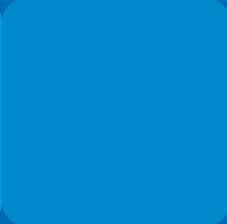
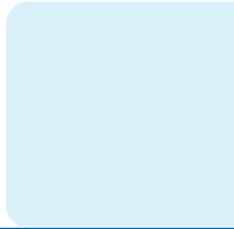
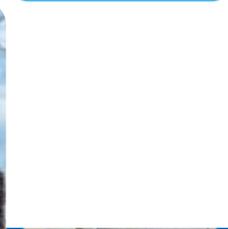
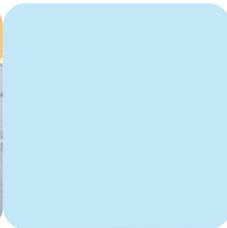




Matrox®

**Lining systems for optimized
bulk material handling**



Thermoplastics

The Matrox® range are polymer engineering plastics that solve the problems of friction, wear and the flow of material in many sectors of the industry.

An exceptional low friction surface, outstanding wear resistance, high impact strength, excellent chemical resistance and superior performance in demanding applications characterize the key properties of the product.

Röchling – outstanding competence

Röchling Engineering Plastics is a world-wide leader with more than 100 years of experience in the development and production of semi-finished products made of engineering plastics for the capital goods industry.

In close co-operation with our customers we developed a range of Matrox® grades that are tailored to the different lining applications with specific requirements.

Highly qualified employees, superior material development, state-of-the-art production facilities, laboratories and a certificated quality management system are the basis for the high quality and economic efficiency of the products. Our excellent reputation among the world's leading flow consultants and engineering experts in the field of bulk solids flow has been achieved by earning respect based on providing the industry with unmatched consistent, reliable solutions to flow problems.

Matrox®

The new formulation of Matrox® has specifically been developed for the bulk material handling and mining industry to reduce the typical flow problems of bulk solids in bins, hoppers, chutes, truck beds and other applications. However, every application makes its own special demands on the lining material. In order to meet these, Röchling Engineering Plastics has cooperated closely with specialists and users in modifying tried and tested plastic materials for widely varying fields of use. The products of the Matrox® range combine the best surface friction qualities with abrasion resistance not only to promote bulk material flow but also to withstand the abrasion resistance of flowing bulk materials in rugged applications under different environmental conditions.

The Matrox® grades are based on a specific formulation of Ultra-High-Molecular Weight Polyethylene (PE-UHMW/PE 1000) that has been developed for the use as a lining-material either in new construction or as a retrofit.

Economic advantages

Compared to steel, Matrox® has considerable economic benefits.

• **Lower cost**

The cost for lining an existing bin with Matrox® is only about one third of the cost for construction steel.

• **Lower weight**

For example, for the refurbishment of a 200 m² steel bin, re-lining it with Matrox® would achieve a reduction in weight of almost three tons compared to the standard method of welding steel sheets (S235JR) (see table). Matrox® reduces the load on the structure and makes installation work much simpler.

• **Longer life span**

The life span of Matrox® is substantially longer than that of conventional construction steel. In the sand-slurry wear test, Matrox® achieved a value of 80 which is 46% better than that of steel at 150 (S235JR). (See p. 9 Estimated wear life).

	Material thickness	Specific gravity thickness g/cm³	Weight for 200 m² [kg]
Steel	3 mm	7.85	4,710
Matrox®	10 mm	0.93	1,860

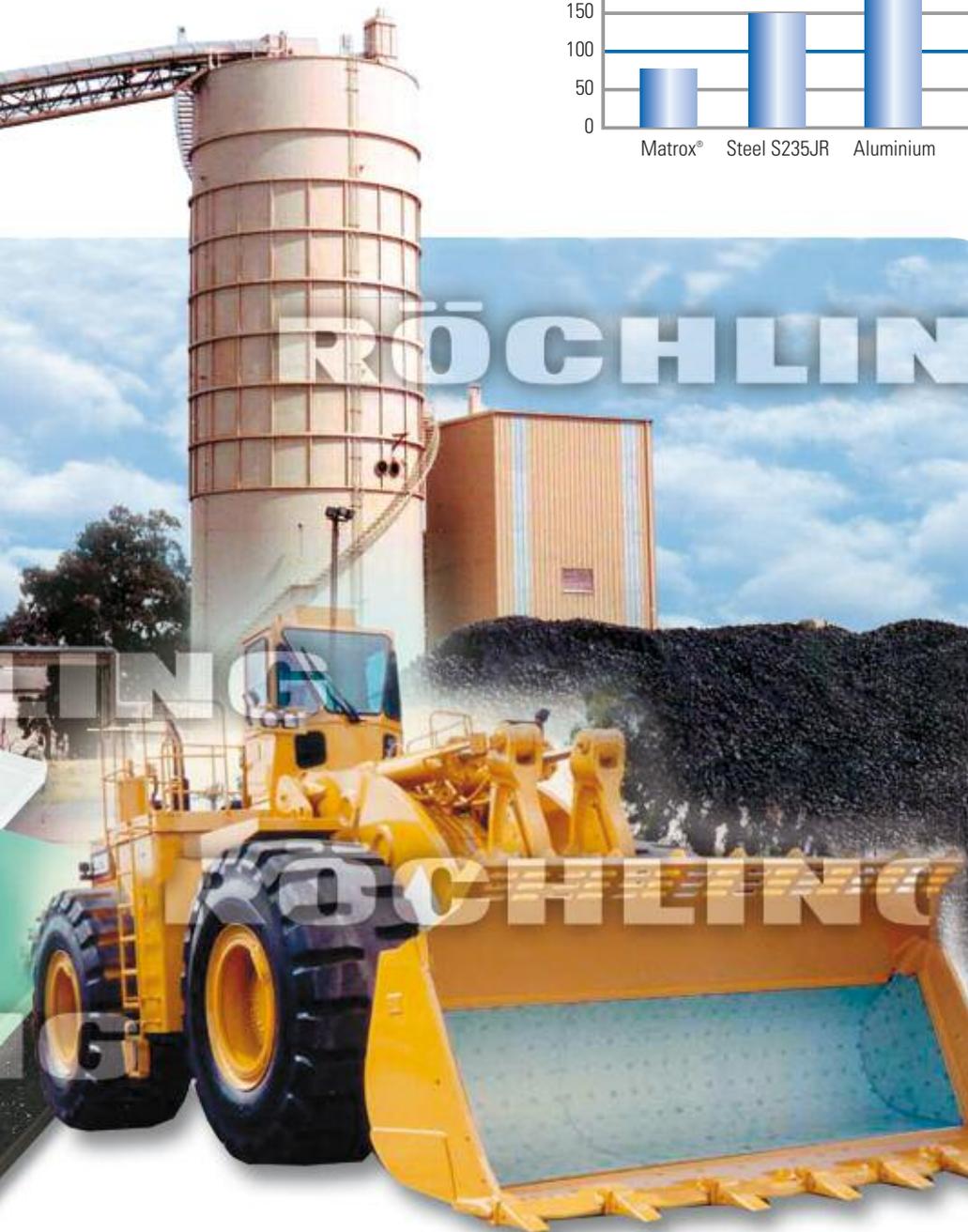
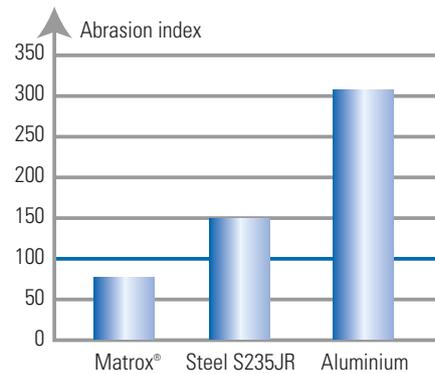
Weight reduction with Matrox® 2,850 kg ~ 60%



