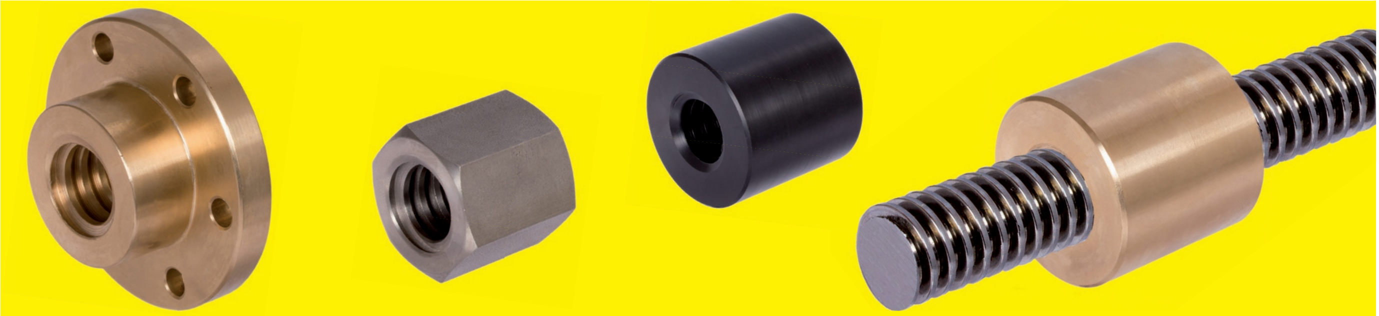


General description
Trapezoidal threads are ideal for movement due to their flank profile. Application: Conversion of a rotary movement into a linear one. Sometimes: Conversion of a linear movement into a rotary one. Trapezoidal threads can also be used as easy-to-loosen fastener.

Thread profile of the catalogue products
Metric DIN-ISO thread according to DIN 103, with 15° flank angle.

Designation of a Trapezoidal thread spindle DIN 103
DIN-number, abbreviation for trapezoidal thread, outside diameter x lead x length
For example: Spindle DIN 103 Tr. 12 x 3 x 1000mm.

Production method
Practically all of the spindles in the catalogue models are rolled. Thread rolling is the most economical production method for series production. Due to the chipless shaping, rolled threaded spindles feature a number of positive characteristics: Higher tensile strength, higher resistance to wear, higher fatigue strength under reversed bending, burnished thread flanks, precise profile, unsevered grain structure and higher resistance to corrosion. During thread rolling a groove forms at the outside diameter. This groove guarantees accuracy and cylindricity of the thread. It has no influence on the functioning of the threaded spindle, as the thread bears its load at the flanks. The threads of the nuts are cut.

Catalogue Spindles page 310 - 312

Single thread right and left	Steel C15	Tr. 10 x 3 to Tr. 70 x 10	**Page 310**
	Stainless 1.4305 STAINLESS	Tr. 10 x 3 to Tr. 50 x 8	**Page 311**
Double thread, right hand	Steel C15	Tr. 12 x 6P3 to Tr. 40 x 14P7	**Page 312**
	Stainless 1.4305 STAINLESS	Tr. 12 x 6P3 to Tr. 40 x 14P7	**Page 312**

Stock lengths: 1000mm, 1500mm, 2000mm, 3000mm.

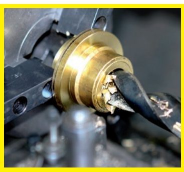
Other lengths and materials as well as customised models on request.

Stock Spindles page 313 - 315

- **Round nuts or hexagon nuts made from steel C35Pb and stainless steel 1.4305.**
  For clamping, manual adjustment and as a fastening nut. Not suitable for drive systems.
- **Round nuts or round flange nuts made from red brass Rg 7.**
  For drive systems at low and medium speed and operating times under 20%. Good dry running properties in situations with insufficient lubrication. In combination with a stainless spindle the drive becomes corrosion resistant.
- **Round flange nuts made from cast iron GG25.**
  As for round flange nut made from red brass but only limited dry-running capabilities and not corrosion proof.
- **Round nuts made from plastic PA6.6 with MoS2.**
  For low-noise drive systems. Maximum permissible peripheral speed $V_{max.}$ = 0.5 m/sec. at low load. Good dry-running properties.

