Chapter 7
Interference fit according to DIN 7190

7.1 General information

The interference fit is a frictional shaft-hub-connection. The joint pressure in the friction surfaces p_F, that is necessary for the power transmission, is generated by the deformation of shaft and hub. According to the manufacturing method, you have to differentiate between a shrink and force fit. Shrink-fitting is a procedure in which heat is used to produce a very strong joint between two pieces of metal, one of which is inserted into the other. Heating causes one piece of metal to contract or expand on to the other, producing interference and pressure which holds the two pieces together. In a force fit of cylindrical parts, the inner member has a greater diameter than the hole of the outer member. The calculation takes place according to DIN 7190 for cylindrical interference fits. In addition to it, the influence of the centrifugal force, the stepped hub geometry, torque, radial force and bending moment are considered as well.

7.2 Application

The standard DIN 7190 defines the calculating basis for interference fits with cylindrical surfaces whose parts are made of metallic materials. This standard applies mainly for the common mechanical engineering but can be used also in other fields (e.g., precision engineering). The calculation method DIN 7190 applies for interference fits with a constant axial length of inner and outer part (see figure 1). The calculation can be used approximately for interference fits according to figure 2. Stress increases in the area of the hub edge are not considered.

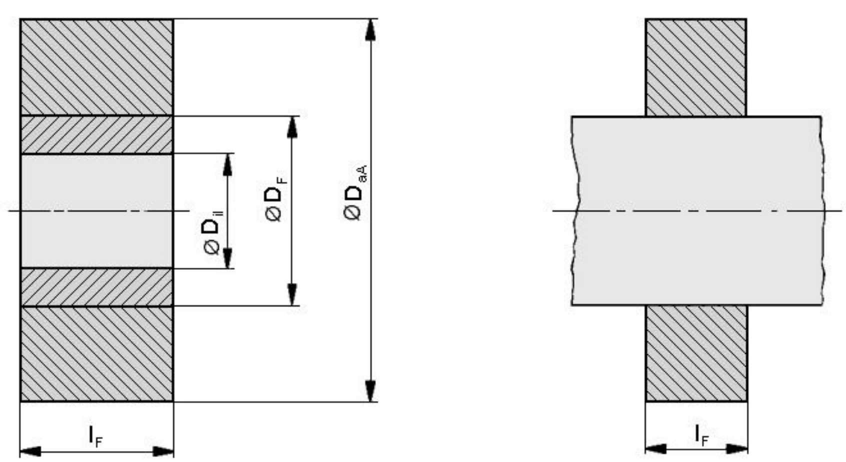


Figure 7.1: Figure 1 and 2

7.3 Selection of fit/tolerances

For a comfortable selection and calculation of possible tolerances, a dialog window for the selection of fits is included. This dialog window contains the tolerance system according to DIN ISO 286 including all IT classes. In DIN ISO 286, the tolerances for the diameter are defined up to 500 mm. The desired tolerance field can be selected for hub and shaft from a listbox. An individual input of the upper and lower deviation is also possible. The lowest and highest interference as well as the fit type for the nominal diameter will be displayed. For the calculation of possible fits, the IT scope can be selected. The following IT scopes are available:

- User-defined (the IT scope can be defined individually)
- Gauge (IT classes 1 to 5)
- Common mechanical engineering (IT classes 6 to 11)
- Rolled, pressed and forged products (IT classes 12 to 16)
- All (IT classes 1 to 18)

To find the right fit, different options are available (see section 7.16.3 ‘Selection of fit / Calculation of possible fits’). Based on the specified loads, the minimum and maximum interference are determined. These values will be displayed automatically in the field ‘Calculation of possible fits’ and provide the basis for the dimensioning and selection of appropriate tolerances. In addition, there is the possibility to define a tolerance field for the hub and shaft. Select the option ‘Show only preferred fits’and click the button ‘Search fits’ and all possible fits will be displayed. Then choose one of the fits.

7.4 The dimensioning

In addition to the possibility to get suggestions for the appropriate fits, further dimensioning functions for the joint diameter, the length, the torque and the axial force are available. In section 7.16.3 you can find an example for the dimensioning of the torque.

7.5 The influence of the centrifugal force

The influence of the centrifugal force on the interference fit by the input of a speed is considered according to F. G. Kollmann´s, Braunschweig ‘Rotierende Pressverbände bei rein elastischer Beanspruchung’ (Konstruktion 33, 1981 H.6, pp.233-239).

7.6 Additional external loads

In addition to the consideration of axial and tangential forces, a radial and a bending moment can be specified. The calculation takes place according to Prof. Gropp ‘Das Übertragungsverhalten dynamisch belasteter Pressverbindungen ...’ and Prof. Hartmann ‘Berechnung und Auslegung elastischer Pressverbindungen’. Resulting from the given loads for the bending moment and radial force, the additional external loads may be determined from the following equations:

$$p_b = \frac{9}{2}\frac{M_b}{(2-Q_W)\cdot D_F \cdot l_F^2} \quad \text{and} \quad p_r = \frac{F_r}{d_F \cdot l_F}$$

For a too small minimum joint compression, the hub lifts-off and a so-called gaping joint occurs. A gaping joint minimizes the joining surface available for the power transmission and is imperative to avoid.

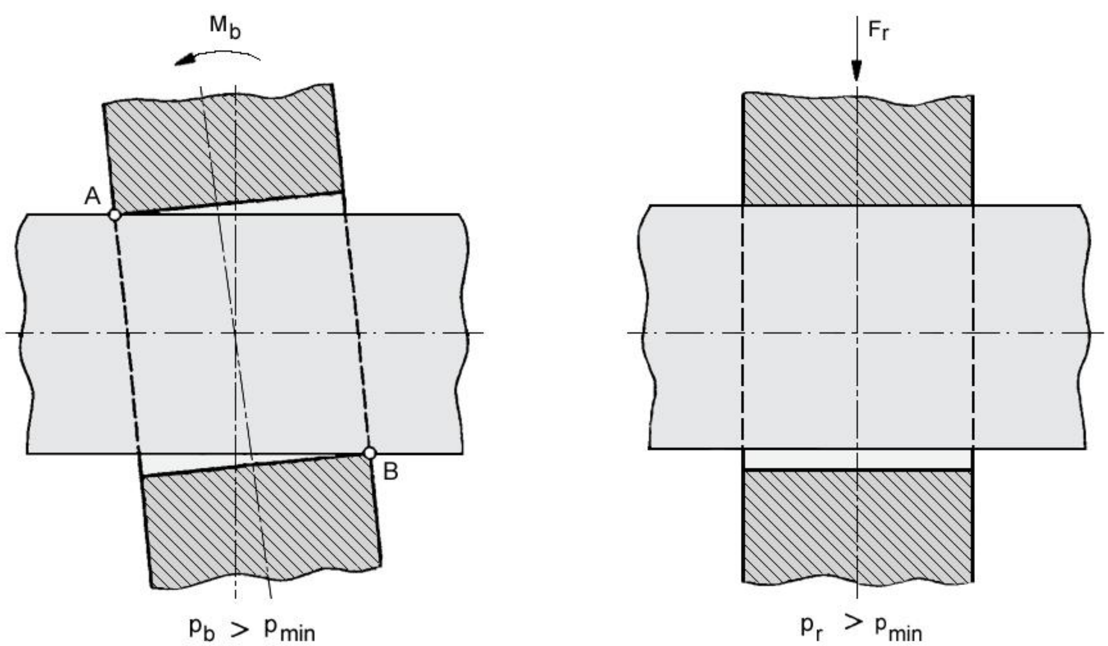


Figure 7.2: Gaping joint

To avoid a gaping joint, the following condition has to be fulfilled:

$$p_{min} \geq p_r + p_b$$

If this condition is not fulfilled, then an appropriate warning/message appears.