Relative volumetric wear according to the sand-slurry process

In the sand-slurry test, a mixture of sand and water is used to test the resistance to abrasion of a test sample compared to a defined reference material of PE-UHMW with a molecular weight of 5 million g/mol to which a fixed value of 100 is assigned. The volume lost by the test sample during the test is then stated as an

index compared with that of the reference material. The lower the value achieved, the better the resistance to abrasion.



Typical applications

The products of the Matrox® range are used in a wide variety of industries that handle bulk materials from the mining level up to and including the final processing or use of the product. Changes in moisture and particle size affect the product's flowability. Traditional steel surfaces become rough or corroded causing the bulk material to stick to the steel. The problems deteriorate and productivity and quality control are compromised.

Mining

- Off-road truck bed liners
- Shovel liners
- Hopper liners
- Chute liners
- Scrapers
- Stacker/Reclaimer bucket liners
- Dragline bucket liners
- Front-end loader buckets

Transportation

- Ship holds
- On-road truck bed liners
- Railcars

Storage and Handling

- Silos, bins, bunkers
- Reclaim hoppers
- Truck dump hoppers
- Rail dump hoppers
- Vibratory feeder pans
- Receiving Hoppers
- Dozer Blade Liners
- Slider beds
- Skirting
- Belt scrapers

Processing

- Day bins
- Surge bins
- Batch hoppers
- Storage silos and bins
- Hoppers
- Chutes
- Feeders
- Screw conveyors

Bulk Materials handled

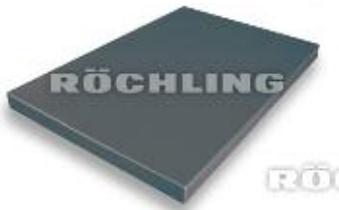
- Coal
- Iron Ore
- Copper Concentrate
- Clay
- Limestone
- Soda Ash
- Chemical Powders
- Nickel Ore
- Peat
- Synthetic Gypsum
- Kaolin Clay
- Potash
- Salt
- Silica Sand
- Soap Detergent
- Wood Chips
- Zinc Concentrate
- Phosphate
- Dust
- Talc
- Bauxite

The Matrox® range of products

In the field of lining technology, the name Matrox® stands for highest quality with regard to resistance to wear and low sliding friction. In order to meet the demanding requirements of the bulk-goods industry, Röchling Engineering Plastics has cooperated with bulk-goods

Matrox®

Matrox® is the classic lining material in our range and has general characteristics of a very high standard. Matrox® has a very low coefficient of sliding friction which is particularly important for the bulk transport and storage of glutinous or tacky materials.



Characteristics

- Very low coefficient of sliding friction
- Very high resistance to wear and abrasion
- High notched-bar impact strength
- Very low water absorption
- High resistance to chemicals
- High resistance to temperature

Fields of application

- Transport industry
- Truck bed lining
- Bin and hopper linings

experts and users in developing more lining materials which are ideal for use in many different fields of application. These members of the Matrox® product family are: Matrox®, Matrox® U 110, Matrox® SE, Matrox® EX 60, Matrox® SI 12, Matrox® X, Matrox® FC and Matrox® PUR.



Matrox®: Lining material for glutinous bulk solids

Matrox® U 110

This material has the characteristics necessary for transporting hot bulk goods such as tar or asphalt. Matrox® U 110 contains a number of additives which allow the material to be used for longer periods of time at temperatures up to 190°C. When planning linings for bulk solids with temperatures as high as this, the thermal expansion of the material has to be taken into account at the design stage.



