Basics - Calculation FKE

The calculation of the values, given in the catalogue, are based on the following assumptions and simplifications:

Distinction between flange connection & pressure ring

The transmissible forces and torque are considered separately for the pressure ring and the flange due to the coupling design. While the pressure ring provides clamping forces only, the transmissible forces and torque must be accommodated by the flange. This results in different values for the shrink connection and the flange.

Transmissible torque

A shrink connection is capable of transmitting torque, bending moment and axial force. The transmissible torque M_{max} is specified in the product data as a sole parameter. If additional loads occur simultaneously then they must be added vectorially to the resultant moment M_{res}. The formula below applies to the resulting moment:

$$M_{res} \leq M_{max}$$

Each different load case must be individually checked against M_{max}!

M_{res} is determined for combined loads as follows:

$$M_{res} = \sqrt{M_T{}^2 + M_B{}^2 + (F_{AX}\ \tfrac{dW}{2})^2}$$

with $M_B \leq 0{,}4\ M_T$ as the limit* for the static bending moment

*In principle, the maximum bending moment corresponds to the maximum transmittable torque. The limitation of 0,4 M_T is due to the change of the surface pressure at the edges of the connection. (This information applies to the shrink connection of the coupling **only**!)

This results in the following relationships:

Torque only:
The maximum torque is equivalent to M_{max} .

Bending moment only:
The maximum static bending moment corresponds to 0,4 M_T .

Axial force only:
The maximum axial force is $M_{max} \frac{2}{d_W}$.

In addition, the load on the flange bolting connection must be taken into account

Transmissible forces and torque at the flange connection

The bolt connection of the flanges is also based on friction. The torque is transmitted via this connection. Whereas the torque capacity usually corresponds to, or is higher than that of the shrink connection it is any transmissible bending moment which must be particulary considered.

Bending influences the bolt connections and the flange itself. The static load case usually corresponds to the transmissible bending moment of the shrink connection, the bending moment capacity is however lower in the dynamic load and will be determined for each individual case by us (refer to the Product questionnaire).

The same applies to axial loads, as they are transmitted directly by the bolt connection of the flanges.

Static and dynamic load

For some applications, a static review of the coupling is sufficient. The clamping forces of the shrink connection are static. Non cyclic torques and/or axial forces can also be considered as static loads. Rotating bending has to be considered as a dynamic load and the coupling must be calculated accordingly. Therefore it is also essential to specify the actual occurring load cases.

Shaft and hub calculation

The flange-hub will be deformed due to the applied clamping force. Shaft stiffness and surface finish should be considered in addition to the clearance between shaft and hub. Stiffness can be ignored for solid shafts, but for hollow shafts (see „Bore in the shaft (hollow shaft)“) there is higher deformation and thus higher stresses in the components. This must be considered in addition to other loads.

The stresses in the hub can be determined by various hypotheses, such as GEH. A discussion and analysis of results is not made here because only a very limited range of static applications could be covered. Various calculation methods for different cases can be found in engineering literature or using specialised software. Often only a calculation via FEA will give reliable results for complex geometry

Notch effect

Generally there is a notch effect on the components caused by the radial pressure of the pressure ring. This depends mainly on the applied pressure. The notch effect is generally higher on the hub than on the shaft, because the pressure ring is directly pressed onto the hub, while the stresses are distributed through the hub before reaching the shaft. The notch factors range from 2,5 to 3,5 for the hub and between 1,5 and 2 for the shaft. This can be mitigated by suitable design features, such as relief notches.

Some standards provide the possibility for a notch factor to be determined by a fit pairing (interference fit) for a shrink-connection. A similar method can also be used for such shrink connections. To this end an oversize can be calculated from the applied surface pressures. As a result a matching fit pair can be determine and thus a resultant notch factor found.

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Bore in the shaft (hollow shaft)

A large bore d_B in the shaft or the use of a hollow shaft, reduces the stiffness of the shaft against radial pressure. This leads to a decrease in pressure p_W, a reduced transmissible torque M, a contraction Δd_B within the shaft and an increase of stresses in these components. Basically, a bore should not be greater than 0,3 d_W.