7.7 The operating factor (application factor)

The operating factor (application factor) is determined for the calculation of the operating torque T_b similarly to the gear calculation according to DIN 3990 with the following table.

Application factors K_A according to DIN 3990-1: 1987-12				
Working characteristics of the driving machine	**Working characteristics of the driven machine**			
	Uniform	Light shocks	Moderate shocks	Heavy shocks
Uniform	1,0	1,25	1,5	1,75
Light shocks	1,1	1,35	1,6	1,85
Moderate shocks	1,25	1,5	1,75	2,0
Heavy shocks	1,5	1,75	2,0	2,25 or higher

Examples for driving machines with various working characteristics according to DIN 3990-1: 1987-12	
Working characteristics	**Driving machine**
Uniform	Electric motor (e.g., d.c. motor), steam or gas turbine with uniform operation[1] (small rarely occurring starting torques)
Light shocks	Steam turbine, gas turbine, hydraulic motor or electric motor (large, frequently occurring starting torques)
Moderate shocks	Multiple-cylinder internal combustion engines
Heavy shocks	Single-cylinder internal combustion engines
[1] Based on vibration tests or on experiences gained from similar installations.	

Examples of working characteristics of driven machines according to DIN 3990-1: 1987-12	
Working characteristics	**Driven machines**
Uniform	Steady load current generator; uniformly loaded conveyor belt or platform conveyor; worm conveyor; light lifts; packing machinery; feed drives for machine tools; ventilators; lightweight centrifuges; centrifugal pumps; agitators and mixers for light liquids or uniform density materials; shears; presses; stamping machines[1]; vertical gears; running gear[2].
Light shocks	Non-uniformly (e.g., with piece or batched components) loaded conveyor belts or platform conveyors; machine tool main drives; heavy lifts; crane slewing gear; industrial and mine ventilator; heavy centrifuges; centrifugal pumps; agitators and mixers for viscous liquids or substances of non-uniform density, multi-cylinder piston pumps, distribution pumps; extruders (general); calendars; rotary kilns; rolling mill stands[3] (continuous zinc and aluminum strip mills, wire and bar mills).
Moderate shocks	Rubber extruders; continuously operating mixers for rubber and plastisc; ball mills (light); woodworking machine (gang saw, lathes); billet rolling mills[3],[4]; lifting gear; single-cylinder piston pumps.
Heavy shocks	Excavator (bucket wheel drives), bucket chain drives; sieve drives; power shovels; ball mills (heavy); rubber kneaders; crushers (stone, ore); foundry machines; heavy distribution pumps; rotary drills; brick presses; debarking mills; peeling machines; cold strip[3],[5]; briquette presses; breaker mills.
[1] Nominal torque: maximum cutting, pressing or stamping torque. [2] Nominal torque: maximum starting torque. [3] Nominal torque: maximum rolling torque. [4] Torque from current limitation. [5] K_A up to 2,0 because of frequent strip cracking.	

7.8 The coefficients of friction

The following table provides some approximate values for the coefficients of adhesion/coefficients of friction for shrink fits according to DIN 7190. The values are on the safe side and can be used for sliding in circumferential and longitudinal direction.

Coefficients of adhesion for shrink fits in longitudinal and circumferential direction during sliding	
Mating of material, lubrication, joining	Coefficients of adhesion ν_R, ν_{rl}, ν_u
Steel/Steel pair	

Pressurized oil assembly normally joined with mineral oil	0,12
Pressurized oil assembly with degreased surfaces joined with glycerine	0,18
Shrink fit normally after heating the outer part up to 300°C in an electric kiln	0,14
Shrink fit with degreased surfaces after heating up to 300°C in an electric kiln	0.20
Steel/Cast iron pair	
Pressurized oil assembly normally joined with mineral oil	0,10
Pressurized oil assembly with degreased surfaces	0,16
Steel/MgAl pair, dry	0,10 to 0,25
Steel/CuZn pair, dry	0,17 to 0,25

The following table specifies the coefficients of adhesion/coefficients of friction for force fits according to DIN 7190. These values are valid for monotonic loading and are determined for inner parts made of X 210 Cr W12. They are valid for steel. After joining, the interference fits require sufficient time (24 hours is best) before first loading to assure a strong joint.

Coefficients of adhesion for force fits during monotonic loading

[1] Coefficients of adhesion are unknown

Materials			Coefficients of adhesion			
old	new		dry		lubricated	
		Number	ν_{ll}	ν_{rl}	ν_{ll}	ν_{rl}
St 60-2	E 335	1.0060	0,11	0,08	0,08	0,07
GS-60	GE 300	1.0558	0,11	0,08	0,08	0,07
RSt37-2	S 235JRG2	1.0038	0,10	0,09	0,07	0,06
GG-25	EN-GJL-250	0,6025	0,12	0,11	0,06	0,05
GGG-60	EN-GJS-600-3	0,7060	0,10	0,09	0,06	0,05
G-AlSi12 (Cu)	EN AB-44000 ff.		0,07	0,06	0,05	0,04
G-CuPb10Sn G-CuSn10Pb10	CB495K	2.1176.01	0,07	0,06	-[1]	-[1]
TiAl6V4	TiAl6V4	3.7165.10	-[1]	-[1]	0,05	-[1]

The above-mentioned table means:

- = Coefficient of adhesion in longitudinal direction for loosening
- = Coefficient of adhesion in longitudinal direction for sliding

The coefficients of adhesive friction/coefficients of friction are dependent upon the following factors:

- Mating of material of inner and outer part,
- Roughness of joining surfaces,
- Condition of joining surfaces before joining (lubricated or not),
- Load of inner and outer part (elastic only or elastic-plastic).

Due to the friction within the joint, the coefficients of adhesive friction are subject to statistical fluctuations. Therefore, the defined coefficients of adhesive friction are approximate values and are on the safe side. The values can be replaced by an experimental determination of values according to DIN 7190.

7.9 The stepped hub geometry

For the stepped hub or/and shaft (see figure below), there is a larger joint compression on the thick-walled segment than on the thin-walled segment for the same fit. Hence, widely different stress and deformation ratios occur on each segment. In that case, the total length L_F has to be used. The hub can be considered as composed of separate discs of different diameters. From it, the mean joint pressure for the interference fit is determined. Because the stresses and deformation cannot change abruptly from one segment to another segment, this method of segmentation presents an approximation. The effort to define the matching conditions or to determine the joint compression by using FEM calculation is just useful for critical cases.