Characteristics

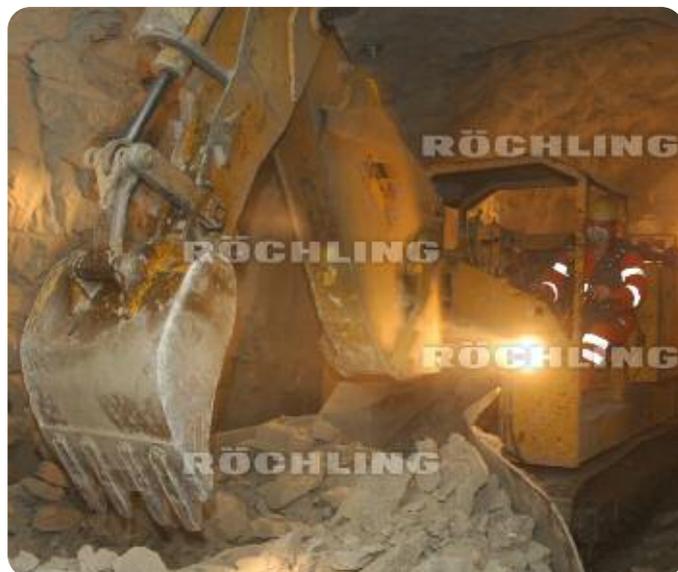
- Very high temperature stability
- Low coefficient of sliding friction
- High resistance to abrasion
- Contains additives which inhibit oxidation
- Good resistance to chemicals
- Very low moisture absorption

Fields of application

- Truck beds
- Bulk-solid containers
- Bin linings
- Conveyor ducts
- Hoppers



Matrox® U 110: The ideal material for hot bulk solids



Matrox® SE

Matrox® SE is recommended for use in areas where it is advisable or obligatory to use materials which are hardly inflammable. This lining material represents an excellent combination of good sliding characteristics and high resistance to wear and also possesses flame-inhibiting qualities of class V0 according to the international test process UL94.

Characteristics

- Flame-inhibiting (UL94, class V0)
- High resistance to wear
- High impact strength
- Good sliding characteristics
- UV-resistant
- Anti-static

Fields of application

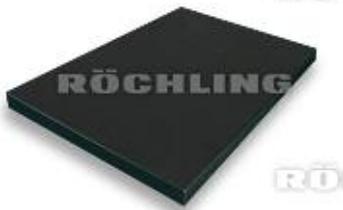
- Mining
- Truck beds
- Hoppers



Matrox® SE: Ideal (among other things) for linings in the mining industry

Matrox® EX 60

Because of its permanently anti-static quality, Matrox® EX 60 is especially suitable for applications in areas where there is a risk of explosion. The material also has a high impact resistance and excellent UV stability. This means that it is ideal for outdoor use, e.g. in open-cast mining.



Characteristics

- Permanently anti-static
- High resistance to wear
- High impact strength
- UV resistant

Fields of application

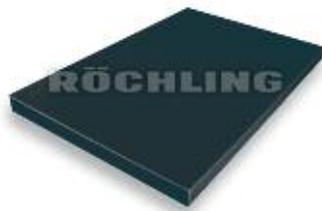
- Open-cast mining
- Truck beds
- Excavator-shovel liners
- Conveyor ducts
- Hopper lining



Anti-static: Matrox® EX 60 in open-cast mining where explosion risk is high

Matrox® SI 12

The good wear and sliding properties of Matrox® SI 12 are ideal for use with certain types of bulk solids such as peat or sand.



Characteristics

- Good resistance to wear
- Good sliding characteristics
- Suitable for outdoor use

Fields of application

- Port construction
- Conveyor and installation technology
- Wood transport



Matrox® SI 12: Balanced properties for less demanding goods



Matrox® X

Coarse-grained solids with sharp edges make extreme demands on the lining material. That is why we have developed Matrox® X. This is our premium product and possesses at optimum sliding properties the highest hardness and resistance to wear of all the members of the Matrox® product family.



Matrox® X: The premium lining for extreme conditions

Characteristics

- Excellent resistance to abrasion
- Very high surface hardness
- Good sliding characteristics
- High impact strength
- Very good resistance to chemicals

Fields of application

- Mining
- Mining vehicles
- Truck beds
- Hopper linings

The Matrox® range of products

Matrox® FC

With its official approval, Matrox® FC is ideal as a lining material for contact with bulk goods in the foodstuffs industry.



Characteristics

- FDA-approved
- High resistance to wear
- High impact strength
- Very low coefficient of sliding friction
- Low moisture absorption

Fields of application

- Foodstuffs industry
- Goods wagons
- Bin lining



Matrox® FC: According to FDA approval, suitable for contact with foodstuffs.

Matrox® PUR

This material is perfect for applications involving extreme wear and tear, impact stress and less demanding sliding requirements. The combination with other products in the Matrox® range allows you to achieve a system which is outstanding for its high resistance to abrasion, excellent sliding characteristics and maximum impact strength at certain defined points. Matrox® PUR is available in a number of hardness grades depending on requirement.

Characteristics

- Extremely resistant to jolt and impact stresses
- Very high elasticity and resistance to tearing
- High abrasion strength
- Sound-absorbing

Fields of application

- Lining of concrete-mixing machinery
- Storage bins
- Transfer funnels in bulk conveying systems
- Infeed-flow pipes
- Crusher plant
- Road-construction machinery



Matrox® PUR: Suitable for applications involving high impact stress and less demanding slide requirements.

● very good ● good ● satisfactory ● moderate ○ not good

	Matrox®	Matrox® U 110	Matrox® SE	Matrox® EX 60	Matrox® X	Matrox® SI 12	Matrox® FC	Matrox® PUR
Resistance to wear	●	●	●	●	●	●	●	●
Impact strength	●	●	●	●	●	●	●	●
Sliding characteristics	●	●	●	●	●	●	●	○
Antistatic properties	○	○	●	●	○	●	○	○
UV resistance	●	●	●	●	●	●	●	●
Service temp. °C continuous	-250...80	-250...110	-250...80	-250...80	-250...80	-150...80	-250...80	-40...60
Service temp. °C briefly	-250...130	-250...190	-250...130	-250...130	-250...130	-250...130	-250...130	-50...80

Sheet sizes

Sheet sizes

Matrox® is available in the following sheet sizes:

Dimensions	Typical thicknesses*
2000 x 1000 mm	6 – 20 mm
3000 x 1250 mm	
4000 x 2000 mm	
6000 x 1000 mm	
6000 x 2000 mm	
6000 x 2500 mm (MegaSheet)	

* If required, also available in thicknesses from 1 to 200 mm.

MegaSheet

MegaSheet is a sheet format especially developed for the lining technology. These sheets are produced in a unique process and have the largest size currently available. The MegaSheets can be utilized either in full size or cut pieces. The large size sheet dimensions allow for fewer seams and more efficient yield.

