KISSsoft evaluation

File

Name : Shafts 1
Description: KISSsoft example
Changed by: kspl on: 07.03.2016 at: 10:53:01

Important hint: At least one warning has occurred during the calculation:

1-> Cross-section B-B:
The notch factor for light interference fits is no longer defined in DIN743.

The notch factor for light interference fits (according to FKM) is
larger than the notch factor for tight interference fits (according to DIN).

In this case, the notch factor for tight interference fits (according to DIN) is used.

Analysis of shafts, axle and beams

Input data

Coordinate system shaft: see picture W-002

Label		Shaft
Drawing		W-007
Initial position (mm)		0.000
Length (mm)		235.000
Speed (1/min)		980.00
Sense of rotation: clockwise		
Material		42 CrMo 4 (1)
Young's modulus (N/mm²)		206000.000
Poisson's ratio nu		0.300
Density (kg/m³)		7830.000
Coefficient of thermal expansion	(10^-6/K)	11.500
Temperature (°C)		20.000
Weight of shaft (kg)		3.025

(Notice: Weight stands for the shaft only without considering the gears)

Weight of shaft, including additional masses (kg)	5.349
Mass moment of inertia (kg*mm²)	3689.337
Momentum of mass GD2 (Nm²)	0.145
Position in space (°)	0.000
Gears mounted with stiffness according to ISO	
Consider deformations due to shearing	
Shear correction coefficient	1.100
Rolling bearing stiffness is calculated from inner bearing geometry	
Tolerance field: Mean value	
Reference temperature (°C)	20.000

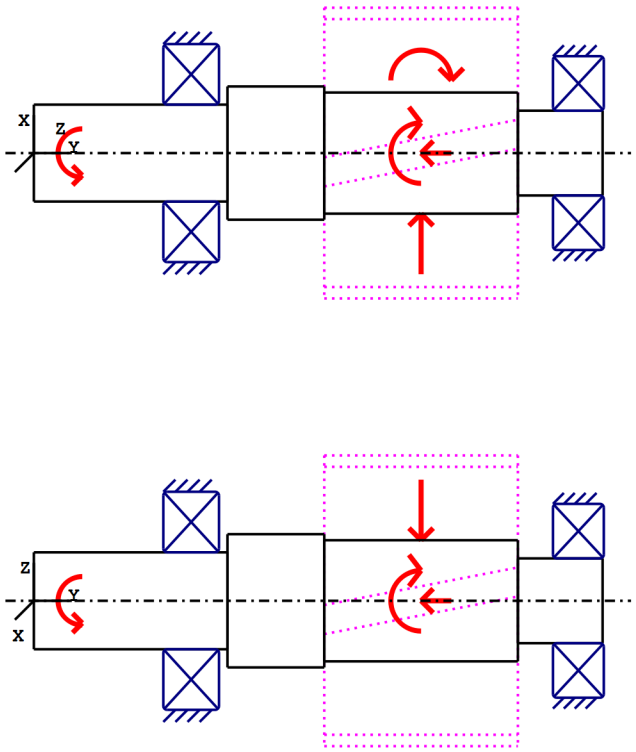


Figure: Load applications

Shaft definition (Shaft)

Outer contour

Cylinder (Cylinder 1) 0.000mm ... 80.000mm

Diameter (mm)	[d]	40.0000
Length (mm)	[l]	80.0000
Surface roughness (µm)	[Rz]	4.8000

Key way (Key) 2.000mm ... 24.000mm
l=22.00 (mm), Rz=16.0, Turned (Ra=3.2µm/125µin)

Interference fit (Interference fit) 0.000mm ... 40.000mm
l=40.00 (mm), Typ=0, Turned (Ra=3.2µm/125µin)

Radius right (Radius right)
r=3.00 (mm), Rz=8.0, Turned (Ra=3.2µm/125µin)

Cylinder (Cylinder 2) 80.000mm ... 120.000mm

Diameter (mm)	[d]	55.0000
Length (mm)	[l]	40.0000
Surface roughness (µm)	[Rz]	16.0000

Cylinder (Cylinder 3) 120.000mm ... 200.000mm

Diameter (mm)	[d]	50.0000
Length (mm)	[l]	80.0000
Surface roughness (µm)	[Rz]	4.8000

Radius left (Radius left)
r=1.00 (mm), Rz=8.0, Turned (Ra=3.2µm/125µin)

Key way (Key) 130.000mm ... 190.000mm
l=60.00 (mm), Rz=16.0, Turned (Ra=3.2µm/125µin)

Cylinder (Cylinder 4) 200.000mm ... 235.000mm

Diameter (mm)	[d]	35.0000
Length (mm)	[l]	35.0000
Surface roughness (µm)	[Rz]	4.8000

Radius left (Radius left)
r=1.00 (mm), Rz=4.8, Turned (Ra=3.2µm/125µin)