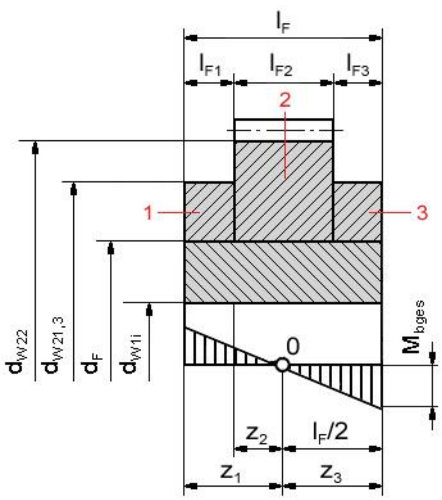


Figure 7.3: The stepped hub

The calculation is determined according to the algorithm in Prof. Hartmann´s 'Berechnung und Auslegung elastischer Pressverbindungen'. Click on the button 'stepped' next to the input field 'Outer diameter hub' to consider the stepped hub geometry. Any number of segments can be defined. The section 7.16.7 'The stepped hub geometry' discusses this issue. The figure shows how the segmentation has be specified. A segment can contain a constant outer hub diameter and inner shaft diameter. If a shaft bore extends over two outer hub diameters of different size, then two segments has to be defined with a different outer hub diameter and equal inner shaft diameter. In case there is a stepped shaft bore within a constant hub outer diameter, then use this method, too (a definition of two segments with equal outer hub diameter and different inner shaft diameter).

7.10 The subsidence/the surface smoothing

Due to the smoothness of asperity peaks during the joining, only the interference U_w is available. Unless there are experimental values, the equations according to DIN 7190 for force and shrink fits are:

$$U = U_o - s \quad \text{and} \quad s = 0,8(R_{zA} + R_{zI})$$

where s is the subsidence that results from the determined surface roughness R_z of inner and outer part. $U_o$is the mean, lowest and highest interference. If the values of the surface roughness for the arithmetic mean value of the profile coordinates R_a (formerly the arithmetical mean deviation of the roughness profile R_a) are specified according to DIN EN ISO 4287, then the determined mean values according to DIN 7190 can be used for the surface roughness R_z (see table below). Select the entry 'User defined' from the listbox 'Surface'. Now the input field next to the listbox is enabled and you can enter a value for the surface roughness R_z.

Comparison of arithmetical mean deviation of the roughness profile R_a with average surface roughness R_z				
R_a in μm		Ra0,8	Ra1,6	Ra3,2
R_z in μm	from	3,15	6,3	12,5
	to	10	20	31,5
Averaged surface roughness R_z in μm		Rz6,3	Rz12,5	Rz20

7.11 The modification of diameter

The calculation of the modification of diameter at the inner and outer diameter of shaft and hub takes place according to Niemann´s 'Maschinenelemente' volume 1 pp.789, 3rd edition 2001. There, the modification of the diameter is considered by the joint pressure and centrifugal force. The influence of temperature on the modification of diameter is considered on the outer diameter of the shaft and on the inner diameter of the hub by the modified interference and joint pressure.

7.12 The menu item 'Options'

The button 'Options' allows you to define the minimum safeties, the mating clearance, the temperatures at joining (room temperature and shaft temperature) as well as the coefficient of friction at joining for pressing in and pressing out for a force fit. Additionally, there is the possibility to enter the number of decimal places for the output of the numerical values in the report (see section 7.16.8 'The button Options').

7.13 Fretting corrosion

According to Niemann 'Maschinenelemente' volume 1 p.800, 3rd edition 2001, the torque is transmitted also during repeated load by elastic transformation (i.e., without slip), if the torque T is smaller than the maximum torque T_E . For a solid shaft, disk-shaped hub with $L_F/D_F > 0,25$ and shaft and hub with equal E modulus, it is expressed as:

$$T_E \leq \frac{T \cdot S_R}{\sqrt{\frac{3}{(1-Q_A^2)}} \cdot 2 \cdot \frac{L_F}{D_F}}$$

$T \cdot S_T$ is the slipping torque against fretting corrosion. This results in remedial measures agaisnt fretting corrosion. The joint pressure, coefficient of adhesion in terms of circumference, the joint diameter or the safety against sliding can be increased in order to avoid micro sliding/fretting corrosion. A rotating bending may cause fretting corrosion. If the mentioned conditions for a possible determination of the maximum torque are given, the maximum torque is calculated for the minimum, mean and maximum interference.

7.14 Assembly and disassembly

Shrink fits: In shrink fits, the outer member is heated or the inner part is cooled, or both, as required. The calculation of the temperatures to cool the inner part or to heat the outer part is dependent upon the chosen minimum fit. Additionally, a mating clearance for joining has to be kept to avoid adhesion. For an individual production, it is recommended to use the following mating clearance

$$U_{s\vartheta} = 0,001 \cdot D_F$$

For the individual production the risk of premature adhesion of the joining parts is covered before the assembly process is completed. By using joining devices, the above recommended mating clearance can be fallen below. Click on the button 'Options' to define the mating clearance (see section 7.16.8 'The button Options'). Two possibilities are available. On the one hand, the mating clearance can be specified dependent upon the joint diameter, on the other hand a mating clearance can be entered directly in μm. In general, the room temperature as well the joint temperature of the inner part are set. The required joint temperature is calculated as follows:

$$\vartheta_{Aerf} = \vartheta_R + \frac{U_F}{\alpha_A \cdot D_F} + \frac{\alpha_I}{\alpha_A} \cdot (\vartheta_I - \vartheta_R)$$

The button 'Options' allows to change the room temperature and the joint temperature of the shaft (see section7.16.8 'The button Options'). The highest joint temperature may not exceed the required work piece features of the heat-treated parts. In the following table, the data according DIN 7190 valid data are specified for the maximum joint temperatures dependent on the material of the outer part and the heat treatment.

Joint temperature	
Material of the outer part (hub)	**Joint temperature °C maximum**
Structural steel lower strength Cast steel Modular cast iron	350
Hardened and tempered steel or cast steel	300
Surface layer hardened steel	250
Case-hardened steel or high-tempered structural steel	200

The following table provides the coefficients of linear thermal expansion for inner and outer part.

Poisson´s ratio, elastic modulus, coefficient of linear thermal expansion					
Materials	Material No.	Poisson´s ratio ν $\approx$	Elastic modulus N/mm^2 $\approx$	Coefficient of linear thermal expansion α $\frac{10^{-6}}{°C}$ Heating $\approx$	Supercool
MgAl8Zn AlMgSi AlCuMg	3.5812 3.2315 3.1325	0,3 0,34 0,33 to 0,34	65 000 to 75 000	23	-18
GG-10[1] GG-15[1]	0.6010 0.6015	0,24	70 000 80 000	10	-8
GG-20[1] GG-25[1]	0.6020 0.6025	0,24 to 0,26	105 000 130 000		
GGG-50	0.7050	0,28 to 0,29	140 000	10	-10
Malleable cast iron		0.25	$>$ 90 000 to 100 000	10	-8
C-steel low alloyed Ni-steel		0,3 to 0,31 0,31	200 000 to 235 000	11	-8,5
Bronze		0,35	80 000 to 85 0000	16	-14
Red brass		0,35 to 0,36		17	-15
CuZn39Pb3 CuZn37	2.0401 2.0321	0,37 0,36		18	-16
[1] Not allowed for system engineering in metallurgy/rolling mills					

Liquid nitrogen $(\vartheta_I = -195,8°C)$ is used to cool shrink fits. Liquid nitrogen shrink fitting is one of the safest assembly methods. In some cases CO_2 dry ice $(\vartheta_I = -78,4°C)$ is also used as a coolant. Based on the maximally permissable temperature of the hub, it must be decided whether the cooling process is necessary or not.