Benefits of using MegaSheet

- Size 6,000 x 2,500 mm (20 ft. x 8 ft.)
- Elimination of cost effective processing-steps
- Waste-reduction (better yields)
- Significant cost advantages for the customer

Matrox® coils

Matrox® coils

Matrox® can also be supplied in rolls. The roll can be cut to specification and offers cost advantages such as:

- easy installation
- less welding work
- fewer fixing elements.

Better unloading

With Matrox® coils it is possible to line virtually any dump truck quickly and easily. The material is available in thicknesses from 6.3 to 15 mm, in widths of up to 5 metres and lengths up to 14.6 metres and is delivered on a pallet.

The caking of material, especially with older or worn truck beds makes unloading more time-consuming. It may also be more dangerous if the

load does not move until the tipping angle is very high and slips out of the bed suddenly and rapidly. Lining with Matrox® ensures reliable and even mass flow. In this way, the load can slide off the bed at a low tipping angle without leaving any significant residue. This shortens the time required and makes the process safer.



Matrox® coils:
Ideal for lining dump-truck beds

Understanding flow problems

Cohesive bulk materials do not flow easily e.g. in chutes and hoppers. They stick to the walls and will affect productivity. This is a common problem because most bins were designed without a thorough knowledge of the bulk material being handled. Moisture, storage time at rest and other factors affect the flow properties of the bulk material.

Arching and ratholes are two common problems that usually develop when either the outlet is too small or when the hopper lining material does not promote flow due to shallow wall angles or rough wall conditions caused by corrosion.

Segregation will occur if material discharges from the bin in a funnel flow pattern. The center portion of the bin empties first, followed by the material along the walls. This creates segregation because as the bin was loaded the finer particles collect in the center of the bin under the charging point while the coarse particles roll to the periphery of the bin along the walls. In order to remix the material during discharge a mass flow pattern is required to minimize or eliminate segregation.

Matrox® reduces the friction between the bulk material and the walls of the hopper and thus allows the material to flow out and to empty the hopper completely.

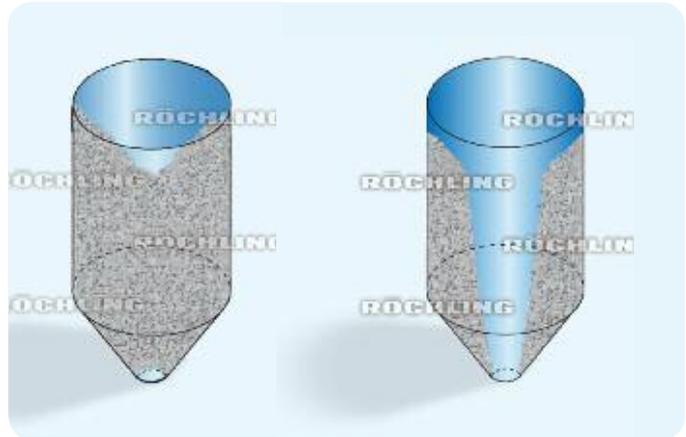
Results of flow problems

- Delayed start-up - increased cost
- Limited live storage
- Spontaneous combustion (stagnant coal)
- Quality compromised
- Segregation
- Silo vibrating or shaking
- Silo structural failure
- Wear of equipment
- Process out-of control
- Operator intervention

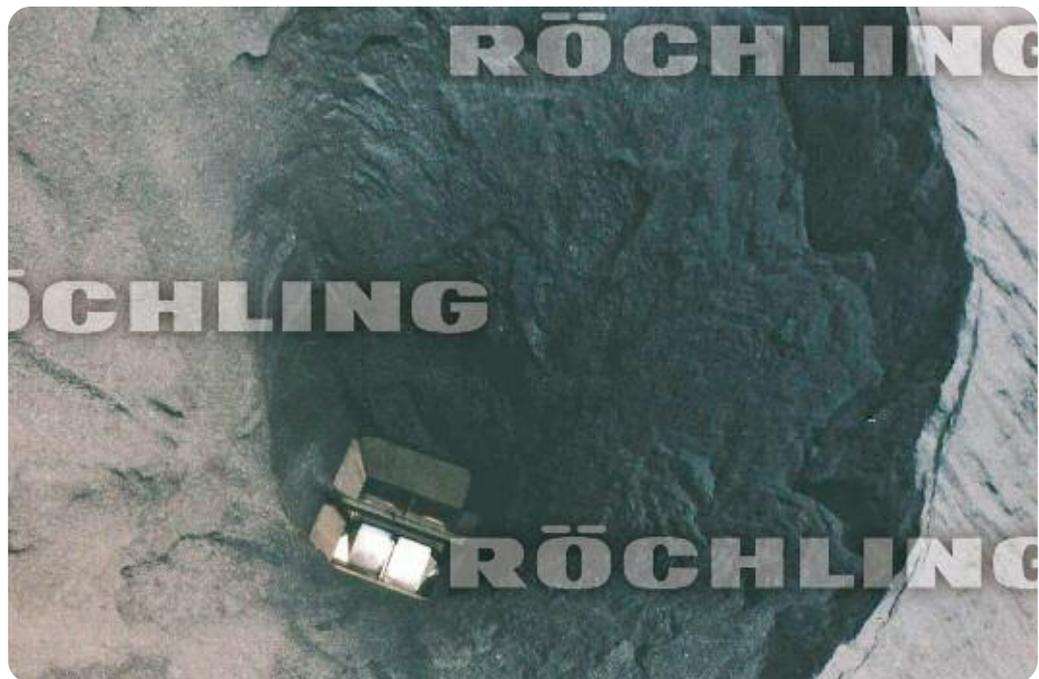
Typical flow patterns

Funnel flow is referred to as first-in last-out and is ideal for free flowing bulk materials. The bulk material discharges from the bin through a small channel in the centre of the bin above the outlet and the material along the wall remains stationary until the end.

