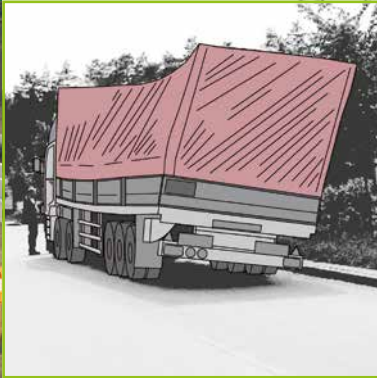
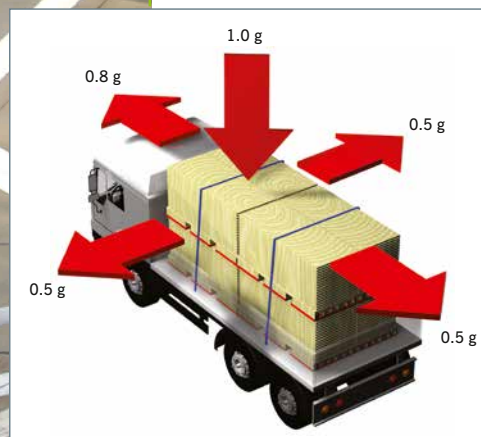


Regupol®



Anti-Slip Mats

Perfect for securing loads in trucks, rail wagons, ships and planes.



Regupol® 7210 LS plus

Regupol® 7210 LS plus is BSW's best-selling anti-slip mat. Offering good value for money, it is suitable for most average transports. **Regupol® 7210 LS plus** has proven its worth for many years and is used as the standard friction-increasing surface by many transport companies and shipping agents today.

Maximum loading

250 t/m² = 2.50 N/mm² when 8 mm thick

Sliding friction coefficient

Sheet 15 of Directive VDI 2700, defines the minimum requirements for anti-slip mats' friction coefficients. The **Regupol® Anti-Slip Mats** easily exceed these minimum requirements by 15-50 % depending on the friction elements. Because the given circumstances are hard to calculate in practice (moisture, soiled load floor), a value of 0.6 μ should be the base for calculations (which is also recommended by sheet 15 of VDI 2700).

In addition, the behaviour of **Regupol®** has been measured under paper coils in a road test and has been certified by DE-KRA. Result: **Regupol®** is suitable as a component in the load securing variation described in VDI 2700 page 9.

BSW does not publish any generalised uncommented sliding friction coefficients. The sliding friction coefficient of a friction-increasing surface depends on the combination of materials involved, the temperature, the condition of the material surfaces and the anti-slip mat (soiling, moisture, etc.). The contact surfaces of load and floor must be swept clean, grease-free and dry to achieve optimum anti-slip properties.

Material

anti-slip mat based on SBR/NBR

Colour

black with green, light green and yellow colour particles

Surface weight

approx. 6.88 kg/m² when 8 mm thick

Bulk density

approx. 860 kg/m³

Tensile strength

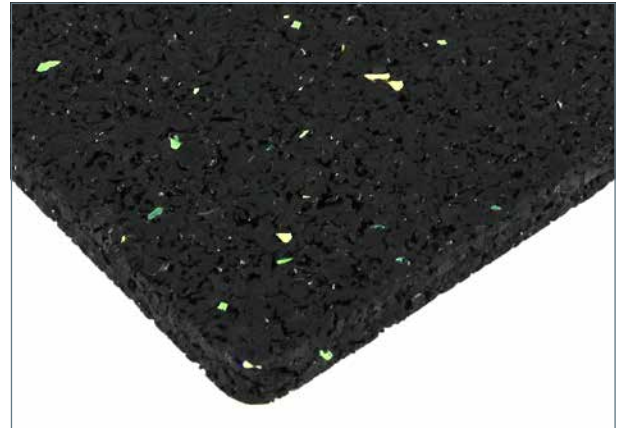
at least 0.60 N/mm² in accordance with DIN EN ISO 1798

Elongation at break

at least 60% in accordance with DIN EN ISO 1798

Temperature resistance

-40 °C to +120 °C



The green/light green/yellow colour marking is the distinguishing feature of the original **Regupol® 7210 LS plus** Anti-Slip Mat.

Discard status

Cracks, holes, crushing, after contact with oil, fuel, chemicals, etc. **Regupol® 7210 LS plus** Anti-Slip Mats are suitable for repeated use through to discard status pursuant to testing by VDZ Dortmund.

Resistance

UV light, sodium chloride, weak acids and alkaline solutions (swells up when exposed to hydrocarbons such as oil, fuel, etc.)

Cleaning

Shaking out, vacuuming, washing, possibly treating with a high-pressure cleaner

Disposal

Considering local regulations, can be deposited with domestic waste as per waste code 070299 according to European Waste Catalogue (EWC).

Delivery form

rolls, sheets, cuttings on request

Thicknesses

3 – 20 mm

On our website www.regupol-load-securing.com you will find anti-slip mats in sizes that BSW keeps in stock for quick delivery. These are cuttings from the anti-slip mat **Regupol® 7210 LS plus**.

Regupol® 9510 RHS plus

Regupol® 9510 RHS plus can take higher loads than **Regupol® 7012 LS plus**. The maximum loading is 3.0 N/mm². It is used in many areas where conventional anti-slip mats based on SBR/NBR are not appropriate because of possible black discolouring.

Maximum loading

300 t/m² = 3.0 N/mm² when 8 mm thick

Sliding friction coefficient

Sheet 15 of Directive VDI 2700, define the minimum requirements for anti-slip mats' friction coefficients. The **Regupol® Anti-Slip Mats** easily exceed these minimum requirements by 15-50 % depending on the friction elements. Because the given circumstances are hard to calculate in practice (moisture, soiled load floor), a value of 0.6 μ should be the base for calculations (which is also recommended by sheet 15 of VDI 2700).

