Shaft Components

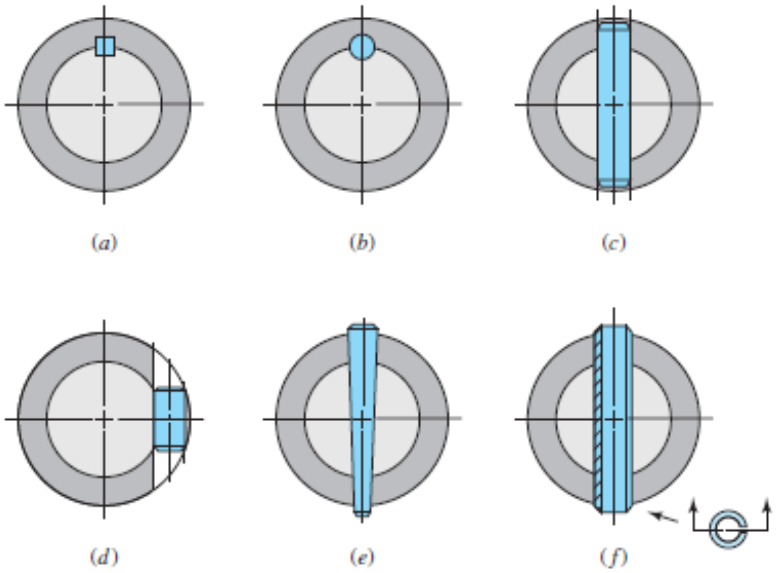
Keys and Pins

Keys and pins are used on shafts to secure rotating elements, such as gears, pulleys, or other wheels. Keys are used to enable the transmission of torque from the shaft to the shaft-supported element. Pins are used for axial positioning and for the transfer of torque or thrust or both.

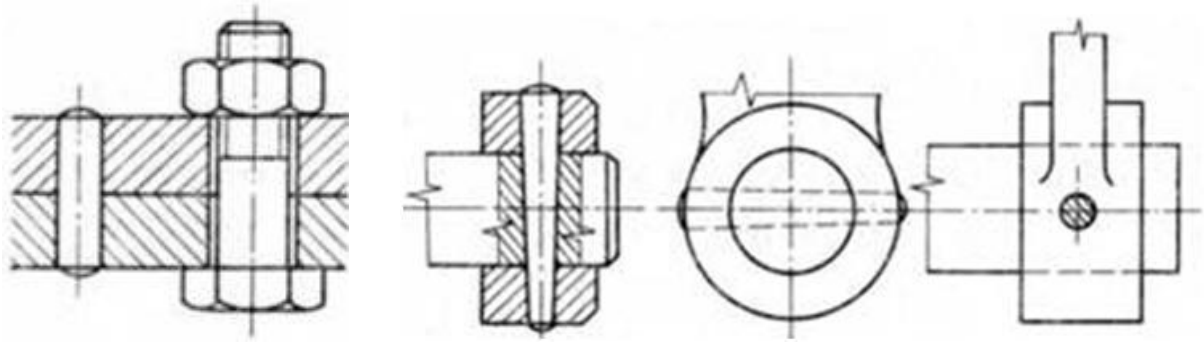
Figure 4.1 shows a variety of keys and pins. Pins are useful when the principal loading is shear and when both torsion and thrust are present. Taper pins are sized according to the diameter at the large end.

Figure 4.1

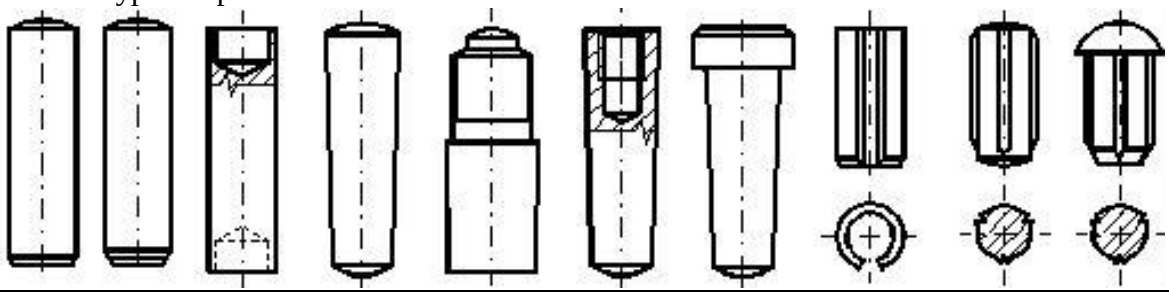
(*a*) Square key; (*b*) round key; (*c* and *d*) round pins; (*e*) taper pin; (*f*) split tubular spring pin. The pins in parts (*e*) and (*f*) are shown longer than necessary, to illustrate the chamfer on the ends, but their lengths should be kept smaller than the hub diameters to prevent injuries due to projections on rotating parts.