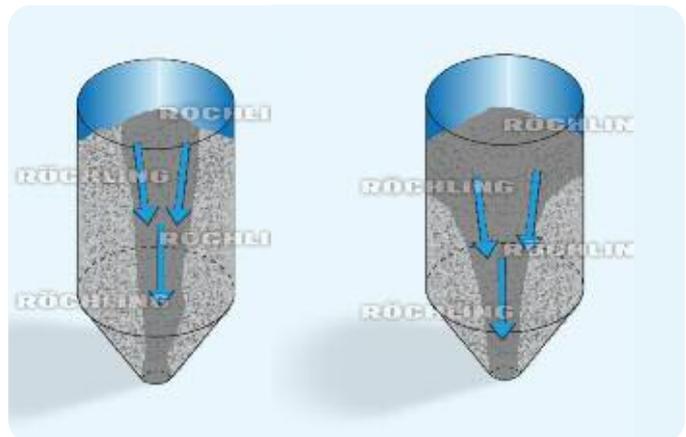
Mass flow is referred to as first-in first-out and is required for cohesive bulk materials. It is defined as all the material is in motion whenever any is withdrawn.



Typical problems: Arches (left) and Ratholes (right) occur when the lining material does not promote the bulk material flow



Rathole: The centre portion of the bin empties first in the form of a funnel (Photo Courtesy of Solids Handling Technologies, Inc.)

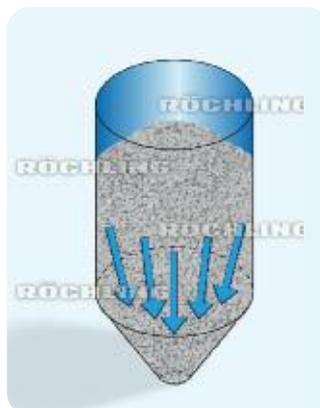


Funnel Flow: The flowing material (dark grey) is forming a funnel, while the rest (grey) is sticking to the walls of the bin

Matrox® was tested against various grades of coal with different moisture contents and time at rest (>72 h). The wall angles required to achieve mass flow vary according to the surface friction of the lining material on the hopper wall.

In order to create mass flow, the hopper walls must be smooth and steep enough and the outlet must be large enough to prevent arching. Please note the different wall angles required to create mass flow in the following chart.

The following chart shows the different wall angles required to create an optimised mass flow for different lining materials.



Mass Flow: All the material is in motion when any is withdrawn

Recommended cone wall angles to achieve maximum mass flow for different wall materials

Bulk material	Diameter of cone outlet	Flow rate	Wall material		
			Matrox®	Stainless Steel acc. DIN 1.4301	UHMW-PE
PRB Coal with 29 % moisture	2 ft. (610 mm)	continuous	56°	81°	62°
		after 3 days rest	60°	81°	63°
	8 ft. (2,440 mm)	continuous	55°	78°	60°
		after 3 days rest	59°	78°	62°
PRB Coal with 36 % moisture	2 ft. (610 mm)	continuous	59°	88°	64°
		after 3 days rest	65°	90°	68°
	8 ft. (2,440 mm)	continuous	57°	76°	58°
		after 3 days rest	62°	78°	63°

Summary of wall friction test results from Jenike & Johanson, Inc., PRB is a sub-bituminous coal mined in the USA, Degrees measured from horizontal

Estimated Wear Life

The following chart shows the estimated life expectancy of a 1/2" (12,7 mm) thick Matrox® liner in a mass flow circular bin having the following dimensions:

- total silo height is 65 ft. (1,981.2 cm),
- hopper section has a 25 ft. (762.0 cm) vertical height
- 25 ft diameter with a 2 ft. (60.96 cm) diameter outlet.

Coal handled	Estimated life of 1/2" (12,7 mm) thick Matrox® liner in years
Bituminous	> 17
Sub-Bituminous (PRB)	> 35
Lignite	> 50

Fixing systems

Matrox® is installed by mechanically fastening it to the substrate using bolted or welded fasteners. Both types are acceptable and are usually chosen based on the requirements of the application and the structure being lined.

Fixing system: Stud welding

In order to fix linings in position, the sheet is always pre-drilled at the fixing points using a special drill. The distance between the individual fixing points depends on the geometry and the material of the container being lined, the operating conditions and the type of fixing process selected.

When the sheets are bolted into position with bolts and disk nuts, we recommend a distance of 150-200 mm. The distance between the holes and the edge of the sheet should not exceed 20-30 mm.

When the pre-drilled lining sheet is positioned in the container it is used as a template for welding.

For stud welding, a threaded bolt is welded through a hole in the sheet to the metal surface below. A hexagon nut or an anti-loosening disk nut is then screwed onto the bolt.

For lining purposes, nuts and threaded bolts of the size M10 have proved to be most suitable. We supply these in various lengths. For simpler installation on uneven surfaces, we have special threaded bolts with pre-determined breaking points.

Advantages:

- Easy removal of the sheets

Ideal applications

- For thicker sheets

Equipment required

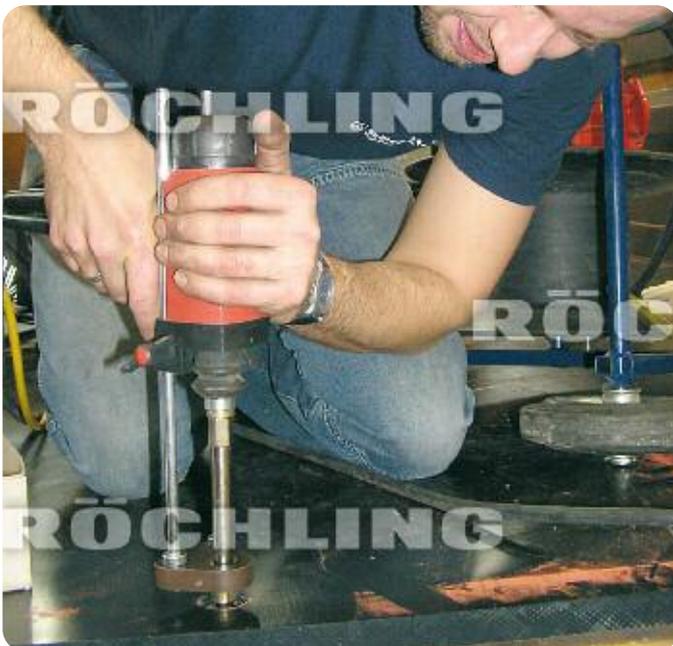
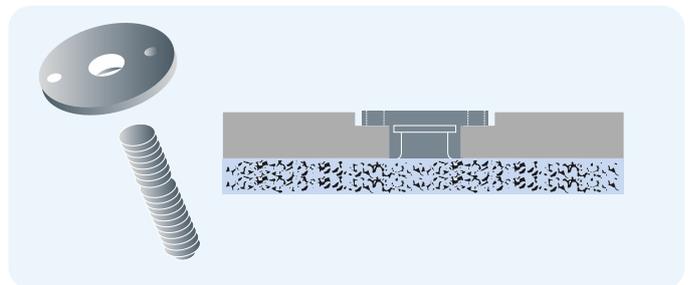
- Suitable graduated drill
- Stud-welding unit
- Threaded bolts (if necessary with pre-determined breaking point)
- Disk nuts
- Fixing tool for tightening the disk nuts.