Spindle and nut components are manufactured in accordance with DIN 103. Zero backlash (adjustable) can only be achieved with a two-part nut or two counteracting nuts. **Spindles and spindle nuts available from drawing on request.**

Chain Tensioners page 322



Reworking within 24h-service possible. Custom made parts on request.

Required Driving Torque for a Threaded Spindle Drive

The required output torque at the spindle can be derived from the axial load, the lead of the spindle and the efficiency of threaded spindle drive and mounting. At short acceleration times and high speeds, the acceleration torque, and with sliding guide the breakaway torque also have to be considered.

Calculation method:

1) Determining the lead angle using α book of tables or DIN sheet or through calculation.

2) Determining the friction coefficient μ using a table.

3) Calculating the effective angle of friction *p'*.

4) Calculating the degree of efficiency η.

5) Calculating the torque M_d.

Important: About 10% should be added to the end result to make up for losses due to bearing situation. Additional friction due to linear guides and possible rotational forces have to considered by adding a respective allowance. This can also be done when calculating the input power.

Calculation:

1) Lead angle α calculated from:

$$\tan \alpha = \frac{P}{d_2 \cdot \pi}$$

2) Selecting the friction coefficient μ from the table.
See table page 295 bottom.

3) Calculating the effective angle of friction *p'* from:

$$\tan p' \approx \mu \cdot 1{,}07$$

4) Calculating the efficiency degree η:

$$\eta = \frac{\tan \alpha}{\tan (\alpha + p')}$$

5) Calculating the torque M_d in Nm:

$$M_d = \frac{F \cdot P}{2000 \cdot \pi \cdot \eta}$$

Torque due to an axial load

Due to their degree of efficiency, many spindle drives with trapezoidal thread are not self-locking, i. e. an applied axial load causes a spindle torque. In this case the efficiency is lower than with a conversion of rotary into linear motion.

Calculation method: as with the conversion of rotary into linear motion, but with M_d` and η'.

Calculating the efficiency degree η':

$$\eta' = \frac{\tan (\alpha - p')}{\tan \alpha}$$

Calculating the torque M_d` in Nm:

$$M_d` = \frac{F \cdot P \cdot \eta'}{2000 \cdot \pi}$$

Legend

α	(alpha) is the lead angle of the thread.
η	(eta) is the degree of efficiency regarding the conversion of rotary into linear motion.
η'	is the degree of efficiency regarding the conversion of linear into rotary motion.
μ	(mü) is the friction coefficient.
π	(pi) is ≈ 3.14.
d_2	is the medium effective diameter.
F	is the overall axial load in N.
M_d	is the driving torque at the spindle end in Nm.
M_d`	is the torque generated by the axial load in Nm.
n	is the speed in min^{-1}.
P	is the spindle lead in mm.
p'	is the effective angle of friction.

Required Driving Power of a Spindle Drive

The power (in kW) can be derived from the driving torque M_d and the spindle speed n (in min^{-1}):

Important: In order to allow for losses caused by the bearing and other frictional losses and the power required for rotatory acceleration, the power selected for the drive should be 60 to 100% above the calculated figure.

Self-locking Capacity of Trapezoidal Spindle Drives

The self-locking capacity is linked to the friction coefficient (determined by the material match spindle/nut, surface quality, lubrication) and to the lead angle. If the lead angle is smaller than the angle of friction, the spindle drive is self-locking.

We need to distinguish between static and dynamic self-locking capacity. With static self-locking capacity a motionless nut remains steadfast, as long as it is not set in motion by other influences.
With dynamic self-locking capacity a moving nut comes to a stop, when it is no longer driven.