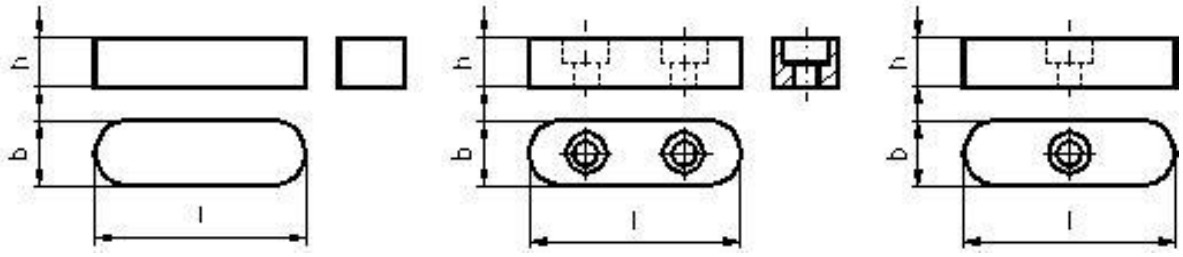
Examples of Practical applications of pins



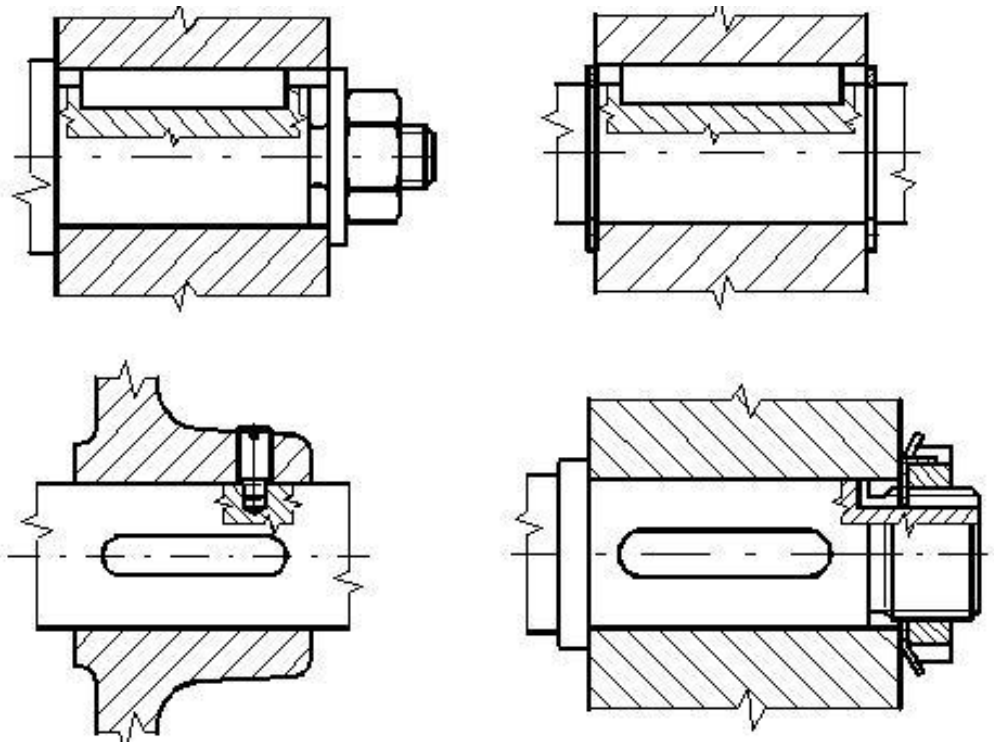
The Basic types of pins



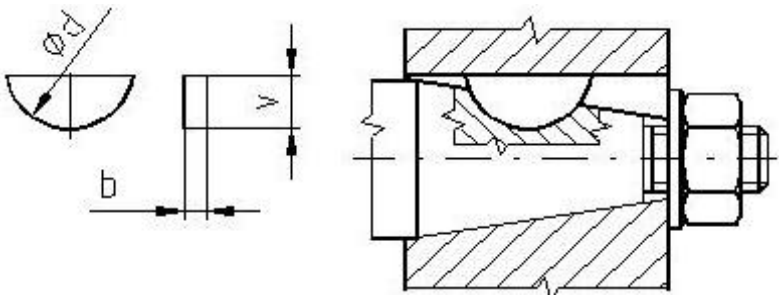
The basic types of square keys



If a square key is used, it is necessary to guaranties axial securing of the joint. Some basic types are shown in the following figures