Forces

Type of force element

Coupling

Label in the model		Coupling / Motor
Position on shaft (mm)	[y_{local}]	20.0000
Position in global system (mm)	[y_{global}]	20.0000
Effective diameter (mm)		0.0000
Radial force factor (-)		0.0000
Direction of the radial force (°)		0.0000
Axial force factor (-)		0.0000
Length of load application (mm)		40.0000
Power (kW)		75.0000 driven (Input)
Torque (Nm)		730.8135
Axial force (N)		0.0000
Shearing force X (N)		0.0000
Shearing force Z (N)		0.0000
Bending moment X (Nm)		0.0000
Bending moment Z (Nm)		0.0000
Mass (kg)		0.0000
Mass moment of inertia Jp (kg*m²)		0.0000
Mass moment of inertia Jxx (kg*m²)		0.0000
Mass moment of inertia Jzz (kg*m²)		0.0000
Eccentricity (mm)		0.0000

Type of force element

Cylindrical gear

Label in the model		Cylindrical gear
Position on shaft (mm)	[y_{local}]	160.0000
Position in global system (mm)	[y_{global}]	160.0000
Operating pitch diameter (mm)		120.0000
Helix angle (°)		15.0000 left
Working pressure angle at normal section (°)		20.0000
Position of contact (°)		180.0000
Length of load application (mm)		80.0000
Power (kW)		75.0000 driving (Output)
Torque (Nm)		-730.8135
Axial force (N)		-3263.6815
Shearing force X (N)		4589.6272
Shearing force Z (N)		-12180.2252
Bending moment X (Nm)		0.0000
Bending moment Z (Nm)		195.8209

Bearing

Label in the model		Roller bearing 1
Bearing type		SKF *21308E
Bearing type		Spherical roller bearings
Bearing position (mm)	[y_{lokal}]	65.000
Bearing position (mm)	[y_{global}]	65.000

Attachment of external ring		Set fixed bearing left
Inner diameter (mm)	[d]	40.000
External diameter (mm)	[D]	90.000
Width (mm)	[b]	23.000
Corner radius (mm)	[r]	1.500
Number of rolling bodies	[Z]	11
Rolling body reference circle (mm)	[D_{pw}]	66.924
Diameter rolling body (mm)	[D_w]	12.879
Rolling body length (mm)	[L_{we}]	10.832
Diameter, external race (mm)	[d_o]	79.640
Diameter, internal race (mm)	[d_i]	54.208
Radius of curvature, external race (mm)	[r_o]	40.331
Radius of curvature, internal race (mm)	[r_i]	40.331
Calculation with approximate bearings internal geometry (*)		
Bearing clearance	0.00 µm	
Basic static load rating	[C_0]	108.000
Basic dynamic load rating	[C]	104.000
Fatigue load rating	[C_U]	11.800
Values for approximated geometry:		
Basic dynamic load rating (kN)	[C_{theo}]	103.963
Basic static load rating (kN)	[C_{0theo}]	108.003

Label in the model		Roller bearing 2
Bearing type		SKF 21307CC
Bearing type		Spherical roller bearings
Bearing position (mm)	[y_{lokal}]	225.000
Bearing position (mm)	[y_{global}]	225.000
Attachment of external ring		Set fixed bearing right
Inner diameter (mm)	[d]	35.000
External diameter (mm)	[D]	80.000
Width (mm)	[b]	21.000
Corner radius (mm)	[r]	1.500
Number of rolling bodies	[Z]	11
Rolling body reference circle (mm)	[D_{pw}]	59.202
Diameter rolling body (mm)	[D_w]	9.114
Rolling body length (mm)	[L_{we}]	9.784
Diameter, external race (mm)	[d_o]	68.160
Diameter, internal race (mm)	[d_i]	50.244
Radius of curvature, external race (mm)	[r_o]	34.674
Radius of curvature, internal race (mm)	[r_i]	34.674
Calculation with approximate bearings internal geometry (*)		
Bearing clearance	0.00 µm	
Basic static load rating	[C_0]	72.000

Basic dynamic load rating	[C]	65.600
Fatigue load rating	[C_U]	8.150
Values for approximated geometry:		
Basic dynamic load rating (kN)	[C_{theo}]	65.601
Basic static load rating (kN)	[C_{0theo}]	72.003

Shaft 'Shaft': Cylindrical gear 'Cylindrical gear' (y= 160.0000 (mm)) is taken into account as component of the shaft.
EI (y= 120.0000 (mm)): 63200.0085 (Nm²), EI (y= 200.0000 (mm)): 63200.0085 (Nm²), m (yS= 160.0000 (mm)): 2.3246 (kg)
Jp: 0.0028 (kg*m²), Jxx: 0.0027 (kg*m²), Jzz: 0.0027 (kg*m²)

Results

Shaft

Maximum deflection (mm)	0.021
Position of the maximum (mm)	200.000
Mass center of gravity (mm)	119.025
Total axial load (N)	-3263.682
Torsion under torque (°)	-0.154