A bolt-firing tool can also be used to mount the lining sheets.

Röchling is associated with qualified installers around the world that understand the complex field of bulk material handling. Proper installation by a qualified distributor or installer is critical to the life expectancy of the liner.



Stud-welding process: lining a hopper



Fixing system
Stud weld

Strong fixing: the stud is welded to the base through the pre-drilled sheet

Fixing system:

Weld washer

With the so-called "weld-washer" fixing system, a plate-shaped pre-stamped metal disk is welded directly to the base through the hole in the sheet. Only one operation is necessary. This fixing system can be used for sheet thicknesses of up to 15 mm. An even lining surface is then created by covering the weld washers with matching Matrox® plastic caps.

Advantages:

- Quick and easy installation
- Cover caps prevent accumulation of bulk material at the fixing points

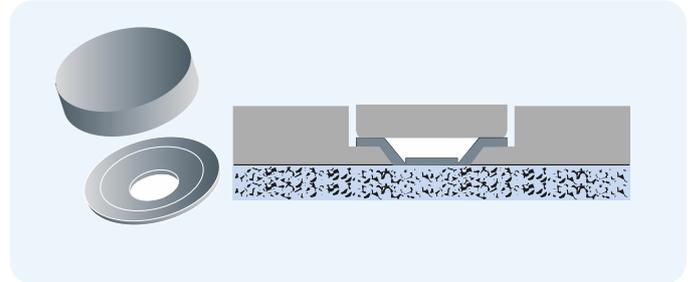
Ideal applications:

- Simplest system for mounting thin lining sheets

Equipment required

- Weld washers
- Suitable graduated drill
- Welding unit (cover gas or electric welding unit)
- Matrox® cover caps

In addition to the systems described above, alternative methods are also available on request. We would be pleased to advise you.



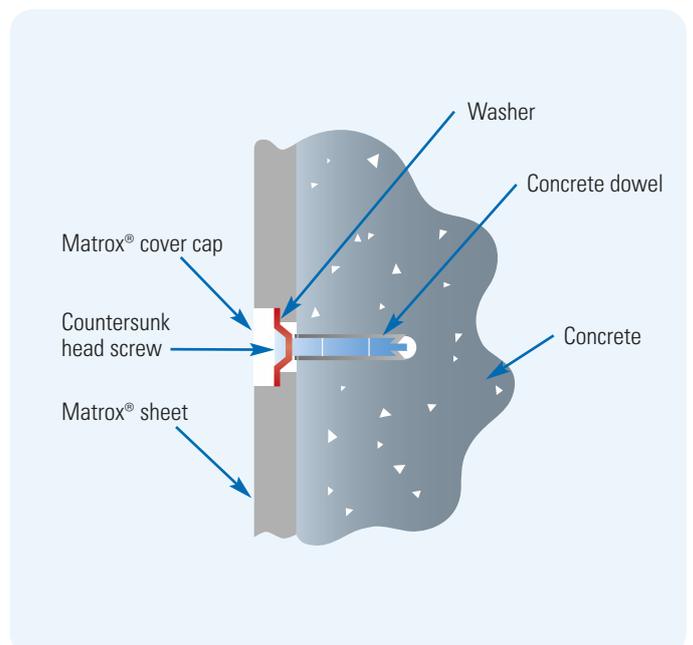
Fixing system:
Weld washer

Fixing to concrete

A system consisting of washers, countersunk head screws, concrete dowels and Matrox® cover caps is particularly suitable for attaching Matrox® sheets to concrete walls or masonry.

This system creates tolerance spaces which help to prevent the formation of bulges at high temperatures. To prevent material from penetrating under the sheet, the sheet is sealed by means of a cap. The benefits of this process are simple attachment of the sheet and excellent durability.

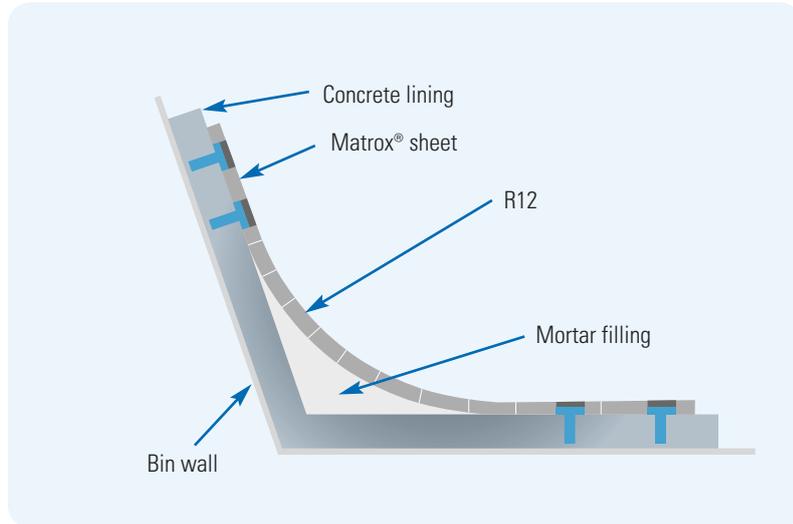
Fixing to
concrete



Fixing a hopper lining

With hopper linings, corners and sharp angles often cause undesirable accumulations of bulk material. For this reason, the lining sheet should, if possible, be curved in corner areas. Depending on the thickness, it may be necessary to use a hot-air blower or a rolling unit to achieve the desired curve.

