■ Choice of Slydring®

The function of Slydring® is to guide the piston and piston rod of a hydraulic cylinder and to absorb the transverse forces which occur. At the same time, metallic contact between the sliding parts of the cylinder, e.g. piston and cylinder barrel or rod and cylinder head, must be prevented. Non-metallic guide rings offer major benefits compared with the traditional metallic guides:

- Cost efficient production
- High load bearing capacity
- Eliminates local stress concentrations
- Wear-resistant, long service lives
- Metal/plastic pairing eliminates fretting and seizure
- Favourable friction behaviour
- Damping of mechanical vibrations
- Good wiping effect, embedding of foreign particles possible
- Protection of the seal against "dieseling"
- Free choice of material of the metal components as guiding properties are no longer required
- Eliminates hydrodynamic pressure problems in the guide system
- Simple closed groove, easy installation
- Low service costs

Materials

In view of the different specific demands made on piston and rod guides, various Slydring® materials are available:

- Highly wear-resistant, low friction, specially modified Turcite® materials for low to medium duty with limited radial forces
- HiMod® materials with friction-reducing fillers for medium to heavy duty
- Orkot® fabric composite materials for heavy duty and high radial forces

In order to choose the most suitable Slydring®, it is first necessary to know all the required functional parameters. Table I can be used to make an initial preselection of the Slydring® and the materials to meet the demands of the application.

Before the final choice of Slydring® and material is made, the details and information must be checked in the relevant data sheets of Slydring® materials.

In principle, piston Slydring® and rod Slydring® are interchangeable if the difference in size is taken into consideration, e.g. piston Slydring®, diameter 100 x 2.5 mm thick can be used as a piston rod Slydring® diameter 95 x 2.5 mm thick. Depending on the material and dimensions of the Slydring®, the thickness tolerance is in the range from +0.00/-0.08 mm except for Turcite Slydring® Article GP41 + GR41 and GP43 + GR43 where it is +0.02/-0.03 mm.

Please do not hesitate to contact our Technical Department for further information on specific applications and special technical questions.

Table I Selection Criteria for Slydring®

Slydring®		Application					Standard[1]	Installation	Material
Type	Page	Field of Application				Mating Surface	ISO	Size Range mm	Recommended Slydring® Material
			Light	Medium	Heavy				
Turcite® / Zurcon® Slydring®	10	Mobile hydraulics	●	–	–	Steel Steel, hardchromed Steel hardened Cast iron	ISO 10766	Off-the-roll up to diameter 4200	Turcite® T47
		Standard cylinders	●	●	–				
		Machine tools	●	●	–				
		Valves	●	●	–	Mild steel Steel Stainless steel Aluminium			Turcite® T51
		Rotary manifolds	●	●	–				
		Gas equipment	●	●	–				
		Pneumatics	●	–	–				
		Wind Power	●	●	–	Mild steel Steel, hardchromed Cast iron Stainless steel Aluminium			Turcite® M12
		Off-road vehicles	●	●	–				
		Injection moulding machines	●	●	–				
		Automotive industry	●	●	–				
		Foodstuff industry	●	●	–	Steel Mild steel Steel, hardchromed Stainless steel Aluminium, Ceramic coating	ISO 10766	Off-the-roll up to diameter 4200	Zurcon® Z80 / Z81 UHMWPE
		Water hydraulics	●	●	–				
		Dry application	●	●	–				
		Pneumatics	●	●	–				
HiMod® Slydring®	23	Mobile hydraulics	●	●	–	Steel Steel, hardchromed Cast iron	ISO 10766	Rings up to diameter 300	HiMod® HM061 POM/Glass fibre
		Standard cylinders	●	●	–				
		Agricultural machinery	●	●	–				
		Mobile hydraulics	●	●	●	Steel Steel, hardchromed Cast iron			HiMod® HM062 PA/Glass fibre + PTFE
		Standard cylinders	●	●	–				
		Agricultural machinery	●	●	–				
Orkot® Slydring®	46	Mobile hydraulics	–	●	●	Steel Steel, hardchromed Cast iron Ceramic coatings Stainless steel	ISO 10766	Rings up to diameter 1600[2]	Orkot® C320 Polymer/fabric
		Standard cylinders	●	●	●				
		Presses	●	●	●				
		Mobile hydraulics	–	●	●				Orkot® C380 Polymer/fabric
		Standard cylinders	●	●	●				
		Water hydraulics	●	●	●				
		Shipping and marine engineering	●	●	●				
		Presses	●	●	●				
		Mobile hydraulics	–	●	●			Rings up to diameter 500	Orkot® C932 Phenolic/cotton
		Standard cylinders	●	●	●				
		Presses	●	●	●				