Bearing

Probability of failure	[n]	10.00	%
Axial clearance	[u_A]	10.00	µm
Lubricant	Oil: ISO-VG 220		
Lubricant with additive, effect on bearing lifetime confirmed in tests			
Oil lubrication with filtration, ISO4406 -/17/14			
Lubricant - service temperature	[T_B]	30.00	°C
Limit for factor aISO	[a_{ISOmax}]	50.00	
Oil level	[h_{oil}]	-30.00	mm
oil bath lubrication			

Rolling bearing service life according to ISO/TS 16281:2008

Shaft 'Shaft' Rolling bearing 'Roller bearing 1'

Position (Y-coordinate)	[y]	65.00	mm
Equivalent load	[P]	17.63	kN
Equivalent load	[P_0]	15.00	kN
Life modification factor for reliability	[a_1]	1.000	
Service life modification factor	[a_{ISO}]	2.207	
Service life	[L_{nh}]	6305.66	h
Service life	[L_{nmh}]	13914.48	h
Contamination factor	[e_C]	0.44	
Operating viscosity	[v]	425.09	mm²/s
Reference viscosity	[v_1]	18.37	mm²/s
Viscosity ratio	[κ]	23.14	
Minimum EHL lubricant film thickness	[h_{min}]	1.367	µm
Static safety factor	[S_0]	7.20	
Calculation with approximate bearings internal geometry			
Reference rating service life	[L_{nrh}]	34651.94	h
Modified reference rating service life	[L_{nrmh}]	182145.63	h
Effective static safety factor	[S_{0w}]	5.65	
Static safety factor	[S_{0ref}]	6.89	
Equivalent load	[P_{0ref}]	15.68	kN
Bearing reaction force	[Fx]	-3.088	kN
Bearing reaction force	[Fy]	3.264	kN
Bearing reaction force	[Fz]	4.977	kN
Bearing reaction force	[Fr]	5.857	kN (121.82°)
Oil level	[H]	8.750	mm
Rolling moment of friction	[M_{rr}]	1.223	Nm
Sliding moment of friction	[M_{sl}]	0.200	Nm
Moment of friction, seals	[M_{seal}]	0.000	Nm
Moment of friction for seals determined according to SKF main catalog 10000/1 EN:2013			
Moment of friction flow losses	[M_{drag}]	0.075	Nm
Torque of friction	[M_{loss}]	1.498	Nm
Power loss	[P_{loss}]	153.724	W
The moment of friction is calculated according to the details in SKF Catalog 2013.			
The calculation is always performed with a coefficient for additives in the lubricant µbl=0.15.			
Displacement of bearing	[u_x]	3.824	µm
Displacement of bearing	[u_y]	-84.864	µm
Displacement of bearing	[u_z]	-6.154	µm
Displacement of bearing	[u_r]	0.007	µm (-58.14°)
Misalignment of bearing	[r_x]	-0.178	mrad (-0.61')
Misalignment of bearing	[r_y]	-1.652	mrad (-5.68')
Misalignment of bearing	[r_z]	-0.051	mrad (-0.18')
Misalignment of bearing	[r_r]	0.185	mrad (0.64')

Shaft 'Shaft' Rolling bearing 'Roller bearing 2'

Position (Y-coordinate)	[y]	225.00	mm
Equivalent load	[P]	7.41	kN
Equivalent load	[P_0]	7.41	kN
Life modification factor for reliability	[a_1]	1.000	
Service life modification factor	[a_{ISO}]	4.281	
Service life	[L_{nh}]	24418.73	h
Service life	[L_{nmh}]	104525.95	h
Contamination factor	[e_C]	0.40	
Operating viscosity	[v]	425.09	mm²/s
Reference viscosity	[v_1]	19.53	mm²/s
Viscosity ratio	[κ]	21.77	
Minimum EHL lubricant film thickness	[h_{min}]	1.189	µm
Static safety factor	[S_0]	9.72	
Calculation with approximate bearings internal geometry			
Reference rating service life	[L_{nrh}]	39551.81	h
Modified reference rating service life	[L_{nrmh}]	283097.09	h
Effective static safety factor	[S_{0w}]	6.17	
Static safety factor	[S_{0ref}]	8.77	
Equivalent load	[P_{0ref}]	8.21	kN
Bearing reaction force	[Fx]	-1.501	kN
Bearing reaction force	[Fy]	0.000	kN
Bearing reaction force	[Fz]	7.256	kN
Bearing reaction force	[Fr]	7.409	kN (101.69°)
Oil level	[H]	4.375	mm
Rolling moment of friction	[M_{rr}]	0.502	Nm
Sliding moment of friction	[M_{sl}]	0.032	Nm
Moment of friction, seals	[M_{seal}]	0.000	Nm
Moment of friction for seals determined according to SKF main catalog 10000/1 EN:2013			
Moment of friction flow losses	[M_{drag}]	0.034	Nm
Torque of friction	[M_{loss}]	0.568	Nm
Power loss	[P_{loss}]	58.286	W
The moment of friction is calculated according to the details in SKF Catalog 2013.			
The calculation is always performed with a coefficient for additives in the lubricant µbl=0.15.			
The factors used to calculate the torque loss have been assumed for this bearing.			
Displacement of bearing	[u_x]	3.224	µm
Displacement of bearing	[u_y]	-85.432	µm
Displacement of bearing	[u_z]	-15.870	µm
Displacement of bearing	[u_r]	0.016	µm (-78.52°)
Misalignment of bearing	[r_x]	0.115	mrad (0.39')
Misalignment of bearing	[r_y]	-2.685	mrad (-9.23')
Misalignment of bearing	[r_z]	0.060	mrad (0.21')
Misalignment of bearing	[r_r]	0.129	mrad (0.44')

