File

Name : Unnamed
Changed by: jirri on: 28.07.2019 at: 20:53:54

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

1-> For shaft with internal diameter the notch factors are not available.
None of the known calculation methods produces reliable data. It is proposed to use the data for the full shaft and to judge the results conservatively.

## Analysis of shafts, axle and beams

### Input data

Coordinate system shaft: see picture W-002

| | | |
|---|---|---|
| Label | | Shaft3 |
| Drawing | | |
| Initial position (mm) | | 0.000 |
| Length (mm) | | 160.000 |
| Speed (1/min) | | 31023.00 |
| Sense of rotation: clockwise | | |
| | | |
| Material | | 34 CrAlNi 7-10 |
| 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 |

Temperature for load spectrum

| No. | Temperature (°C) |
|---|---|
| 1 | 70.000 |
| 2 | 65.000 |
| 3 | 50.000 |
| 4 | 50.000 |
| 5 | 50.000 |
| 6 | 50.000 |
| 7 | 50.000 |
| 8 | 50.000 |
| 9 | 50.000 |
| 10 | 50.000 |

| | |
|---|---|
| Weight of shaft (kg) | 2.377 |
| (Notice: Weight stands for the shaft only without considering the gears) | |
| Weight of shaft, including additional masses (kg) | 5.132 |
| Mass moment of inertia (kg*mm²) | 8368.585 |
| Momentum of mass GD2 (Nm²) | 0.328 |

The direction of the weight is not considered
Regard gears as masses and stiffness
Consider deformations due to shearing

| | |
|---|---|
| Shear correction coefficient | 1.100 |
| Contact angle of rolling bearings is considered | |
| Tolerance field: Mean value | |
| Reference temperature (°C) | 20.000 |

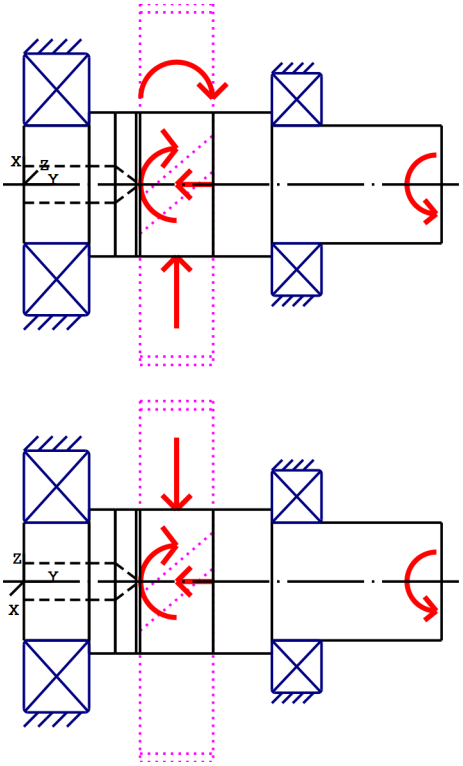

Figure: Load applications

**Shaft definition (Shaft3)**

**Outer contour**

| Cylinder (Cylinder) | | | 0.000mm ... 25.000mm |
|---|---|---|---|
| Diameter (mm) | [d] | 45.0000 | |
| Length (mm) | [l] | 25.0000 | |
| Surface roughness (µm) | [Rz] | 8.0000 | |

Radius right (Radius right)
r=0.77 (mm), Rz=8.0, Turned (Ra=3.2µm/125µin)

Chamfer left (Chamfer left)
l=2.00 (mm), alpha=45.00 (°)

| Cylinder (Cylinder) | | | 25.000mm ... 95.000mm |
|---|---|---|---|
| Diameter (mm) | [d] | 55.0000 | |
| Length (mm) | [l] | 70.0000 | |
| Surface roughness (µm) | [Rz] | 8.0000 | |

| Cylinder (Cylinder) | | | 95.000mm ... | 160.000mm |
|---|---|---|---|---|
| Diameter (mm) | [d] | 45.0000 | | |
| Length (mm) | [l] | 65.0000 | | |
| Surface roughness (µm) | [Rz] | 8.0000 | | |

Radius left (Radius left)
r=2.00 (mm), Rz=8.0, Turned (Ra=3.2µm/125µin)

**Inner contour**

| Cylinder inside (Cylinder inside) | | | 0.000mm ... | 35.000mm |
|---|---|---|---|---|
| Diameter (mm) | [d] | 14.0000 | | |
| Length (mm) | [l] | 35.0000 | | |
| Surface roughness (µm) | [Rz] | 8.0000 | | |

| Conical bore (Conical bore) | | | 35.000mm ... | 43.000mm |
|---|---|---|---|---|
| Diameter left (mm) | [$d_l$] | 14.0000 | | |
| Diameter right (mm) | [$d_r$] | 2.0000 | | |
| Length (mm) | [l] | 8.0000 | | |
| Surface roughness (µm) | [Rz] | 8.0000 | | |

**Forces**

| Type of force element | | **Coupling** | | |
|---|---|---|---|---|
| Label in the model | | Coupling2(In) | | |
| Position on shaft (mm) | [$y_{local}$] | 158.0000 | | |
| Position in global system (mm) | [$y_{global}$] | 158.0000 | | |
| Effective diameter (mm) | | 60.0000 | | |
| Radial force factor (-) | | 0.0000 | | |
| Direction of the radial force (°) | | 0.0000 | | |
| Axial force factor (-) | | 0.0000 | | |
| Length of load application (mm) | | 10.0000 | | |
| Power (kW) | | 756.2503 | | |
| Torque (Nm) | | 232.7840 | | |
| Axial force (load spectrum) (N) | | 0.0000 / | 0.0000 / | 0.0000 |
| Shearing force X (load spectrum) (N) | | 0.0000 / | 0.0000 / | 0.0000 |
| Shearing force Z (Load spectrum) (N) | | 0.0000 / | 0.0000 / | 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 | | |

Load spectrum, driven (input)
Example with file (with factors)

| No. | Frequency (%) | Speed (1/min) | Power (kW) | Torque (Nm) |
|---|---|---|---|---|
| 1 | 1.0000e+001 | 31023.000 | 756.250 | 232.784 |
| 2 | 1.0000e+001 | 31023.000 | 680.625 | 209.506 |
| 3 | 1.0000e+001 | 34125.300 | 665.500 | 186.227 |
| 4 | 1.0000e+001 | 34125.300 | 582.313 | 162.949 |
| 5 | 1.0000e+001 | 37227.600 | 544.500 | 139.670 |
| 6 | 1.0000e+001 | 37227.600 | 453.750 | 116.392 |
| 7 | 1.0000e+001 | 43432.200 | 423.500 | 93.114 |
| 8 | 1.0000e+001 | 43432.200 | 317.625 | 69.835 |
| 9 | 1.0000e+001 | 43432.200 | 211.750 | 46.557 |
| 10 | 1.0000e+001 | 43432.200 | 105.875 | 23.278 |

| | | | | |
|---|---|---|---|---|
| Type of force element | | **Cylindrical gear** | | |
| Label in the model | | z3 | | |
| Position on shaft (mm) | [$y_{local}$] | 58.5000 | | |
| Position in global system (mm) | [$y_{global}$] | 58.5000 | | |
| Operating pitch diameter (mm) | | 137.9310 | | |
| Helix angle (°) | | 20.2317 left | | |
| Working pressure angle at normal section (°) | | 21.6623 | | |
| Position of contact (°) | | 180.0000 | | |
| Length of load application (mm) | | 28.0000 | | |
| Power (kW) | | 756.2500 | | |
| Torque (Nm) | | -232.7839 | | |
| Axial force (load spectrum) (N) | | -1244.0123 / | -1119.6111 / | -995.2099 |
| Shearing force X (load spectrum) (N) | | 1428.8073 / | 1285.9266 / | 1143.0459 |
| Shearing force Z (Load spectrum) (N) | | -3375.3668 / | -3037.8301 / | -2700.2934 |
| Bending moment X (Load spectrum) (Nm) | | 0.0000 / | 0.0000 / | 0.0000 |
| Bending moment Z (Load spectrum) (Nm) | | 85.7940 / | 77.2146 / | 68.6352 |