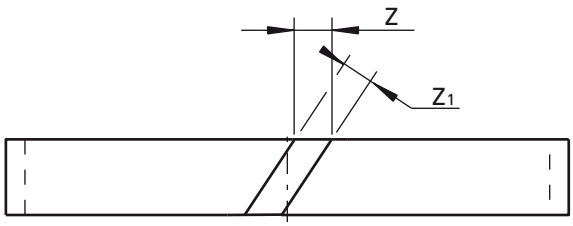
1) For Slydring® to other standards, e.g. to French standard NF E 48-037, please contact us.
2) Segments made from strip material can be used for larger diameters.

Forms of Supply

Two characteristics must be observed with respect to the forms of supply for Slydring®:

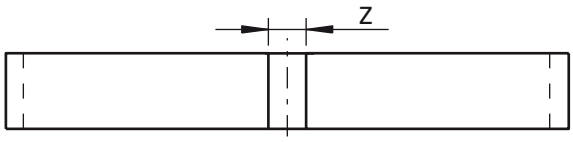
- Type of cut

Figure 1 shows the angle cut which are the most frequently used standard type of cut. Rings with other types of cut are available on request. Design Code as shown in Table III.

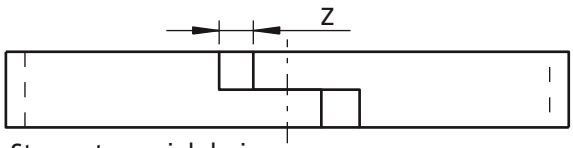


Angle cut, standard design

Note: "Z" is the gap size for Turcite® and Zurcon® Slydring®
"Z_1" is the gap size for HiMod® and Orkot® Slydring®



Straight cut, special design



Step cut, special design

Figure 1 Type of cut

- Design type

Slydring® have a rectangular cross-section with rounded or chamfered edges, thus preventing impermissible edge forces in the corner radii of the grooves. The chamfers also serve to facilitate installation, e.g. when inserting into the cylindrical tube or guide bush.

Slydring® are supplied ready to fit with the gap necessary (dimension Z or Z_1) for their function. The ring ends are finished as standard with an angle cut.

For further details, please refer to Table II.

Slydring® are depending on material supplied as split rings and/or as strip material.

Strip material is available in rolls or precut to size as listed in Table II.

Table II Forms of Supply for Slydring®

Material	Ring Diameter mm	Cut Strip for Diameter mm	Off-the-Roll
Turcite® T47/T51/M12	-	8 - 4200	See Table V
Zurcon® Z80 / Z81	on request	30 - 4200	on request
Orkot® C320/C380	16 - 1600	300 -2000	see page 46
Orkot® C932	16 - 500	-	-
HiMod® HM061	up to 300	-	-
HiMod® HM062	up to 300	-	-

Table III Design Codes for Cut

Material	Turcite®		Zurcon®	HiMod®	Orkot®	
	T47 T51 M12		Z80	HM061 HM062	C320 C380 C932	C320 C380
Code for cut	Strip With Teardrop structure*	Strip Without Teardrop structure	Strip Without Teardrop structure	Ring Without Teardrop structure	Ring Without Teardrop structure	Strip Without Teardrop structure
Angle cut	**0**	L	**0**	**0**	**0**	A
Straight cut	B	D	D	**D****	H	D
Step cut	C	E	E	E	-	E

Design Code **0**, in bold types are the standard Slydring® versions

* Standard for **Turcite**® Slydring®
** HiMod® Wear Rings for non ISO groove dimensions have as standard a straight cut Code D.

