has to pile and compact the gravel around the tunnel.



FOR CUT-AND-COVER TUNNEL CONSTRUCTIONS





AGRU waterstop profiles

Waterproofing tunnels is essential for the lifetime of the construction. Modern tunnel lining is designed to offer the possibility of repair work of hollow spots or leaky areas with special injection resins.

Waterstops are installed when casting the joints of the inner shell to create separate compartments.


AGRU waterstop profiles with integrated injection outlets provide a perfect anchoring to the concrete to withstand highest back-pressure. Integrated injection hoses enable defined injection of resins at repair sections.

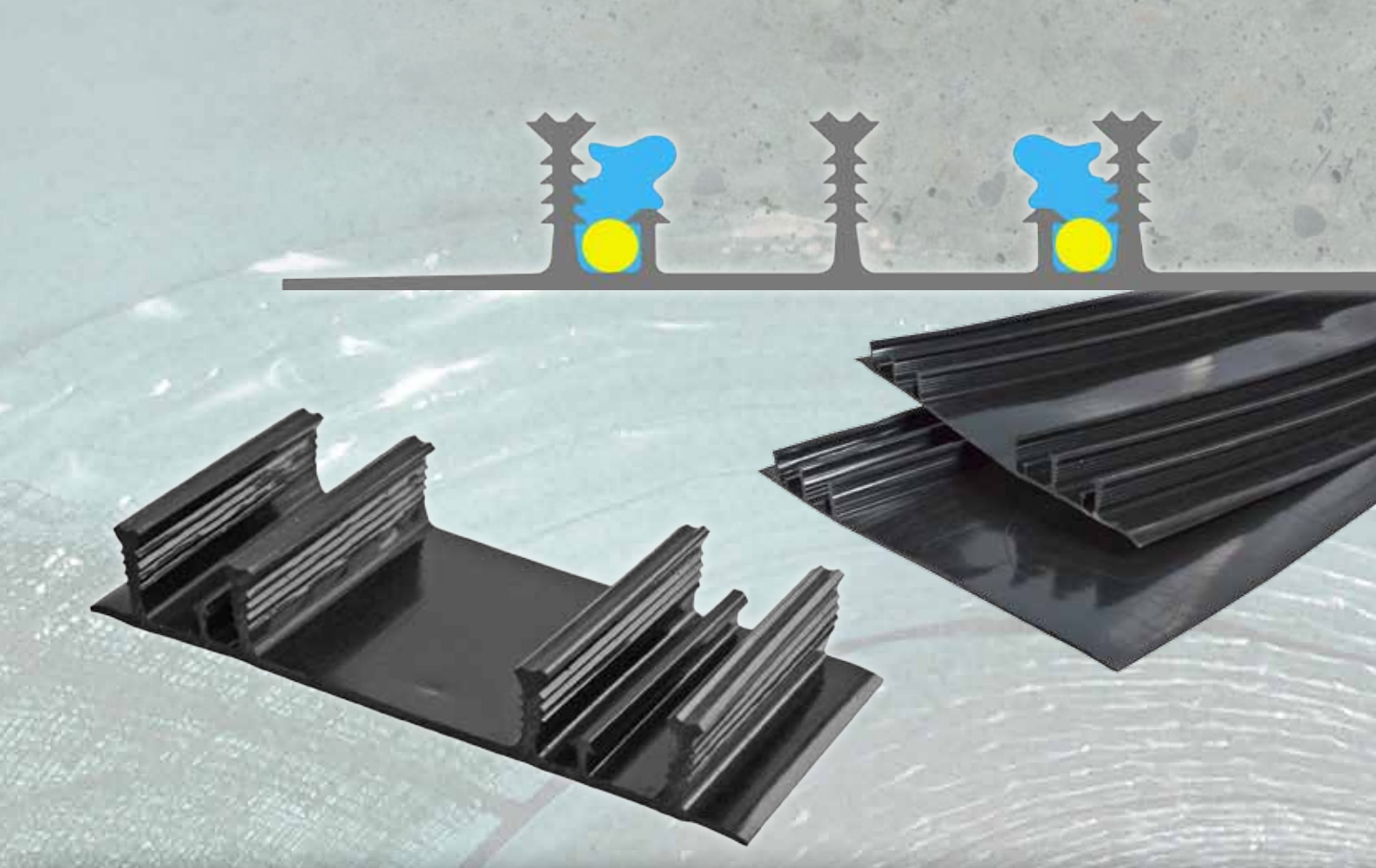
MONOLITHIC SYSTEMS



Advantages of waterstop profiles

The perfect solution for attaching the liners and concrete protective liners to concrete constructions.

- Designed according to DIN 18197:2005 and DIN 18541:2006
 - Integrated injection hose clamp for OD 9 - 12 mm
 - Defined outlets for even distribution
 - Polyolefin based VLDPE resin
 - Optimised compatibility with polyolefin based tunnel liners
 - Free of plasticisers and halogens
 - Dimensions: 120/2 - 240/4 - 250/3 - 500/3 - 500/6 - 600/6
- 



PERFECT SOLUTIONS



Drainage

Different drainage systems are available for tunnel constructions (undrained, partially drained and drained) which have to be adjusted to the local and structural conditions.

The choice of material and dimensions of the drainage system is of great importance. Bright coloured inside walls provide an optimal illumination during camera inspections. Smooth surfaces have to be chosen to avoid depositions.

Projects without drainage may cause damage to the complete system.



EASYFIX

EASYFIX – THE SYSTEM WITH VELCRO PROFILE PLATE!

- A complete solution by AGRU for tunnel constructions
- Fast and reliable installation of tunnel liners
- Appropriate VLDPE tunnel liner with fabric backing
- Widths up to 4 m



● LINING SYSTEMS

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