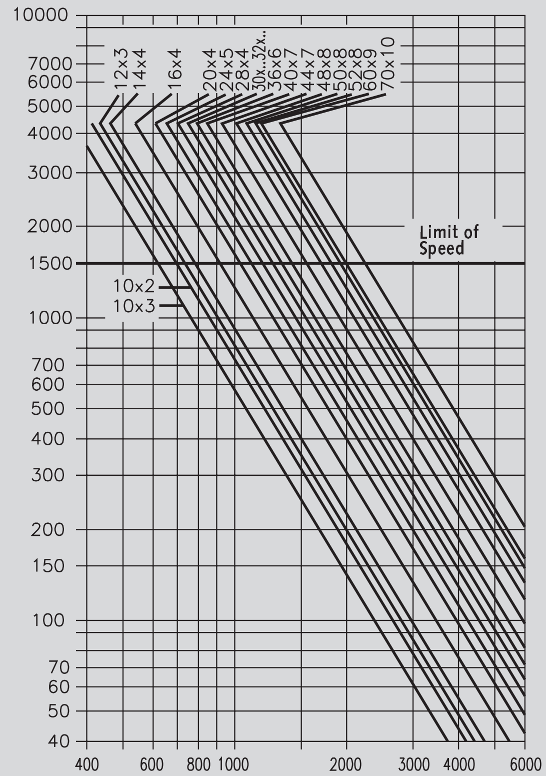
In theory all listed single-thread spindle drives - except for plastic nuts - are self locking, as the lead angle is smaller than the angle of friction. A small vibration may, however be enough to set the nut moving. The only dynamic self-locking drive is size 70 x 10, as only here the lead angle is small enough (friction coefficient 0.05 = 2.86°).

Attention: the above statements are only valid under the assumption that the friction coefficients listed in the catalogue are really fitting. In practice surface properties and the type of lubrication and lubricant used may cause derivation from the original value. To be on the safe side, a locking device (clamping device) should be fitted. In connection with plastic nuts, **none** of the spindle drives listed are self-locking.

Due to their large lead, double-threaded spindle drives are generally not self-locking.

Critical Speed of Trapezoidal-Thread Spindles

With thin, fast running spindles there is a danger that resonant bending vibration occurs. The method described below helps to determine the resonant frequency provided a rigid enough installation. Speeds close to the critical speed also immensely increase the risk of lateral buckling - the critical speed must therefore always be considered when calculating the critical buckling length. (see following chapter “critical buckling force”)

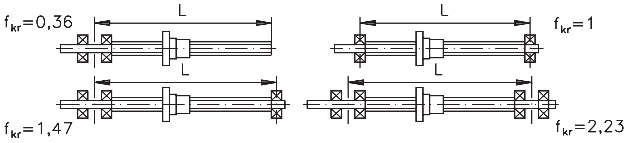


$n_{perm.} = n_{kr} \cdot f_{kr} \cdot c_{kr}$

$n_{perm.}$ is the fastest permissible spindle speed in min^{-1}.

n_{kr} is the critical spindle speed in min^{-1} - corresponds to the natural bending vibrations of the spindle and leads to resonance occurrences.

f_{kr} is a corrective factor, considering the spindle bearing. Precondition is a rigid enough installation of the spindle and a fixed bearing.
The following drawing shows 4 classic installation methods of f_{kr} for standard spindle bearings:



c_{kr} is a corrective factor, considering the influence of the critical buckling force. We would advise to first determine $n_{kr} \cdot f_{kr}$ and to then to equate $n_{perm.}$ with the actual speed n. This then leads to c_{kr} for $n/(n_{kr} \cdot f_{kr})$, and with these figures the diagramme then renders c_k (c_{kr}) the related maximum axial pressure load.

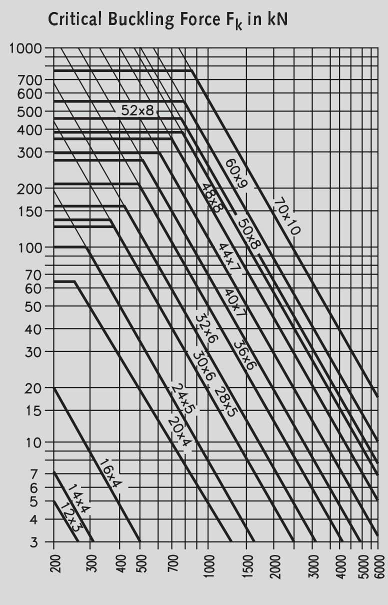
Critical Buckling Force of Trapezoidal-Threaded Spindles

With thin spindles under pressure load there is a risk that lateral buckling occurs. Before the permissible pressure load is determined, the safety factors of the mechanism have to be considered .

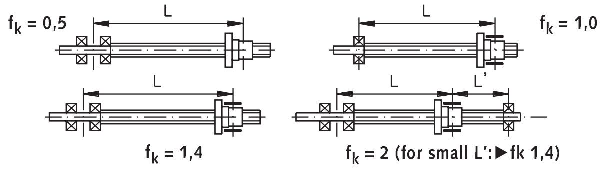
$F_{zul.} = F_k \cdot f_k \cdot c_k$

$F_{perm.}$ is the strongest permissible axial force (pressure load) on the spindle in kN.