Force fits: The required pressing force for joining is determined from:

$$F_e = \pi \cdot D_F \cdot l_F \cdot \vartheta_{ll} \cdot p_{max}$$

The 'Option' button allows to define the coefficients of adhesion ν_{ll} for pressing in and pressing out (see also section 7.16.8 'The button Options'). The table (see table 7.8) specifies the coefficient of adhesion ν_{ll}. The maximum joint pressure p_{max} is determined for the highest interference. In case the joining surfaces are not lubricated with grease, larger coefficients of friction and larger longitudinal and tangential forces occur. There is a risk of scuffing for joining surfaces that are not lubricated, in particular for a elastic-plastic dimensioning. Before joining, the joining surfaces should be lubricated with oil.

Furthermore, the following information has to be considered for the engineering design according to DIN 7190:

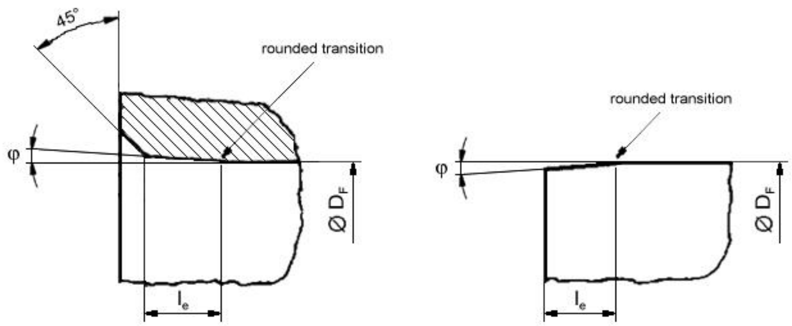


Figure 7.4: Force fits

The values for the edge length l_e are specified in the following table. The measurement is indicated in mm.

The edge length l_e					
D_F			D_F		
over	to	l_e	over	to	l_e
50	80	4	400	630	8
80	160	5	630	800	9
160	250	6	800	1000	10
250	400	7	1000	-	10

- When joining parts, no sharp edges and transitions must not occur.
- The bevel angle φ should not exceed 5°.
- This applies for the calculation of the edge length

$$l_e \approx \sqrt[3]{D_F}$$

During the manufacturing process of interference fits by force fitting, the joining area is provided with a thin oil film over the entire surface. A jamming of the assembled parts must be avoided. The slip-stick effect can be avoided by the press-in speed and discharge speed of approx. 50 mm/s and sufficient pressing force (2,5x extraction force). Force fits requires sufficient time (24 hours) before first loading, then the complete adhesive force is reached (only 70% immediately after pressing).

7.15 Example of interference fits

The following section gives some guidance on selecting fits according to E. & K. Felber. There are features that can be expected in general during the assembly. The assembly rules specify the character of the fit and all features correspond to the mean value of fits. The list contains fits that are used frequently. Almost all fits can be formed in quality (e.g., from H8/u8 to H8/u7 to H6/u6). In general, the standard fits (e.g., H8/u7) can be used. According to the function, you have to select fine qualities (e.g., H6/u6) for larger requirements (requirements for accuracy and uniformity). The following examples are taken from the mechanical engineering and cannot to be considered as complete in any detail.

Examples for interference fits: H8/u8; U8/h7; H8/s7; S7/h6; H7/r6; R7/h6

Features, assembly rule: The parts are assembled and tightened and have a strong interference. The parts are pressed together or assembled into position while hot and cooled. In general, a safety device against torsion or shifting in lengthwise direction is not necessary.

Examples: Spur gears that are mounted tightly on a shaft, couplings, collar rings, press rings, wheel rims, bearing bushings in housings, bushings in gear hubs, tight pivots, bushings made of synthetic resin pressed material, parts which cannot be loosened by large forces.

7.16 Example: Interference fit calculation according to DIN 7190

Our calculation example shall support you with a fast start into the interference fit calculation module with its numerous possibilities. Let´s take a look at the follwing example.

7.16.1 Start the calculation module

Please login with your user name and your password. Select the module through the tree structure of the Project Manager by double-clicking on the module or clicking on the button 'New calculation'.

The calculation module is opened in a new window.

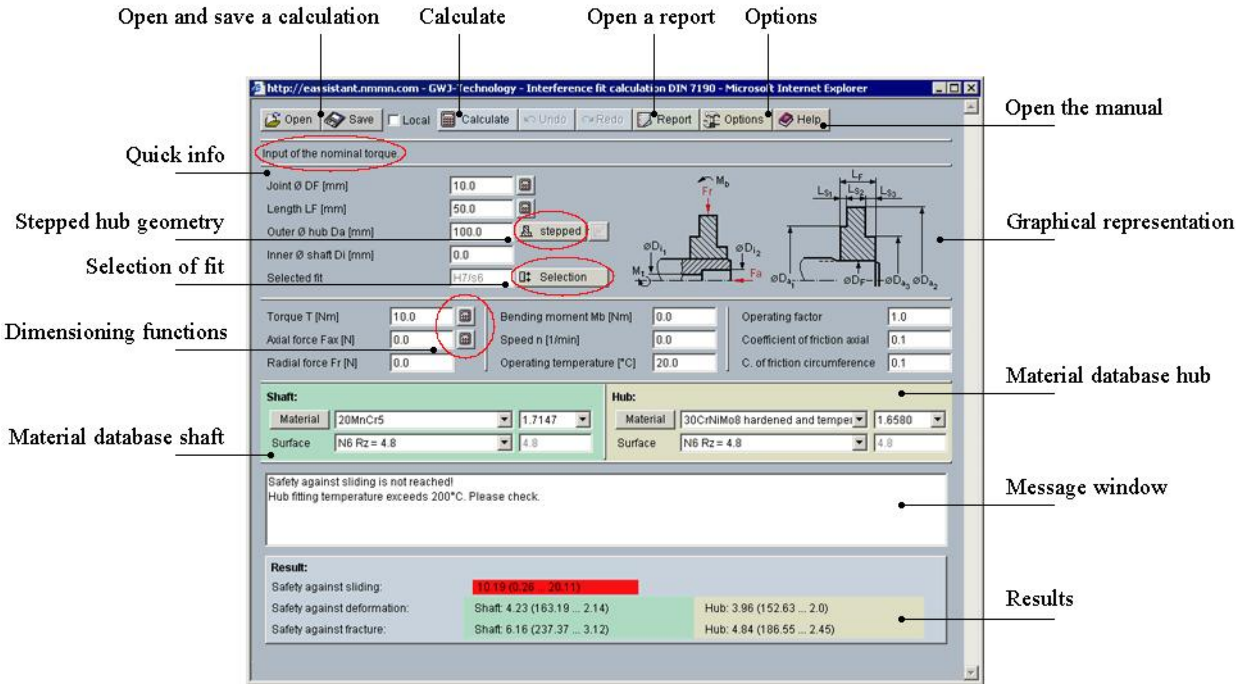


Figure 7.5: A general overview

7.16.2 The input values

A cylindrical interference fit has to be dimensioned against sliding. Enter the following values into the appropriate input fields:

Joint diameter	= 50 mm
Length	= 20 mm
Outer diameter hub	= 95 mm
Inner diameter shaft	= 30 mm
Torque	= 80 Nm
Axial force	= 125 N
Speed	= 2.000 min/-1
Operating temperature	= 25 °C
Operating factor	= 1.2
Coefficient of friction axial	= 0.15
Coefficient of friction circumference	= 0.15
Material shaft	= 20MnCr5
Surface shaft	= N6
Material hub	= C45 hardened and tempered
Surface hub	= Rz = 6

7.16.3 The calculation

Please enter the values into the input fields. When you enter your data, the results are determined and displayed immediately in the result panel. During the input of the values it can happen that the results will be marked in red. Nevertheless please continue to input the data as usual.