The cavity thus created behind the sheet is then filled with a polymer (epoxy-resin) mortar. Countersunk screws and expansion dowels are used to fix the lining sheet into position.

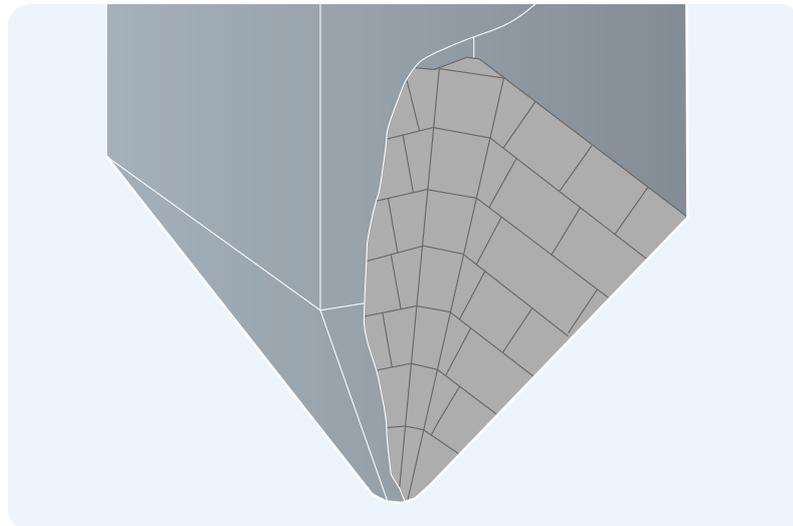


Fastening of hopper lining

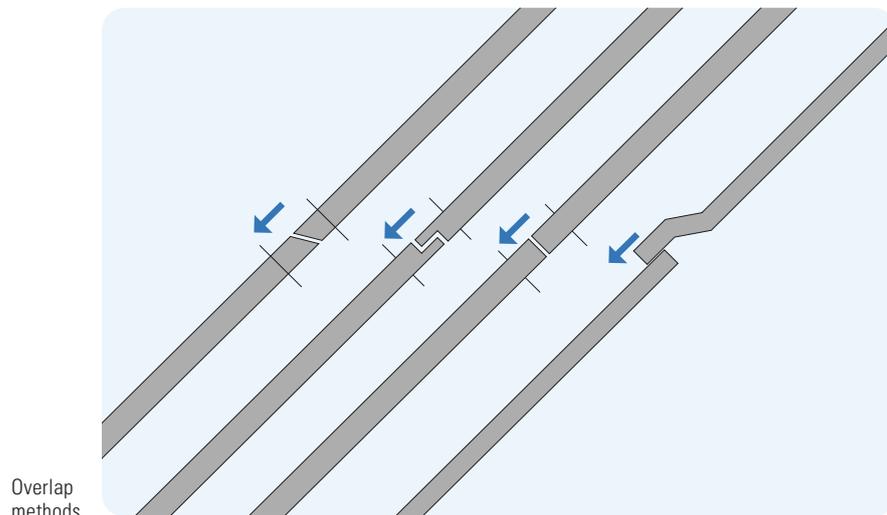
Laying technique

When lining hoppers and bins, the liner sheets are laid horizontally starting at the bottom and working upwards. We recommend offsetting the vertical joints of the sheets. Depending on the type of bulk solid in question, it may be necessary to improve the material flow by overlapping the lining sheets. This also prevents fine-grained material from working its way under the lining.

The diagram shows the methods which can be used for the overlap. The direction of flow is indicated by the arrow. Alternatively, the joints may be sealed with a special extrusion welding device.



The sheets are laid horizontally from bottom to top in the offset position



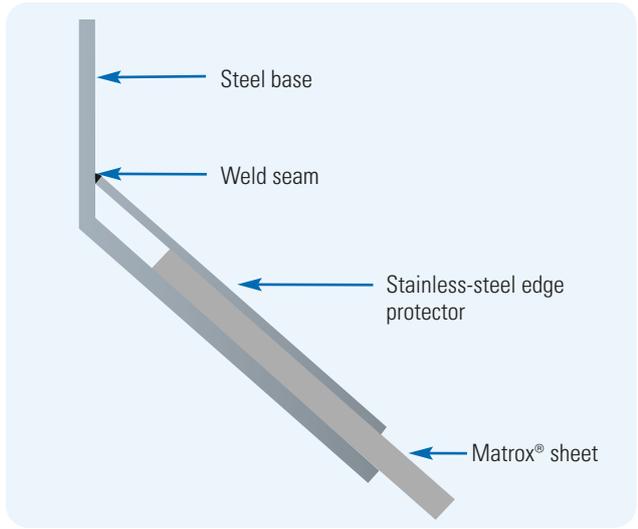
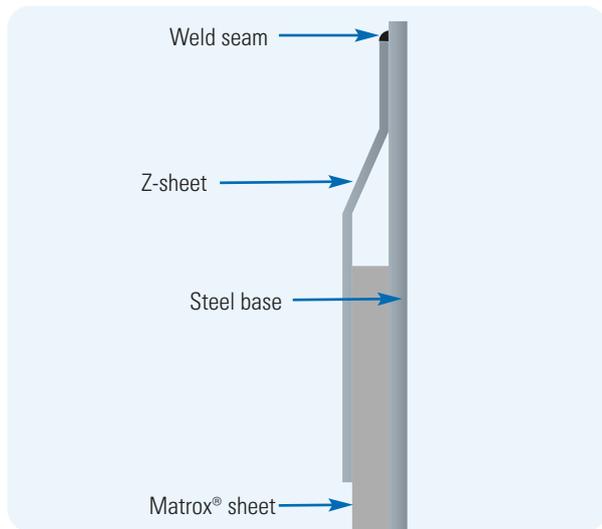
Overlap methods

Edge protection

When installing all types of lining, the top row of sheets must be protected by a sealing strip to prevent material from working its way under the sheets. The strips may be of aluminium (truck bed) or steel plates as required.

When fixing the strips, ensure that the material can expand and contract freely due to thermal effects.