Teardrop structure: A detailed description can be found on page 10.

■ Design Instructions

Selection of Slydring®

An initial choice can be made for various applications by checking the Selection Criteria for Slydring® in Turcite®, Zurcon®, HiMod® or Orkot®, see Table I and the pages 10, 14, 23, 25 and 46.

The values for the load on the Slydring® are valid for a load distribution as illustrated in Figure 2. The flexibility of the materials ensures a relatively constant specific load, irrespective of the size of the radial forces F, as with increasing radial loading, the guide surface subjected to the load increases also.

The radial forces which occur can vary within wide ranges and cannot always be calculated exactly in advance. For such cases, a safety factor of at least 2 is recommended when calculating (see calculation example).

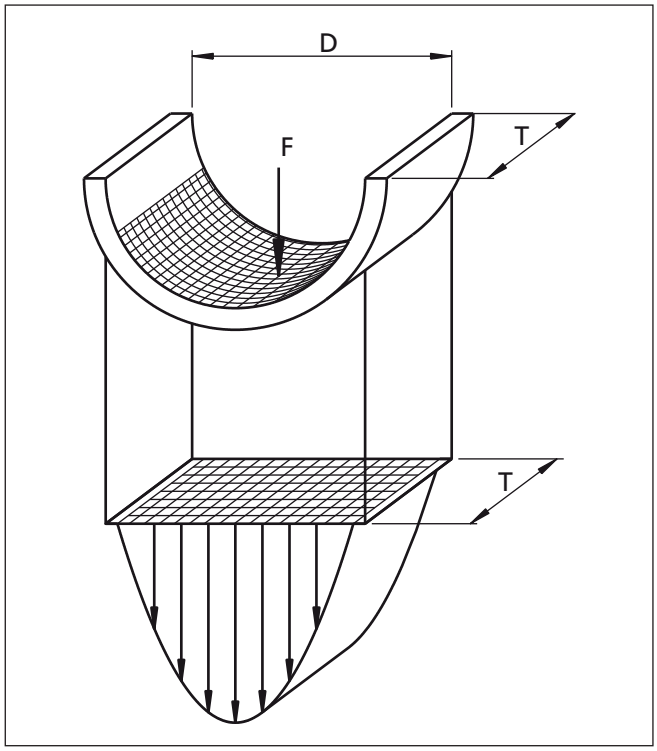


Figure 2 Load distribution

The large effective bearing area of non-metallic Slydring® gives low maximum contact pressure.

Dimensioning of Slydring®

The radial bearing pressure and the resulting elastic deflection are important parameters in the design of the Slydring®. The radial offset resulting from the dimensional tolerances, deflection and wear should always be less than the smallest gap to be sealed by the system.On request, we are willing to carry out dimensioning calculations for specific applications.

A rough estimate of the number and width of Slydring® required can be calculated using the following formula:

$$\text{Slydring® width } T_{total} = \frac{F \times f}{d_N \times Pr}$$

where:
F = Maximum radial load [N]
f = Safety factor
d_N = Rod diameter [mm]
Pr = Radial Slydring® pressure [N/mm^2]
Example:
d_N = 60 mm
F = 40.000 N
t = 40 °C
f = 2

Slydring® material Orkot® C 380
Pr 100 N/mm^2

$$T_{total} = \frac{40.000 \times 2}{60 \times 100} = 13.3 \text{ mm}$$

From Table IV, a groove with a width of 15 mm or 2 grooves with widths of 9.7 mm are selected. The installation of two strips is recommended as this gives a wider guide length.

Selected:
2 strips Series GR69 with a groove width L_2 = 9.7 mm
See Figure 4 and 5.

The standard installation arrangement for pistons and rods is shown in Figure 3 and Figure 4.