(*) Note about roller bearings with an approximated bearing geometry:
The internal geometry of these bearings has not been input in the database.
The geometry is back-calculated as specified in ISO 281, from C and C0 (details in the manufacturer's catalog).

For this reason, the geometry may be different from the actual geometry.
This can lead to differences in the service life calculation and, more importantly, the roller bearing stiffness.

Utilization, with reference to the required service life

[H] (5000.000)

B1	B2
0.34	0.30

B1: Roller bearing 1
B2: Roller bearing 2

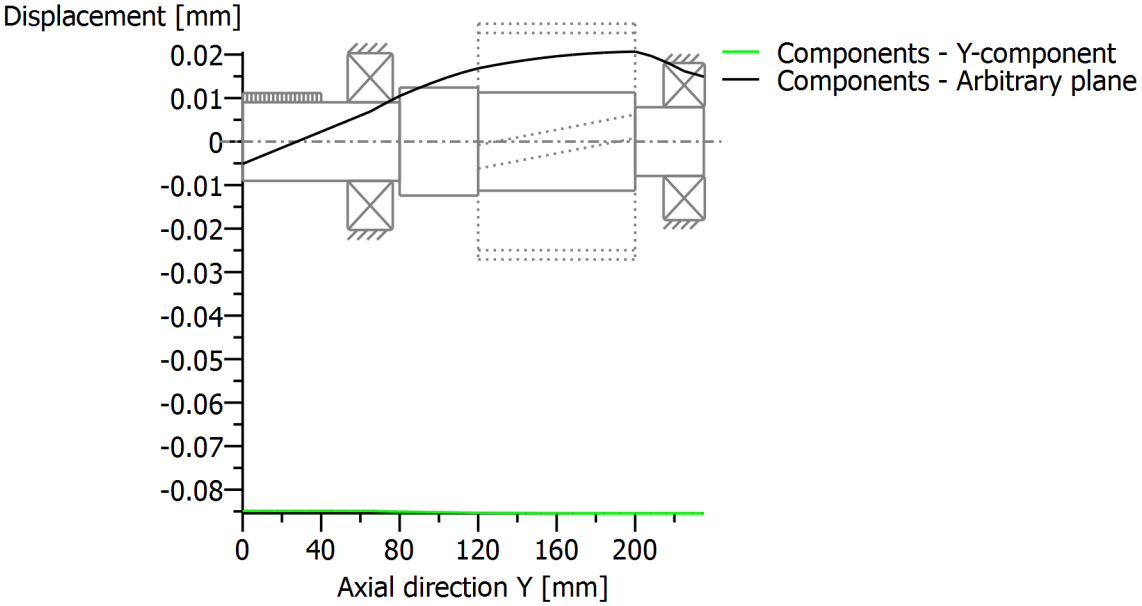
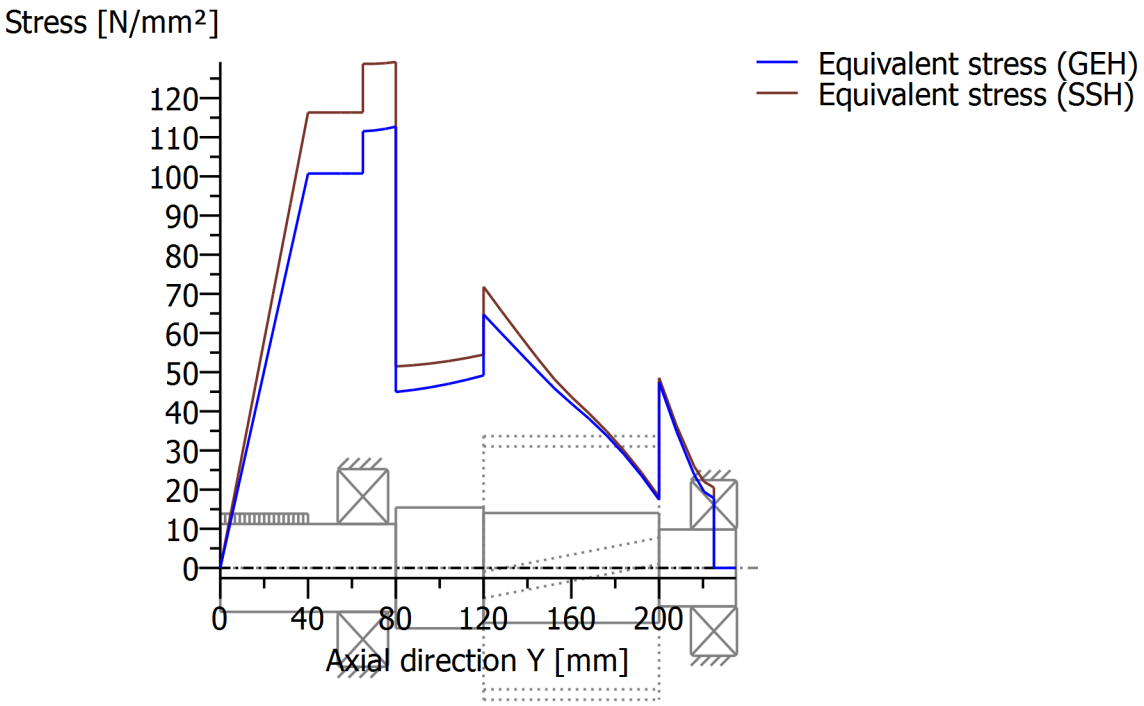