Edge strips prevent penetration of material beneath the liner sheet



Lining is a matter of experience

The choice of lining material depends on a number of factors such as the type of bulk solid, the geometry of the object being lined as well as other factors affecting the flow of material and amount of wear. Röchling Engineering Plastics has a wealth of experience in lining technology

Truck-bed linings

Depending on their shape, truck beds have number of different problem areas. Material sticks in the corners, the flow is impeded and the bed is exposed to additional wear. Depending on the design of the bed, the shape, grain-size, moisture content and temperature of the bulk solid, we recommend the following products:

Matrox®
Matrox® U 110
Matrox® EX 60
Matrox® X

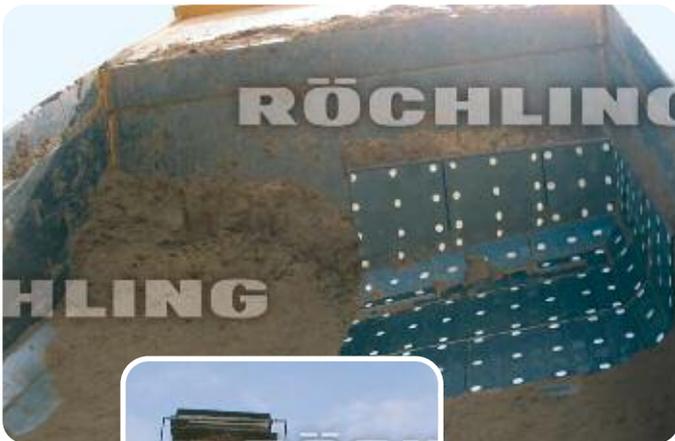
For applications involving heavy impact stresses, we can also supply a combination of the above Matrox® types and polyurethane.

going back over 40 years. This experience is at your service. We can advise you on the right type of lining material and fixing technology for your application. Our priorities are the durability and efficiency of the lining.



Professional lining:
 Z-sheets attached to the truck bed prevent material from drifting under the lining sheet

Comparison between Matrox® and steel. The material adheres to large areas of the unlined steel surface. The area lined with Matrox® is almost completely free



Strongly anchored:
 Installation of Matrox® sheets in a funnel-shaped dump truck using the stud-welding process

Mining vehicle. Matrox® X-lined truck bed for ore transport in Australia



Hopper and silo lining

One of the main challenges in lining hoppers and silos is the high amount of wear caused by the impact of material falling from a height. The funnel-shaped outlet causes problems with regard to core and mass flow. Special safety regulations or, for example, the handling of foodstuffs, create additional demands.

We recommend:

Matrox® EX 60
Matrox® SE
Matrox® SI 12
Matrox® FC

Here too we can supply combinations of Matrox® and polyurethane for applications involving high impact stresses.

Emptying a bin:
The Matrox® lining of the bin ensures even and undisrupted loading of the bulk material



View into a hopper from below. With large-grained bulk goods, which may cause serious localised wear, lining the exposed parts with Matrox® may considerably prolong the life span of the hopper



Hopper lining with weld washers.
The distribution of fixing points can be clearly seen



Coal hopper in a power station lined with Matrox® EX 60. Operating reliability and undisrupted infeed of raw material are essential in the power industry

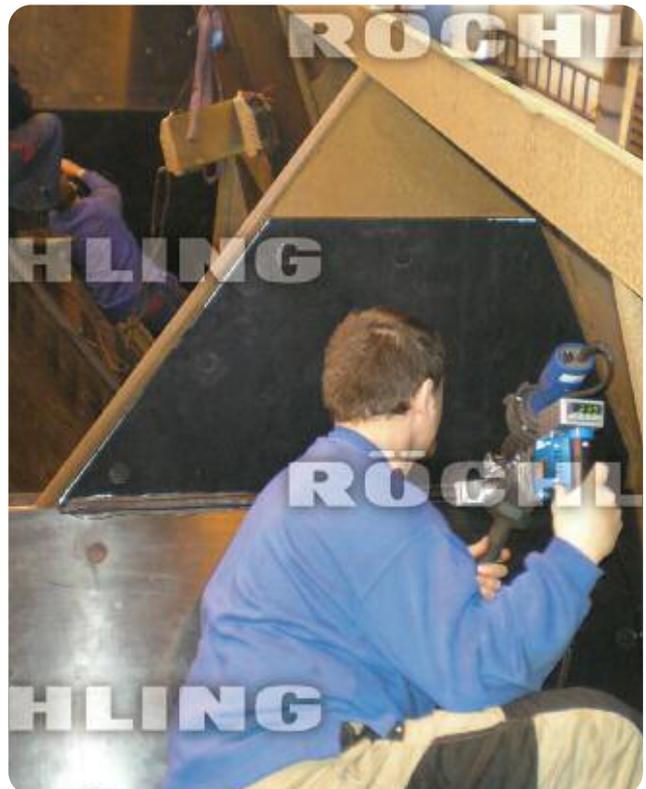
Wagon lining

The universal use of goods wagons for all kinds of bulk solids requires a fine balance between protection from abrasion and low friction to promote flow. For hopper, cradle or standard-type wagons we recommend the use of **Matrox® SI 12**. For some types of bulk goods, special linings may be necessary. We would be pleased to advise you.

Universal in application: Because of their various fields of use, the lining of goods wagons must be suitable for all types of material



Wagon lining with Matrox® SI 12:
The clean and easy emptying of each wagon ensures rapid unloading of entire goods trains



Welding work for lining a goods wagon. The Matrox® lining is welded at the angled edges of the joints to prevent material collecting in the corners

In addition to high-quality lining sheets, Röchling Engineering Plastics also supplies fastening systems for permanent installation as well as the required advisory and support services.



Expertise on site: Our experienced installation partners are at your service

We supply your system solution, consisting of:

- The optimum lining materials for the specific requirements
- Sheets cut to size
- Fastening materials such as bolts, nuts, drills, cover caps, and (on hire) stud-welding equipment

Our experienced installation partners are at your service on site worldwide.

In our development and training centre in Haren, Germany, we also organise workshops for our customer's employees to familiarise them with all aspects of lining technology, including different welding techniques and fastening systems.



Theory and practice:
At the Röchling training centre, our customers learn the fundamentals of lining technology



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