Load spectrum, driving (output)

Example with file (with factors)

| No. | Frequency (%) | Speed (1/min) | Power (kW) | Torque (Nm) |
|---|---|---|---|---|
| 1 | 1.0000e+001 | 31023.000 | -756.250 | -232.784 |
| 2 | 1.0000e+001 | 31023.000 | -680.625 | -209.506 |
| 3 | 1.0000e+001 | 34125.300 | -665.500 | -186.227 |
| 4 | 1.0000e+001 | 34125.300 | -582.313 | -162.949 |
| 5 | 1.0000e+001 | 37227.600 | -544.500 | -139.670 |
| 6 | 1.0000e+001 | 37227.600 | -453.750 | -116.392 |
| 7 | 1.0000e+001 | 43432.200 | -423.500 | -93.114 |
| 8 | 1.0000e+001 | 43432.200 | -317.625 | -69.835 |
| 9 | 1.0000e+001 | 43432.200 | -211.750 | -46.557 |
| 10 | 1.0000e+001 | 43432.200 | -105.875 | -23.278 |

**Bearing**

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| | | |
|---|---|---|
| Label in the model | | RollerBearing1 |
| Bearing type | | SKF 7309 BECBY |
| Bearing type | | Angular contact ball bearing (single row) |
| | | SKF EXPLORER |
| Bearing position (mm) | [$y_{lokal}$] | 12.500 |
| Bearing position (mm) | [$y_{global}$] | 12.500 |
| Attachment of external ring | | Free bearing |
| Inner diameter (mm) | [d] | 45.000 |
| External diameter (mm) | [D] | 100.000 |
| Width (mm) | [b] | 25.000 |
| Corner radius (mm) | [r] | 1.500 |
| Basic static load rating (kN) | [$C_0$] | 45.000 |
| Basic dynamic load rating (kN) | [C] | 64.000 |
| Fatigue load rating (kN) | [$C_u$] | 1.900 |
| Values for approximated geometry: | | |
| Basic dynamic load rating (kN) | [$C_{theo}$] | 0.000 |
| Basic static load rating (kN) | [$C_{0theo}$] | 0.000 |
| Correction factor Basic dynamic load rating | | |
| | [$f_C$] | 1.000 |
| Correction factor Basic static load rating | | |
| | [$f_{C0}$] | 1.000 |

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| | | |
|---|---|---|
| Label in the model | | RollerBearing2 |
| Bearing type | | Koyo 7209 FY |
| Bearing type | | Angular contact ball bearing (single row) |
| Bearing position (mm) | [$y_{lokal}$] | 104.500 |
| Bearing position (mm) | [$y_{global}$] | 104.500 |
| Attachment of external ring | | Fixed bearing |
| Inner diameter (mm) | [d] | 45.000 |
| External diameter (mm) | [D] | 85.000 |
| Width (mm) | [b] | 19.000 |
| Corner radius (mm) | [r] | 1.100 |
| Basic static load rating (kN) | [$C_0$] | 26.600 |
| Basic dynamic load rating (kN) | [C] | 47.200 |
| Fatigue load rating (kN) | [$C_u$] | 1.700 |
| Values for approximated geometry: | | |
| Basic dynamic load rating (kN) | [$C_{theo}$] | 0.000 |
| Basic static load rating (kN) | [$C_{0theo}$] | 0.000 |
| Correction factor Basic dynamic load rating | [$f_C$] | 1.000 |
| Correction factor Basic static load rating | [$f_{C0}$] | 1.000 |

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Shaft 'Shaft3': Cylindrical gear 'z3' (y= 58.5000 (mm)) is taken into account as component of the shaft.
EI (y= 44.5000 (mm)): 92531.1324 (Nm²), EI (y= 72.5000 (mm)): 92531.1324 (Nm²), m (yS= 58.5000 (mm)): 2.7550 (kg)
Jp: 0.0076 (kg*m²), Jxx: 0.0040 (kg*m²), Jzz: 0.0040 (kg*m²)

**Results**

Note: the maximum deflection and torsion of the shaft under torque,
the life modification factor aISO, and the bearing's thinnest lubricant film thickness EHL, are
predefined for the first load bin.

**Shaft**

| | |
|---|---|
| Maximum deflection (µm) | 0.713 |
| Position of the maximum (mm) | 160.000 |
| Mass center of gravity (mm) | 77.554 |
| Total axial load (N) | -1244.012 |
| Torsion under torque (°) | 0.030 |

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**Bearing**

| | | | |
|---|---|---|---|
| Probability of failure | [n] | 1.00 | % |
| Axial clearance | [$u_A$] | 10.00 | µm |
| Lubricant | Oil: ISO-VG 220 | | |
| Lubricant - service temperature | [$T_B$] | 70.00 | °C |

Rolling bearings, classical calculation (contact angle considered)

**Shaft 'Shaft3' Rolling bearing 'RollerBearing1'**

| | | | |
|---|---|---|---|
| Position (Y-coordinate) | [y] | 12.50 | mm |

| | | | |
|---|---|---|---|
| Life modification factor for reliability[$a_1$] | | 0.248 | |
| Nominal bearing service life | [$L_{nh}$] | 8262.51 | h |
| Operating viscosity | [v] | 48.88 | mm²/s |
| Static safety factor | [$S_0$] | 19.08 | |

| | Bearing reaction force | | | | Bearing reaction moment | | | |
|---|---|---|---|---|---|---|---|---|
| | Fx (kN) | Fy (kN) | Fz (kN) | Fr (kN) | Mx (Nm) | My (Nm) | Mz (Nm) | Mr (Nm) |
| 1 | -1.647 | 0.000 | 1.688 | 2.358 | 0.000 | 0.000 | 0.000 | 0.000 |
| 2 | -1.482 | 0.000 | 1.519 | 2.122 | 0.000 | 0.000 | 0.000 | 0.000 |
| 3 | -1.318 | 0.000 | 1.350 | 1.886 | 0.000 | 0.000 | 0.000 | 0.000 |
| 4 | -1.153 | 0.000 | 1.181 | 1.651 | 0.000 | 0.000 | 0.000 | 0.000 |
| 5 | -0.988 | 0.000 | 1.013 | 1.415 | 0.000 | 0.000 | 0.000 | 0.000 |
| 6 | -0.823 | 0.000 | 0.844 | 1.179 | 0.000 | 0.000 | 0.000 | 0.000 |
| 7 | -0.659 | 0.000 | 0.675 | 0.943 | 0.000 | 0.000 | 0.000 | 0.000 |
| 8 | -0.494 | 0.000 | 0.506 | 0.707 | 0.000 | 0.000 | 0.000 | 0.000 |
| 9 | -0.329 | 0.000 | 0.338 | 0.472 | 0.000 | 0.000 | 0.000 | 0.000 |
| 10 | -0.165 | 0.000 | 0.169 | 0.236 | 0.000 | 0.000 | 0.000 | 0.000 |