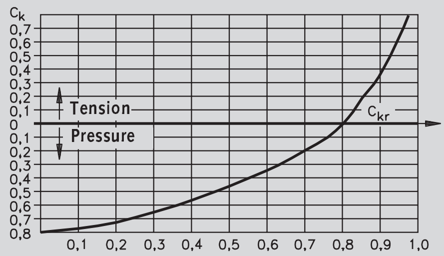
F_k is the critical buckling force in kN in connection with the free length L.



f_k is a corrective factor, considering the spindle bearing Precondition is a rigid enough installation of the spindle and a fixed bearing. The following table shows classic installation methods of f_k for standard spindle ends.



c_k is a corrective factor, considering the influence of the critical speed.



c_{kr} is here calculated as follows: $c_{kr} = \frac{n}{n_{kr} \cdot f_k}$

n is effective spindle speed in min^{-1}

n_{kr} is the critical spindle speed in min^{-1} according to the diagramme above.

f_k is the corrective factor of the critical spindle speed, under of the spindle bearing method. Values for f_k see above.

Load Capacity

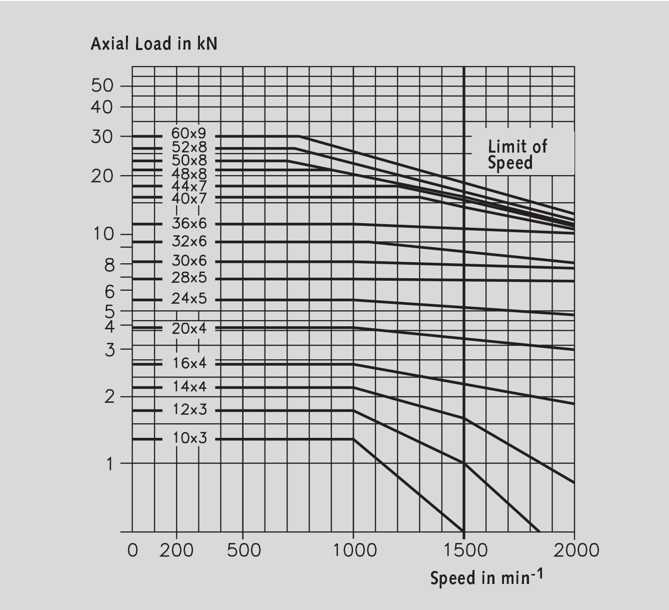
The load capacity for slide pairings usually depends on the material used, the surface properties, intake condition, lubrication conditions and gliding speed, on the temperature and thus on the duty cycle and possibilities for heat dissipation as well as the type of load (constant, fluctuating, alternating, shocks...).
The diagrammes below allow an assessment of the permissible axial load in connection with the speed of trapezoidal-threaded nuts on rolled trapezoidal-threaded spindles at normal operating conditions.

Load table for nuts made from steel C35 see page 309.

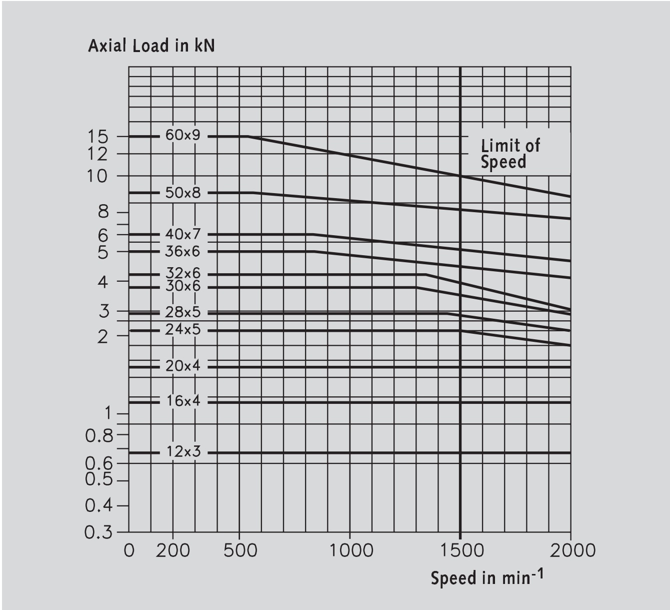
Regarding the Operating Times

Especially single-thread, trapezoidal-threaded spindle drives, due to their low degree of efficiency, convert most of the input power of the shaft into heat, which is first absorbed by spindle and then has to be dissipated. At low power and short operating times the natural dissipation and radiation of heat is usually sufficient. With continuous operation quite substantial cooling capacities might be required. As a thermodynamic calculation of these difficulties is usually to complex or even impossible, already existing comparative calculations are often the only source of information.