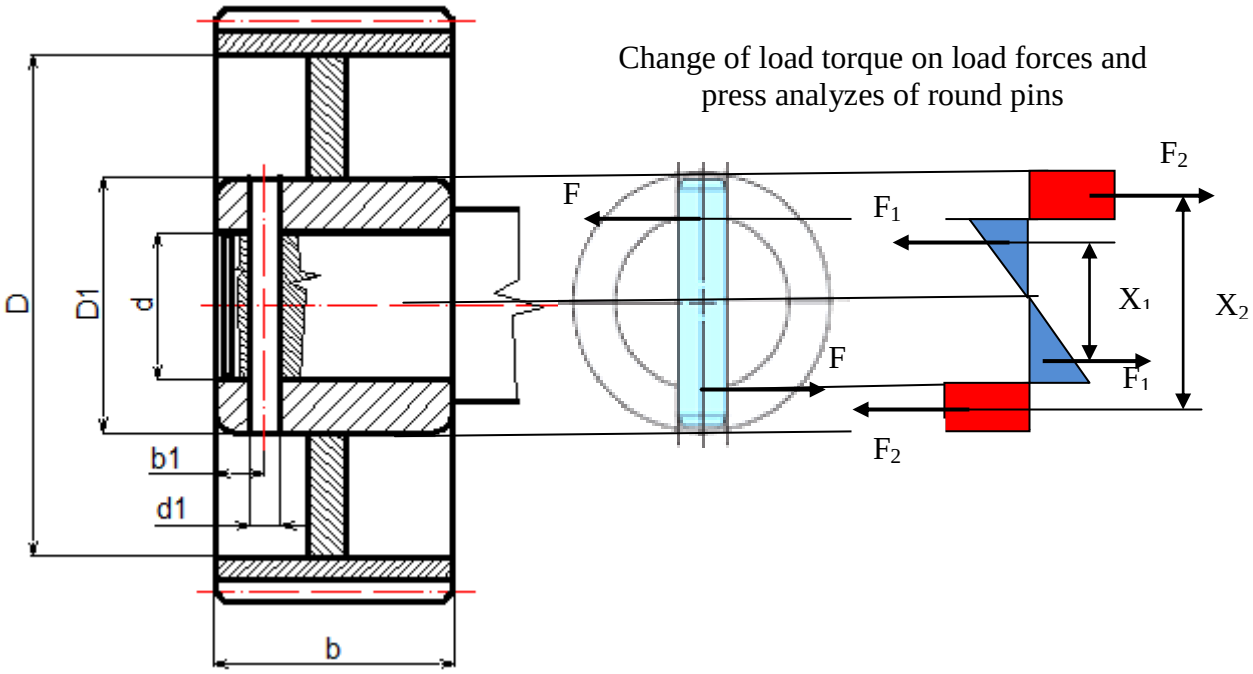


The application of a Woodruff´s key significantly lowers the cross section of the shaft. Therefore, it is more suitable to use it to connect the cone shafts of the shafts to the flange.



Design of pins

A.) Stress control of round pins



Change of load torque on load forces and press analyzes of round pins

Analyzes of load torque $\mathbf{M_k}$ and change on load forces

A1. Shear stress of pins

Area of pins

Finally shear stress

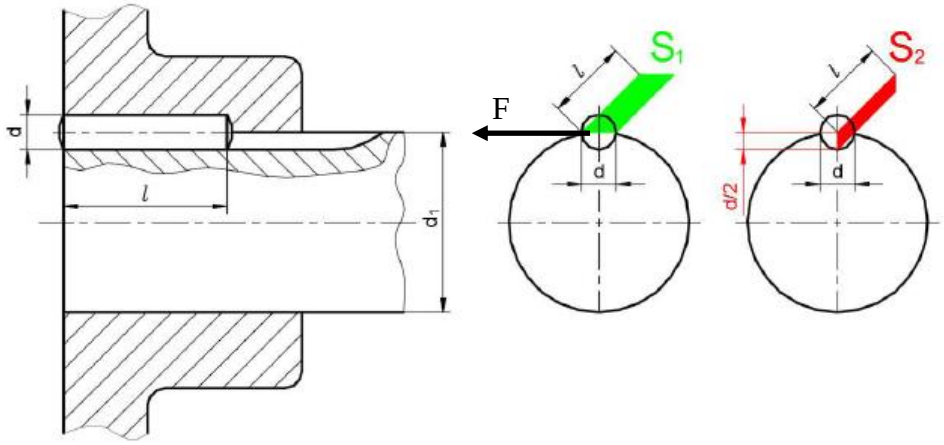
Press stress of pins
A1. Press area (blue color in fig.) ***pin- shaft***.