| | Displacement of bearing | | | | Misalignment of bearing | | | |
|---|---|---|---|---|---|---|---|---|
| | ux (µm) | uy (µm) | uz (µm) | rr (µm) | rx (mrad) | ry (mrad) | rz (mrad) | rr (mrad) |
| 1 | 0.0000 | -62.9988 | 0.0000 | 0.0000 | -0.011 | 0.000 | -0.003 | 0.011 |
| 2 | 0.0000 | -57.6989 | 0.0000 | 0.0000 | -0.010 | 0.000 | -0.003 | 0.010 |
| 3 | 0.0000 | -41.8188 | 0.0000 | 0.0000 | -0.009 | 0.000 | -0.003 | 0.009 |
| 4 | 0.0000 | -41.8091 | 0.0000 | 0.0000 | -0.008 | 0.000 | -0.002 | 0.008 |
| 5 | 0.0000 | -41.7992 | 0.0000 | 0.0000 | -0.006 | 0.000 | -0.002 | 0.007 |
| 6 | 0.0000 | -41.7894 | 0.0000 | 0.0000 | -0.005 | 0.000 | -0.002 | 0.006 |
| 7 | 0.0000 | -41.7795 | 0.0000 | 0.0000 | -0.004 | 0.000 | -0.001 | 0.005 |
| 8 | 0.0000 | -41.7696 | 0.0000 | 0.0000 | -0.003 | 0.000 | -0.001 | 0.003 |
| 9 | 0.0000 | -41.7597 | -0.0000 | 0.0000 | -0.002 | 0.000 | -0.001 | 0.002 |
| 10 | 0.0000 | -41.7499 | -0.0000 | 0.0000 | -0.001 | 0.000 | -0.000 | 0.001 |

**Shaft 'Shaft3' Rolling bearing 'RollerBearing2'**

| | | | |
|---|---|---|---|
| Position (Y-coordinate) | [y] | 104.50 | mm |
| Life modification factor for reliability[$a_1$] | | 0.248 | |
| Nominal bearing service life | [$L_{nh}$] | 8816.47 | h |
| Operating viscosity | [v] | 48.88 | mm²/s |
| Static safety factor | [$S_0$] | 15.63 | |

| | Bearing reaction force | | | | Bearing reaction moment | | | |
|---|---|---|---|---|---|---|---|---|
| | Fx (kN) | Fy (kN) | Fz (kN) | Fr (kN) | Mx (Nm) | My (Nm) | Mz (Nm) | Mr (Nm) |
| 1 | 0.218 | 1.243 | 1.688 | 1.702 | -0.000 | 0.000 | -0.000 | 0.000 |
| 2 | 0.196 | 1.119 | 1.519 | 1.532 | -0.000 | 0.000 | 0.000 | 0.000 |
| 3 | 0.175 | 0.993 | 1.350 | 1.361 | -0.000 | 0.000 | 0.000 | 0.000 |
| 4 | 0.153 | 0.870 | 1.181 | 1.191 | -0.000 | 0.000 | -0.000 | 0.000 |
| 5 | 0.131 | 0.746 | 1.013 | 1.021 | -0.000 | 0.000 | 0.000 | 0.000 |
| 6 | 0.109 | 0.621 | 0.844 | 0.851 | -0.000 | 0.000 | -0.000 | 0.000 |
| 7 | 0.087 | 0.497 | 0.675 | 0.681 | 0.000 | 0.000 | 0.000 | 0.000 |
| 8 | 0.065 | 0.373 | 0.506 | 0.511 | -0.000 | 0.000 | 0.000 | 0.000 |
| 9 | 0.044 | 0.249 | 0.338 | 0.340 | -0.000 | 0.000 | 0.000 | 0.000 |
| 10 | 0.022 | 0.124 | 0.169 | 0.170 | -0.000 | 0.000 | 0.000 | 0.000 |

| | Displacement of bearing | | | | Misalignment of bearing | | | |
|---|---|---|---|---|---|---|---|---|
| | ux (µm) | uy (µm) | uz (µm) | rr (µm) | rx (mrad) | ry (mrad) | rz (mrad) | rr (mrad) |
| 1 | 0.0000 | -10.0000 | 0.0000 | 0.0000 | 0.011 | 0.144 | 0.006 | 0.013 |
| 2 | 0.0000 | -10.0000 | 0.0000 | 0.0000 | 0.010 | 0.130 | 0.006 | 0.012 |
| 3 | 0.0000 | -10.0000 | 0.0000 | 0.0000 | 0.009 | 0.115 | 0.005 | 0.010 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 4 | 0.0000 | -10.0000 | 0.0000 | 0.0000 | 0.008 | 0.101 | 0.004 | 0.009 |
| 5 | 0.0000 | -10.0000 | 0.0000 | 0.0000 | 0.007 | 0.086 | 0.004 | 0.008 |
| 6 | 0.0000 | -10.0000 | 0.0000 | 0.0000 | 0.006 | 0.072 | 0.003 | 0.006 |
| 7 | 0.0000 | -10.0000 | 0.0000 | 0.0000 | 0.004 | 0.058 | 0.003 | 0.005 |
| 8 | 0.0000 | -10.0000 | 0.0000 | 0.0000 | 0.003 | 0.043 | 0.002 | 0.004 |
| 9 | 0.0000 | -10.0000 | 0.0000 | 0.0000 | 0.002 | 0.029 | 0.001 | 0.003 |
| 10 | 0.0000 | -10.0000 | 0.0000 | 0.0000 | 0.001 | 0.014 | 0.001 | 0.001 |

Damage (%) [Lreq] ( 7200.000)

| Bin no | B1 | B2 |
|---|---|---|
| 1 | 27.00 | 25.29 |
| 2 | 19.68 | 18.44 |
| 3 | 15.20 | 14.24 |
| 4 | 10.19 | 9.54 |
| 5 | 7.00 | 6.56 |
| 6 | 4.05 | 3.79 |
| 7 | 2.42 | 2.27 |
| 8 | 1.02 | 0.96 |
| 9 | 0.30 | 0.28 |
| 10 | 0.07 | 0.07 |
| Σ | 86.92 | 81.44 |

Utilization (%) [Lreq] ( 7200.000)

| B1 | B2 |
|---|---|
| 95.52 | 93.47 |

Note: Utilization = (Lreq/Lh)^(1/k)
Ball bearing: k = 3, roller bearing: k = 10/3