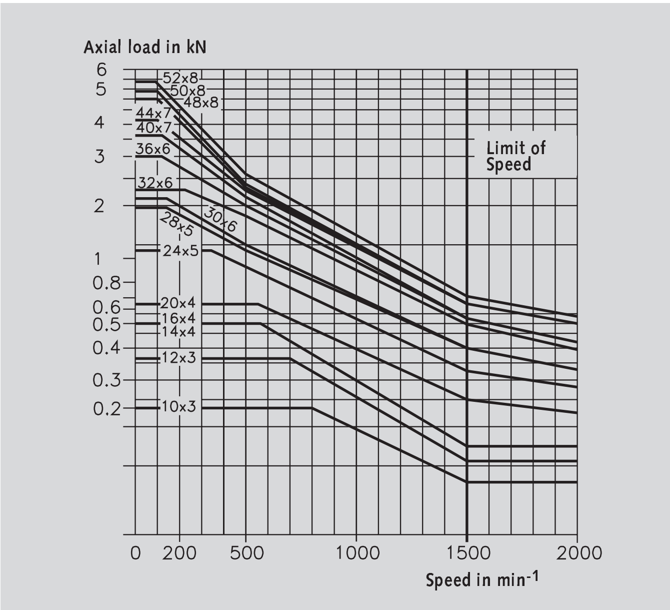
Round nuts made from red brass Rg7



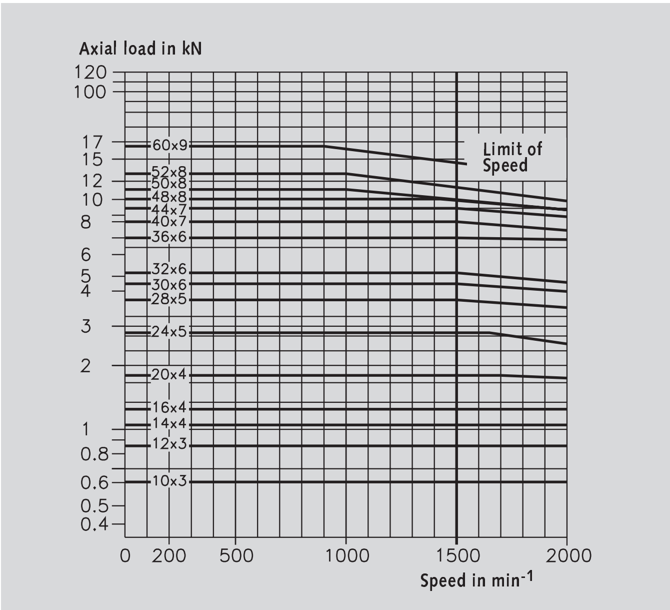
Round nuts made from plastic



Round flange nuts made from cast iron GG25



Round flange nuts made from red brass Rg7



Approx. 80% of the axial force in kN are permissible for double-threaded nuts .

Load Table for Single-Thread Steel Nuts in kN Static (without Safety Margin)

Maximum static load capacity in kN for single-thread, trapezoidal-threaded nuts made from steel C35 at a surface pressure of 25 N/mm^2.

The figures do not include any safety margin. Depending on the application a safety of 1.5 to 6 might be required (this means the figures in the table have to be divided by 1.5 to 6).

In addition the spindle has to be checked for buckling. The decisive factor in this calculation is the free spindle length and the bearing of the spindle, see page 307.

With dynamic load, the surface pressure must be no larger than 10 N/mm^2.

With double-threaded nuts about 80% of the axial load in kN is permissible.

Trapezoidal Thread Ø x Lead mm	Length at h= 1.5 x d mm	Load Capacity at h= 1.5 x d kN	Length at h= 2 x d mm	Load Capacity at h= 2 x d kN
10 x 3	15	3,6	20	4,8
12 x 3	18	5,3	24	7,0
14 x 4	21	6,9	28	9,3
16 x 4	24	9,2	32	12,3
18 x 4	27	11,8	36	15,8
20 x 4	30	14,8	40	19,8
24 x 5	36	21,2	48	28,3
28 x 5	42	29,2	56	38,9
30 x 6	45	33,4	60	44,5
32 x 6	48	35,8	64	47,8
36 x 6	54	48,9	72	65,3
40 x 7	60	60,2	80	80,3
44 x 7	66	73,1	88	97,5
48 x 8	72	87,2	96	116,3
50 x 8	75	94,9	100	126,5
52 x 8	78	102,9	104	137,3
60 x 9	90	137,3	120	183,0
70 x 10	105	211,3	-	-

PA6.6 with MoS2, a Special Polyamide, Suitable for Nuts with Trapezoidal Thread

Material Properties

This plastic is a low-maintenance material for bearings. Compared to other plastics it has a much higher wear resistance. The spec. surface pressure is 35 N/mm^2 at 23°C/ 50% RH. Threaded nuts made from plastic are more resistant against loads caused by impacts or shocks then red brass and grey cast iron-nuts. The material is also quieter than red brass and grey cast iron and increases the service life.

Properties	Unit of Measurement	Plastic PA6.6 with MoS2
Tensile Strength	N/mm^2	90 (82)
Elongation at Break	%	20 (70)
Flexural Modus	N/mm^2	3600 (1500)
Compressive Strength		
at 1% Deformation	N/mm^2	37
Izod Impact, Notched	kJ/m^2	3.35 (>10)
Shore Hardness D	D	80 - 90
Coefficient of Linear Thermal Expansion	10^{-6}/°C	63
Thermal Conductivity	W/mk	0.21
Thermal Compr. Strength 0.46 N/mm^2	°C	204 - 254
Melting Point	°C	260
Resistivity	Ω cm	>10^{13} (10^{12})
Dielelectric Constant	-	3.6 (5.1)
Dissipation Factor	-	0.03 (0.2)
Water Absorption 24 hours	%	0.5 - 1.3
Water Absorption max.	%	6 - 8

Figures are valid for a water content below 0.2%, Figures in ( ) at standard climate 23°C/50% RF. Chemically resistant against all solutions, lubricants, hydrocarbons, ketones, aqueous solutions and alkaline solutions pH5-pH11. Chemically unstable against phenols, cresols, formic acid, concentrated mineral acids and alkali, oxidisers including halogens.

Wear Properties

Common constructions (threaded spindle made from steel, nut made from grey cast iron or bronze) lead to wear of the threaded spindle and the nut. A threaded nut made from plastic does not affect the spindle, i.e. if unexpected wear occurs, only the nut has to be changed. In the pairing steel/plastic there is generally no hardening of the spindle required.

Fixing Plastic Nuts

The plastic nut can be pressed into the housing with a slight over-size of 0.1 - 0.2 mm. It can be secured against turning and displacement with any of the common locking elements used in machine building, or with a flange attached to the face side.

Attention: The over-size used for pressing the nut in passes on 1 : 1 to the inner diameter which reduces the clearance.

Note

For systems with relatively high loads or extreme operating conditions we would advise you to contact us.

Maintenance

The nuts only need to be lubricated on the first mounting, after that they are maintenance free. In order to prolong the service life of the nuts, they can be relubricated, if required. Any fat not containing molybdenum sulphide (Molykote) can be used.

Tolerances

Other than for the rest of the trapezoidal-threaded nuts, the flank clearance is kept at the upper tolerance limit, as the plastic expands when heating up.

Comparison of Friction Coefficients

Spindle / Nut	Static Dry	Static Oil Lubricated	Dynamic Dry	Dynamic Oil Lubricated	Dry-Running Characteristics
Steel / Steel	0.33	0.10	0.15	0.05	none
Steel / Cast iron	0.20	0.10	0.10	0.05	limited
Steel / Red brass	0.20	0.10	0.10	0.05	good
Steel / plastic	0.10	0.04	0.10	0.01-0.04	excellent
Stainl. steel / Stainl. steel	0.33	0.1	0.15	0.05	none
Steel / Stainless steel	0.33	0.1	0.15	0.05	none