The cross pin connects 2 flanges (torque load)

The easiest and oldest way joints. It is a joint with a shape contact. The pin serves primarily to ensure the mutual positioning of the two parts. They are cylindrical or conical. The pins are dimensioned under simplified assumptions without will and without the pressing effect. When calculating the pin, the length of the pin should not be considered, which is different from the nominal cross-section see, for example, the thread in the pin etc.

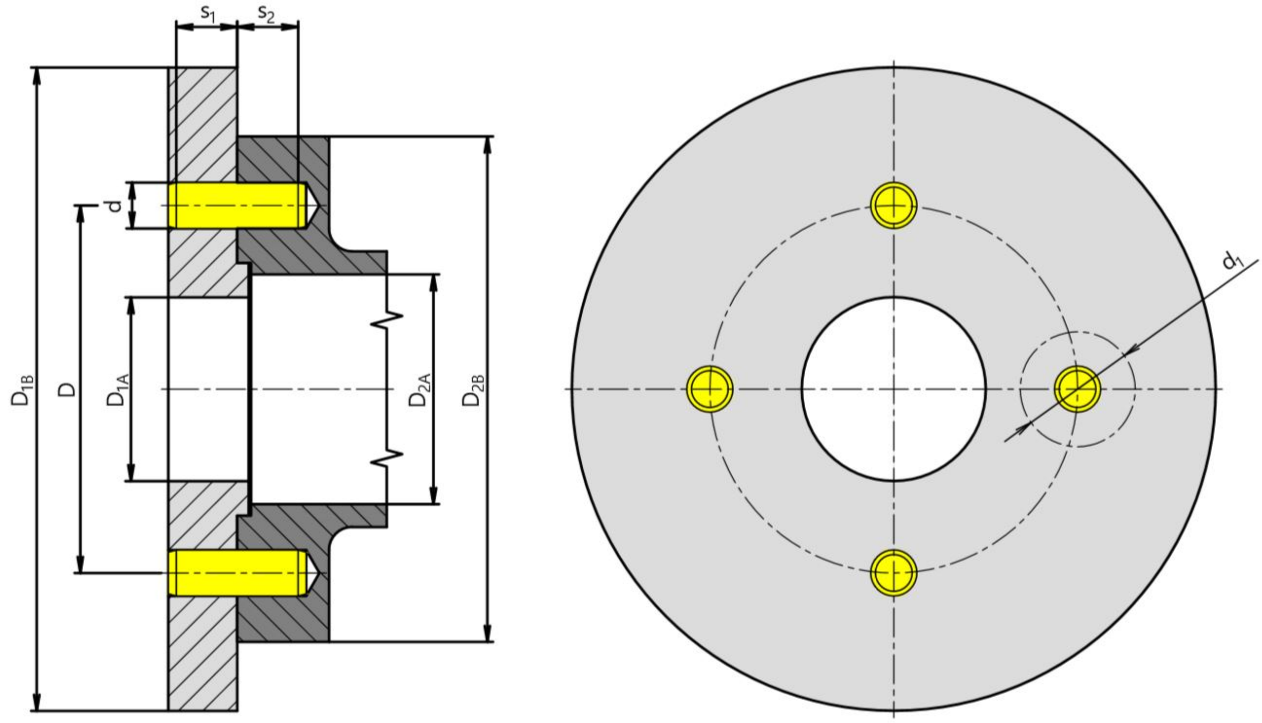

Fig. 1 the cross pin connects 2 flanges (torque load)

Shear stress in the pin:

$$\tau_p = \frac{8M_k}{i * \pi * d^2 * D} \leq \tau_{all}$$

τ_p	shear stress in the pin	[MPa]
M_T	torque	[Nm]
D	Pitch diameter for pins	[mm]
i	number of pins	[]
d	diameter of the pin	[mm]
τ_{all}	allowable shear stress	[MPa]