B1: RollerBearing1
B2: RollerBearing2

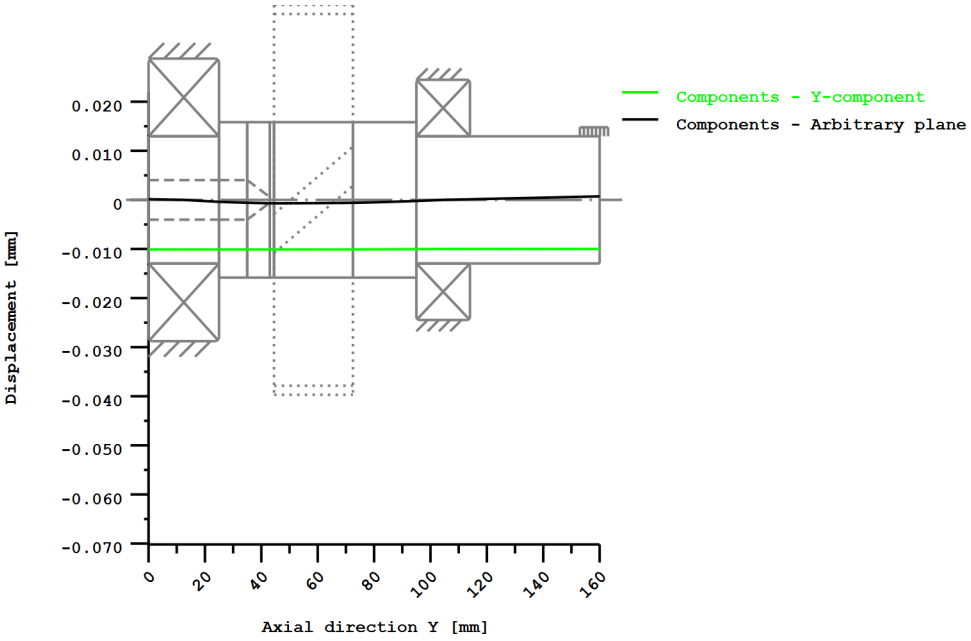
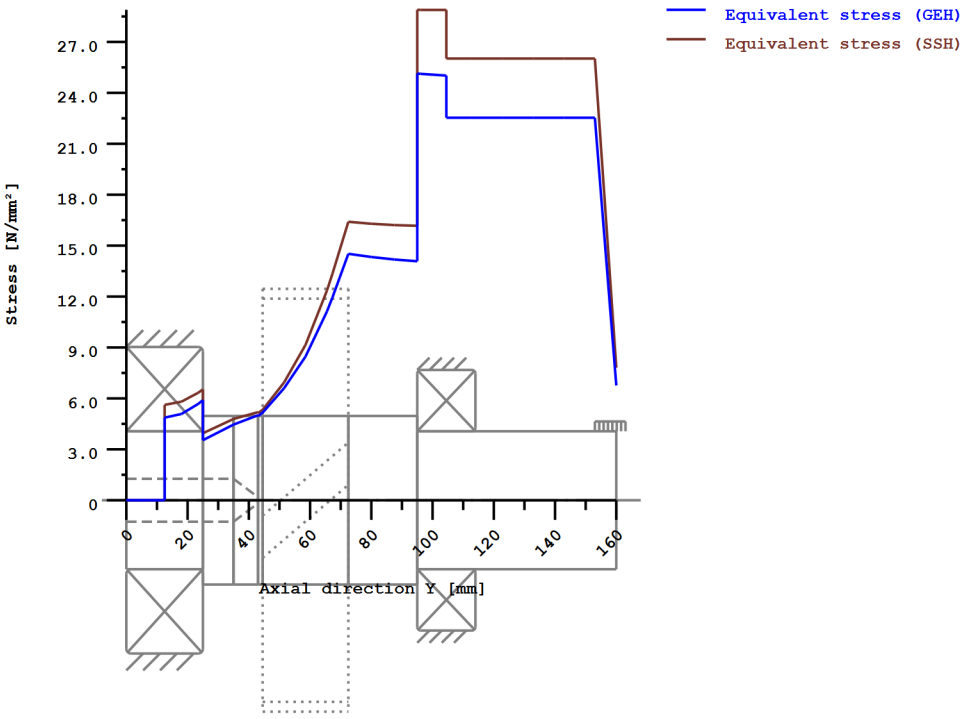



Figure: Deformation (bending etc.) (Arbitrary plane 119.7807783 121)




Nominal stresses, without taking into account stress concentrations
GEH(von Mises): sigV = ((sigB+sigZ,D)^2 + 3*(tauT+tauS)^2)^1/2
SSH(Tresca): sigV = ((sigB-sigZ,D)^2 + 4*(tauT+tauS)^2)^1/2

Figure: Equivalent stress

## Strength calculation according to DIN 743:2012
## with finite life fatigue strength according to FKM standard and FVA draft

**Summary**

**Shaft3**

---

| | |
|---|---|
| Material | 34 CrAlNi 7-10 |
| Material type | Nitriding steel |
| Material treatment | gas-nitrided |
| Surface treatment | No |

Calculation of service strength and static strength
S-N curve (Woehler line) according Miner elementary

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

| Cross section | Position (Y-Coord) (mm) | |
|---|---|---|
| A-A | 12.50 | Interference fit |
| B-B | 25.00 | Shoulder |
| C-C | 58.50 | Smooth shaft |
| D-D | 95.00 | Shoulder |
| E-E | 104.50 | Interference fit |

Results:

| Cross section | Kfb | Kfσ | K2d | SZ | SS |
|---|---|---|---|---|---|
| A-A | 2.56 | 1.00 | 0.88 | 9999.99 | 9999.99 |
| B-B | 2.06 | 0.88 | 0.88 | 53.14 | 115.00 |
| C-C | 1.00 | 0.88 | 0.87 | 44.90 | 49.53 |
| D-D | 1.69 | 0.88 | 0.88 | 17.29 | 16.86 |
| E-E | 2.56 | 1.00 | 0.88 | 18.16 | 16.96 |
| Required safeties: | | | | 1.40 | 1.40 |

Abbreviations:
Kfb: Notch factor bending
Kfσ: Surface factor
K2d: size factor bending
SZ: Safety fatigue strength
SS: Safety against yield point

**Service life and damage**

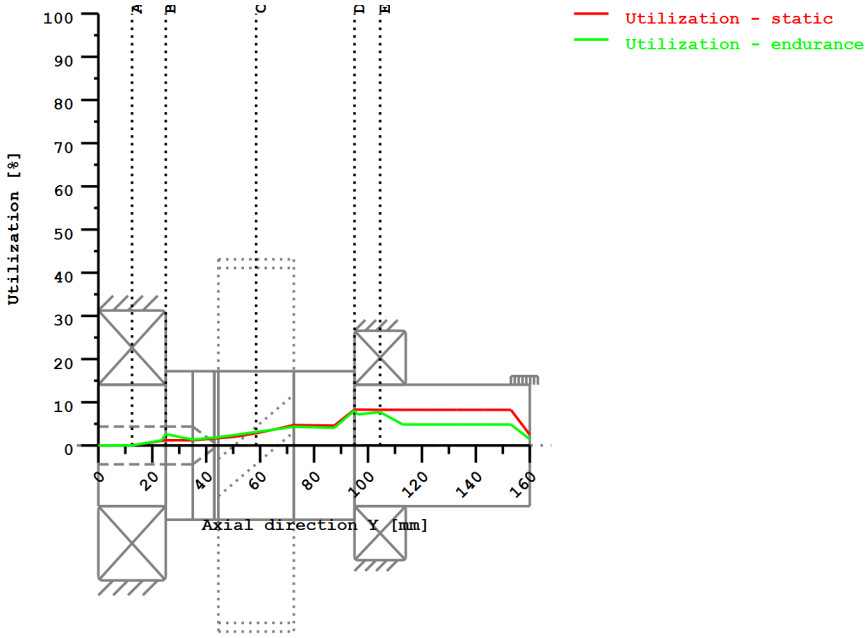
| | | |
|---|---|---|
| System service life (h) | [Hatt] | 1000000.00 |
| Damage to system (%) | [D] | 0.00 |