Figure: Deformation (bending etc.) (Arbitrary plane 284.0014088 120)



GEH(von Mises): sigV = ((sigB+sigZ,D)^2 + 3*(tauT+tauS)^2)^1/2SSH(Tresca): sigV = ((sigB-sigZ,D)^2 + 4*(tauT+tauS)^2)^1/2

Figure: Equivalent stress

KISSSOFT
Calculation programs for machine design

Strength calculation as specified in DIN 743:2012

Summary

Shaft

Drawing	W-007
Material	42 CrMo 4 (1)
Material type	Through hardened steel
Material treatment	alloyed, through hardened
Surface treatment	No

Calculation of endurance limit and the static strength

Calculation for load case 2 (σav/σmv = const)

Cross section	Position (Y-Coord) (mm)	
A-A	136.30	Key
B-B	75.40	Interference fit
C-C	200.00	Shoulder
D-D	80.00	Shoulder

Results:

Cross section	Kfb	Kfσ	K2d	SD	SS
A-A	2.98	1.00	0.87	3.65	10.51
B-B	2.69	1.00	0.89	3.80	5.44
C-C	2.33	0.90	0.90	4.01	13.21
D-D	1.77	0.87	0.89	4.10	5.13
Required safeties:			1.20	1.20	

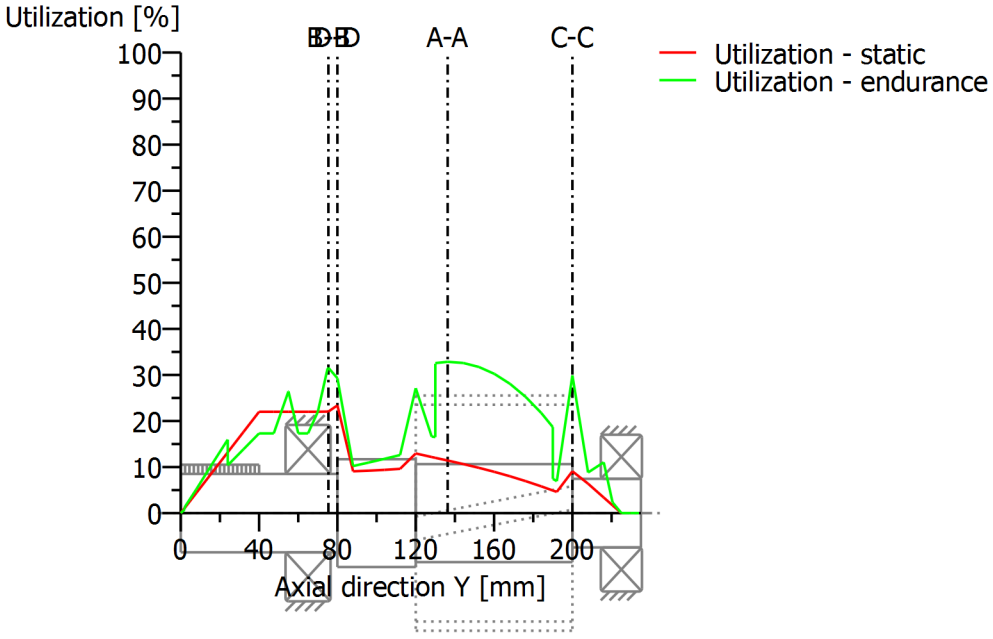
Abbreviations:
Kfb: Notch factor bending
Kfσ: Surface factor
K2d: size factor bending
SD: Safety endurance limit
SS: Safety against yield point

Utilization (%A)

[Smin/S]