Finally press

A2. Press area (red color in fig.) ***pin- flange***.
Area of press is linearism.

Finally press

B.) Stress control of round key

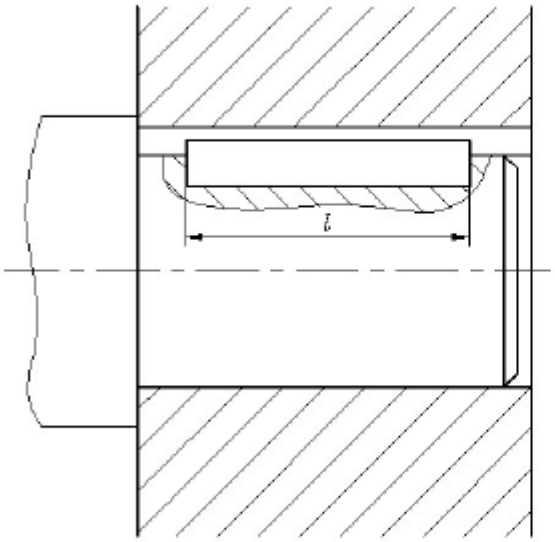


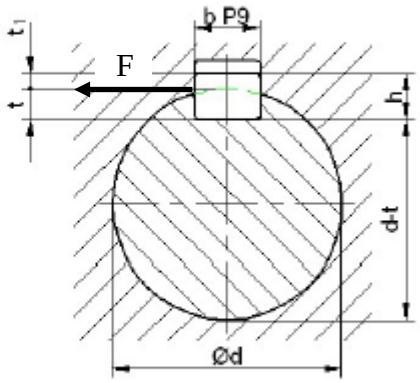
B1. Shear stress of round key (green area)

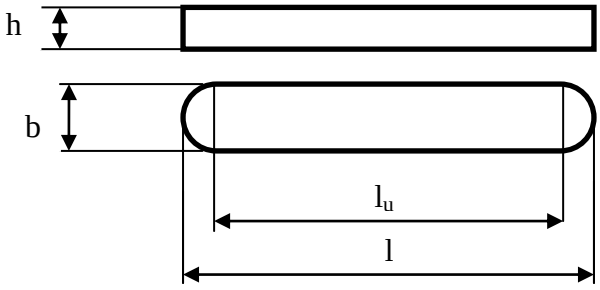
B2. Press stress of round key
Press area (red color in fig.) ***round key- shaft, or round key - flange***.

p_D – steel – steel – 120MPa, p_D – steel – cast iron – 80MPa, p_D – steel – aluminum alloy – 60MPa

Design of square keys







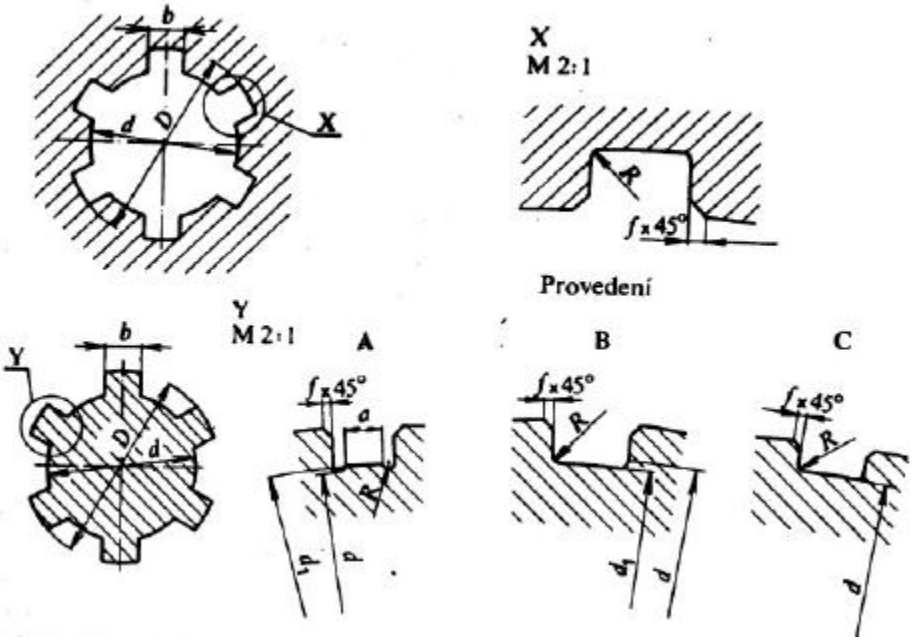
The basic dimension of square keys
b- width of square key [mm]
l – length of square key [mm]
h – height of square key [mm]
l_u – used length of square key [mm], $l_u = l - b$