In addition, the behaviour of **Regupol®** has been measured under paper coils in a road test and has been certified by DE-KRA. Result: **Regupol®** is suitable as a component in the load securing variation described in VDI 2700 page 9.

BSW does not publish any generalised uncommented sliding friction coefficients. The sliding friction coefficient of a friction-increasing surface depends on the combination of materials involved, the temperature, the condition of the material surfaces and the anti-slip mat (soiling, moisture, etc.). The contact surfaces of load and floor must be swept clean, grease-free and dry to achieve optimum anti-slip properties.

Material

anti-slip mat made of butyl rubber

Colour

multi-coloured

Surface weight

approx. 8.4 kg/m² when 8 mm thick

Bulk density

approx. 1,050 kg/m³

Tensile strength

at least 0.60 N/mm² in accordance with DIN EN ISO 1798

Elongation at break

at least 60% in accordance with DIN EN ISO 1798

Temperature resistance

-40 °C to +120 °C



The **Regupol® 9510 RHS plus** Anti-Slip Mat is made from butyl rubber.

Discard status

Cracks, holes, crushing, after contact with oil, fuel, chemicals, etc. **Regupol® 9510 RHS plus** Anti-Slip Mats are suitable for repeated use through to discard status pursuant to testing by VDZ Dortmund.

Resistance

UV light, sodium chloride, weak acids and alkaline solutions (swells up when exposed to hydrocarbons such as oil, fuel, etc.)

Cleaning

Shaking out, vacuuming, washing, possibly treating with a high-pressure cleaner

Disposal

Considering local regulations, can be deposited with domestic waste as per waste code 070299 according to European Waste Catalogue (EWC).

Delivery form

rolls, sheets, cuttings on request

Thicknesses

3 – 12 mm

Regupol® 1000 LSE

Regupol® 1000 LSE is a premium product. The anti-slip mat is suitable for loading of up to 6.30 N/mm² and thus for heavy transports. In a widespread trial, the winter suitability of various anti-slip mats was tested by the TUL-LOG Institute Dresden in the BASt Federal Highway Research Institute.

Together with just one other mat, **Regupol® 1000 LSE** achieved sliding friction coefficients under winter conditions of more than 0.6 μ , while being exposed to a sodium chloride brine to simulate melted snow and ice contaminated with gritting salt, at a temperature of -15°C. This result means that **Regupol® 1000 LSE** is probably the only anti-slip mat that is suitable for all kinds of transport right through to heavy loads under winter conditions.

Maximum loading

630 t/m² = 6.30 N/mm² when 8 mm thick

Sliding friction coefficient

Sheet 15 of Directive VDI 2700, define the minimum requirements for anti-slip mats' friction coefficients. The **Regupol® Anti-Slip Mats** easily exceed these minimum requirements by 15-50 % depending on the friction elements. Because the given circumstances are hard to calculate in practice (moisture, soiled load floor), a value of 0.6 μ should be the base for calculations (which is also recommended by sheet 15 of VDI 2700).

BSW does not publish any generalised uncommented sliding friction coefficients. The sliding friction coefficient of a friction-increasing surface depends on the combination of materials involved, the temperature, the condition of the material surfaces and the anti-slip mat (soiling, moisture, etc.). The contact surfaces of load and floor must be swept clean, grease-free and dry to achieve optimum anti-slip properties.

Material

anti-slip mat based on SBR/NBR

Colour

black with red particles

Surface weight

approx. 7.8 kg/m² when 8 mm thick

Bulk density

approx. 983 kg/m³

Tensile strength

at least 0.60 N/mm² in accordance with DIN EN ISO 1798

Elongation at break

at least 60% in accordance with DIN EN ISO 1798



The red colour marking is the distinguishing feature of the original **Regupol® 1000 LSE** Anti-Slip Mat.

Temperature resistance

-40°C to +120 °C

Discard status

Cracks, holes, crushing, after contact with oil, fuel, chemicals, etc. **Regupol® 1000 LSE** Anti-Slip Mats are suitable for repeated use through to discard status pursuant to testing by VDZ Dortmund.

Resistance

UV light, sodium chloride, weak acids and alkaline solutions (swells up when exposed to hydrocarbons such as oil, fuel, etc.)

Cleaning

Shaking out, vacuuming, washing, possibly treating with a high-pressure cleaner

Disposal

Considering local regulations, can be deposited with domestic waste as per waste code 070299 according to European Waste Catalogue (EWC).

Delivery form

rolls, sheets, cuttings on request

Thicknesses

from 8 mm

Regupol® RHM Squared Timber

Regupol® Squared Timbers are friction-increasing surfaces used for securing all kinds of general cargo that cannot be palletised and that are loaded by forklift truck or crane. The squared timbers act as spacers for positioning the forks or crane clamps when loading and unloading. They are fitted with **Regupol® Anti-Slip Mats** on the top and bottom longitudinal side to give them a friction-increasing effect. The **Regupol® Anti-Slip Mats** are firmly joined to the timber to prevent any displacement between mat and timber during loading processes. The squared timbers have a narrow right-angled cross-section to prevent them rolling.

Application

Under precast concrete parts, loose pipes, pipe packages, steel girders, reinforcing steel mesh and other general cargo that cannot be palletised

Maximum loading of Regupol® 7210 LS plus
 $250 \text{ t/m}^2 = 2.50 \text{ N/mm}^2$ when 8 mm thick

Sliding friction coefficient
 see page 3 for **Regupol® 7210 LS plus**.

Material

anti-slip mat based on SBR/NBR

Colour

black with green, light green and yellow colour particles

Weight Regupol® RHM Squared Timber
 approx. 10 kg

Temperature resistance of Regupol® 7210 LS plus
 $-40 \text{ }^\circ\text{C}$ to $+120 \text{ }^\circ\text{C}$

Discard status

Cracks, holes, crushing, after contact with oil, fuel, chemicals, etc. **Regupol® 7210 LS plus** Anti-Slip Mats are suitable for repeated use through to discard status pursuant to testing by VDZ Dortmund.