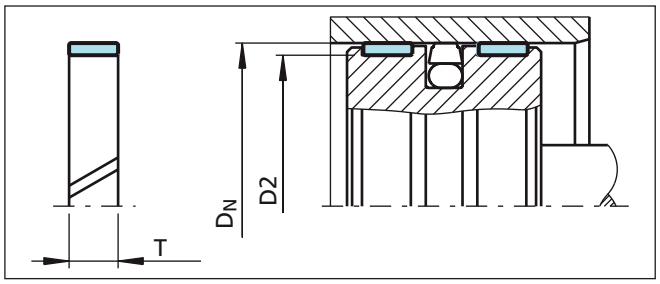


Figure 3 Piston guide

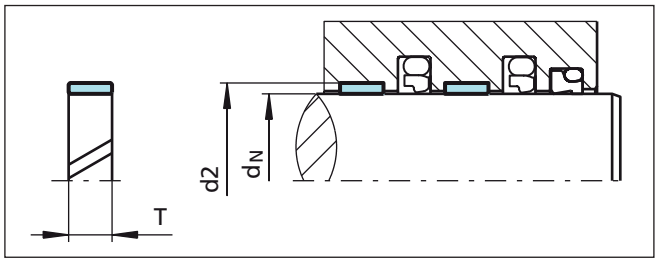


Figure 4 Rod guide

To further improve the operational safety, particularly under high loads, the installation of a 3rd strip made of material Turcite® T47 is recommended. It is installed on the oil side and serves eg as an internal scraper.

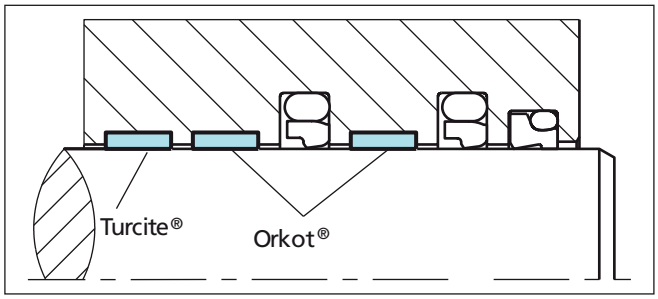


Figure 5 Rod guide for high loads
(See also Figure 15)

■ Turcite® Slydring® for Piston and Rod

Description

Turcite® Slydring® are used as piston and rod guides due to their outstanding friction behaviour, stick-slip free running and good resistance to high temperatures and chemicals.

Slydring® are available as off-the-roll materials for cutting to length in the users works as listed in Table V. Sections cut to size ready for installation is available for rod and piston diameters according to Table II.

Slydring® have a geometrically rectangular cross-section and are chamfered at the edges for easy installation into the grooves.

- Teardrop structure

Slydring® up to and including 4 mm radial thickness in Turcite® materials are as standard supplied with "teardrop" structure on the sliding surfaces. This structure comprises small lubricant pockets on the surface which improve the initial lubrication and promote the formation of a lubricant film. They also help to protect the seal system through their ability to embed any foreign particles. In order to be able to use the strip material for both piston and piston rod guides, the rings have this same teardrop structure on both sides.