Cross section	Static	Endurance
A-A	11.420	32.848
B-B	22.050	31.556
C-C	9.083	29.893
D-D	23.394	29.291

Maximum utilization (%)	[A]	32.848



Utilization = Smin/S (%)
Figure: Strength

Calculation details

General statements

Label	Shaft		
Drawing	W-007		
Length (mm)		[l]	235.00
Speed (1/min)		[n]	980.00

Material	42 CrMo 4 (1)
Material type	Through hardened steel
Material treatment	alloyed, through hardened
Surface treatment	No

	Tension/Compression	Bending	Torsion	Shearing
Load factor static calculation	1.700	1.700	1.700	1.700
Load factor endurance limit	1.000	1.000	1.000	1.000

Reference diameter material (mm)	[dB]	16.00
σB according to DIN 743 (at dB) (N/mm²)	[σB]	1100.00
σS according to DIN 743 (at dB) (N/mm²)	[σS]	900.00

[σzdW] (bei dB) (N/mm²)		440.00
[σbW] (bei dB) (N/mm²)		550.00
[τtW] (bei dB) (N/mm²)		330.00
Thickness of raw material (mm)	[dWerkst]	60.00

Material data calculated according DIN743/3 with K1(d)
Geometric size factor K1d calculated with shaft diameter D
Material strength calculated from shaft diameter
(Requirement: Heat treatment of pre-turned shaft)

Notice: The following material values are only valid for
the first cross-section, the next ones are corresponding
to their actual 'Diameter for size factor'..

[σBeff] (N/mm²)	1002.77
[σSeff] (N/mm²)	795.98
[σbF] (N/mm²)	955.17
[τtF] (N/mm²)	551.47
[σBRand] (N/mm²)	708.00
[σzdW] (N/mm²)	401.11
[σbW] (N/mm²)	501.39
[τtW] (N/mm²)	300.83

Endurance limit for single stage use

Calculation for load case 2 (σ.av/σ.mv = const)

Cross section 'A-A' Key

Comment	Y= 130.00...190.00mm		
Position (Y-Coordinate) (mm)		[y]	136.30
External diameter (mm)		[da]	50.000
Inner diameter (mm)		[di]	0.000
Diameter for size factors (mm)		[deff]	50.000
Notch effect	Key		
Number of keys	[n]	1	
Groove with manufactured with end milling cutter			
Standard:	DIN 6885.1:1968 Default		
[b, t] (mm)	14.000 5.600		
Mean roughness (µm)		[Rz]	16.000

		Tension/Compression	Bending	Torsion	Shearing
Stress: (N) (Nm)					
Mean value	[Fzdm, Mbm, Tm, Fqm]	-1299.4	0.0	291.0	0.0
Amplitude	[Fzda, Mba, Ta, Fqa]	1299.4	375.6	291.0	3279.3
Maximum value	[Fzdmax, Mbmax, Tmax, Fqmax]	-4417.8	638.6	989.2	5574.8

Cross section, moment of resistance: (mm²)					
[A, Wb, Wt, A]		1963.5	12271.8	24543.7	1963.5
Stresses: (N/mm²)					
[σzdm, σbm, τm, τqm] (N/mm²)		-0.662	0.000	11.855	0.000
[σzda, σba, τa, τqa] (N/mm²)		0.662	30.609	11.855	2.227
[σzdmax,σbmax,τmax,τqmax] (N/mm²)		-2.250	52.035	40.306	3.786
Technological size influence	[K1(sB)]	0.871			
	[K1(sS)]	0.832			
		Tension/Compression	Bending	Torsion	
Notch effect coefficient	[ß(dB)]	2.958	2.958	1.800	
[dB] (mm) = 40.0					
Geometrical size influence	[K3(d)]	0.940	0.940	0.968	
Geometrical size influence	[K3(dB)]	0.947	0.947	0.971	
Notch effect coefficient	[ß]	2.981	2.981	1.807	
Geometrical size influence	[K2(d)]	1.000	0.873	0.873	
Influence coefficient surface roughness					
	[KF]	1.000	1.000	1.000	
Roughness factor is included into the notch effect coefficient					
Influence coefficient surface strengthening					
	[KV]	1.000	1.000	1.000	
Total influence coefficient	[K]	2.981	3.413	2.069	
Present safety factor for endurance limit:					
Equivalent mean stress (N/mm²)	[σmV]		20.522		
Equivalent mean stress (N/mm²)	[τmV]		11.848		
Fatigue limit of part (N/mm²)	[σWK]	128.630	140.423	138.967	
Influence coefficient of mean stress sensitivity.					
	[ψσK]	0.072	0.079	0.078	
Permissible amplitude (N/mm²)	[σADK]	23.385	133.356	128.897	
Safety against fatigue	[S]		3.653		
Required safety against fatigue	[Smin]		1.200		
Result (%)	[S/Smin]		304.4		
Present safety factor					
for proof against exceed of yield point:					
Static notch sensitivity factor	[K2F]	1.000	1.200	1.200	
Increase coefficient	[γF]	1.000	1.000	1.000	
Yield stress of part (N/mm²)	[σFK]	748.576	898.291	518.629	
Safety yield stress	[S]		10.508		