**Utilization (%) [Smin/S]**

| Cross section | Static | Endurance |
|---|---|---|
| A-A | 0.010 | 0.010 |
| B-B | 1.217 | 2.635 |

| | | |
|---|---|---|
| C-C | 2.826 | 3.118 |
| D-D | 8.305 | 8.097 |
| E-E | 8.256 | 7.709 |

| | | |
|---|---|---|
| Maximum utilization (%) | [A] | 8.305 |




Utilization = Smin/S (%)

Figure: Strength

## Calculation details

### General statements

| | | | |
|---|---|---|---|
| Label | Shaft3 | | |
| Drawing | | | |
| Length (mm) | | [l] | 160.00 |
| Speed (1/min) | | [n] | 31023.00 |
| Material | 34 CrAlNi 7-10 | | |
| Material type | Nitriding steel | | |
| Material treatment | gas-nitrided | | |
| 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] | 100.00 |
| σB according to DIN 743 (at dB) (N/mm²) | [σB] | 850.00 |
| σS according to DIN 743 (at dB) (N/mm²) | [σS] | 650.00 |
| [σzdW] (bei dB) (N/mm²) | | 340.00 |
| [σbW] (bei dB) (N/mm²) | | 425.00 |
| [τtW] (bei dB) (N/mm²) | | 255.00 |
| Thickness of raw material (mm) | [dWerkst] | 60.00 |

Material data calculated according DIN743/3 with K1(d)
Material strength calculated from size of raw material
Geometric size factor K1d calculated from raw material diameter

| | |
|---|---|
| [σBeff] (N/mm²) | 850.00 |
| [σSeff] (N/mm²) | 650.00 |
| [σbF] (N/mm²) | 650.00 |
| [τtF] (N/mm²) | 375.28 |
| [σBRand] (N/mm²) | 0.00 |
| | |
| [σzdW] (N/mm²) | 340.00 |
| [σbW] (N/mm²) | 425.00 |
| [τtW] (N/mm²) | 255.00 |

Service strength for a load spectrum
S-N curve (Woehler lines) according to Miner elementary according to FKM guideline

| | | |
|---|---|---|
| Required life time | [H] | 18000.00 |
| Number of load cycles (Mio) | [NL] | 40875.905 |

Data of S-N curve (Woehler line) analog to FKM standard:

| | | |
|---|---|---|
| [kσ, kτ] | 15 | 25 |
| [kDσ, kDτ] | 0 | 0 |
| [NDσ, NDτ] | 1e+006 | 1e+006 |
| [NDσII, NDτII] | 0 | 0 |

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

**Cross section 'A-A' Interference fit**

| | | |
|---|---|---|
| Comment | | |
| Position (Y-Coordinate) (mm) | [y] | 12.500 |
| External diameter (mm) | [da] | 45.000 |
| Inner diameter (mm) | [di] | 14.000 |
| Notch effect | | Interference fit |
| Characteristics: | Firm interference fit | |
| Mean roughness (µm) | [Rz] | 8.000 |

| | | Tension/Compression | Bending | Torsion | Shearing | |
|---|---|---|---|---|---|---|
| Load: (N) (Nm) | | | | | | |
| Mean value | [Fzdm, Mbm, Tm, Fqm] | -0.9 | 0.0 | 0.0 | 0.0 | |
| Amplitude | [Fzda, Mba, Ta, Fqa] | 0.9 | 0.0 | 0.0 | 2358.1 | |
| Maximum value | [Fzdmax, Mbmax, Tmax, Fqmax] | -3.1 | 0.0 | 0.0 | | 4008.8 |
| Cross section, moment of resistance: (mm²) | | | | | | |
| [A, Wb, Wt, A] | | 1436.5 | 8862.4 | 17724.7 | 1436.5 | |

Load spectrum, load base values (Mean-value + Amplitude):

| No. | Frequency (%) | Tens./Compres. (N) | Bending (Nm) | Torsion (Nm) | Shearing (N) |
|---|---|---|---|---|---|
| 1 | 1.0000e+001 | -0.847 | 0.001 | 0.000 | 2358.119 |
| 2 | 1.0000e+001 | -0.789 | 0.001 | 0.000 | 2122.307 |
| 3 | 1.0000e+001 | -1.848 | 0.002 | 0.000 | 1886.501 |
| 4 | 1.0000e+001 | -0.616 | 0.001 | 0.000 | 1650.683 |
| 5 | 1.0000e+001 | -0.616 | 0.001 | 0.000 | 1414.871 |
| 6 | 1.0000e+001 | -0.615 | 0.000 | 0.000 | 1179.059 |
| 7 | 1.0000e+001 | -0.615 | 0.000 | 0.000 | 943.248 |
| 8 | 1.0000e+001 | -0.615 | 0.000 | 0.000 | 707.436 |
| 9 | 1.0000e+001 | -0.205 | 0.000 | 0.000 | 471.623 |
| 10 | 1.0000e+001 | -0.205 | 0.000 | 0.000 | 235.812 |

| | | | | | |
|---|---|---|---|---|---|
| Stresses: (N/mm²) | | | | | |
| [σzdm, σbm, τm, τqm] (N/mm²) | | -0.001 | 0.000 | 0.000 | 0.000 |
| [σzda, σba, τa, τqa] (N/mm²) | | 0.001 | 0.000 | 0.000 | 2.810 |
| [σzdmax,σbmax,τmax,τqmax] (N/mm²) | | -0.002 | 0.000 | 0.000 | 4.776 |
| | | | | | |
| Technological size influence | [K1(σB)] | 1.000 | | | |
| | [K1(σS)] | 1.000 | | | |

| | | Tension/Compression | Bending | Torsion |
|---|---|---|---|---|
| Notch effect coefficient | [ß(dB)] | 2.550 | 2.550 | 1.650 |
| [dB] (mm) = 40.0 | | | | |
| Geometrical size influence | [K3(d)] | 0.951 | 0.951 | 0.974 |
| Geometrical size influence | [K3(dB)] | 0.955 | 0.955 | 0.976 |
| Notch effect coefficient | [ß] | 2.559 | 2.559 | 1.653 |
| Geometrical size influence | [K2(d)] | 1.000 | 0.880 | 0.880 |
| Influence coefficient surface roughness | [KF] | 1.000 | 1.000 | 1.000 |
| Roughness factor is included into the notch effect coefficient | | | | |
| Surface stabilization factor | [KV] | 1.000 | 1.000 | 1.000 |
| Total influence coefficient | [K] | 2.559 | 2.906 | 1.877 |
| | | | | |
| Present safety for endurance limit: | | | | |
| Equivalent mean stress (N/mm²) | [σmV] | | 0.001 | |
| Equivalent mean stress (N/mm²) | [τmV] | | 0.000 | |
| | | | | |
| Fatigue limit of part (N/mm²) | [σWK] | 132.887 | 146.238 | 135.820 |
| Influence coefficient of mean stress sensitivity. | | | | |
| | [ψσK] | 0.085 | 0.094 | 0.087 |
| Permissible amplitude (N/mm²) | [σADK] | 126.013 | 137.890 | 131.577 |
| Permissible amplitude (N/mm²) | [σANK] | 126.013 | 137.890 | 131.577 |
| Effective Miner sum | [DM] | 1.000 | 1.000 | 1.000 |
| Load spectrum factor | [fKoll] | 1.000 | 1.000 | 1.000 |
| Safety against fatigue | [S] | | 9999.990 | |
| Required safety against fatigue | [Smin] | | 1.400 | |
| Result (%) | [S/Smin] | | 1000000.0 | |
| | | | | |
| Present safety | | | | |
| for proof against exceed of yield point: | | | | |
| Static notch sensitivity factor | [K2F] | 1.000 | 1.000 | 1.000 |
| Increase coefficient | [γF] | 1.000 | 1.000 | 1.000 |
| Yield stress of part (N/mm²) | [σFK] | 650.000 | 650.000 | 375.278 |
| Safety yield stress | [S] | | 9999.990 | |
| Required safety | [Smin] | | 1.400 | |
| Result (%) | [S/Smin] | | 1000000.0 | |