Allowable shear stress:

$$\tau_{all} = \frac{0{,}4R_{p0,2T}}{S_F} * C_c$$

τ_{all}	allowable shear stress	[MPa]
$R_{p0,2T}$	the minimum yield strength or 0,2% proof strength at calculation temperature	[MPa]
S_F	safety factor	[]

C_c	coefficient according to load	[]

Coefficient according to load:

load	[]
Unidirectional load, non-impact load	0,8
Unidirectional load, with a small impact load	0,7
Unidirectional load, with a big impact load	0,6
Alternating load, with a small impact load	0,45
Alternating load, with a big impact load	0,25

Bearing stress in the pin and flange 1:

$$p_1 = \frac{2 * M_T}{i * s_1 * d * D} \leq \sigma_{all}$$

P_1	bearing stress in the pin and flange 1	[MPa]
M_T	torque	[Nm]
D	Pitch diameter for pins	[mm]
i	number of pins	[]
s_1	pin length in flange 1	[mm]
d	diameter of the pin	[mm]
σ_{all}	allowable bearing stress	[MPa]

Allowable bearing stress:

$$\sigma_{all} = \frac{0{,}9 R_{p0,2T}}{S_F} * C_c$$

σ_{all}	allowable bearing stress	[MPa]
$R_{p0,2T}$	the minimum yield strength or 0,2% proof strength at calculation temperature	[MPa]
S_F	safety factor	[]
C_c	coefficient according to load	[]

Bearing stress in the pin and flange 2:

$$p_2 = \frac{2 * M_T}{i * s_2 * d * D} \leq \sigma_{all}$$

P_2	Bearing stress in the pin and flange 2	[MPa]
M_T	torque	[Nm]
D	Pitch diameter for pins	[mm]
i	number of pins	[]
s_2	pin length in flange 2	[mm]
d	diameter of the pin	[mm]
σ_{all}	allowable bearing stress	[MPa]

Axial stress in the flange 1:

$$\sigma_{A1} = \frac{K_{t1} * 4 * M_T}{i * D * (D_{1B} - D_{1A} - 2d) * s_1} \leq \sigma_{Aall}$$

σ_{A1}	Axial stress in the flange 1	[MPa]
K_{t1}	concentration factor in flange 1	[]
M_T	torque	[Nm]
D	Pitch diameter for pins	[mm]
s_1	pin length in flange 1	[mm]
D_{1B}	outer diameter of flange 1	[mm]
D_{1A}	inner diameter of flange 1	[mm]
i	number of pins	[]
d	diameter of the pin	[mm]
σ_{Aall}	allowable axial stress	[MPa]

Concentration factor in flange 1:

$$K_{t1} = C_{1A} + C_{1B}\left(\frac{d}{2c_1}\right) + C_{1C}\left(\frac{d}{2c_1}\right)^2 + C_{1D}\left(\frac{d}{2c_1}\right)^3$$

$$C_{1A} = 2{,}9969 - 0{,}0090\left(\frac{c_1}{e_1}\right) + 0{,}01338\left(\frac{c_1}{e_1}\right)^2$$

$$C_{1B} = 0{,}1217 + 0{,}5180\left(\frac{c_1}{e_1}\right) - 0{,}5297\left(\frac{c_1}{e_1}\right)^2$$

$$C_{1C} = 0{,}5565 + 0{,}7215\left(\frac{c_1}{e_1}\right) + 0{,}6153\left(\frac{c_1}{e_1}\right)^2$$

$$C_{1D} = 4{,}082 + 6{,}0146\left(\frac{c_1}{e_1}\right) - 3{,}9815\left(\frac{c_1}{e_1}\right)^2$$

$$c_1 = min\left\{\frac{D - D_{1A}}{2}; \frac{D_{1B} - D}{2}\right\}$$

$$e_1 = max\left\{\frac{D - D_{1A}}{2}; \frac{D_{1B} - D}{2}\right\}$$

K_{t1}	concentration factor in flange 1	[]
C_{1A}	coefficient	[]
C_{1B}	coefficient	[]
C_{1C}	coefficient	[]
C_{1D}	coefficient	[]
d	diameter of the pin	[mm]
c_1	dimension	[mm]
e_1	dimension	[mm]
D	Pitch diameter for pins	[mm]
D_{1B}	outer diameter of flange 1	[mm]

D_{1A}	inner diameter of flange 1	[mm]

Allowable axial stress:

$$\sigma_{Aall} = \frac{0{,}45R_{p0,2T}}{S_F} * C_c$$

σ_{Aall}	allowable axial stress	[MPa]
$R_{p0,2T}$	the minimum yield strength or 0,2% proof strength at calculation temperature	[MPa]
S_F	safety factor	[]
C_c	coefficient according to load	[]

Axial stress in the flange 2:

$$\sigma_{A2} = \frac{K_{t2} * 4 * M_T}{i * D * (D_{2B} - D_{2A} - 2d) * s_2} \leq \sigma_{Aall}$$

σ_{A2}	Axial stress in the flange 2	[MPa]
K_{t2}	concentration factor in flange 2	[]
M_T	torque	[Nm]
D	Pitch diameter for pins	[mm]
s_2	pin length in flange 2	[mm]
D_{2B}	outer diameter of flange 2	[mm]
D_{2A}	inner diameter of flange 2	[mm]
i	number of pins	[]
d	diameter of the pin	[mm]
σ_{Aall}	allowable axial stress	[MPa]

Concentration factor in flange 2:

$$K_{t2} = C_{2A} + C_{2B}\left(\frac{d}{2c_2}\right) + C_{2C}\left(\frac{d}{2c_2}\right)^2 + C_{2D}\left(\frac{d}{2c_2}\right)^3$$

$$C_{2A} = 2{,}9969 - 0{,}0090\left(\frac{c_2}{e_2}\right) + 0{,}01338\left(\frac{c_2}{e_2}\right)^2$$

$$C_{2B} = 0{,}1217 + 0{,}5180\left(\frac{c_2}{e_2}\right) - 0{,}5297\left(\frac{c_2}{e_2}\right)^2$$

$$C_{2C} = 0{,}5565 + 0{,}7215\left(\frac{c_2}{e_2}\right) + 0{,}6153\left(\frac{c_2}{e_2}\right)^2$$

$$C_{2D} = 4{,}082 + 6{,}0146\left(\frac{c_2}{e_2}\right) - 3{,}9815\left(\frac{c_2}{e_2}\right)^2$$

$$c_2 = min\left\{\frac{D - D_{2A}}{2}; \frac{D_{2B} - D}{2}\right\}$$

$$e_2 = max\left\{\frac{D - D_{2A}}{2}; \frac{D_{2B} - D}{2}\right\}$$

K_{t2}	concentration factor in flange 2	[]
C_{2A}	coefficient	[]
C_{2B}	coefficient	[]
C_{2C}	coefficient	[]
C_{2D}	coefficient	[]
d	diameter of the pin	[mm]
c_2	dimension	[mm]
e_2	dimension	[mm]
D	Pitch diameter for pins	[mm]
D_{2B}	outer diameter of flange 2	[mm]
D_{2A}	inner diameter of flange 2	[mm]

Diameter in which there must be no other debilitating element:

$$d_1 = \frac{4M_T}{D * i} * max\left\{\frac{1}{\tau_{all} * s_1}; \frac{1}{\tau_{all} * s_2}\right\} + d$$

d_1	diameter in which there must be no other debilitating element	[mm]
M_T	torque	[Nm]
D	Pitch diameter for pins	[mm]
i	number of pins	[]
s_1	pin length in flange 1	[mm]
s_2	pin length in flange 2	[mm]
d	diameter of the pin	[mm]
τ_{all}	allowable shear stress	[MPa]

In the marked diameter d_1 and there must be no other weakening element in the cross-section in which the pin is located.

Literature:

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