Required safety	[Smin]	1.200
Result (%)	[S/Smin]	875.7

Cross section 'B-B' Interference fit

Comment	Y= 54.60... 75.40mm	
Position (Y-Coordinate) (mm)	[y]	75.40
External diameter (mm)	[da]	40.000
Inner diameter (mm)	[di]	0.000
Diameter for size factors (mm)	[deff]	40.000
Notch effect	Interference fit	
Characteristics:	Slight interference fit	
Mean roughness (µm)	[Rz]	4.800

		Tension/Compression	Bending	Torsion	Shearing
Stress: (N) (Nm)					
Mean value	[Fzdm, Mbm, Tm, Fqm]	-1631.8	0.0	365.4	0.0
Amplitude	[Fzda, Mba, Ta, Fqa]	1631.8	60.7	365.4	5851.3
Maximum value	[Fzdmax, Mbmax, Tmax, Fqmax]	-5548.3	103.2	1242.4	9947.2
Cross section, moment of resistance: (mm²)					
[A, Wb, Wt, A]		1256.6	6283.2	12566.4	1256.6

Stresses: (N/mm²)					
[σzdm, σbm, τm, τqm] (N/mm²)		-1.299	0.000	29.078	0.000
[σzda, σba, τa, τqa] (N/mm²)		1.299	9.658	29.078	6.208
[σzdmax,σbmax,τmax,τqmax] (N/mm²)		-4.415	16.419	98.866	10.554
Technological size influence	[K1(sB)]	0.897			
	[K1(sS)]	0.865			

		Tension/Compression	Bending	Torsion
Notch effect coefficient	[ß(dB)]	2.686	2.686	1.786
[dB] (mm) = 40.0				
Geometrical size influence	[K3(d)]	0.952	0.952	0.972
Geometrical size influence	[K3(dB)]	0.952	0.952	0.972
Notch effect coefficient	[ß]	2.686	2.686	1.786
Geometrical size influence	[K2(d)]	1.000	0.888	0.888
Influence coefficient surface roughness	[KF]	1.000	1.000	1.000

Roughness factor is included into the notch effect coefficient

Influence coefficient surface strengthening				
	[KV]	1.000	1.000	1.000
Total influence coefficient	[K]	2.686	3.024	2.011

Present safety factor for endurance limit:				
Equivalent mean stress (N/mm²)	[σmV]		50.348	
Equivalent mean stress (N/mm²)	[τmV]		29.068	
Fatigue limit of part (N/mm²)	[σWK]	146.853	163.052	147.125
Influence coefficient of mean stress sensitivity.				
	[ψσK]	0.080	0.090	0.081
Permissible amplitude (N/mm²)	[σADK]	19.567	110.936	136.154
Safety against fatigue	[S]		3.803	
Required safety against fatigue	[Smin]		1.200	
Result (%)	[S/Smin]		316.9	

Present safety factor				
for proof against exceed of yield point:				
Static notch sensitivity factor	[K2F]	1.000	1.200	1.200
Increase coefficient	[γF]	1.000	1.000	1.000
Yield stress of part (N/mm²)	[σFK]	778.230	933.876	539.174
Safety yield stress	[S]		5.442	
Required safety	[Smin]		1.200	
Result (%)	[S/Smin]		453.5	

Cross section 'C-C' Shoulder

Comment	Y= 200.00mm			
Position (Y-Coordinate) (mm)		[y]	200.00	
External diameter (mm)		[da]	35.000	
Inner diameter (mm)		[di]	0.000	
Diameter for size factors (mm)		[deff]	50.000	
Notch effect	Shoulder			
[D, r, t] (mm)	50.000	1.000	0.000	
Mean roughness (µm)		[Rz]	4.800	

		Tension/Compression	Bending	Torsion	Shearing
Stress: (N) (Nm)					
Mean value	[Fzdm, Mbm, Tm, Fqm]	-0.0	0.0	0.0	0.0
Amplitude	[Fzda, Mba, Ta, Fqa]	0.0	185.2	0.0	7406.7
Maximum value	[Fzdmax, Mbmax, Tmax, Fqmax]	-0.0	314.8	0.0	12591.4