Resistance

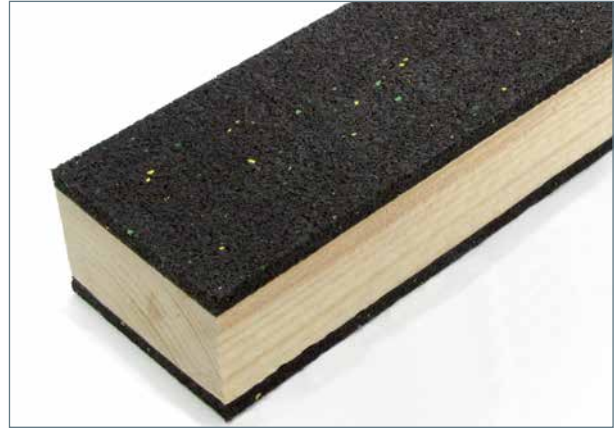
UV light, sodium chloride, weak acids and alkaline solutions (swells up when exposed to hydrocarbons such as oil, fuel, etc.)

Cleaning

Vacuuming, washing, possibly treating with a high-pressure cleaner

Disposal

Considering legal regulations, can be deposited with residual waste as per waste code 200301 according to European Waste Catalogue (EWC) without difficulty.



Delivery form

quantities as required

Thicknesses

Squared timber: 2,380 x 100 x 60 mm

Regupol® Anti-Slip Mat

2,380 x 100 x 8 mm

Other dimensions possible on request

Regupol® Webbing Protectors

Regupol® Webbing Protectors safeguard lashing straps from premature wear and tear caused by sharp edges, and protect breakable loads from damage. **Regupol® Webbing Protectors** ensure that the lashing strap slides across the load on both edges when being lashed and that the lashing capacity of the belt is evenly distributed. Their underside consists of robust, anti-slip **Regupol®** material, and their upper side of a special fabric layer.

Material

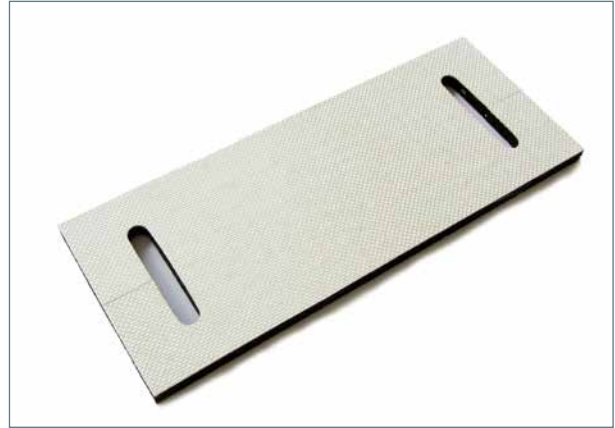
Robust, friction-enhancing and pressure-resistant **Regupol®** anti-slip material with a special fabric on the upper side.

Disposal

Considering legal regulations, can be deposited with residual waste as per waste code 200301 according to European Waste Catalogue (EWC) without difficulty.

Advantages

- Fast, simple fixing
- No threading of the lash required
- Rear side original **Regupol® Anti-Slip Mats**
- Improvement of the transfer coefficient K
- Flexible and optimally adaptable for all lashes



The underside of the **Regupol® Webbing Protectors** consists of robust, anti-slip **Regupol®** material.

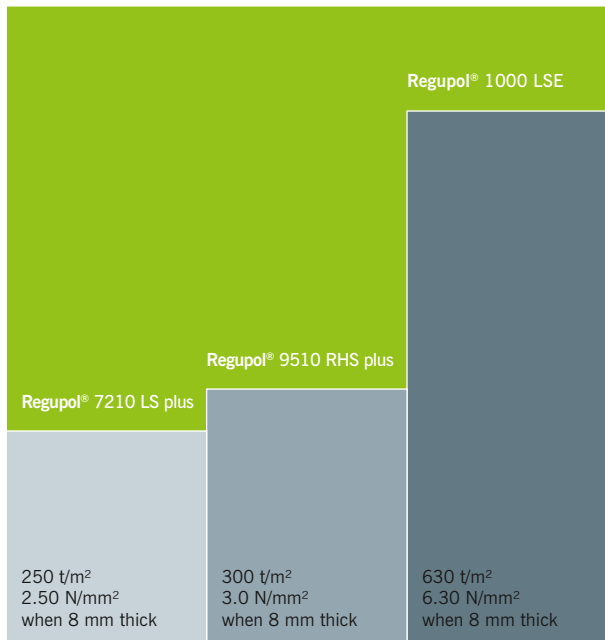


Regupol® Webbing Protectors can be fitted in just a few moves.



Maximum loading

The choice of suitable anti-slip mat depends on the expected maximum loading. This diagram gives an overview of the maximum loading for the three **Regupol®** Anti-Slip Mats.



According to VDI 2700, sheet 15, the maximum loading of anti-slip mats is selected so as not to exceed a deformation of 30% of the material thickness.

Regupol® Anti-Slip Mats are tested by:



TÜV NORD Group (TÜV - technical inspection agency)



Berufsgenossenschaftliches Institut für Arbeitsschutz

Institute for Occupational Safety and Health of the German Social Accident Insurance



Verpackungstechnisches Dienstleistungszentrum



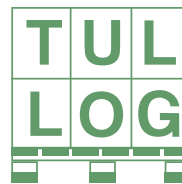
Deutsche Bahn AG

German national railway company



Fraunhofer Institut Materialfluss und Logistik

Fraunhofer Institute for Material Flow and Logistics (IML)



Regupol® easy LaSi Software

Regupol® easy LaSi Software is freely accessible software for calculating loading safety. The new software includes four loading safety methods, for calculating and documenting the result quickly and straightforwardly. The software is free to use and can be accessed via the website: www.regupol-easycargosec.eu. It is not necessary to download the software, the user can enter the data required directly on the interactive website and the result will appear immediately. **Regupol® easy LaSi Software** is currently available in German, English, French, Polish, Czech, Danish, Hungarian and Italian. Further language versions will follow in the future.