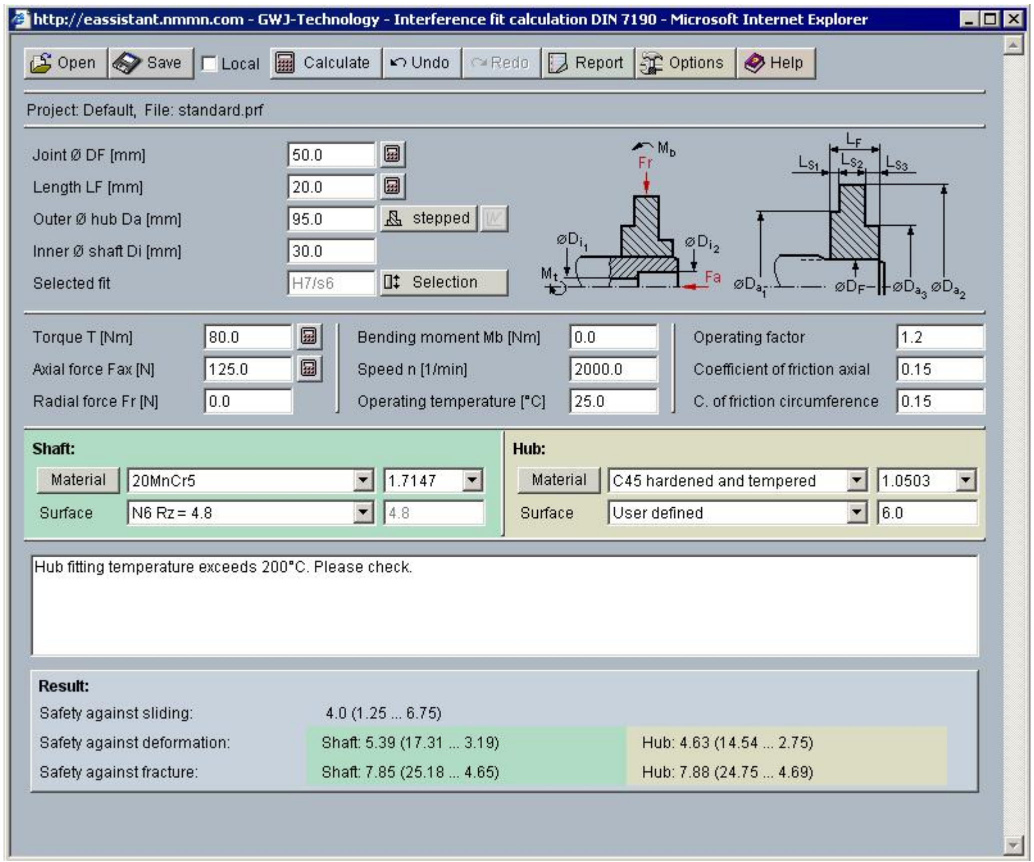
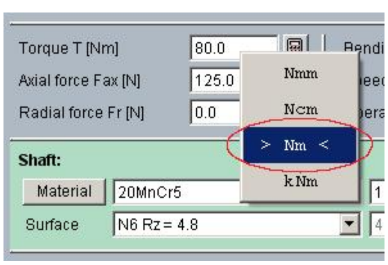


Figure 7.6: The input of the values

Please note: Please note the section 'Selection of fit' for the specification of the tolerances. With the definition of the surface quality of the hub, you have to notice that the given value (Rz=6) has to be entered by the 'User defined' input. Select 'User defined' in the appropriate listbox and enter the desired value into the input field next to the listbox.

Please note: Change the unit of measurement

If you right-click into an input field, then you can change the unit of measurement very easily.



1. Just a right-click on the input field where you want to change the unit.

A context menu is opened. You will get a survey of all units whichare available. The two arrows mark the current setting.

2. Select a unit.

With the modification of the measurement, the description of theinput field changes. The current value will be converted into theappropriate unit of measurement.

Selection of fit / Calculation of possible fits

The button 'Selection' allows you to open the dialog window for selection of fits. Here you can choose the possible tolerances or the appropriate fits can be suggested.

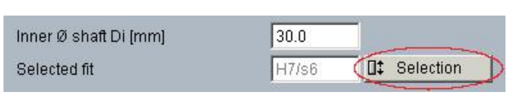


Figure 7.7: The button 'Selection of fit'

You will find the tolerance system according to DIN ISO 286 with all IT classes. On the top of the dialog window, you can select easily the tolerance field for the shaft and hub via listboxes.

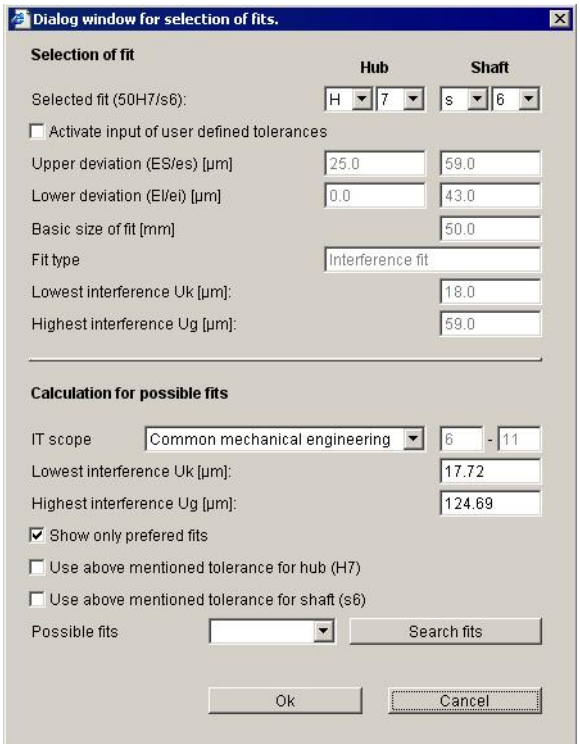


Figure 7.8: Dialog window for the selection of fits

For the selected tolerance the upper deviation and the lower deviation for shaft and hub will be displayed. Furthermore the specification of the fit type as well as the highest and lowest interference occurs.

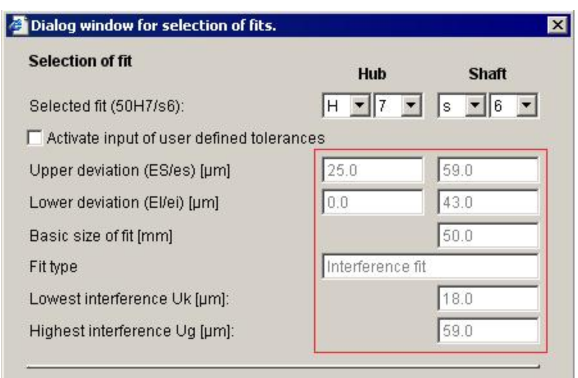


Figure 7.9: The deviation for the tolerance

All deviations for the shaft and hub can be entered directly. You have to select the option ‘Activate input of user defined tolerances’.

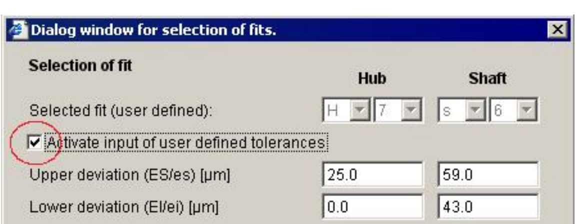


Figure 7.10: User-defined tolerances

For the dimensioning of a fit you have got different possiblities. In the following we describe these possibilities for you. In our example we will explain, how you can find the right fit with the calculation of possible fits.

- You can specify the lowest and highest interference for the calculation of possible fits by yourself. In case you have defined all data in the main mask of the calculation module before, the required lowest and highest interference will be entered automatically.

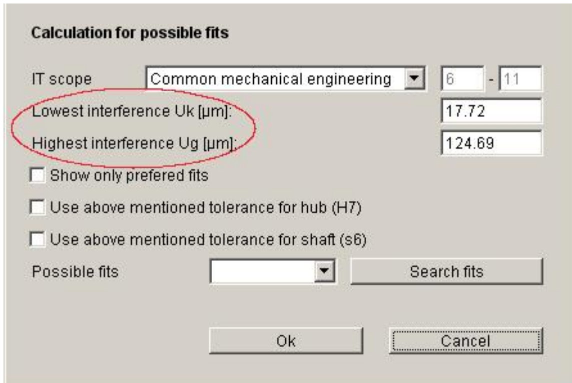


Figure 7.11: Lowest and highest interference

- The button ‘Search fits’ shows you all possible fits. There the message ‘More than 500 fits were found. Only preferred fits are shown’ appears. Please confirm this message with ‘OK’. Then select a fit from the listbox.

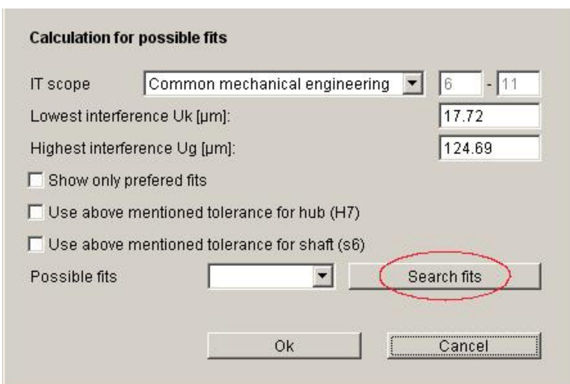


Figure 7.12: Search the fits

The option ‘Show only preferred fits’ is activated automatically and all preferred fits will be displayed in thelistbox.

- Another possibility is to activate the option ‘Show only preferred fits’ already before. Then the fit search is limited automatically.

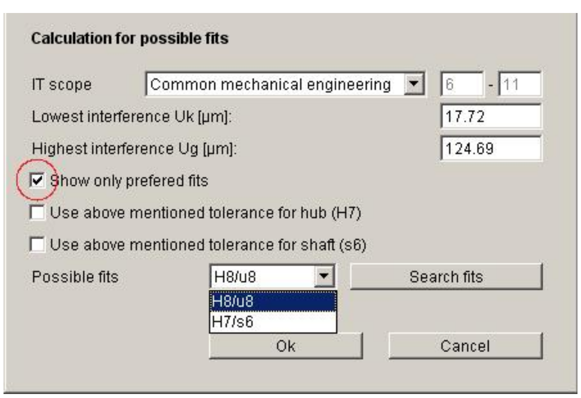


Figure 7.13: Show only preferred fits

Please confirm with the button ‘OK’.

The fit is taken over to the main mask of your calculation.

The selection of fits based on the calculation example

Click on the button ‘Selection’.

Figure 7.14: The button ‘Selection’

The dialog window for the selection of fits opens.

Activate the option ‘Show only preferred fits’.

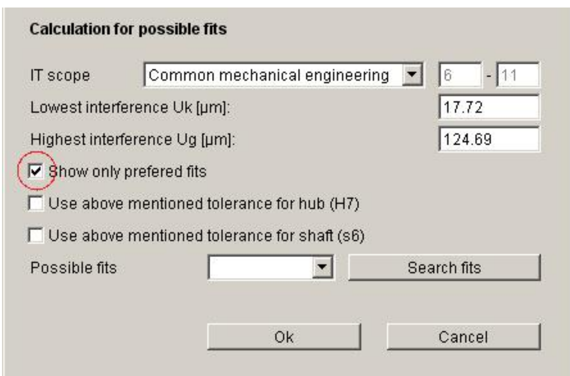


Figure 7.15: Activate preferred fits

Click on the button ‘Search fits’.

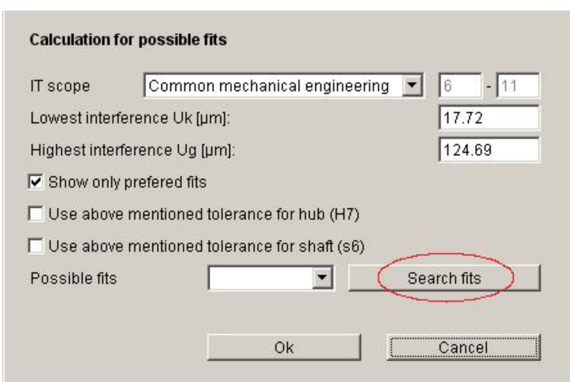


Figure 7.16: Search fits

Two fits are suggested.

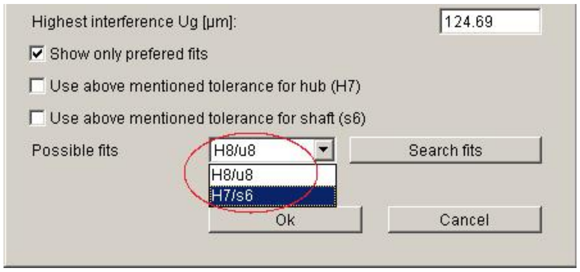


Figure 7.17: Suggestion of possible fits

Select the fit H7 / s6.

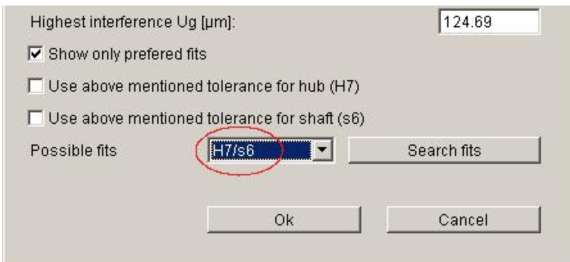


Figure 7.18: Select the fit

Confirm with the button OK.

The interference fit is taken over to the main mask of the calculation module.

The dimensioning of the maximum torque

Due to the fit calculation, a safety close to the given minimum safety has been determined. By the help of the comfortable dimensioning functions, other values can be checked and optimized regarding the use of the minimum safety. So the maximum torque can be defined using the given minimum safety against sliding $(S_R = 1.2)$. The button ‘Options’ allows you to specify the minimum safety (see section 7.16.8 ‘The button Options’). Click on the dimensioning button (‘calculator symbol’) next to the input field for the torque.

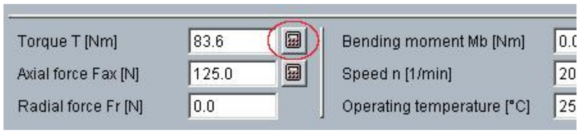


Figure 7.19: The dimensioning function

Now the torque is determined.

Figure 7.20: The minimum safety

Here the maximum torque is ‘83.60 Nm’. If you enter now a higher value than ‘83.60 Nm’, the safety against sliding is fallen below.

The result panel is marked in red. You also get an appropriate information in the message window.

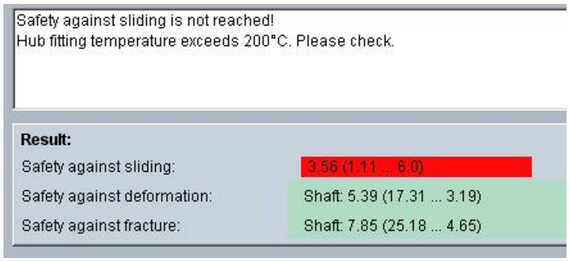


Figure 7.21: The result panel

Now click on the calculator symbol again, then the maximum torque is determined (83.50 Nm) and the minimum safety of '1.2' is fulfilled. The specifications of the results is given for the mean, highest, and lowest interference. If the minimum safety is not fulfilled, then the safety is marked in red.

The 'Redo' and 'Undo' button

The button 'Undo' allows you to reset your input to an older state. The button 'Redo' reverses the undo.

Figure 7.22: Button 'Redo' and 'Undo'

The material selection

Select the material and the roughness from the material selection. Use the entry 'User defined' to specify your individual material.

Figure 7.23: The material selection

In case you need further information on the corresponding material, easily click on the button 'Material'. This applies for the shaft as well as for the hub.

The message window

The calculation module contains a message window. You will find a message window in all calculation modules where you will get some hints, messages, or warnings. You will find all information and hints, which are displayed in the message window, in the calculation report later.

Figure 7.24: The message window

The quick info line

Move the mouse pointer to an input field or a button, then you will get some additional information. This information will be displayed in the quick info line.

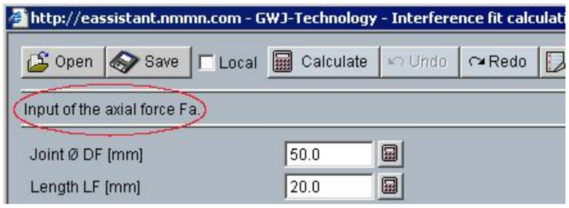


Figure 7.25: The quick info line

7.16.4 The results

The specification of the results is displayed for the mean, minimum, and maximum interference of the fit. In case a minimum safety is not fulfilled, the result will then be marked in red. After the value was taken over, the results will be determined and displayed.

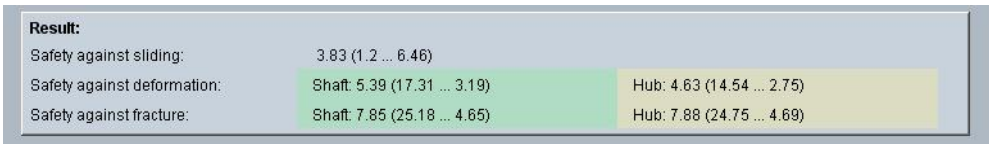


Figure 7.26: The results

7.16.5 The documentation: The calculation report

In case you have finished your calculation, please click on the button ‘Report’.

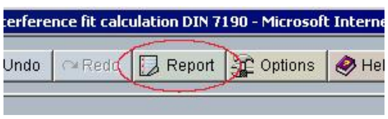


Figure 7.27: The button ‘Report’

The calculation report is opened.

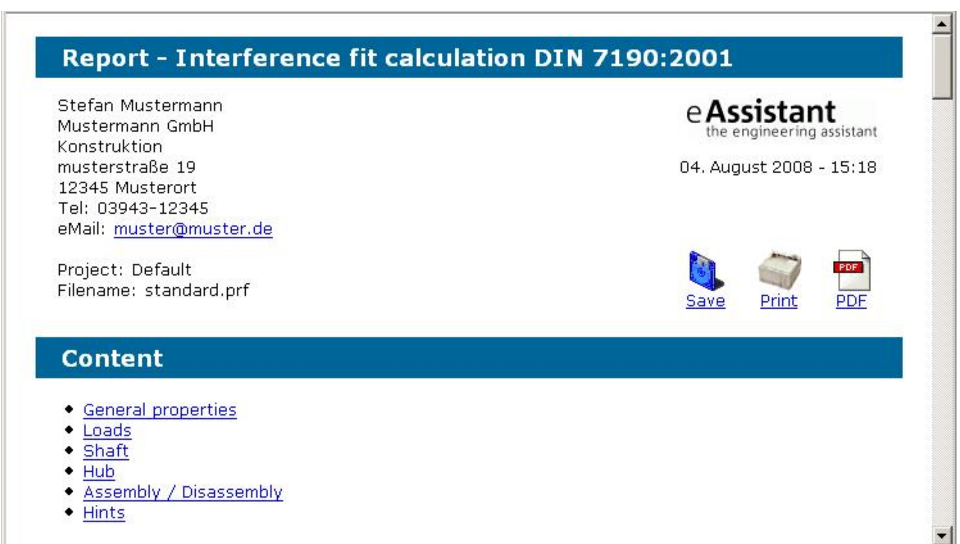


Figure 7.28: The calculation report

The calculation report contains a table of contents. You can navigate through the report via the table of contents that provides links to the input values, results and figures. The report is available in HTML and PDF format. Calculation reports, saved in HTML format, can be opened in a web browser or in Word for Windows.

Figure 7.29: PDF, Save, Print

- To save the report in the HTML format, please select 'File' → 'Save as' from your browser menu bar. Select the file type 'Webpage complete', then just click on the button 'Save'.
- If you click on the symbol 'Print', then you can print the report very easily.
- If you click on the symbol 'PDF', then the report appears in the PDF format. If you right-click on the PDF symbol, you should see the 'Save Target As' option. Click on that option and you will see the dialog box for saving the report.

7.16.6 How to save the calculation

After accomplishing your calculation, save the calculation either on the eAssistant server or on your workstation locally. Click on the button 'Save'.

Figure 7.30: The button 'Save'

If you have activated the option 'Enable file save local' in the Project Manager and the option 'Local' in the calculation module, a standard Windows dialog for saving the file on your workstation appears.

Please note: You must not forget that the calculation module has to be closed to activate the option 'Enable file save local.'

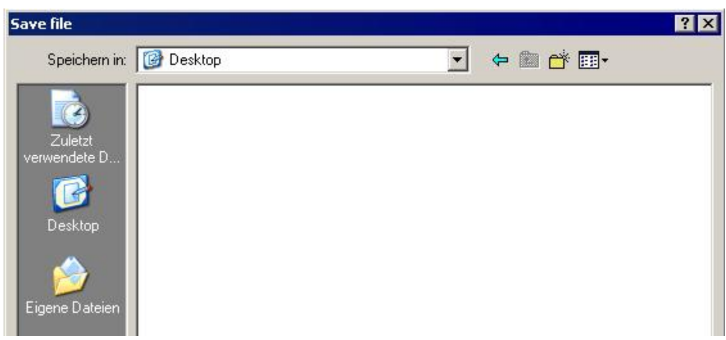


Figure 7.31: Windows dialog to save the file

In case you have not activated this option, a new window is opened and you can save the calculation on the eAssistant server (find further information in the chapter 'The general functions').

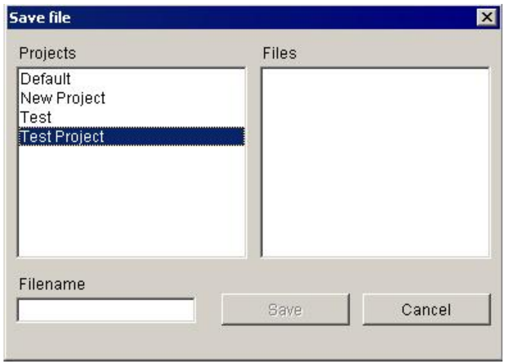


Figure 7.32: Save the calculation

Please enter a name into the input field ‘Filename’ and click on the button ‘Save’. Then click on the button ‘Refresh’ in the Project Manager. Your saved calculation file is displayed in the window‘File’.