Cross section, moment of resistance: (mm²)					
[A, Wb, Wt, A]		962.1	4209.2	8418.5	962.1
Stresses: (N/mm²)					
[σzdm, σbm, τm, τqm] (N/mm²)		-0.000	0.000	0.000	0.000
[σzda, σba, τa, τqa] (N/mm²)		0.000	43.995	0.000	10.265
[σzdmax,σbmax,τmax,τqmax] (N/mm²)		-0.000	74.792	0.000	17.450
Technological size influence	[K1(sB)]	0.871			
	[K1(sS)]	0.832			
		Tension/Compression	Bending	Torsion	
Stress concentration factor	[a]	2.807	2.485	1.772	
References stress slope	[G']	2.478	2.478	1.150	
Notch sensitivity factor	[n]	1.065	1.065	1.045	
Notch effect coefficient	[ß]	2.635	2.333	1.696	
Geometrical size influence	[K2(d)]	1.000	0.897	0.897	
Influence coefficient surface roughness					
	[KF]	0.898	0.898	0.941	
Influence coefficient surface strengthening					
	[KV]	1.000	1.000	1.000	
Total influence coefficient	[K]	2.748	2.714	1.953	
Present safety factor for endurance limit:					
Equivalent mean stress (N/mm²)	[σmV]		0.000		
Equivalent mean stress (N/mm²)	[τmV]		0.000		
Fatigue limit of part (N/mm²)	[σWK]	139.492	176.610	147.241	
Influence coefficient of mean stress sensitivity.					
	[ψσK]	0.078	0.101	0.083	
Permissible amplitude (N/mm²)	[σADK]	139.492	176.610	147.241	
Safety against fatigue	[S]		4.014		
Required safety against fatigue	[Smin]		1.200		
Result (%)	[S/Smin]		334.5		
Present safety factor					
for proof against exceed of yield point:					
Static notch sensitivity factor	[K2F]	1.000	1.200	1.200	
Increase coefficient	[γF]	1.100	1.100	1.000	
Yield stress of part (N/mm²)	[σFK]	823.433	988.120	518.629	
Safety yield stress	[S]		13.212		
Required safety	[Smin]		1.200		
Result (%)	[S/Smin]		1101.0		

Cross section 'D-D' Shoulder

Comment	Y= 80.00mm			
Position (Y-Coordinate) (mm)		[y]		80.00
External diameter (mm)		[da]		40.000
Inner diameter (mm)		[di]		0.000
Diameter for size factors (mm)		[deff]		55.000
Notch effect	Shoulder			
[D, r, t] (mm)	55.000	3.000	0.000	
Mean roughness (µm)		[Rz]		8.000

		Tension/Compression	Bending	Torsion	Shearing
Stress: (N) (Nm)					
Mean value	[Fzdm, Mbm, Tm, Fqm]	-1631.8	0.0	365.4	0.0
Amplitude	[Fzda, Mba, Ta, Fqa]	1631.8	87.6	365.4	5850.9
Maximum value	[Fzdmax, Mbmax, Tmax, Fqmax]	-5548.3	148.9	1242.4	9946.6
Cross section, moment of resistance: (mm²)					
[A, Wb, Wt, A]		1256.6	6283.2	12566.4	1256.6

Stresses: (N/mm²)					
[σzdm, σbm, τm, τqm] (N/mm²)		-1.299	0.000	29.078	0.000
[σzda, σba, τa, τqa] (N/mm²)		1.299	13.942	29.078	6.208
[σzdmax,σbmax,τmax,τqmax] (N/mm²)		-4.415	23.701	98.866	10.554
Technological size influence	[K1(sB)]	0.861			
	[K1(sS)]	0.818			

		Tension/Compression	Bending	Torsion
Stress concentration factor	[a]	2.030	1.843	1.437
References stress slope	[G']	0.859	0.859	0.383
Notch sensitivity factor	[n]	1.040	1.040	1.027
Notch effect coefficient	[ß]	1.952	1.772	1.399
Geometrical size influence	[K2(d)]	1.000	0.888	0.888
Influence coefficient surface roughness	[KF]	0.866	0.866	0.923
Influence coefficient surface strengthening	[KV]	1.000	1.000	1.000
Total influence coefficient	[K]	2.107	2.150	1.659

Present safety factor for endurance limit:				
Equivalent mean stress (N/mm²)	[σmV]		50.348	
Equivalent mean stress (N/mm²)	[τmV]		29.068	
Fatigue limit of part (N/mm²)	[σWK]	179.732	220.195	171.209
Influence coefficient of mean stress sensitivity.				
	[ψσK]	0.105	0.132	0.099
Permissible amplitude (N/mm²)	[σADK]	20.354	149.256	155.731
Safety against fatigue	[S]		4.097	
Required safety against fatigue	[Smin]		1.200	
Result (%)	[S/Smin]		341.4	
Present safety factor				
for proof against exceed of yield point:				
Static notch sensitivity factor	[K2F]	1.000	1.200	1.200
Increase coefficient	[γF]	1.100	1.050	1.000
Yield stress of part (N/mm²)	[σFK]	809.501	927.246	509.853
Safety yield stress	[S]		5.130	
Required safety	[Smin]		1.200	
Result (%)	[S/Smin]		427.5	

Remarks:

- The shearing force is not considered in the analysis specified in DIN 743.
- Cross section with interference fit:
  The notching factor for the light fit case is no longer defined in DIN 743.
  The values are imported from the FKM-Guideline..

End of Report lines:
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