The four loading safety measures

Regupol® easy LaSi Software calculates the following safety measures:

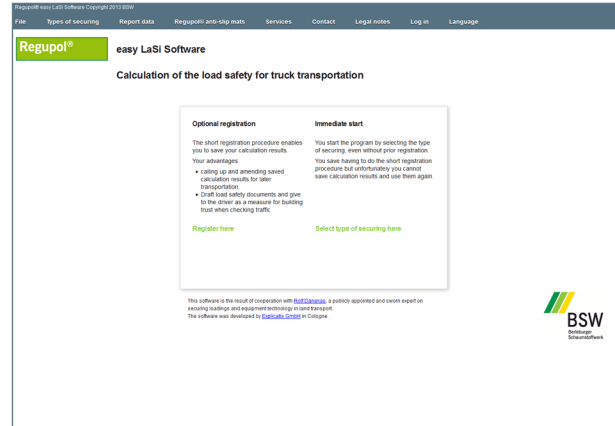
- Lashing down with or without form locking
- Restraint lashings combined with side lashing
- Diagonal lashing
- Transversal lashing

Calculation results

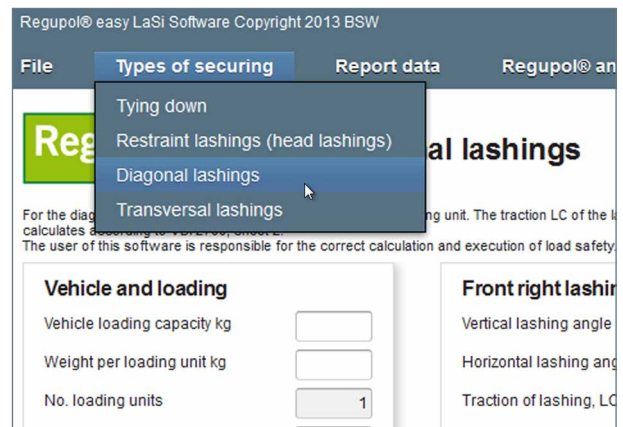
The software either confirms the correctness of the load safety or formulates warning notes and correctional recommendations for inadequate safety measures. The calculation results can be saved and printed out in the form of a report, which serves as working instructions for those responsible for loading safety, and as a back-up document for traffic checks for the driver.

The individual calculation results can be saved, along with the associated report, and can be called up again and quickly updated or modified for the same or similar transports.

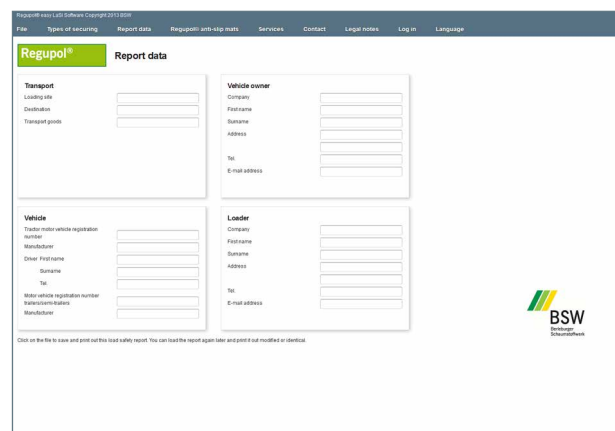
The correctness of the calculated results has been monitored and confirmed by an independent appraiser.



The homepage for **Regupol® easy LaSi Software** is www.regupol-easycargosec.eu. There is no need to download the software.



The four loading safety measures in the software.



The software report data.

Regupol® easy LaSi Card

The **Regupol® easy LaSi card** calculates two methods for securing stable loading units with **Regupol® Anti-Slip Mats**:

- The tie-down lashing procedure
- The diagonal lashing procedure

With just a few manipulations, the number or traction of lashing belts required can be recorded quickly and straightforwardly. Moreover, the **Regupol® easy LaSi** is fitted with a lashing protractor so that it is also easy to identify the angle of the lashing belt. Structured graphs summarising the maximum loading for **Regupol® Anti-Slip Mats** help determine the optimum size and thickness to be applied for the best possible securing of the load. The handy format and simple description means you can take the card with you anywhere and it can be used independently by anyone.



Detailed view of the **Regupol® easy LaSi Card**.

Technical
advice
is free

The card is available
from BSW upon request.

Product pass

On request, BSW sends all customers the Product Passes for **Regupol® Anti-Slip Mats**. They verify that the used anti-slip mats are genuine (colour quality code) and indicate the main technical details. The driver should keep the Product Pass in the vehicle at all times and present it at any traffic checks.

The Product Passes can also be downloaded at our website www.regupol-load-securing.com.

In conjunction with the loading safety reports from **Regupol® easy LaSi Software** available at www.regupol-easycargosec.eu, any driver whose load is secured using **Regupol® Anti-Slip Mats**, has the documents to prove that all necessary securing measures have been met.

Regupol® Anti-Slip Mats

Product Information

Quality Label: Regupol® Anti-Slip Mats are colour coded. The

Regupol® 7210 LS plus	Regupol® 9510 R45 plus	Regupol® 1000 LSE Heavy Duty Mat	
Product Photos			
Maximum Loading	300 t/m² = 3,00 N/m² at 8 mm thickness	4,50 t/m² = 4,50 N/m² at 8 mm thickness	
Colours	black with dark green, light green and yellow particles, highly protected colour loading	multicoloured	black with orange particles
Friction Coefficient	Based on 11 control and 8 years experience (DIN EN ISO 22033) with the minimum requirement for a value of 0,75. The Regupol® Anti-Slip Mats exceed these requirements by 11,5% (slip-resistance of the friction surface). Because the same circumstances are not to be used for permanent operation, check the floor, a value of 0,75 is required for the only calculation which is also recommended by DIN 113 of VDI 2232.		
Weight per m²	approx. 6,80 kg/m²	approx. 8,40 kg/m²	approx. 7,80 kg/m²
End of Service Life	Check the anti-slip mats before using and after being used for visible defects. They should be discarded in the case of the following defects: non-compliance in per cent 10 of thickness ISO 22033. Check the uniform distribution of pressure marks, holes in the material, cracked state. Damage due to contact with aggressive substances, contamination in other vehicles or by road debris.		
Resistance	UV, sodium chloride, weak acids and bases (resisting in hydrochloric acid, NaOH, etc.)		
Cleaning	Shaking out, vacuuming, washing off, treatment with a high-pressure cleaner if necessary		
Disposal	Considering local regulations, can be disposed with domestic waste on per waste code 070299 according to European Waste Catalogue (EWC)		

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Phone + 49 2751 803-0 • www.berleburger.com

Usage instructions

BSW provides all customers with instructions for the correct use of **Regupol® Anti-Slip Mats**. Besides important general notes, they describe which criteria and measures are to be considered when selecting and using **Regupol® Anti-Slip Mats**. It also provides information on care and cleaning as well as technical data. You will find detailed usage instructions available to download on our website: www.regupol-load-securing.com

Regupol® Anti-Slip Mats

4. Important technical data

The maximum loads for **Regupol® Anti-Slip Mats** are defined by the requirement that the load does not lead to a distortion of the mat greater than 30%.

Conversion from Newtons to kg per unit of area
1.00 N/m² = 0,102 kg/m²
10.00 N/m² = 1,020 kg/m²
100.00 N/m² = 10,200 kg/m²

The most important technical characteristics of **Regupol® Anti-Slip Mats** considerably exceed the minimum requirements according to VDI 2202, page 19. These requirements are:

- Elongation at break 60%
- Minimum tensile strength $\sigma_{0.6}$ 0,6 N/m²
- Sliding friction coefficient approximately 0,7 depending on substrate

Further characteristics are:

- temperature resistance -40°C up to +120°C
- UV light resistance
- Resistance to sodium chloride
- Resistance to weak acids and alkalis

AMW user instructions, version 1, release 04 2014, page 2 of 2

Regupol® User instructions

Regupol® Anti-Slip Mats

1. General notes

The correct technical term for anti-slip mats is "slip-resistant matting". This term means that the material is capable of completely prevent the load from slipping, but can only inhibit such movements. Slip-resistant material is classified as a so-called load-securing aid.

A basic prerequisite for laying **Regupol® Anti-Slip Mats** is a clean, wet and dry laying area. **Regupol® Anti-Slip Mats** have a defined proportion of hollow space. This gives them a significant advantage over anti-slip mats with closed, foil-like surfaces, as they only absorb small amounts of dirt. However, a contaminated loading surface can weaken the slip-inhibiting characteristics.

The load-securing measures should only be planned and carried out by qualified persons. The basis should first be a load distribution plan taking into account the weight and centre of gravity of the load, its supporting surface and surface pressures as well as the dimensions of the anti-slip mats, etc. The sliding friction coefficient of the Anti-Slip Mats is usually calculated as a maximum of 0,6, even if it is higher with many mats.

Furthermore, when planning load securing, the most suitable backup method must be determined. Detailed help on calculating load-securing measures is offered by the software that is available at:

www.regupol-easy-lasi.de

It can be customised for every type of transport to assist in producing a load safety report that can be given to the driver and which documents the technical correctness of securing the load or traffic checks.

2. Applications for Regupol® Anti-Slip Mats

Select the size of the **Regupol® Anti-Slip Mats** so that they are still fully usable. A minimum of 10 mm protrusion on each side is recommended. This makes checking easier and ensures that the load for which it is being used can be pressed more safely into the anti-slip mat.

Important: Measure the **Regupol® Anti-Slip Mat** to ensure the load does not have any contact with the loading area (no direct friction). The aim should be designed to ensure that there is a maximum of 30% distortion under a load

Their thickness is still 70% of their original. Please note the details of maximum loads for **Regupol® Anti-Slip Mats** (see page 2).

The load should never be secured using anti-slip mats only, as there may be a risk of tipping. Additional measures, i.e. usually securing with lashings, must ensure there is contact with the friction partner - loading area, anti-slip mats - in any and all driving circumstances, i.e. braking, swerving manoeuvres or vertical loading movements.

Check whether there are already defects in anti-slip mats that have already been used before laying. These include, in particular:

- Tears
- Remaining deformities or pressure marks
- Areas of material that have coarsened
- Severely worn areas
- Damage due to contact with aggressive substances
- Brittleness
- Contamination that affects the mats working

Where there is contact with sodium chloride or weak acids and alkalis, the **Regupol® Anti-Slip Mats** should be cleaned prior to re-use by rinsing with water, and checked for damage.

Which **Regupol® Anti-Slip Mat** for which type of transport?

- Regupol® 7210 LS plus** for all current types of transport
- Regupol® 9510 R45 plus** for all transport goods that are susceptible to discolouration
- Regupol® 1000 LSE** heavy transport, open transport and open heavy transport when there is frost

3. Cleaning and removal

Regupol® Anti-Slip Mats should be cleaned by shaking out, vacuuming, washing or possibly by using a high-pressure cleaner.

Regupol® Anti-Slip Mats can be disposed of with household waste without any problem, according to waste code no. 070299 based on EAW, taking account of local provisions.

AMW user instructions, version 1, release 04 2014, page 1 of 2

Training documents

BSW provides information folders with training documents for driving schools and training courses:

- easy LaSi card
- Loading safety manual
- Various product samples
- Product information
- Business cards



Training documents for driving schools.

Loading recommendation

On the website www.regupol-load-securing.com BSW offers downloads of the four loading recommendations for the following products:

- Loading recommendation for standing paper rolls
- Loading recommendation for steel pipes and rods
- Loading recommendations for coils or split strips on pallets or free-standing
- Loading recommendation for coils or composites in a coil trough

These recommendations on various types of loading describe, for example, the requirements regarding vehicle and loading surface for loading safety, the frictional force, etc. Images, illustrations and calculation examples convey further information.

Regupol®
Anti-Slip Mats

Loading recommendations for paper coils standing upright

Requirements for vehicle and floor

Depending on the specific cargo, the right vehicle has to be used with a corresponding superstructure and devices for securing the load. The floor must be swept clean and as dry as possible. The load rating of the cargo floor must be sufficient and, as necessary, proven.

Lashing points for securing the load

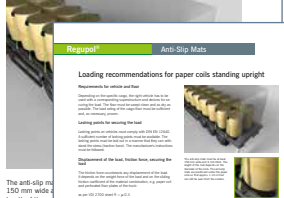
Lashing points on vehicles must comply with DIN EN 12640. A sufficient number of lashing points must be available. The lashing points must be laid out in a manner that they can withstand the stress (traction force). The manufacturer's instructions must be followed.

Displacement of the load, friction force, securing the load

The friction force counteracts any displacement of the load. It depends on the weight force of the load and on the sliding friction coefficient of the material combination, e.g. paper coil and perforated floor plates of the truck.

as per VDI 2700 sheet 9 = $\mu = 0.3$

Standing paper coils are usually loaded with a positive fit up against the front end wall. Lashing straps are also used and



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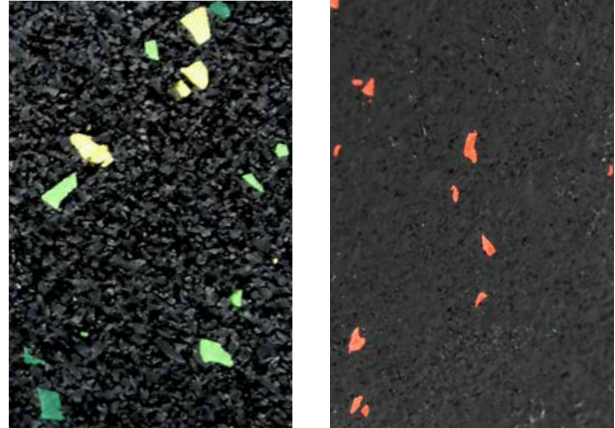
as per VDI 2700 sheet 9 = $\mu = 0.3$

Standing paper coils are usually loaded with a positive fit up against the front end wall. Lashing straps are also used and

Loading recommendation for standing paper rolls.

Quality features

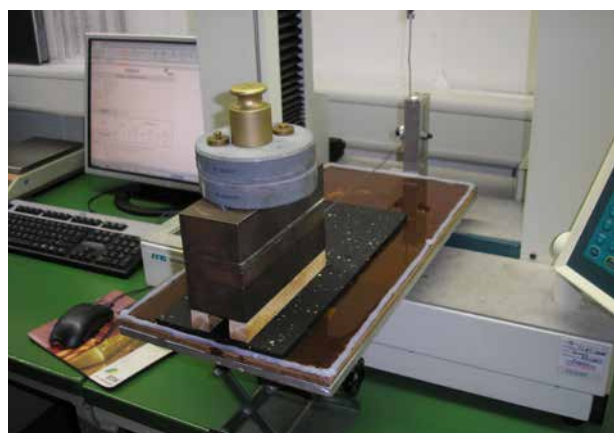
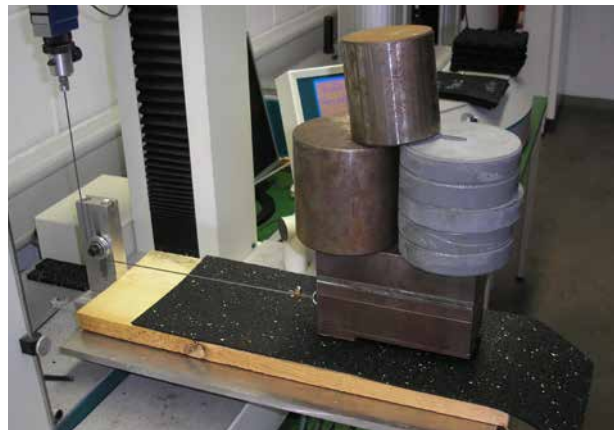
Regupol® Anti-Slip Mats are colour coded. The distinctive (and legally protected) yellow and green or red particles distinguish genuine **Regupol® Anti-Slip Mats**. Mistakes (genuine or otherwise) in supply are thus avoided. Only original **Regupol® Anti-Slip Mats** possess these colour codings. **Regupol® Anti-Slip Mats** consist of rubber fibres. They are ideal particularly for heavy loads, sharp edged cargo, transporting paper, steel sheets, chipboards, reinforcing steel mesh and all palletised loads. The special advantage of **Regupol® Anti-Slip Mats** with their highly porous structure consists in absorbing soiling and moisture etc. from the floor. In contrast to anti-slip films and similar materials with a smooth surface, it therefore prevents any notable loss in sliding friction coefficient. **Regupol® Anti-Slip Mats** are suitable for repeated use.



Colour coding of the original: Left: **Regupol® 7210 LS plus**, green-light green-yellow. Right: **Regupol® 1000 LSE**, red.

Testing the material combination

Every material combination, i.e. floor, anti-slip mat and the load resting on it, generates other sliding friction coefficients with a friction-increasing surface. **Regupol® Anti-Slip Mat** values are available for common material combinations. Furthermore, using a laboratory test, we offer to determine the sliding friction coefficients of the **Regupol® Anti-Slip Mats** selected by our clients in other material combinations.

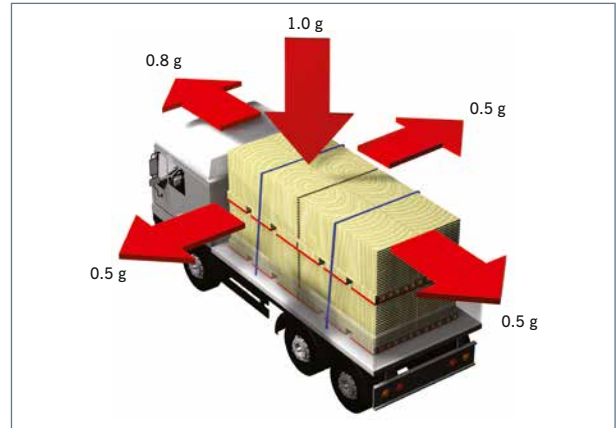


The sliding friction coefficient of the **Regupol® Anti-Slip Mats**, with the respective material combinations, will be determined in our own laboratory (above and below).

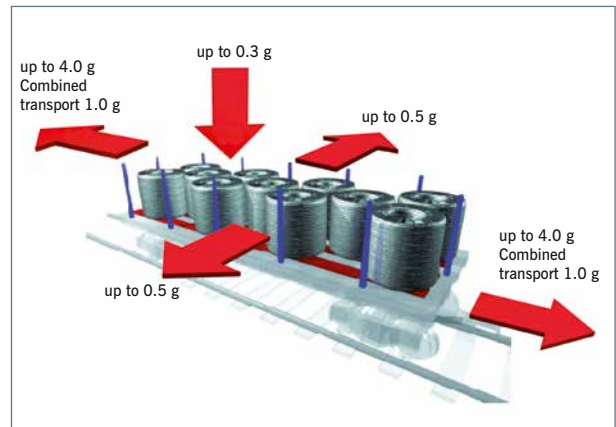
Forces under Various Movements

1.0 G indicates the weight of loads. According to this, forces achieve up to 80% of the stated value due to various movements by means of transportation.

Inasmuch as friction force and securing force are acting together against cargo slippage, **Regupol® Anti-Slip Mats** are furthermore able to increase the friction force. Excellent anti-slip mats ensure at least 60% of load securing. However, tie-downs and similar fixing equipment must not be forgotten.



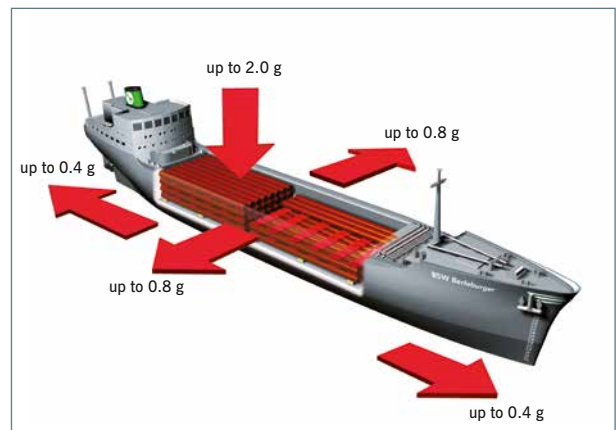
80% of load weight has to be compensated for load securing during driving manoeuvres of trucks.



Extreme forces are generated during rail transport: load securing must withstand four times the load weight.



Correct load securing: anti-slip mats are coloured red.



In ship transportation, these forces are doubled for the same loading weight.

Acceleration forces during transport

The dangers resulting from incorrectly secured loads are frequently underestimated. The acceleration forces under normal traffic conditions reach levels approaching the actual weight of the load. The friction force F_F of an anti-slip mat therefore counteracts any displacement of the load and is described in physical terms as follows:

$$F_F = \mu \times F_G \text{ (friction force)}$$

$$F_G = \text{weight}$$

$$\mu = \text{sliding friction coefficient}$$

$$m = \text{mass}$$

$$g = \text{gravitational acceleration}$$

$$F_G = m \times g$$

The difference between inertia force F_M and friction force F_F is known as securing force F_R :

$$F_R = F_{x,y} - F_F$$

The securing force F_R is the force that the securing equipment has to absorb in a forwards direction.

Loads are secured correctly by achieving a balance between the opposing forces occurring during transport.

The loads are adequately secured when the sum of the friction force F_F and the securing force F_R is at least as large as the inertia force F_M .

The friction force is increased by anti-slip mats, the securing force by lashing straps and other equipment.

As the weight acting in a forwards direction when the truck brakes can reach up to 80% of the load weight (0.8 g), the load must be secured accordingly.

Load securing

= friction force + securing force

The load only has to be secured for normal driving, not for a traffic accident. Normal driving also includes emergency braking, drastic avoidance manoeuvres and poor road surfaces.

The following forces can occur in normal driving:

- maximum 0.8 g in the direction of travel, corresponding to 80% of the load weight
- maximum 0.5 g to the sides, corresponding to 50% of the load weight
- maximum 0.5 g to the rear, corresponding to 50% of the load weight

Example

ascertaining the preload force with and without anti-slip mats

$$\text{Preload force: } F_T = \frac{(c_x - \mu_D)}{\mu_D \cdot \sin_a} \cdot \frac{F_G}{K}$$

$$c_x = 0,8$$

$$\mu_D = 0,2 \text{ (without anti-slip mat)}$$

$$\sin_a = 1$$

$$F_G = 10.000 \text{ daN}$$

$$K = 1,5$$

$$\text{Preload force: } F_T = \frac{(0,8 - 0,2)}{0,2 \cdot 1} \cdot \frac{10.000}{1,5}$$

$$F_T = 19.999,98 \text{ daN}$$

For a preload force of 500 daN per lashing strap, altogether **40 lashing straps** are needed here without anti-slip mats.

When anti-slip mats are used to increase the sliding friction coefficient to μ 0.6, this **reduces the number of lashing straps to 5**.

Cost savings with Anti-Slip Mats

Example: For a load of 7500 kg standing freely on the loading platform (chipboard floor, coefficient of sliding friction approx. μ 0.3) at 10 truckloads per day / 240 transports per year.

For a pre-tension force of 500 daN per lashing strap, 17 lashing straps are required when no anti-slip mats are used.

The use of anti-slip mats doubles the coefficient of sliding friction to μ 0.6 and reduces the number of straps required to 4.

Savings by using Anti-Slip Mats:

approx. 32 000 euros per year.

Comparative calculations

Costs without Anti-Slip Mats

34 lashing straps
(17 per transport x 2 purchases per year)
= 340 euros : 240 days = 1.42 euros per transport **1.42**

Pre-tension per belt 2 minutes
= for 17 belts 34 minutes per transport
at 35 euros per hour salary costs
= 19.83 euros per transport **19.83**

34 edge protection brackets x 2 per year
= 68 brackets
= 68 euros per year : 240 days
= 0.28 euros per transport **0.28**

Costs per transport		21.53
x 10 transports per day	=	215.30
x 240 days	=	51 672
		<hr/>
		euros per year

Costs with Anti-Slip Mats

8 lashing straps
(4 per transport x 2 purchases per year)
= 80 euros : 240 days = 0.33 euros per transport **0.33**

Anti-slip mats
= 10 euros per truck for an average of 4 transports
= 2.50 euros per transport **2.50**

Positioning the anti-slip mats 1 minute per transport
at 35 euros per hour salary costs
= 0.60 euros **0.60**

Pre-tensioning per belt 2 minutes
= for 4 belts 8 minutes per transport
at 35 euros per hour salary costs
= 4.67 euros per transport **4.67**

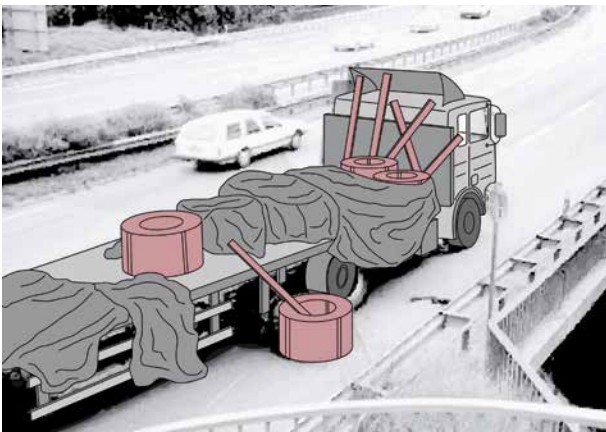
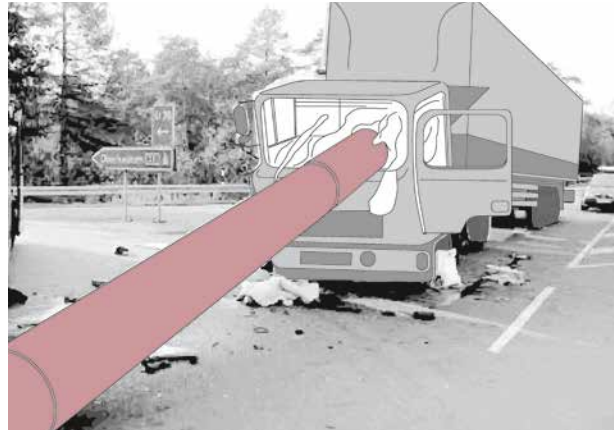
8 edge protection brackets x 2 per year
= 16 brackets
= 16 euros per year : 240 days
= 0.07 euros per transport **0.07**

Costs per transport		8.17
x 10 transports per day	=	81.70
x 240 days	=	19 608
		<hr/>
		euros per year

Consequences of Securing Cargo Incorrectly

When goods are being transported, acceleration and braking together with lateral centrifugal force or vibration generate forces approaching the actual weight of the load. As a result, the load can slip and cause severe damage to property as well as accidents with casualties.

For example, the load can break through the front wall of a truck and cause severe injury to the driver. Dangers are also involved in unloading loads which have slipped. Frequently the load also falls from the vehicle and causes a hazard to other road users. Incorrectly secured loads are often also damaged themselves. In Germany alone, this results in load damages amounting to several hundred million euros a year. Incorrectly secured loads are estimated to cause approx. 20% of all accidents in heavy goods traffic.



Legal foundations

Article 22 (1) German Road Traffic Regulations

The equipment for securing the load and loading devices are to be stowed and secured so that they cannot slide, fall over, roll backwards, fall down or cause avoidable noise even during emergency braking or sudden evasive action, in compliance with state-of-the-art technology.

Article 23 German Road Traffic Regulations

The vehicle's driver is responsible for ensuring that his vision is not impaired [...] by the [...] load, equipment or condition of the vehicle. He must ensure that the vehicle, train or towing combination and the load are in full compliance with the regulations and that the load does not jeopardise the vehicle's roadworthiness.

Article 31 (2) German Road Traffic Regulations

The owner must not order or permit the vehicle to be used if he knows or must know that the load is not correct or that the roadworthiness of the vehicle is jeopardised by the load or occupancy.

An entrepreneur is therefore already in violation of the German Road Traffic Licensing Regulations by failing to use a vehicle with the necessary equipment for adequately securing the load.

Article 412 (1) German Civil Code

Unless indicated otherwise by circumstances or traffic customs, the consignor shall load, stow, fasten and unload the goods in a manner safe for transport. The haulage contractor shall ensure that the load is safe for operations.

Civil Law: German Commercial Code (HGB)

Consignor

According to Article 412 German Commercial Code, the consignor is responsible for loading the goods in a manner safe for transport

Haulage Contractor

According to Article 412 German Commercial Code, the haulage contractor is responsible for loading the goods in a manner safe for operation.

Public Law: German Road Traffic Regulations, German Road Traffic Licensing Regulations

Loader, Driver

According to Article 22 German Road Traffic Regulations, loader and driver are obliged to secure the load.

Vehicle Owner

According to Article 31 Road Traffic Licensing Regulations, the vehicle's owner is obliged to equip the vehicle.

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