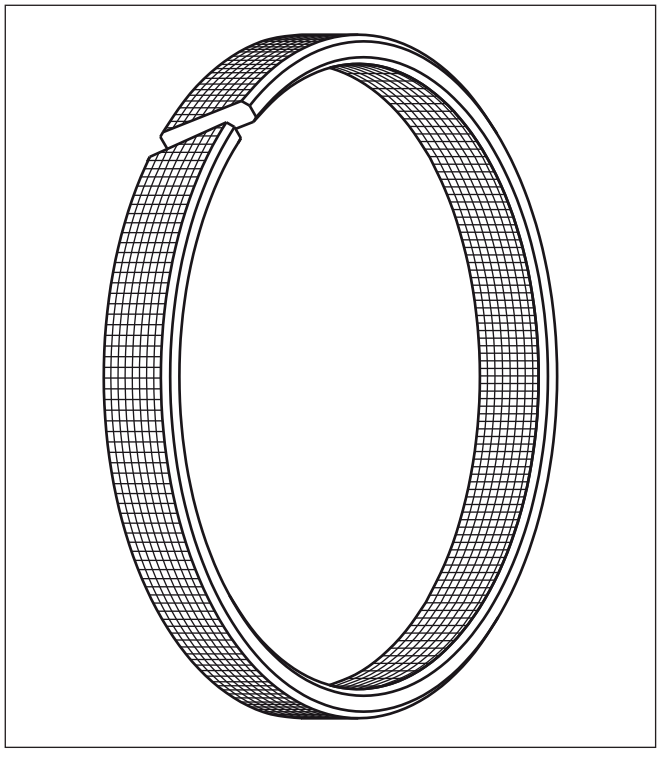


Figure 6 Turcite® Slydring® with teardrop structure

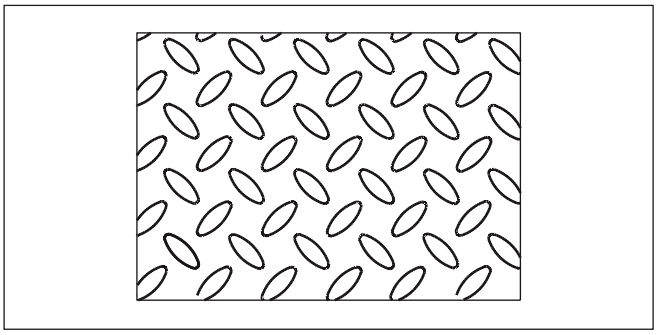


Figure 7 Teadrop structure for Turcite® Slydring®

Slydring® can also be delivered without teardrop structure. In this case, this must be indicated in the TSS Article No. (see Design Code for cut/type in Table III).

Advantages

- No stick-slip effect when starting for smooth operation even at very low speeds
- Minimum static and dynamic friction coefficient for low operating temperature and energy loss
- Outstanding lubrication conditions further improved by the Teardrop structure
- Suitable for non lubricating fluids depending on Turcite® material for optimum design flexibility
- High wear resistance ensures long service life
- Installation grooves according to ISO 10766
- Suitable for most hydraulic fluids in relation with the majority of modern hardware materials and surface finish depending on material selected.
- Suitable for new environmentally safe hydraulic fluids
- The embedding of foreign particles is enhanced
- Good damping effect, absorbs vibrations

Application Examples

The Turcite® Slydring® is successfully applied in demanding applications as a standard guiding element for hydraulic operated pistons, plus for piston rods with special requirements, in:

- Machine tools
- Injection moulding machines
- Press brakes
- Presses
- Robotics & Handling machinery
- Automation
- Positioning cylinders
- Servo hydraulics
- Piston accumulators
- Shock absorber
- Valves for hydraulic & pneumatic circuits
- Agriculture
- Chemical and Process Industry

Technical Data

The Turcite® Slydring® with angle cut is recommended for reciprocating movements

Speed:	Up to 15m/s
Temperature:	-60 °C to +150 °C (200 °C)
Media:	Mineral Oil based Hydraulic fluids, barely flammable hydraulic fluids, environmentally safe hydraulic fluids (biological degradable oils), water, air and others. Depending on the Turcite® material compatibility.
Clearance:	The maximum permissible radial clearance smax is depending on the actual sealing system.
Radial Slydring® pressure Pr:	Max. 15 N/mm^2 at 25 °C Max. 12 N/mm^2 at 80 °C Max. 8 N/mm^2 at 120 °C

When calculating the width of Turcite® Slydring® it is recommended to use a safety factor f=2 (see page 8).

With the Turcite® materials it must be taken into account that the permissible surface pressure decreases with increasing temperatures. The load bearing ability for dynamic applications in practice is dependent primarily on the operating temperature. This should therefore generally not exceed 150 °C.

Important Note:
The above stated limits for pressure and speed are maximum values individually. Friction heat generated by the combination of pressure and speed may cause local heat built-up. Care should be taken not to apply high values for pressure and speed at the same time.