**Cross section 'B-B' Shoulder**

| | | |
|---|---|---|
| Comment | Y= 99.73mm | |
| Position (Y-Coordinate) (mm) | [y] | 25.000 |
| External diameter (mm) | [da] | 45.000 |
| Inner diameter (mm) | [di] | 14.000 |
| Notch effect | | Shoulder |

| | | | | |
|---|---|---|---|---|
| [D, r, t] (mm) | 55.000 | 0.770 | 5.000 | |
| Mean roughness (µm) | | [Rz] | | 8.000 |

| | | Tension/Compression | Bending | Torsion | Shearing | |
|---|---|---|---|---|---|---|
| Load: (N) (Nm) | | | | | | |
| Mean value | [Fzdm, Mbm, Tm, Fqm] | -0.9 | 0.0 | 0.0 | 0.0 | |
| Amplitude | [Fzda, Mba, Ta, Fqa] | 0.9 | 29.5 | 0.0 | 2358.1 | |
| Maximum value | [Fzdmax, Mbmax, Tmax, Fqmax] | -3.1 | 50.1 | 0.0 | | 4008.8 |
| Cross section, moment of resistance: (mm²) | | | | | | |
| [A, Wb, Wt, A] | | 1436.5 | 8862.4 | 17724.7 | 1436.5 | |

Load spectrum, load base values (Mean-value + Amplitude):

| No. | Frequency (%) | Tens./Compres. (N) | Bending (Nm) | Torsion (Nm) | Shearing (N) |
|---|---|---|---|---|---|
| 1 | 1.0000e+001 | -0.847 | 29.476 | 0.000 | 2358.119 |
| 2 | 1.0000e+001 | -0.789 | 26.529 | 0.000 | 2122.307 |
| 3 | 1.0000e+001 | -1.848 | 23.581 | 0.000 | 1886.501 |
| 4 | 1.0000e+001 | -0.616 | 20.633 | 0.000 | 1650.683 |
| 5 | 1.0000e+001 | -0.616 | 17.686 | 0.000 | 1414.871 |
| 6 | 1.0000e+001 | -0.615 | 14.738 | 0.000 | 1179.059 |
| 7 | 1.0000e+001 | -0.615 | 11.790 | 0.000 | 943.248 |
| 8 | 1.0000e+001 | -0.615 | 8.843 | 0.000 | 707.436 |
| 9 | 1.0000e+001 | -0.205 | 5.895 | 0.000 | 471.623 |
| 10 | 1.0000e+001 | -0.205 | 2.948 | 0.000 | 235.812 |

| | | | | | |
|---|---|---|---|---|---|
| Stresses: (N/mm²) | | | | | |
| [σzdm, σbm, τm, τqm] (N/mm²) | | -0.001 | 0.000 | 0.000 | 0.000 |
| [σzda, σba, τa, τqa] (N/mm²) | | 0.001 | 3.326 | 0.000 | 2.810 |
| [σzdmax,σbmax,τmax,τqmax] (N/mm²) | | -0.002 | 5.654 | 0.000 | 4.776 |

| | | |
|---|---|---|
| Technological size influence | [K1(σB)] | 1.000 |
| | [K1(σS)] | 1.000 |

| | | Tension/Compression | Bending | Torsion |
|---|---|---|---|---|
| Stress concentration factor | [a] | 3.115 | 2.801 | 1.899 |
| References stress slope | [G'] | 3.232 | 3.232 | 1.494 |
| Notch sensitivity factor | [n] | 1.359 | 1.359 | 1.244 |
| Notch effect coefficient | [ß] | 2.292 | 2.061 | 1.526 |
| Geometrical size influence | [K2(d)] | 1.000 | 0.880 | 0.880 |
| Influence coefficient surface roughness | [KF] | 0.875 | 0.875 | 0.928 |
| Surface stabilization factor | [KV] | 1.000 | 1.033 | 1.033 |
| Total influence coefficient | [K] | 2.435 | 2.404 | 1.753 |
| Present safety for endurance limit: | | | | |
| Equivalent mean stress (N/mm²) | [σmV] | | 0.001 | |
| Equivalent mean stress (N/mm²) | [τmV] | | 0.000 | |
| Fatigue limit of part (N/mm²) | [σWK] | 139.623 | 176.792 | 145.490 |
| Influence coefficient of mean stress sensitivity. | | | | |
| | [ψσK] | 0.089 | 0.116 | 0.094 |
| Permissible amplitude (N/mm²) | [σADK] | 132.023 | 176.788 | 140.603 |
| Permissible amplitude (N/mm²) | [σANK] | 132.023 | 176.788 | 140.603 |
| Effective Miner sum | [DM] | 1.000 | 1.000 | 1.000 |
| Load spectrum factor | [fKoll] | 1.000 | 1.000 | 1.000 |

| | | | | |
|---|---|---|---|---|
| Safety against fatigue | [S] | | 53.140 | |
| Required safety against fatigue | [Smin] | | 1.400 | |
| Result (%) | [S/Smin] | | 3795.7 | |
| | | | | |
| Present safety | | | | |
| for proof against exceed of yield point: | | | | |
| Static notch sensitivity factor | [K2F] | 1.000 | 1.000 | 1.000 |
| Increase coefficient | [γF] | 1.000 | 1.000 | 1.000 |
| Yield stress of part (N/mm²) | [σFK] | 650.000 | 650.000 | 375.278 |
| Safety yield stress | [S] | | 115.003 | |
| Required safety | [Smin] | | 1.400 | |
| Result (%) | [S/Smin] | | 8214.5 | |

**Cross section 'C-C' Smooth shaft**

| | | |
|---|---|---|
| Comment | | |
| Position (Y-Coordinate) (mm) | [y] | 58.500 |
| External diameter (mm) | [da] | 55.000 |
| Inner diameter (mm) | [di] | 0.000 |
| Notch effect | | Smooth shaft |
| Mean roughness (µm) | [Rz] | 8.000 |

| | | Tension/Compression | Bending | Torsion | Shearing | |
|---|---|---|---|---|---|---|
| Load: (N) (Nm) | | | | | | |
| Mean value | [Fzdm, Mbm, Tm, Fqm] | 310.6 | 0.0 | 58.2 | 0.0 | |
| Amplitude | [Fzda, Mba, Ta, Fqa] | 310.6 | 71.5 | 58.2 | 932.5 | |
| Maximum value | [Fzdmax, Mbmax, Tmax, Fqmax] | 1056.0 | 121.5 | 197.9 | | 1585.3 |
| Cross section, moment of resistance: (mm²) | | | | | | |
| [A, Wb, Wt, A] | | 2375.8 | 16333.8 | 32667.7 | 2375.8 | |

Load spectrum, load base values (Mean-value + Amplitude):

| No. | Frequency (%) | Tens./Compres. (N) | Bending (Nm) | Torsion (Nm) | Shearing (N) |
|---|---|---|---|---|---|
| 1 | 1.0000e+001 | 621.160 | 71.473 | 116.392 | 932.539 |
| 2 | 1.0000e+001 | 559.017 | 64.326 | 104.753 | 839.285 |
| 3 | 1.0000e+001 | 495.757 | 57.178 | 93.114 | 746.024 |
| 4 | 1.0000e+001 | 434.789 | 50.031 | 81.474 | 652.777 |
| 5 | 1.0000e+001 | 372.588 | 42.884 | 69.835 | 559.523 |
| 6 | 1.0000e+001 | 310.388 | 35.737 | 58.196 | 466.269 |
| 7 | 1.0000e+001 | 248.187 | 28.589 | 46.557 | 373.015 |
| 8 | 1.0000e+001 | 185.987 | 21.442 | 34.918 | 279.762 |
| 9 | 1.0000e+001 | 124.196 | 14.295 | 23.278 | 186.508 |
| 10 | 1.0000e+001 | 61.996 | 7.147 | 11.639 | 93.254 |

| | | | | | |
|---|---|---|---|---|---|
| Stresses: (N/mm²) | | | | | |
| [σzdm, σbm, τm, τqm] (N/mm²) | 0.131 | 0.000 | 1.781 | 0.000 | |
| [σzda, σba, τa, τqa] (N/mm²) | 0.131 | 4.376 | 1.781 | 0.523 | |
| [σzdmax,σbmax,τmax,τqmax] (N/mm²) | 0.444 | 7.439 | 6.057 | 0.890 | |

| | | |
|---|---|---|
| Technological size influence | [K1(σB)] | 1.000 |
| | [K1(σS)] | 1.000 |

| | | Tension/Compression | Bending | Torsion |
|---|---|---|---|---|
| Notch effect coefficient | [ß] | 1.000 | 1.000 | 1.000 |
| Geometrical size influence | [K2(d)] | 1.000 | 0.867 | 0.867 |
| Influence coefficient surface roughness | [KF] | 0.875 | 0.875 | 0.928 |
| Surface stabilization factor | [KV] | 1.000 | 1.033 | 1.033 |
| Total influence coefficient | [K] | 1.143 | 1.254 | 1.191 |
| | | | | |
| Present safety for endurance limit: | | | | |
| Equivalent mean stress (N/mm²) | [σmV] | | 3.088 | |
| Equivalent mean stress (N/mm²) | [τmV] | | 1.783 | |
| | | | | |
| Fatigue limit of part (N/mm²) | [σWK] | 297.552 | 338.841 | 214.094 |
| Influence coefficient of mean stress sensitivity. | | | | |
| | [ψσK] | 0.212 | 0.249 | 0.144 |
| Permissible amplitude (N/mm²) | [σADK] | 26.396 | 288.205 | 187.111 |
| Permissible amplitude (N/mm²) | [σANK] | 26.396 | 288.205 | 187.111 |
| Effective Miner sum | [DM] | 1.000 | 1.000 | 1.000 |
| Load spectrum factor | [fKoll] | 1.000 | 1.000 | 1.000 |
| Safety against fatigue | [S] | | 44.898 | |
| Required safety against fatigue | [Smin] | | 1.400 | |
| Result (%) | [S/Smin] | | 3207.0 | |
| | | | | |
| Present safety for proof against exceed of yield point: | | | | |
| Static notch sensitivity factor | [K2F] | 1.000 | 1.000 | 1.000 |
| Increase coefficient | [γF] | 1.000 | 1.000 | 1.000 |
| Yield stress of part (N/mm²) | [σFK] | 650.000 | 650.000 | 375.278 |
| Safety yield stress | [S] | | 49.532 | |
| Required safety | [Smin] | | 1.400 | |
| Result (%) | [S/Smin] | | 3538.0 | |

**Cross section 'D-D' Shoulder**

| | | | | |
|---|---|---|---|---|
| Comment | Y= 76.73mm | | | |
| Position (Y-Coordinate) (mm) | | [y] | | 95.000 |
| External diameter (mm) | | [da] | | 45.000 |
| Inner diameter (mm) | | [di] | | 0.000 |
| Notch effect | | | Shoulder | |
| [D, r, t] (mm) | 55.000 | 2.000 | 5.000 | |
| Mean roughness (µm) | | [Rz] | | 8.000 |

| | | Tension/Compression | Bending | Torsion | Shearing | |
|---|---|---|---|---|---|---|
| Load: (N) (Nm) | | | | | | |
| Mean value | [Fzdm, Mbm, Tm, Fqm] | 621.6 | 0.0 | 116.4 | 0.0 | |
| Amplitude | [Fzda, Mba, Ta, Fqa] | 621.6 | 16.2 | 116.4 | 1701.7 | |
| Maximum value | [Fzdmax, Mbmax, Tmax, Fqmax] | 2113.4 | 27.5 | 395.7 | | 2892.9 |
| Cross section, moment of resistance: (mm²) | | | | | | |
| [A, Wb, Wt, A] | | 1590.4 | 8946.2 | 17892.4 | 1590.4 | |

Load spectrum, load base values (Mean-value + Amplitude):

| No. | Frequency (%) | Tens./Compres. (N) | Bending (Nm) | Torsion (Nm) | Shearing (N) |
|---|---|---|---|---|---|
| 1 | 1.0000e+001 | 1243.166 | 16.166 | 232.784 | 1701.713 |

| | | | | | |
|---|---|---|---|---|---|
| 2 | 1.0000e+001 | 1118.822 | 14.550 | 209.506 | 1531.542 |
| 3 | 1.0000e+001 | 993.362 | 12.933 | 186.227 | 1361.355 |
| 4 | 1.0000e+001 | 870.193 | 11.316 | 162.949 | 1191.199 |
| 5 | 1.0000e+001 | 745.792 | 9.700 | 139.670 | 1021.028 |
| 6 | 1.0000e+001 | 621.391 | 8.083 | 116.392 | 850.857 |
| 7 | 1.0000e+001 | 496.990 | 6.467 | 93.114 | 680.685 |
| 8 | 1.0000e+001 | 372.589 | 4.850 | 69.835 | 510.514 |
| 9 | 1.0000e+001 | 248.598 | 3.233 | 46.557 | 340.344 |
| 10 | 1.0000e+001 | 124.196 | 1.617 | 23.278 | 170.172 |

Stresses: (N/mm²)

| | | | | |
|---|---|---|---|---|
| [σzdm, σbm, τm, τqm] (N/mm²) | 0.391 | 0.000 | 6.505 | 0.000 |
| [σzda, σba, τa, τqa] (N/mm²) | 0.391 | 1.807 | 6.505 | 1.427 |
| [σzdmax,σbmax,τmax,τqmax] (N/mm²) | 1.329 | 3.072 | 22.117 | 2.425 |

| | | |
|---|---|---|
| Technological size influence | [K1(σB)] | 1.000 |
| | [K1(σS)] | 1.000 |

| | | Tension/Compression | Bending | Torsion |
|---|---|---|---|---|
| Stress concentration factor | [a] | 2.273 | 2.072 | 1.535 |
| References stress slope | [G'] | 1.288 | 1.288 | 0.575 |
| Notch sensitivity factor | [n] | 1.226 | 1.226 | 1.151 |
| Notch effect coefficient | [ß] | 1.853 | 1.690 | 1.333 |
| Geometrical size influence | [K2(d)] | 1.000 | 0.880 | 0.880 |
| Influence coefficient surface roughness | [KF] | 0.875 | 0.875 | 0.928 |
| Surface stabilization factor | [KV] | 1.000 | 1.033 | 1.033 |
| Total influence coefficient | [K] | 1.996 | 1.995 | 1.540 |
| Present safety for endurance limit: | | | | |
| Equivalent mean stress (N/mm²) | [σmV] | | 11.274 | |
| Equivalent mean stress (N/mm²) | [τmV] | | 6.509 | |
| Fatigue limit of part (N/mm²) | [σWK] | 170.329 | 212.994 | 165.536 |
| Influence coefficient of mean stress sensitivity. | | | | |
| | [ψσK] | 0.111 | 0.143 | 0.108 |
| Permissible amplitude (N/mm²) | [σADK] | 21.778 | 89.793 | 149.408 |
| Permissible amplitude (N/mm²) | [σANK] | 21.778 | 89.793 | 149.408 |
| Effective Miner sum | [DM] | 1.000 | 1.000 | 1.000 |
| Load spectrum factor | [fKoll] | 1.000 | 1.000 | 1.000 |
| Safety against fatigue | [S] | | 17.290 | |
| Required safety against fatigue | [Smin] | | 1.400 | |
| Result (%) | [S/Smin] | | 1235.0 | |
| Present safety for proof against exceed of yield point: | | | | |
| Static notch sensitivity factor | [K2F] | 1.000 | 1.000 | 1.000 |
| Increase coefficient | [γF] | 1.000 | 1.000 | 1.000 |
| Yield stress of part (N/mm²) | [σFK] | 650.000 | 650.000 | 375.278 |
| Safety yield stress | [S] | | 16.857 | |
| Required safety | [Smin] | | 1.400 | |
| Result (%) | [S/Smin] | | 1204.0 | |

**Cross section 'E-E' Interference fit**

| | | |
|---|---|---|
| Comment | | |
| Position (Y-Coordinate) (mm) | [y] | 104.500 |
| External diameter (mm) | [da] | 45.000 |
| Inner diameter (mm) | [di] | 0.000 |
| Notch effect | | Interference fit |
| Characteristics: | Firm interference fit | |
| Mean roughness (µm) | [Rz] | 8.000 |

| | | Tension/Compression | Bending | Torsion | Shearing | |
|---|---|---|---|---|---|---|
| Load: (N) (Nm) | | | | | | |
| Mean value | [Fzdm, Mbm, Tm, Fqm] | 621.6 | 0.0 | 116.4 | 0.0 | |
| Amplitude | [Fzda, Mba, Ta, Fqa] | 621.6 | 0.0 | 116.4 | 1701.7 | |
| Maximum value | [Fzdmax, Mbmax, Tmax, Fqmax] | 2113.4 | 0.0 | 395.7 | 2892.9 | |
| Cross section, moment of resistance: (mm²) | | | | | | |
| [A, Wb, Wt, A] | | 1590.4 | 8946.2 | 17892.4 | 1590.4 | |

Load spectrum, load base values (Mean-value + Amplitude):

| No. | Frequency (%) | Tens./Compres. (N) | Bending (Nm) | Torsion (Nm) | Shearing (N) |
|---|---|---|---|---|---|
| 1 | 1.0000e+001 | 1243.166 | 0.000 | 232.784 | 1701.713 |
| 2 | 1.0000e+001 | 1118.822 | 0.000 | 209.506 | 1531.542 |
| 3 | 1.0000e+001 | 993.362 | 0.000 | 186.227 | 1361.355 |
| 4 | 1.0000e+001 | 870.193 | 0.000 | 162.949 | 1191.199 |
| 5 | 1.0000e+001 | 745.792 | 0.000 | 139.670 | 1021.028 |
| 6 | 1.0000e+001 | 621.391 | 0.000 | 116.392 | 850.857 |
| 7 | 1.0000e+001 | 496.990 | 0.000 | 93.114 | 680.685 |
| 8 | 1.0000e+001 | 372.589 | 0.000 | 69.835 | 510.514 |
| 9 | 1.0000e+001 | 248.598 | 0.000 | 46.557 | 340.344 |
| 10 | 1.0000e+001 | 124.196 | 0.000 | 23.278 | 170.172 |

| | | | | | |
|---|---|---|---|---|---|
| Stresses: (N/mm²) | | | | | |
| [σzdm, σbm, τm, τqm] (N/mm²) | 0.391 | 0.000 | 6.505 | 0.000 | |
| [σzda, σba, τa, τqa] (N/mm²) | 0.391 | 0.000 | 6.505 | 1.427 | |
| [σzdmax,σbmax,τmax,τqmax] (N/mm²) | 1.329 | 0.000 | 22.117 | 2.425 | |

| | | |
|---|---|---|
| Technological size influence | [K1(σB)] | 1.000 |
| | [K1(σS)] | 1.000 |

| | | Tension/Compression | Bending | Torsion |
|---|---|---|---|---|
| Notch effect coefficient | [ß(dB)] | 2.550 | 2.550 | 1.650 |
| [dB] (mm) = 40.0 | | | | |
| Geometrical size influence | [K3(d)] | 0.951 | 0.951 | 0.974 |
| Geometrical size influence | [K3(dB)] | 0.955 | 0.955 | 0.976 |
| Notch effect coefficient | [ß] | 2.559 | 2.559 | 1.653 |
| Geometrical size influence | [K2(d)] | 1.000 | 0.880 | 0.880 |
| Influence coefficient surface roughness | [KF] | 1.000 | 1.000 | 1.000 |
| Roughness factor is included into the notch effect coefficient | | | | |
| Surface stabilization factor | [KV] | 1.000 | 1.000 | 1.000 |
| Total influence coefficient | [K] | 2.559 | 2.906 | 1.877 |

Present safety for endurance limit:

| | | | | |
|---|---|---|---|---|
| Equivalent mean stress (N/mm²) | [σmV] | | 11.274 | |
| Equivalent mean stress (N/mm²) | [τmV] | | 6.509 | |
| | | | | |
| Fatigue limit of part (N/mm²) | [σWK] | 132.887 | 146.238 | 135.820 |
| Influence coefficient of mean stress sensitivity. | | | | |
| | [ψσK] | 0.085 | 0.094 | 0.087 |
| Permissible amplitude (N/mm²) | [σADK] | 21.778 | 0.058 | 124.963 |
| Permissible amplitude (N/mm²) | [σANK] | 21.778 | 0.058 | 124.963 |
| Effective Miner sum | [DM] | 1.000 | 1.000 | 1.000 |
| Load spectrum factor | [fKoll] | 1.000 | 1.000 | 1.000 |
| Safety against fatigue | [S] | | 18.161 | |
| Required safety against fatigue | [Smin] | | 1.400 | |
| Result (%) | [S/Smin] | | 1297.2 | |
| | | | | |
| Present safety | | | | |
| for proof against exceed of yield point: | | | | |
| Static notch sensitivity factor | [K2F] | 1.000 | 1.000 | 1.000 |
| Increase coefficient | [γF] | 1.000 | 1.000 | 1.000 |
| Yield stress of part (N/mm²) | [σFK] | 650.000 | 650.000 | 375.278 |
| Safety yield stress | [S] | | 16.957 | |
| Required safety | [Smin] | | 1.400 | |
| Result (%) | [S/Smin] | | 1211.2 | |

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: 871