Shear stress of square key

Press stress of square key

Press area: ***square key- shaft, or square key - flange***.

Design of splined shaft



Press condition between shaft and flange

$$p \leq p_D$$

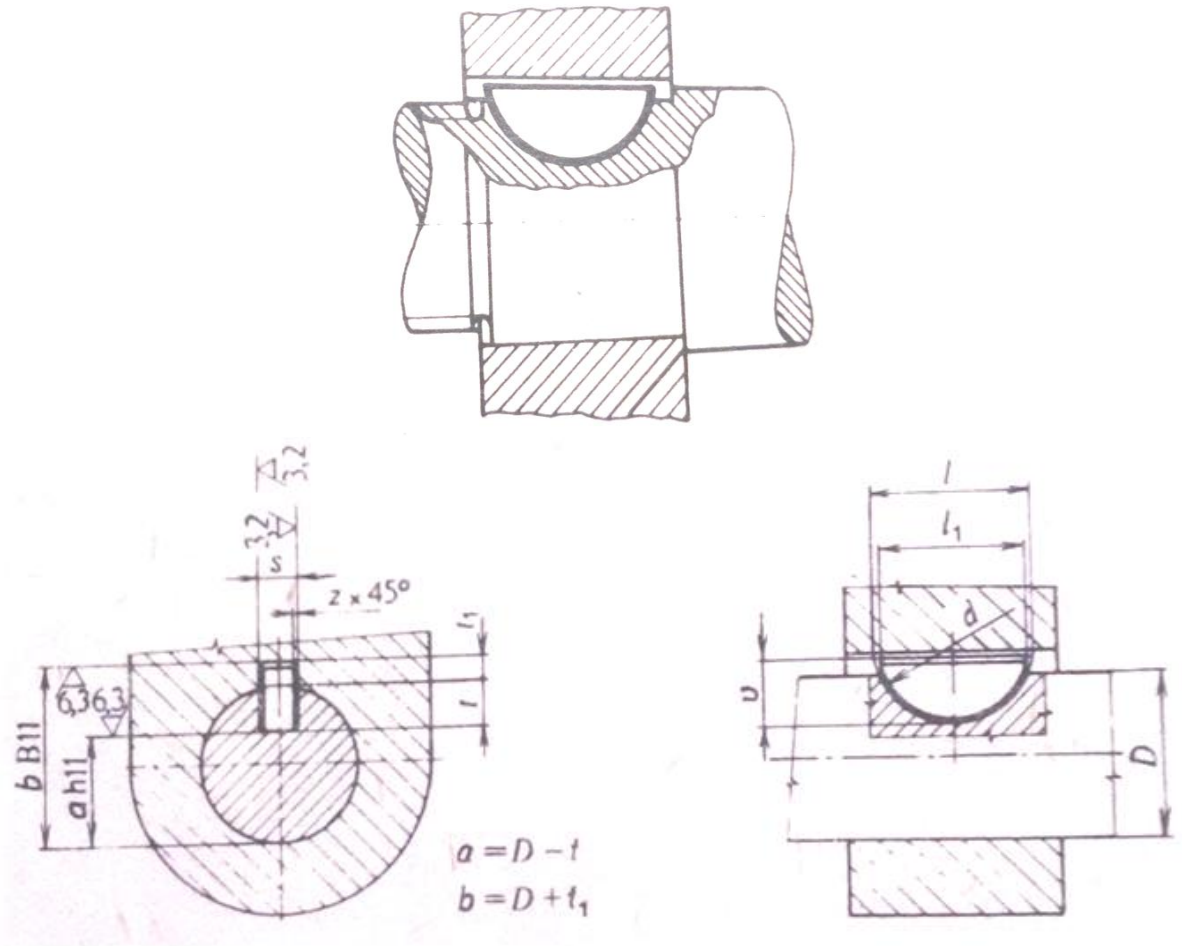
p_D – steel – steel – 120MPa, p_D – steel – cast iron – 80MPa, p_D – steel – aluminum alloy – 60MPa

p_D – steel – steel – 20MPa – axial moving flange

Length of splined shaft

Design of Woodruff´s key

The design a Woodruff´s key, we use the standard. The dimensions of the Woodruff´s key are assigned to the dimensions of the shaft.