Materials

Standard Application:

- For hydraulic components with reciprocating movement in mineral oils or medium with good lubricating performance. Low friction, high resistance to wear, heat and chemicals:

Turcite® T47 (bronze filled)

Special Application:

- For lubricated and poor lubricated linear and slow rotary moving hydraulic and pneumatic components:

Turcite® T51 (carbon filled)

- For all commonly applied hydraulic fluids including fluids with low lubrication performance, lowest friction and wear, improved absorption of abrasive contaminants, no wear or abrasion of counter surface:

Turcite® M12 (mineral fiber and additive filled)

Table IV Serial Numbers for Turcite® Slydring® in T47, T51, M12

Piston Serial No.	Rod Serial No.	Off-the-roll Serial No.	Groove Width L_2	Ring Thickness W
GP06	GR06	GM0600000-	6.00	1.00
GP22	GR22	GM2200000-	3.20	1.50
GP31	GR31	GM3100000-	10.00	1.50
GP41	GR41	GM4100000-	2.50	1.55
GP43	**GR43**	**GM4300000-**	**4.00**	**1.55**
GP49	GR49	GM4900000-	9.70	2.00
GP53	GR53	GM5300000-	15.00	2.00
GP64	GR64	GM6400000-	4.20	2.50
GP65	**GR65**	**GM6500000-**	**5.60**	**2.50**
GP67	GR67	GM6700000-	6.30	2.50
GP68	GR68	GM6800000-	8.10	2.50
GP69	**GR69**	**GM6900000-**	**9.70**	**2.50**
GP73	**GR73**	**GM7300000-**	**15.00**	**2.50**
GP74	GR74	GM7400000-	20.00	2.50
GP75	**GR75**	**GM7500000-**	**25.00**	**2.50**
GP76	GR76	GM7600000-	30.00	2.50
GP94	GR94	GM9400000-	20.00	3.00
GP98	**GR98**	**GM9800000-**	**25.00**	**4.00**
GP99	-	GM9900000-	9.70	4.00

Further dimensions on request.

Dimensions in **bold** are suitable for installation in grooves to ISO 10766.

Table V Turcite® Slydring® Serial No. GM Length of the roll

Turcite® T47, T51, M12		
Serial number	**Thickness W mm**	**Minimum length m**
GM06	1.00	27.0
GM22 GM31	1.50	19.0
GM41 GM43	1.55	18.5
GM49 GM53	2.00	12.0
GM64 GM65 GM67 GM68 GM69 GM73 GM74 GM75 GM76	2.50	9.0
GM94	3.00	7.0
GM98 GM99	4.00	4.5

Off-the-roll material can only be supplied as complete rolls.

Length of roles varies depending on thickness and material.

Turcite® from the roll, calculation of the Linear Length

The linear length of Turcite® and Zurcon® is calculated such that a gap "Z" is created at the ends of the strip after installation (see Figure 3 and Figure 4). This is required for the following reasons:

- Compensation of the linear expansion of the strips due to the effects of temperature
- Avoidance of intermediate pressures and entrained pressures.

When ordering strips off-the-roll for manufacturing of Turcite® and Zurcon® Slydring® in your own works, the length of the strip can be calculated using the following formulae:

Piston Slydring®:

$L = c \times (D_N - W) - k$ [mm]

Rod Slydring®:

$L = c \times (d_N + W) - k$ [mm]

D_N = Bore diameter [mm]

d_N = Rod diameter [mm]

W = Ring thickness [mm]

c = 3.11 material factor, valid for Turcite® and Zurcon® Materials

k = Temperature constant:
0.8 for operating temperatures up to 120 °C.

2.0 only for applications > 120 °C.

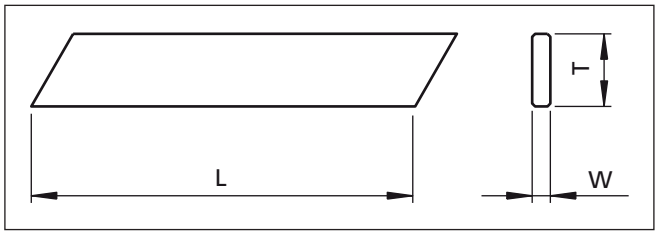


Figure 8 Cut length