7.16.7 The stepped hub geometry

Here you can define the geometry for the hub with a varying outer diameter and a varying shaft hole. Click on the button ‘stepped’ next to the input field ‘Outer diameter hub’.

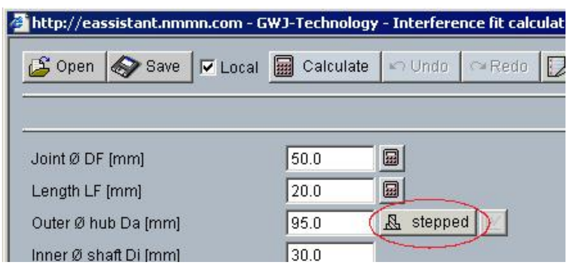


Figure 7.33: The button ‘Stepped’

A new window is opened.

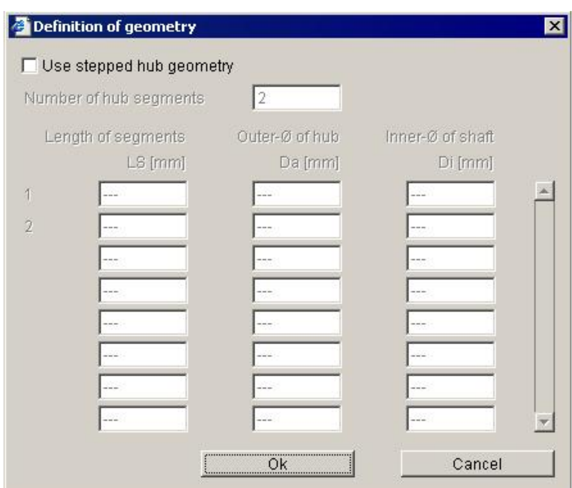


Figure 7.34: Definition of geometry

Activate the option ‘Use stepped hub geometry’.

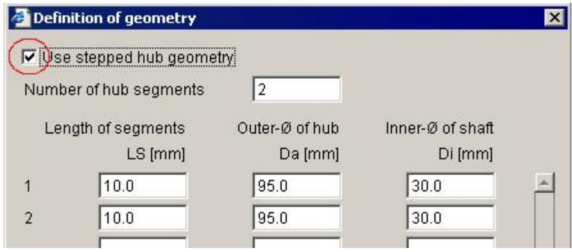


Figure 7.35: Stepped hub geometry

Define here the several hub segments. Enter the number of hub segments, the lengths of segments, the outerdiameter of the hub as well as the inner diameter of the shaft.

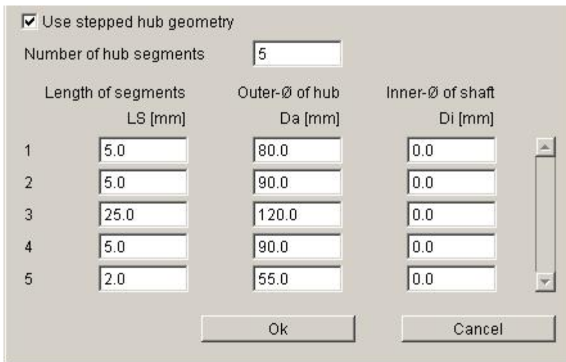


Figure 7.36: Define several segments

Please confirm with the button ‘OK’.

All the input values will be taken over. The ‘Diagram’ button is activated.

Figure 7.37: The ‘Diagram’ button

Click on the ‘Diagram’ button.

The diagram is opened. That diagram shows the compressive stress along the length of the pressfit.

The current values can be selected and displayed using the mouse pointer. On the basis of the minimum, mean and maximum interference, all values for the minimum (pk), mean (p) and maximum (pG) compressive stress will be represented.

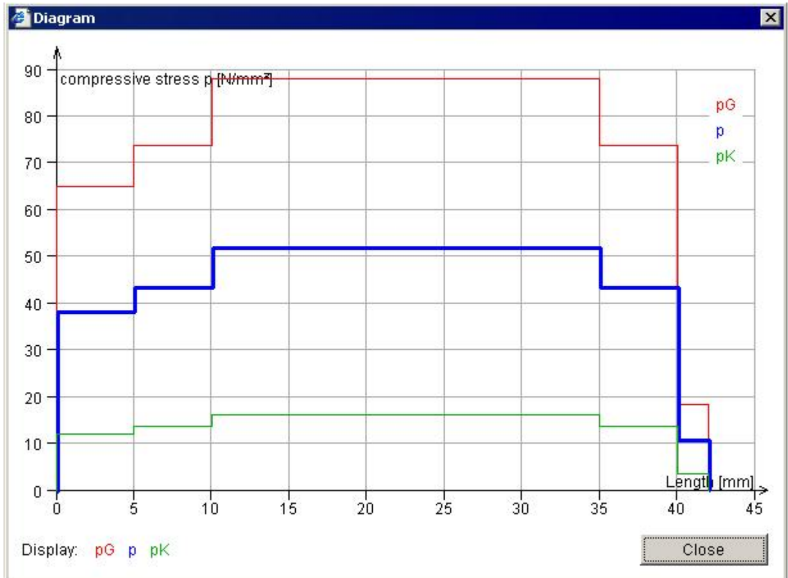


Figure 7.38: The diagram ‘compressive stress’

7.16.8 The button ‘Options’

The button ‘Options’ allows you to define the minimum safeties, the mating clearance, the temperature at joining (room temperature and shaft temperature) as well as the coefficients of friction at joining for pressing in and pressing out for a force fit. Additionally, there is the possibility to enter the number of decimal places for the output of the numerical values in the report. Click on the button ‘Options’.

Figure 7.39: The ‘Options’ button

A new window is opened.

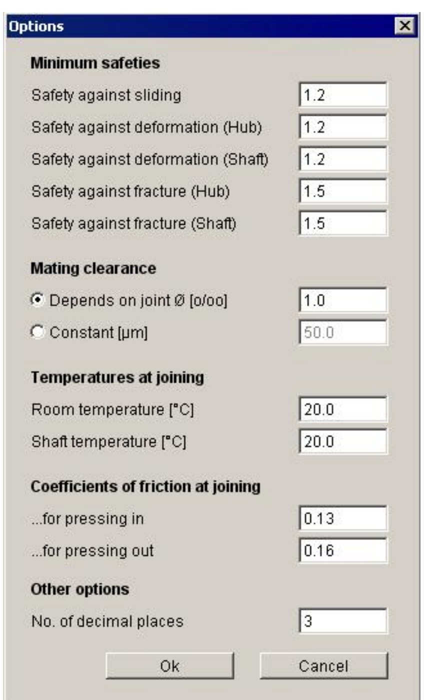


Figure 7.40: The ‘Options’ button

The following options are available:

- Minimum safeties
- Mating clearance
- Temperature at joining
- Coefficients of friction at joining

Our manual is improved continually. Of course we are always interested in your opinion, so wewould like to know what you think. We appreciate your feedback and we are looking for ideas,suggestions or criticism. If you have anything to say or if you have any questions, please let usknow via telephone *+49 (0) 531 129 399-0* or email *eAssistant@gwj.de*.