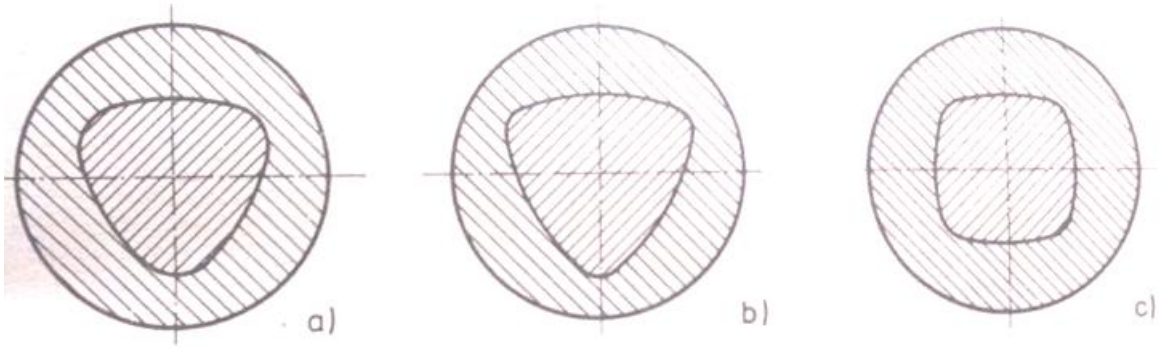


Shear stress of Woodruff´s key

Press stress of Woodruff´s key
Press area ***Woodruff´s key – shaft, Woodruff´s key –flange.***

Design of polygonal shaft journals

The advantage of fast assembly and disassembly of the flange on the shaft is offered by solutions using polygonal shaft journals. The basic species are shown in the following figures. Referred to as PB, PC3 and PC4. Profiles PC3 and PC4 are able to transmit large torques even when the hub is slid ably mounted relative to the shaft.

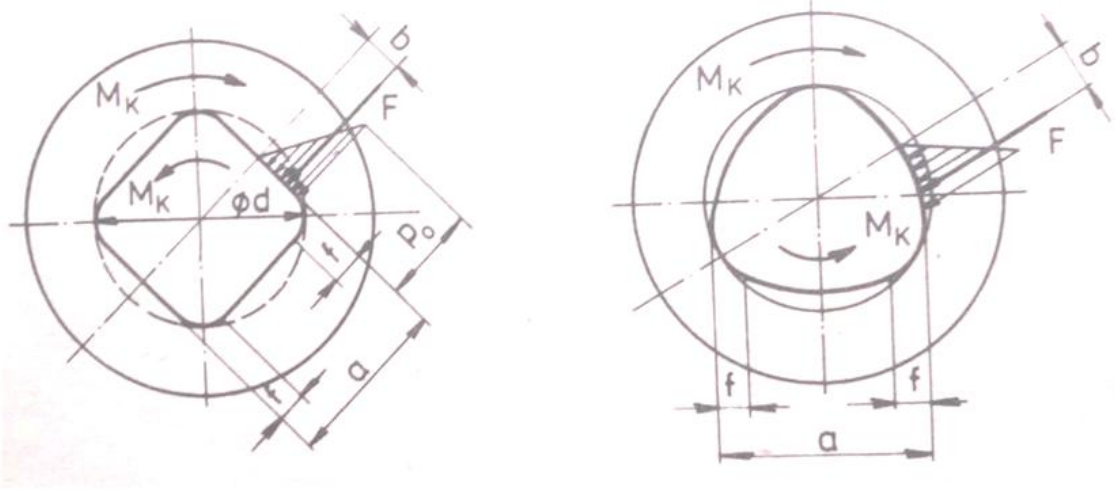


The design is based on the condition of bending moment or torque:

Minimum hub thickness for PC3 profile:

Minimum hub thickness for PC4 profile:

We assume that the connection is without clearance and without preload and that the loading torque induces a shear stress on half of each side of the profile.



Condition for loading

We get the resulting formula to determine the length of the connection:

The following applies to the pressure check: