Technical Plastics
for the lifting and
transporting industry

Rope sheaves
Multi-Wire Sheave
Runner wheels
Outrigger floats
Wear elements
In recent years and decades, machine components made from high quality technical materials have become increasingly important in the manufacture of machinery and equipment. Schwartz was founded in 1924 as the first European manufacturer of non-metallic friction bearings for steel rolling mills. Since then we have become the leading manufacturer of technical plastics and an efficient partner to the industry on the continuously developing field of technical plastics.

Our registered trademarks LAMIGAMID®, LAMINEX® and OPTAMID® are the names of our thermo- and duroplast plastics, known all over the world as high quality polymer materials with the following interesting advantages:

- low specific weight
- great rigidity and hardness
- high impact value even at low temperatures
- friction- and wear-resistance
- excellent sliding and emergency running properties
- corrosion resistance
- no, or very low moisture absorption
- good to very good resistance to chemicals and hydrolysis
- dimensional stability
- virtually no limit to the variety of dimensions and shapes
- lowest maintenance
Plastic machine parts and their areas of application

For the production of lifting, handling and transportation equipment, Schwartz Technical Plastics supplies:

- rope sheaves
- runner wheels
- outrigger floats
- wear liners
- sliding bearings
- rope pulleys
- hose reels
- support rollers
- gear wheels
- toothed racks

Areas of application:

<table>
<thead>
<tr>
<th>Crane Installations</th>
<th>Conveyors and Transporting Equipment</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Building cranes</strong></td>
<td><strong>Overhead conveyors</strong></td>
</tr>
<tr>
<td><strong>Bridge cranes</strong></td>
<td><strong>Stackers</strong></td>
</tr>
<tr>
<td>- Overhead and other travelling cranes</td>
<td><strong>Lifts</strong></td>
</tr>
<tr>
<td><strong>Deck cranes</strong></td>
<td><strong>Bucket conveyors</strong></td>
</tr>
<tr>
<td><strong>Cranes for Installation on vehicles</strong></td>
<td><strong>Escalators</strong></td>
</tr>
<tr>
<td>- Railway-cranes</td>
<td><strong>Fork lifts</strong></td>
</tr>
<tr>
<td>- Lattice mast cranes</td>
<td></td>
</tr>
<tr>
<td>- Mobile port cranes</td>
<td></td>
</tr>
<tr>
<td>- Truck charging cranes</td>
<td></td>
</tr>
<tr>
<td>- Crawler cranes</td>
<td></td>
</tr>
<tr>
<td>- Telescopic cranes</td>
<td></td>
</tr>
<tr>
<td><strong>Dockside cranes</strong></td>
<td><strong>Trolley conveyors</strong></td>
</tr>
<tr>
<td>- Container cranes</td>
<td><strong>Marshalling installations</strong></td>
</tr>
<tr>
<td>- Slewing cranes</td>
<td><strong>Shelf handling equipment</strong></td>
</tr>
<tr>
<td>- Ship discharging cranes</td>
<td><strong>Inclined hoists</strong></td>
</tr>
<tr>
<td>- Floating cranes</td>
<td><strong>Transport installations</strong></td>
</tr>
<tr>
<td><strong>Cable cranes</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Off-Shore pedestal cranes</strong></td>
<td></td>
</tr>
<tr>
<td>- Container bridges</td>
<td></td>
</tr>
<tr>
<td>- Stockyard cranes</td>
<td></td>
</tr>
<tr>
<td><strong>Grab divices</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Spreaders</strong></td>
<td></td>
</tr>
</tbody>
</table>
A variety of materials are available for the production of machine parts used in lifting, handling and transportation equipment. A lot of these items are made of LAMIGAMID® 310, 314, 318 (WFN), 319, 320, 324/327 and our high-performance polyamide LAMIGAMID® 1200.

<table>
<thead>
<tr>
<th>Material</th>
<th>mechanical properties</th>
<th>Applications</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Density</td>
<td>Yield point/ Tensile strength</td>
</tr>
<tr>
<td></td>
<td>g/cm³</td>
<td>N/mm²</td>
</tr>
<tr>
<td>LAMIGAMID® 310</td>
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<td>75</td>
</tr>
<tr>
<td>LAMIGAMID® 314</td>
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<td>LAMIGAMID® 318</td>
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</tr>
<tr>
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</tr>
<tr>
<td>LAMIGAMID® 319 M3</td>
<td>1,15</td>
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</tr>
<tr>
<td>LAMIGAMID® 319 M8</td>
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</tr>
<tr>
<td>LAMIGAMID® 320</td>
<td>1,15</td>
<td>90</td>
</tr>
<tr>
<td>LAMIGAMID® 324/327</td>
<td>1,16</td>
<td>95</td>
</tr>
<tr>
<td>LAMIGAMID® 1200</td>
<td>1,03</td>
<td>60</td>
</tr>
</tbody>
</table>

Table 1: Mechanical properties of some LAMIGAMID materials (mean values) and their applications. The table „Synthetic Materials, technical data“ will show you further mechanical, electrical and thermal properties. Use the QR-Code or visit our website schwartz-plastic.com.
LAMIGAMID® 310 - standard quality

is a resilient-hard cast polyamide. This material features:

- low specific weight
- high strength hardness and toughness
- high resistance to tear and wear
- low surface pressure with regard to metallic partners
- good sliding and emergency running properties
- good resistance against sea water, oil and grease
- good corrosion and weathering resistance

LAMIGAMID® 314

is a resilient-hard cast polyamide with a MoS₂-additive. This additive leads to an increase in the material’s degree of crystallization which, in turn, increases the surface hardness, thereby slightly improving the coefficient of friction in case of dry-run.

LAMIGAMID® 318 (WFN)

is a casting material with liquid lubricant. It even has a lower coefficient of sliding friction and can be used to produce all conceivable forms. Round and angled shapes can be fabricated without any problem. If you need to take your wearpads into the third dimension, then LAMIGAMID® 318 is the perfect material for you. Temperature range from -40°C to +60°C.

LAMIGAMID® 319

is a resilient-hard cast polyamide, oilfilled. The added oil is an integral component of the material and contributes a lot to an essential reduction of the coefficient of friction in case of dry-run. The material is self-lubricating and may be used with out additional lubricants. LAMIGAMID 319’s wear resistance characteristics are superior to those of the standard quality. In addition, the material absorbs considerably less humidity.

LAMIGAMID® 319 M3 and M8

is the result of innovative development and many years’ experience. With these variations we extend our range of materials in the field of self-lubricating materials. LAMIGAMID 319 M3 and M8 are perfect the materials for specific requirements.

LAMIGAMID® 319 M3 and M8 are only available in a high level order. To get further information please contact us.

LAMIGAMID® 320

is a super-hard cast polyamide. The material was especially developed for heavily loaded runner wheels. Its E-modulus is superior to that of the standard quality. This also applies to its ball indentation hardness. The material may be used under considerably higher limit loads.

LAMIGAMID® 324/327

corresponds to the LAMIGAMID 320 quality. In order to increase the degree of crystallization and the heat deflection temperature the material is enriched with MoS² and a heat stabilizer. These additions enable the material to be run under high speeds and high loads. Even in the case of high temperatures the admissible limit loads are superior to those of the normal qualities.

LAMIGAMID® 1200

LAMIGAMID® 1200 is our high-performance polyamide quality. It is the result of innovative development and many year’s experience. Cast without pressure for an almost tension-free, homogeneous material with excellent properties for high-stress applications. Using our own compositions and production processes, we are able to reach a very high molecular weight and crystallinity. Thanks to these characteristics, Schwartz has received USP VI authorisation for cast polyamide 12 - LAMIGAMID® 1200.
**Description of the Process**

LAMIGAMID® 310 consists of three components: Caprolactam, activator and catalyst. Caprolactam is the raw material, whereas the activator and catalyst are intended to control polymerization. The dosage of these two latter components influences the courses of the reaction. By varying the dosage of the individual components the material may be produced in resilient, resilient-hard or super hard quality.

Caprolactam, the raw material, is melted in two different vessels together with the activator (2) on the one hand and the catalyst (3) on the other; subsequently the two separate melts are mixed (4) and cast into preheated moulds.

Reaction (polymerization) takes place in these moulds; the polyamide crystallizes and solidifies. After a certain period of time the mould can be opened and the casting can be removed.

**Centrifugal Moulding**

This procedure is used for the production of mouldings of circular symmetry, such as rope sheaves, runner wheels or tubes.

In the centrifugal process the preheated mould rotates at a high speed about a horizontal or vertical axis. The centrifugal force presses the melt against the mould’s walls. Items produced in this process are characterized by high strength.

**Gravity Casting**

In this process the melt is gravity-fed into pre-heated moulds. The gravity process is used for the production of semifinished products such as round rods, plates, plungers, large tubes and other mouldings such as outrigger floats.
At Schwartz Technical Plastics we love a challenge. Come to us with your specifications and requirements and let us help you find the perfect solution. Our technical plastics are ideal for individual and demanding applications.

Our highly qualified team will work closely with you to come up with the best technical and economically viable solution. We specialize in the development and manufacture of custom-made components for our customers. Our modern manufacturing plants and state-of-the-art processes are tailored to suit each individual materials and offer speed, flexibility and the highest quality standards. (Certified according to DIN EN ISO 9001, VDeh EN 29004 / ISO 9004, type approvals from DNV, Germanischer Lloyd, Lloyd’s Register and Bureau Veritas.)

Our engineers make sure that your plans are perfectly implemented, but they can do much more. Should you require help or consultation at the planning stage, our staff is happy to offer their ideas and experience. Great ideas and perfect materials – that’s what defines Schwartz Plastics.
Rope Sheaves made of LAMIGAMID® Materials

The use of plastic rope sheaves in rope gearings is more and more increasing. LAMIGAMID® rope sheaves are used in all types of cranes, electrical and chain hoists, handling and transportation installations, lifting platforms and many other devices.

Reasons for the application of LAMIGAMID® rope sheaves are:

- considerably lower weight
- extended wire rope life
- improved vibration dampening

Rope sheaves made of plastic can be used for any lifting, handling or transportation equipment, except for units used in high-temperature plants. LAMIGAMID® rope sheaves are produced in the same sizes as metallic ones. They can also be used for rope tensions of the same kind. The admissible inclined tension is 3°.

Several years of application in many hoists, handling and transportation installations have shown that their wear behaviour is at least equivalent to that of metallic wheels. In a great number of installations the use of LAMIGAMID® rope sheaves has resulted in even much better periods of service life.

Rope sheaves are made from LAMIGAMID® 310 and 319. Our standard quality for sheaves is LAMIGAMID® 310. This quality is used for almost all sheaves intended for use with roller or sliding bearing.

LAMIGAMID® 319 is particularly used for sheaves which are intended for low rope tensions and low circumferential speeds. These sheaves can be used without a roller or sliding bearing. They can be mounted directly onto the shaft. For technical properties, please refer to Table 1 on page 4 or table „Synthetic Materials, technical data“.

Under load, LAMIGAMID® rope sheaves can be used at temperatures from +60° C down to —40° C.
The weight of LAMIGAMID® Rope Sheaves

Owing to the low specific weight of the plastic material, LAMIGAMID® rope sheaves are considerably lighter than rope sheaves made of steel or aluminium. For your information we have indicated below the specific weight of different rope sheaves materials:

<table>
<thead>
<tr>
<th>Material</th>
<th>Specific Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Steel</td>
<td>approx. 7.85 g/cm³</td>
</tr>
<tr>
<td>Aluminium</td>
<td>approx. 2.70 g/cm³</td>
</tr>
<tr>
<td>LAMIGAMID</td>
<td>approx. 1.15 g/cm³</td>
</tr>
</tbody>
</table>

The weight of a 710 mm steel rope sheave is approximately 116 kg—compared to 32 kg of a corresponding pulley made of LAMIGAMID®. If 20 rope sheaves of a 710 mm diameters are required within one boom, the use of LAMIGAMID® sheaves will result in a weight saving of approx. 1680 kg. These considerably lower weights provide the following advantages to the designer and user:

- increase in the hoisting capacity
- reduction of the booms’ own weight
- in mobile cranes: reduction of the loads acting upon the axles
- easier and quicker installation of sheaves

Wire Rope Life

Using LAMIGAMID® sheaves considerably extends the ropes life expectancy. The life time is essentially determined by the line pull, the rope diameter and the shape of the groove. It is also influenced by the sum of radial and lateral pressures which occur between rope and groove.

As a result of these forces, the phenomenon of surface pressure alternation occurs in the rope or cable wires. The extent of the occurrence of this phenomenon depends on the material of the sheave and the relation of the values of the E-module of groove material and rope wire: the smaller this relation is, the smaller will be the occurrence of this phenomenon. Therefore hard sheave materials such as steel, cast iron or hard cast aluminium will lead to high surface pressures causing fracture of the rope strands.

The situation is drastically altered with rope sheaves made of LAMIGAMID®. The E-module of our LAMIGAMID grades range from 2.500 to 3.400 N/mm², which means that the degree of surface pressure between rope groove and rope is insignificant. With a wrap angle of 180° the sheave adapts more snugly to the rope; this leads to an increased number of contact points between rope and wheel.

Tests and observations made have shown that the use of LAMIGAMID® sheaves almost eliminates wear on the outer rope layers, the number of bending alternations till the rupture of the rope can be doubled or increased even more.

www.schwartz-plastic.com
Customized products in large dimensions.

We are able to manufacture Sheaves having a diameter of 3500 mm.

Production of LAMIGAMID®-Rope Sheaves

The rope sheaves are either spuncast in special moulds (type A) or machine-finished from cast bars using CNC turning machines (type B).

Type A

The sheaves are cast in centrifugal moulds. The moulds produce an almost ready-to-install centrifugal casting. Only the centerbore and the groove are mechanically finished in order to assure perfect alignment with the groove. More than 200 different shapes are available. Spun-cast sheaves are produced with outer diameters of 320 to 1.500 mm.

Type B

Sheaves with outer diameters of 50 to 320 mm are machine-finished from cast bars. Machining is carried out on CNC-controlled lathes. The wheels’ lateral surfaces are usually plain, but they can also be delivered with lateral recesses. Any optional specification can be supplied. This type of sheave is available with outer diameters up to 3.500 mm.

Both the spun-cast sheaves as well as the machine-finished ones are generally subjected to a thermal conditioning process. The sheaves are both tempered and conditioned, whereas the machine-finished are only tempered. This is to insure that all the material used is stress-free.
Finding the perfect solution

Our engineers make sure that your plans are perfectly implemented, but they can do much more. Should you require help or consultation at the planning stage, our staff is happy to offer their ideas and experience. Great ideas and perfect materials – that’s what defines Schwartz Plastics.

Design of LAMIGAMID® Sheaves

Both with regard to the outside and groove base diameter as well as to the sheave and bore width, the dimensions of LAMIGAMID® sheaves are identical to those of corresponding metal sheaves. The design of the webs of spun-cast sheaves is adapted to the material involved. The tolerances applicable to LAMIGAMID® sheaves are appropriate for plastic materials.

a) Tolerances for Spun-Cast Sheaves

<table>
<thead>
<tr>
<th></th>
<th>Ø Outside mm from 300 - 500</th>
<th>Ø Outside mm from 500-800</th>
<th>Ø Outside mm exceeding 800</th>
</tr>
</thead>
<tbody>
<tr>
<td>D2 Ø Outside</td>
<td>± 2,0</td>
<td>± 3,0</td>
<td>± 5,0</td>
</tr>
<tr>
<td>D1 Ø groove base</td>
<td>±2,0</td>
<td>± 3,0</td>
<td>± 5,0</td>
</tr>
<tr>
<td>D3 Ø bore diameter</td>
<td>± 2,0</td>
<td>± 3,0</td>
<td>± 3,5</td>
</tr>
<tr>
<td>Mismatch</td>
<td>±1,0</td>
<td>± 1,5</td>
<td>± 2,0</td>
</tr>
<tr>
<td>Width</td>
<td></td>
<td>B1</td>
<td>B2</td>
</tr>
<tr>
<td></td>
<td>up to 60 mm</td>
<td>from 61 - 100 mm</td>
<td>exceeding 100 mm</td>
</tr>
<tr>
<td>B1 sheave width</td>
<td>-1,5</td>
<td>-2,0</td>
<td>-2,5</td>
</tr>
<tr>
<td>B2 bore width</td>
<td>± 0,1</td>
<td>± 0,1</td>
<td>± 0,1</td>
</tr>
</tbody>
</table>

Table 2
b) Groove Profiles and Groove Radii

<table>
<thead>
<tr>
<th>Nominal diameter of rope/cable d1</th>
<th>h</th>
<th>i</th>
<th>m</th>
<th>Groove radius</th>
<th>Nominal diameter of rope/cable d1</th>
<th>Guide values</th>
<th>Groove radius</th>
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<tr>
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<td></td>
<td>4</td>
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<td>11</td>
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<td>31,32</td>
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<td>18</td>
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<td>7</td>
<td>12,5</td>
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<td>82,5</td>
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<td>37,5</td>
<td>48</td>
<td>8</td>
<td>13</td>
<td>60</td>
<td>85</td>
</tr>
</tbody>
</table>

Table 3
LAMIGAMID® sheaves are suitable for use with roller bearings or anti-friction bearings made of plastic material or bronze. LAMIGAMID® 319 sheaves can run directly on steel shafts.

<table>
<thead>
<tr>
<th>LAMIGAMID®-quality</th>
<th>with roller bearing</th>
<th>with anti-friction bearings made of self-lubricating plastic</th>
<th>with cast-in bushing made of steel/bronze</th>
<th>without additional bearing</th>
</tr>
</thead>
<tbody>
<tr>
<td>310</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>no</td>
</tr>
<tr>
<td>319</td>
<td>no</td>
<td>no</td>
<td>no</td>
<td>yes</td>
</tr>
</tbody>
</table>

Table 4: Bearing types for LAMIGAMID® sheaves

a) Roller Bearings

Most of the sheaves are used together with roller bearings. In most cases these bearings are directly pressed into the bore holes. An eventual excessive squeeze between the bearing and the bore is relieved by means of a pressed-in intermediate steel bushing in which the bearings are then mounted. The roller bearing is press-fit into the bore of the LAMIGAMID® sheave by way of cold pressing. For reasons of convenience this operation is carried out using a press. Depending on the type of the roller bearing there are certain minus tolerances which are observed for bore holes. The minus tolerance refers to the respective outside diameter of the roller bearing.

b) Journal Bearing Bushes

LAMIGAMID® 310 sheaves may also be equipped with plastic or metal sliding bearings. In this case the admissible load for the sheave depends on the bearing capacity of the respective sliding bearing.

Such plastic bearing bushings are made from LAMIGAMID® 319 or 510. Both these materials are self-lubricating to a large extent. The average bearing pressure is calculated according to:

\[ P = \frac{F}{b \cdot d} \text{ N/mm}^2 \]

\[ F = \text{Axle load in N} \]

\[ d = \text{Hub width in mm} \]

\[ b = \text{Diameter of the bore in mm} \]

For both these materials one can assume a max. admissible PV value of approx. 0.05 N/mm² · m/s. If possible the average bearing pressure should be less than 25 N/mm².

Metal sliding bearings are inserted in the sheaves by way of casting or pressing them in. If they are press-fit it is recommended to secure them mechanically. The static friction between the metal and the plastic is not sufficient so that the bearings might possibly creep out of the centerbore in an axial direction.

If the sheaves are to be equipped with thin-walled sliding bearings, intermediate steel bushings are inserted in the wheel by way of casting in or press fitting.

c) Operation without Rolling or Journal Bearing Bush

Sheaves made of LAMIGAMID® 319 are always used without additional bearings. LAMIGAMID® 319 is characterized by a low friction coefficient in dry-run, and low moisture absorption.

Prior to using LAMIGAMID® sheaves the main bearing pressure has to be calculated. This can be done using Equation 5.

Example:

<table>
<thead>
<tr>
<th>Rope Sheave</th>
<th>Rope tension = 500 N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Centerbore</td>
<td>V = 1,0 m/s</td>
</tr>
<tr>
<td>Hub width</td>
<td>Wrap angle 180°</td>
</tr>
</tbody>
</table>

\[ P = \frac{2 \cdot 500}{30 \cdot 30} = 1000 \text{ N} \]

\[ P = 1,11 \text{ N/mm}^2 \]

Table 12 on page 31 shows whether the sheave can be used at the determined bearing pressure and the circumferential velocity of 1.0 m/s.

For non-stop operation the bearing pressure is too high. At a circumferential speed of 1.0 m/s its maximum would be 0.5 N/mm². However, if the sheave is only subject to short-term loads, the use of LAMIGAMID® 319 could possibly be taken into consideration. In this case the bearing pressure may exceed the values shown in table 12 by a factor of 2.5.
Multi-Wire-Sheave

An innovative solution for sheaves with different cable diameters

Offshore cranes that work in different depths need to be equipped with cables and sheaves of varying groove diameters. Whereas thicker and lighter polymer cables are used in cranes working in areas of extreme depth, applications at surface level or in lofty heights require heavier yet thinner steel cables. In many cases a single crane system is used to work both areas, in which case it becomes necessary to equip the sheave with different sheave groove diameters, since changing the roll during operation is hardly possible.

The multi-wire sheave is suitable for wire cables with a diameter of 76 mm to 130 mm and a groove profile of 45° to 40°. This safe and simple solution saves both money and time, since the need to disassemble or remove sheaves before changing cables no longer arises. Cable groove segments can be removed separately as needed.

The removable plastic parts are manufactured from LAMIGAMID® 310.

Working closely with our partner company Van Mechelen Lifting Gear, we have developed a new pulley system that incorporates a LAMIGAMID® cap with grooves that can be adjusted to fit different cable diameters. This innovative development brings together the best qualities of metal and LAMIGAMID®, offering strength and stability on the one hand, while at the same time being low in weight and real easy on the cables.

The advantages of LAMIGAMID® 310 at a glance:

- low specific weight
- high strength hardness and toughness
- high resistance to tear and wear
- low surface pressure with regard to metallic partners
- good sliding and emergency running properties
- good resistance against sea water, oil and grease
- good corrosion and weathering resistance.
Areas of application for Sheaves made of LAMIGAMID
Areas of application for heavy runner wheels made of LAMIGAMID®
For quite a number of years LAMIGAMID® runner wheels have now been successfully used for heavy-duty service in lifting, handling, transportation and conveying installations.

Runner wheels made of LAMIGAMID® materials should be used if the following demands are to be fulfilled:

- extremely silent run
- reduced rail wear
- resistance against corrosion
- physiological harmlessness

LAMIGAMID® runner wheels can be used in any known type of lifting, handling, transportation and conveying installation as long as the admissible limit loads are not exceeded.

The use of plastic runner wheels is not, or only conditionally, possible if:

- the rolling speed exceeds 5 m/s
  (In this case the heating-up of the tread would become too great.)

If a cylindrical LAMIGAMID® runner wheel comes in contact with a steel rail, the flattening of this wheel is approximately seven times as much as in the case of a steel wheel; as a result the load acting on the synthetic wheel is only one seventh of the load which would act on a comparable steel wheel. This explains the greater carrying capacity of LAMIGAMID® runner wheels.

In the case of a crowned, i.e. spherical, wheel tread the situation is even more favourable. A ball-shaped tread corresponds to the ideal case of a ball being in contact with a plane surface. Although the corresponding flattening is only four times as great as in the case of a cylindrical wheel, the load acting on the wheel is never-the-less only one thirteenth of the corresponding value of a steel/steel combination.

LAMIGAMID® runner wheels are highly resistant to wear as long as the admissible limit loads are observed. The wear rate of driven wheels is slightly higher than that of idling ones. The rate will be increased by sharp braking manoeuvres or excessive acceleration.

If possible, plastic runner wheels should be used without wheel flange. The wear rate of flanged runner wheels can be very high if the wheels run on curved paths or if the wheel flanges are subject to great guiding forces. LAMIGAMID® runner wheels reduce the shocks acting on the roller bearing and therefore contribute to an essential extension of the bearings’ service life.
Runner wheels for heavy-duty service can be made from LAMIGAMID® grades 310, 319, 320, 324/327 and 1200. For the mechanical properties of the different materials please refer to Table 1 on page 4 or to our chart “Synthetic Material, technical data”.

All LAMIGAMID® materials are highly fatigue resistant and characterized by excellent elastic capacity. Their E-moduli are considerably lower than those of steel, cast steel, cast iron or nodular cast iron. These low E-moduli are advantageous for highly stressed runner wheels. The plastic materials deform, thereby creating larger support surfaces which, in turn, result in smaller maximum surface pressure values. The elastic property is sufficient to restore the wheel to its original form after the load is released. If a runner wheel has been subjected to the maximum admissible loads over a long period of time, the contact points may show visible flattening. However, these flattenings will be stretched after a few roll motions.

**LAMIGAMID® 310**

The standard grade for runner wheels is LAMIGAMID® 310, a resilient-hard cast polyamide. Most of the runner wheels made from this material are used in connection with roller or sliding bearings.

LAMIGAMID® 310 is used to produce runner wheels e.g. for lifts, construction site cranes, material hoists, vertical conveyors and material handling equipment, sliding doors, etc.

**LAMIGAMID® 319**

is a resilient-hard cast polyamide, oilfilled. Owing to the material’s low friction coefficient in dry run and its minimal humidity absorption, LAMIGAMID® 319 runner wheels can be used without rolling or sliding bearing. They are also suitable for outdoor or underwater service.

Runner wheels made of this material are used e.g. in lifts, stage equipment, overhead conveyors and marshalling installations.

**LAMIGAMID® 320**

is a cast polyamide of a particularly hard composition. This material has been designed for runner wheels used for service under high stress. Both statically as well as dynamically, LAMIGAMID® 320 can be subjected to higher loads than the standard grade. Even under static load no visible flattening will occur as long as the limit loads are not exceeded.

LAMIGAMID® 320 is used for runner wheels in electrical and chain hoists, lift trucks, portal cranes, bridge cranes, shelf handling installations, etc.

**LAMIGAMID® 324/327**

is also a particularly hard cast polyamide. In order to increase its degree of crystallization the material is modified by means of MoS₂ and a heat stabliler.

Owing to these additions, runner wheels made of LAMIGAMID® 324/327 can be subjected to even higher loads. In addition, they can be used at higher velocities. LAMIGAMID® 324/327 is used to produce runner wheels for electrical and chain hoists, portal cranes, bridge cranes, shelf handling installations etc.

**LAMIGAMID® 1200**

is our high-performance polyamid quality. It is the result of innovative development and many year’s experience. Cast without pressure for an almost tension-free, homogeneous material with excellent properties for high-stress applications. Using our own compositions and production processes, we are able to reach a very high molecular weight and crystallinity. Thanks to these characteristics, Schwartz has received USP VI authorisation for cast polyamide 12 - LAMIGAMID® 1200.
In most cases LAMIGAMID® runner wheels are made from round bar stock or from pipes. Runner wheels with outside diameters of 40 -300 mm are machined on CNC-controlled lathes.

Exhibit 2: Different designs of runner wheels made of LAMIGAMID® materials

LAMIGAMID® runner wheels can be supplied in any desired size and shape. All the cast or spun-cast materials used are subjected to thermal conditioning and characterized by excellent plastic properties.

Design Information

The use of LAMIGAMID® runner wheels depends on:

- the wheel load
- the travelling speed
- the ambient temperature

Before using runner wheels made of plastic it is necessary to calculate the deformation of the tread and the acting in the bore.

Exhibit 3: Load diagram

Our engineers make sure that your plans are perfectly implemented, but they can do much more. Should you require help or consultation at the planning stage, our staff is happy to offer their ideas and experience. Great ideas and perfect materials – that’s what defines Schwartz Plastics.
LAMIGAMID® runner wheels can be manufactured with any desired kind of centerbore. Exhibit 4 shows some of the possible centerbore types:

1) Smooth passage bore
2) with pressed-in bearing bush, e.g. made of LAMIGAMID® 510
3) with two ball bearing seats
4) with ball bearing seat and two grooves for Seeger circlip rings
5) with feather key groove
6) with multiple spline toothing according to DIN 5480

Abbildung 4

The loads acting in the bores have to be calculated in any case. This can be done using the following equation:

\[ P_{\text{max}} = \frac{F}{b \cdot d} = \text{[N/mm}^2\text{]} \]

1. Smooth Bore

Runner wheels are made with a smooth bore if they

- run directly on an axle
- are shrunk on steel shafts
- are used with a press fit metal bushing

As a rule, runner wheels which run directly on a shaft are produced from LAMIGAMID 319. For runner wheels made of LAMIGAMID® 319 one can assume a max. admissible \( P \text{v} \) value of approx. 0.5 N/mm\(^2\) · ms. If possible the main bearing pressure should be less than 25 N/mm\(^2\).

LAMIGAMID® runner wheels can also be shrunk on steel shafts. The runner wheels are either heated up to 60°C and then shrunk on, or pressed on cold.

Both ways ensure a tight fit. In these cases the main bearing pressure may be approx. 65 N/mm\(^2\), the short-term load may even be as high as 90 N/mm\(^2\).

It is also possible to press metal bushings into LAMIGAMID® runner wheels. Cold pressing is recommended. The pressure between the bushing and the hub should not exceed 65 N/mm\(^2\).

2. Centerbores for Roller Bearings

The bore can be supplied with grooves for Seeger circlip rings (Exhibit 4, item 4) or with two bearing seats (item 3). The roller bearings are fitted with 0.5% minus tolerance and in most cases additionally fixed by means of locking rings which secure the wheel in axial direction. Insertion is accomplishe d by means of cold pressing. Maximum permanent pressure between plastic hub and bearing may be 65 N/m-m/², maximum short-term pressure is 90 N/mm².
3. Centerbores with Feather Key Grooves

LAMIGAMID® runner wheels can also be used with feather key groove in the bore. In the case of load transmission by feather key the admissible surface pressure acting on the keyway flanks has to be calculated in every individual case.

The values shown in the table must not be exceeded.

If the load at the keyway flanks is too great one has to use a steel hub. In the case of runner wheels with a tape-red web the hub diameter should at least be 1.6 times the shaft diameter. The corresponding equation is: \( d_n > 1.6 \ d \).

The length of the hub should be sufficient to ensure that the surface pressure at the keyway flanks will not exceed the values shown in Table 5.

4. Centerbores with Multiple Spline Toothing

LAMIGAMID® runner wheels can also be supplied with a multiple spline toothing according to DIN 5482 in the bore. This type of linkage offers several advantages:

- friction-type connection
- transmission of great torque values
- convenient installation
- convenient removal, the plastic wheels will not become shrunk on the steel shafts even after years

The equation for the calculation of the minimum keyway surface is:

\[
\text{min. surface of keyway} = \frac{9860 + 10^3 \cdot p (kW)}{r + r + p} \quad [\text{mm}^2]
\]

\( r = \) radius keyway centre in mm
\( p = \) admissible surface pressure (table 5)

<table>
<thead>
<tr>
<th>LAMIGAMID® 310</th>
<th>LAMIGAMID® 320</th>
<th>LAMIGAMID® 324/327</th>
</tr>
</thead>
<tbody>
<tr>
<td>N/mm²</td>
<td>22</td>
<td>25</td>
</tr>
</tbody>
</table>

**Table 5:**
Max. admissible surface pressure at keyway flanks for LAMIGAMID® materials.
**Press-in Plastic Bushes**

LAMIGAMID® runner wheels can also be realized with press-fit bushes made of self-lubricating plastics. Such bushes are made from LAMIGAMID® 319, 510 or 600. The selection of the respective bushing material depends on the environmental conditions. The guide value for all these materials is an admissible PV value of approx. 0.05 N/mm² m/s.

LAMIGAMID® 319 is used as bushing material for minor loads and motions. For economic reasons press fit of LAMIGAMID® 319 bushings is carried out only in the case of large runner wheels. Runner wheels with outside diameters up to 300 mm are produced in plain LAMIGAMID® 319.

LAMIGAMID® 510 absorbs very little moisture. This material does not swell. It can therefore be used for underwater service. However, its notched impact strength is subject to certain limitations. Hard shocks and impacts may lead to the destruction of the bushings. In addition, this material is not suitable for applications with high edge pressures. LAMIGAMID® 510 is characterized by excellent resistance against abrasion and wear.

LAMIGAMID® 600 also absorbs very little moisture. However, this material is more sensitive to abrasion and wear than LAMIGAMID® 510, but features a better impact strength.

**Design of LAMIGAMID Runner Wheels**

Runner wheels made of LAMIGAMID 310, 319, 320 or 324/327 are produced by spun moulding. They are available in any design.

LAMIGAMID runner wheels are used with the same dimensions and designs as metal wheels.

---

### a) Standard Design:

<table>
<thead>
<tr>
<th>Wheel size</th>
<th>Ø a</th>
<th>b</th>
<th>Ø c</th>
<th>Ø d</th>
<th>e</th>
<th>Type of bushing</th>
<th>Load capacity in N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ø 125 x 40</td>
<td>125</td>
<td>40</td>
<td>51,8</td>
<td>45</td>
<td>15</td>
<td>6304</td>
<td>26000</td>
</tr>
<tr>
<td>Ø 150 x 50</td>
<td>150</td>
<td>50</td>
<td>51,8</td>
<td>45</td>
<td>15</td>
<td>6304</td>
<td>26000</td>
</tr>
<tr>
<td>Ø 200 x 50</td>
<td>200</td>
<td>50</td>
<td>61,8</td>
<td>55</td>
<td>17</td>
<td>6305</td>
<td>35000</td>
</tr>
<tr>
<td>Ø 250 x 65</td>
<td>250</td>
<td>65</td>
<td>61,8</td>
<td>55</td>
<td>17</td>
<td>6305</td>
<td>35000</td>
</tr>
<tr>
<td>Ø 300 x 75</td>
<td>300</td>
<td>75</td>
<td>71,8</td>
<td>65</td>
<td>19</td>
<td>6306</td>
<td>45000</td>
</tr>
</tbody>
</table>

Table 6

- LAMIGAMID® 310
- LAMIGAMID® 319
- LAMIGAMID® 320
- LAMIGAMID® 324/327
- LAMIGAMID® 1200
b) Single-Flange Wheels

Dimensions

D = 60 - 300 mm
- made from round bar stock
- machined on CNC-controlled lathes

D = 300 - 1000 mm
- spun-cast in moulds
- minor quantities made from round bar stock

Available in:
- LAMIGAMID® 310
- LAMIGAMID® 319
- LAMIGAMID® 320
- LAMIGAMID® 324/327
- LAMIGAMID® 1200

Examples of use:
- Electrical and chain hoists
- Warehouse installations

Table 7

<table>
<thead>
<tr>
<th>Nominal Ø (d₁)</th>
<th>b</th>
<th>d₂</th>
<th>d₃ max.</th>
<th>d₄</th>
<th>l</th>
<th>l₁</th>
<th>L₂</th>
<th>Toothed ring m</th>
<th>Z</th>
<th>Min. rail width</th>
<th>Max. wheel load N</th>
</tr>
</thead>
<tbody>
<tr>
<td>200</td>
<td>50</td>
<td>230</td>
<td>100</td>
<td>225</td>
<td>95</td>
<td>35</td>
<td>70</td>
<td>3</td>
<td>75</td>
<td>40</td>
<td>35000</td>
</tr>
<tr>
<td>250</td>
<td>60</td>
<td>270</td>
<td>120</td>
<td>264</td>
<td>120</td>
<td>40</td>
<td>80</td>
<td>3</td>
<td>88</td>
<td>48</td>
<td>55000</td>
</tr>
<tr>
<td>300</td>
<td>65</td>
<td>335</td>
<td>150</td>
<td>330</td>
<td>120</td>
<td>45</td>
<td>90</td>
<td>3</td>
<td>110</td>
<td>52</td>
<td>66000</td>
</tr>
<tr>
<td>315</td>
<td>75</td>
<td>350</td>
<td>150</td>
<td>340</td>
<td>140</td>
<td>50</td>
<td>100</td>
<td>4</td>
<td>85</td>
<td>60</td>
<td>82000</td>
</tr>
<tr>
<td>400</td>
<td>75</td>
<td>430</td>
<td>180</td>
<td>424</td>
<td>140</td>
<td>50</td>
<td>100</td>
<td>4</td>
<td>106</td>
<td>60</td>
<td>100000</td>
</tr>
<tr>
<td>500</td>
<td>85</td>
<td>540</td>
<td>200</td>
<td>528</td>
<td>170</td>
<td>55</td>
<td>110</td>
<td>6</td>
<td>88</td>
<td>70</td>
<td>140000</td>
</tr>
<tr>
<td>630</td>
<td>95</td>
<td>680</td>
<td>250</td>
<td>664</td>
<td>200</td>
<td>60</td>
<td>120</td>
<td>8</td>
<td>83</td>
<td>82</td>
<td>180000</td>
</tr>
</tbody>
</table>
LAMIGAMID® runner wheels and pulleys are highly resistant to wear and tear. The achieved service life periods correspond to those of steel wheels. However, there are differences in the wear rates for idler or driven wheels. Hard braking or rapid acceleration, e.g. through sharp reversal in direction, can cause slippage of the wheels on the track. This may result in high wear rates.

The flanges of runner wheels are subject to excessive wear if the wheels are used on curved paths and subjected to high guiding forces. It is therefore recommended to use LAMIGAMID® runner wheels without flanges.

The wear rate of LAMIGAMID® wheels running on concrete is also very low.
As a result of the degree of flattening occurring at the contact points, which is greater than in the case of steel wheels, LAMIGAMID® runner wheels are characterized by a slightly greater rolling resistance.

At normal room temperatures the rolling resistance μR is approximately $3.5 \times 10^{-3}$. At higher temperatures, this value rises up $8 \times 10^{-3}$.

However field operation gathered with the use of runner wheels and pulleys made of LAMIGAMID® has shown that the required drive power does not have to be increased.

The force required for motion is opposed to the rolling resistance. The equation for the calculation of the rolling resistance is:

$$ W_R = \mu \cdot F \text{ (N)} $$

The rolling resistance coefficient $\mu$, of the various LAMIGAMID® runner wheels and sheaves is shown in Exhibit 5 as a function of the temperature.

In the case of permanent service of highly loaded and/or fast travelling wheels and sheaves, the rolling resistance coefficient valid for temperatures from 60° C to 80° C should also be applied for normal room temperatures, since the flexion acting in the wheel will increase the temperature.

When calculating the rolling resistance the friction resistance occurring at the seat of the wheel has to be considered, too.

The values shown in exhibit 5 are only guide values. It has not been possible to include important factors, e.g. wheel diameter, wheel load, speed and surface of the rail track.

---

**Exhibit 5:**

Coefficient of rolling resistance as a function of temperature:

- **a** = LAMIGAMID® 310 u.319
- **b** = LAMIGAMID® 320, 324/327 und 1200

**Example:**

**Runner wheel of a crane**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wheel diameter</td>
<td>D = 250 mm</td>
</tr>
<tr>
<td>Wheel width</td>
<td>b = 50 mm</td>
</tr>
<tr>
<td>Wheel pressure</td>
<td>F = 40000 N</td>
</tr>
<tr>
<td>Environmental temp</td>
<td>= 50°C</td>
</tr>
<tr>
<td>Material</td>
<td>LAMIGAMID 320</td>
</tr>
</tbody>
</table>

According to Exhibit 5 = $\mu = 3,8 \cdot 10^2$

Calculation:

$$ W_R = \mu \cdot F = 3,8 \cdot 10^2 \cdot 40,000 = 152 \text{ N} $$

Rolling resistance is 152 N.
Outrigger Floats made of LAMIGAMID®

Even great shock or impact stresses will not lead to a breakage of the plastic floats. LAMIGAMID® outrigger floats are used for support pressures from 250 -1500 kN.

Their advantages:

- high load capacity
- weight reduction compared to steel constructions
- break, shock and impact resistant
- favourable price

Telescopic cranes, vehicles carrying concrete pumps, building equipment and military vehicles are more and more often equipped with outrigger floats made of engineering plastics. These outrigger floats are produced from a LAMIGAMID® grade of a particularly impact resistant composition of high load capacity.

LAMIGAMID®-Qualities for outrigger plates

LAMIGAMID® 300

LAMIGAMID® 300 is a so called block polymer. Adding laurinlactam (monomer for cast polyamide-12) to melted caprolactam results in a polyamide with a higher impact resistance, especially at low temperatures, than LAMIGAMID® 310. This material is therefore ideally suited for use in applications with sudden stress or shock situations and it is also more suitable than LAMIGAMID® 310 for use at temperatures below 0°C.

LAMIGAMID® 400

is a semi-crystalline, amorphous, elastomer-modified thermoplastic material. It’s crystallinity offers high stability, rigidity, hardness and abrasion resistance while the amorphic areas and elastomer components provide high flexibility, elasticity and malleability. The material is UV-resistant.

By varying the elastomer content the material can be given specific properties, ranging from viscous-hard to highly-elastic. LAMIGAMID® 400 is available as

LAMIGAMID® 400 B: viscous - hard
LAMIGAMID® 400 D: highly viscous, highly elastic

LAMIGAMID® 400 is the ideal engineering plastic. Because it is possible to modify the material specifically, it can be used for numerous applications.
Outrigger floats with outside diameters below 400 mm are produced from semifinished blanks. From 400 mm upwards they are cast in special moulds. Table 8 shows the standard dimensions.

In the case of these outrigger floats only the smaller upper diameter and the spherical radius are subjected to machining. In addition the bores for fastening the holding devices are drilled.

The bores are then equipped with press-fit steel insert nuts. Small outrigger floats are produced from round bar stock or blanks. Overall machining of these parts is carried out on CNC-controlled lathes.

Other dimensions and designs up to Ø 900 mm are available upon request.

### Design

LAMIGAMID® outrigger floats are designed either in round or square shape.

The top of the outrigger float is equipped with screwed on steel holding devices. These holding devices are designed according to the site requirements or the customer’s specifications. Upon request we supply these outrigger floats completely assembled and ready to be installed.

### Calculation

For LAMIGAMID® outrigger floats, only the surface pressure acting between the ball at the hydraulic cylinder and the outrigger float has to be calculated.

The equation is:

$$ P_{\text{max}} = \frac{F}{S^2 \cdot \pi} \quad [\text{N/mm}^2] $$

- $F$ = Support pressure in N
- $S$ = Contact-Diameter in mm

Under permanent load the surface pressure $P_{\text{max}}$ may be approx. 55 N/mm². This value may be exceeded for short-term loads.
When working with mobile cranes, access lifts, telehandlers and many other items of construction machinery, it is particularly important to keep the friction resistances encountered during telescoping as low as possible. To stop friction from blocking you, Schwartz provides premium high-tech plastics with outstanding sliding properties and high load ratings. The perfect outfit for daily heavy-duty operations.

Benefits:

- jerkless starts
- excellent friction- and wear-resistance
- high strength
- good running
- lowest moisture absorption
- long maintenance intervals

The special LAMIGAMID® materials from Schwartz (see reverse) display their talents as soon as the movement starts. The transition from standstill to sliding phase is barely perceptible. The familiar “jerk” typically felt when a telescopic movement is initiated disappears almost completely. Those of your customers who have to control movements smoothly and with millimetre precision will especially appreciate this benefit.

While flat wear pads can easily be cut out of a block of material, round and angular shapes demand considerably more expertise and engineering. We can produce wear pads in all shapes, exactly as you need them, nothing is impossible. We bring your friction perfectly round corners and through bends.
Production of LAMIGAMID® Wear Pads

Wear liners and spacers made of LAMIGAMID® materials are available in any design (cp. Exhibit 6). They are manufactured from sheet material. The sheets’ dimensions are 2000 x 1000 mm or 2000 x 500 mm respectively. Their thickness ranges from 10 to 100 mm. Larger LAMIGAMID® 319 sliding elements are cast in moulds. Machining is carried out on modern machining equipment.

Exhibit 6: Different designs of wear liners and spacers

Finding perfect solutions

While flat wear pads can easily be cut out of a block of material, round and angular shapes demand considerably more expertise and engineering. We can produce wear pads in all shapes, exactly as you need them, nothing is impossible. We bring your friction perfectly round corners and through bends.
Wear liners and spacers can be produced from LAMIGAMID® 318, 319, LAMIGAMID® 510 or LAMIGAMID® 700.

The selection of the material depends on:

- the surface pressure
- the sliding velocity
- the environmental conditions

The materials mentioned are characterized by different mechanical and thermal properties. Apart from that, their individual moisture absorption rates differ. We refer to our table „Synthetic Materials, technical data".

LAMIGAMID® 319 M3 and M8 are only available in a high level order. To get further information please contact us.

### Materials

LAMIGAMID® materials are characterized by different load capacities.

<table>
<thead>
<tr>
<th>Materials</th>
<th>adm. surface pressure in N/mm²</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>permanent</td>
</tr>
<tr>
<td>LAMIGAMID® 318</td>
<td>55</td>
</tr>
<tr>
<td>LAMIGAMID® 319</td>
<td>65</td>
</tr>
<tr>
<td>LAMIGAMID® 319 M3</td>
<td>62</td>
</tr>
<tr>
<td>LAMIGAMID® 319 M8</td>
<td>60</td>
</tr>
<tr>
<td>LAMIGAMID® 510</td>
<td>65</td>
</tr>
<tr>
<td>LAMIGAMID® 700</td>
<td>12</td>
</tr>
</tbody>
</table>

**Table 9**: Guide values for the admissible static surface pressures at normal room temperature

### Coefficient of Dynamic Friction

<table>
<thead>
<tr>
<th>Materials</th>
<th>Dynamic friction coefficient in dry run</th>
<th>Dynamic friction coefficient with oil lubrication</th>
</tr>
</thead>
<tbody>
<tr>
<td>LAMIGAMID® 318</td>
<td>0,12 - 0,18</td>
<td>0,04 - 0,08</td>
</tr>
<tr>
<td>LAMIGAMID® 319</td>
<td>0,14 - 0,20</td>
<td>0,04 - 0,08</td>
</tr>
<tr>
<td>LAMIGAMID® 319 M3</td>
<td>0,12 - 0,18</td>
<td>0,03 - 0,08</td>
</tr>
<tr>
<td>LAMIGAMID® 319 M8</td>
<td>0,10 - 0,16</td>
<td>0,03 - 0,08</td>
</tr>
<tr>
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<td>0,24 - 0,28</td>
<td>0,02 - 0,08</td>
</tr>
<tr>
<td>LAMIGAMID® 700</td>
<td>- 0,29</td>
<td>0,02 - 0,08</td>
</tr>
</tbody>
</table>

**Table 10**: Dynamic friction coefficient with regard to hardened steel 2162. Peak-to-valley height = 2 µm, surface pressure = 0,05 N/mm², V = 0,6 m/s.

### Absorption of Moisture

<table>
<thead>
<tr>
<th>Materials</th>
<th>Moisture absorption</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Standard atmosphere</td>
</tr>
<tr>
<td>LAMIGAMID® 318</td>
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</tr>
<tr>
<td>LAMIGAMID® 319</td>
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<td>LAMIGAMID® 510</td>
<td>0,4 %</td>
</tr>
<tr>
<td>LAMIGAMID® 700</td>
<td>0 %</td>
</tr>
</tbody>
</table>

**Table 11**
Design of Shape

Wear liners and spacers are available in any design. The sliding segments are subjected to overall machining, i.e. they are delivered ready to be installed.

Calculation

In most cases the use of wear liners and spacers does not require any calculation. Normally the occurring surface pressures and sliding velocities are far lower than the admissible values.

Static loading can be calculated according to the known formulae. For the admissible dynamical loads, please refer to the following diagramm.

| Table 12: |
| Max. admissible loads as a function of surface pressure and sliding speed. The values shown in the diagram are only valid for continuous movements. The indicated admissible static limit loads can be applied for discontinuous movements.

Miscellaneous

Sliding elements used in telescopic booms do not have to be lubricated. An application of grease prior to installation is sufficient. If possible the countersurface should be made of stainless material. However, this is not understood as an absolute prerequisite. The countersurface should consist of a material having a peak-to-value height of Rt 5 to 8.
Headquarter
Schwartz GmbH
Hagdornstraße 3
D-46509 Xanten
Phone: 02801 76-0
Fax: 02801 76 55
E-Mail: info@schwartz-plastic.com

Sales Office USA
Schwartz Technical Plastics, Inc.
2301 Duss Avenue, Suite 24, Ambridge, PA 15003, USA
Phone: +1 724-266-7045
Fax: +1 412-202-9999
E-Mail: sales.usa@schwartz-plastic.com

Czech Republic
Schwartz Technické Plasty CR s.r.o.
Petrovická 22, 59231 Nové Mesto na Moravě, Tschechische Republik
Phone: +420 566 618 205
Fax: +420 566 618 206
E-Mail: info@schwartz-plastic.cz

China
Schwartz Technical Plastics Co., Ltd.
Room 805, Wisdom Garden, No. 380, Xinsong Road, Minhang, District, Shanghai 201100, P.R. China
Phone: +86 21 5887 2225
Fax: +86 21 5887 2280
E-Mail: info@schwartz-plastic.com

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