# _O.GB.GearPairConst1.GearPairCalc1

## CALCULATION OF A HELICAL GEAR PAIR

Drawing or article number:
Gear 1: 0.000.0
Gear 2: 0.000.0

Calculation method DIN 3990:1987 Method B

| | | ------- GEAR 1 | -------- GEAR 2 -- |
|---|---|---|---|
| Power (kW) | [P] | 204.465 | |
| Speed (1/min) | [n] | 3550.0 | 2662.5 |
| Torque (Nm) | [T] | 550.0 | 733.3 |
| Application factor | [KA] | 1.25 | |
| Required service life (h) | [H] | 25000.00 | |
| Gear driving (+) / driven (-) | | + | - |

Working flank gear 1: Right flank

### 1. TOOTH GEOMETRY AND MATERIAL

(geometry calculation according to DIN 3960:1987)

| | | ------- GEAR 1 | -------- GEAR 2 -- |
|---|---|---|---|
| Center distance (mm) | [a] | 80.000 | |
| Centre distance tolerance | ISO 286:2010 Measure js7 | | |
| Normal module (mm) | [mn] | 2.7500 | |
| Pressure angle at normal section (°) | [alfn] | 20.0000 | |
| Helix angle at reference circle (°) | [beta] | 10.0000 | |
| Number of teeth | [z] | 24 | 32 |
| Facewidth (mm) | [b] | 40.00 | 38.00 |
| Hand of gear | | right | left |
| Accuracy grade | [Q-DIN 3961:1978] | 6 | 6 |
| Inner diameter (mm) | [di] | 40.00 | 60.00 |
| Inner diameter of gear rim (mm) | [dbi] | 0.00 | 0.00 |

Material
Gear 1: 18CrNiMo7-6, Case-carburized steel, case-hardened
ISO 6336-5 Figure 9/10 (MQ), core strength >=25HRC Jominy J=12mm<HRC28
Gear 2: 18CrNiMo7-6, Case-carburized steel, case-hardened
ISO 6336-5 Figure 9/10 (MQ), core strength >=25HRC Jominy J=12mm<HRC28

| | | ------- GEAR 1 | -------- GEAR 2 -- |
|---|---|---|---|
| Surface hardness | | HRC 61 | HRC 61 |
| Fatigue strength. tooth root stress (N/mm²) | [σFlim] | 430.00 | 430.00 |
| Fatigue strength for Hertzian pressure (N/mm²) | [σHlim] | 1500.00 | 1500.00 |
| Tensile strength (N/mm²) | [σB] | 1200.00 | 1200.00 |
| Yield point (N/mm²) | [σS] | 850.00 | 850.00 |
| Young's modulus (N/mm²) | [E] | 206000 | 206000 |
| Poisson's ratio | [v] | 0.300 | 0.300 |
| Roughness average value DS, flank (µm) | [RAH] | 0.60 | 0.60 |
| Roughness average value DS, root (µm) | [RAF] | 3.00 | 3.00 |
| Mean roughness height, Rz, flank (µm) | [RZH] | 4.80 | 4.80 |
| Mean roughness height, Rz, root (µm) | [RZF] | 20.00 | 20.00 |

Gear reference profile 1 :
Reference profile 1.25 / 0.38 / 1.0 ISO 53.2:1997 Profil A
Dedendum coefficient [hfP*] 1.250

| | | |
|---|---|---|
| Root radius factor | [rhofP*] | 0.380 (rhofPmax*= 0.472) |
| Addendum coefficient | [haP*] | 1.000 |
| Tip radius factor | [rhoaP*] | 0.000 |
| Protuberance height factor | [hprP*] | 0.000 |
| Protuberance angle | [alfprP] | 0.000 |
| Tip form height coefficient | [hFaP*] | 0.000 |
| Ramp angle | [alfKP] | 0.000 |
| | not topping | |

| | | |
|---|---|---|
| Gear reference profile | 2 : | |
| Reference profile | 1.25 / 0.38 / 1.0 ISO 53.2:1997 Profil A | |
| Dedendum coefficient | [hfP*] | 1.250 |
| Root radius factor | [rhofP*] | 0.380 (rhofPmax*= 0.472) |
| Addendum coefficient | [haP*] | 1.000 |
| Tip radius factor | [rhoaP*] | 0.000 |
| Protuberance height factor | [hprP*] | 0.000 |
| Protuberance angle | [alfprP] | 0.000 |
| Tip form height coefficient | [hFaP*] | 0.000 |
| Ramp angle | [alfKP] | 0.000 |
| | not topping | |

Summary of reference profile gears:

| | | | |
|---|---|---|---|
| Dedendum reference profile | [hfP*] | 1.250 | 1.250 |
| Tooth root radius Refer. profile | [rofP*] | 0.380 | 0.380 |
| Addendum Reference profile | [haP*] | 1.000 | 1.000 |
| Protuberance height factor | [hprP*] | 0.000 | 0.000 |
| Protuberance angle (°) | [alfprP] | 0.000 | 0.000 |
| Tip form height coefficient | [hFaP*] | 0.000 | 0.000 |
| Ramp angle (°) | [alfKP] | 0.000 | 0.000 |

| | | | |
|---|---|---|---|
| Type of profile modification: | none (only running-in) | | |
| Tip relief (µm) | [Ca] | 2.0 | 2.0 |

| | | |
|---|---|---|
| Lubrication type | | Oil bath lubrication |
| Type of oil | | Oil: ISO-VG 220 |
| Lubricant base | | Mineral-oil base |
| Kinem. viscosity oil at 40 °C (mm²/s) | [nu40] | 220.00 |
| Kinem. viscosity oil at 100 °C (mm²/s) | [nu100] | 17.50 |
| Specific density at 15 °C (kg/dm³) | [roOil] | 0.895 |
| Oil temperature (°C) | [TS] | 70.000 |

| | | ------- GEAR 1 -------- | GEAR 2 -- |
|---|---|---|---|
| Overall transmission ratio | [itot] | -1.333 | |
| Gear ratio | [u] | 1.333 | |
| Transverse module (mm) | [mt] | 2.792 | |
| Pressure angle at pitch circle (°) | [alft] | 20.284 | |
| Working transverse pressure angle (°) | [alfwt] | 23.546 | |
| | [alfwt.e/i] | 23.570 / | 23.521 |
| Working pressure angle at normal section (°) | [alfwn] | 23.212 | |
| Helix angle at operating pitch circle (°) | [betaw] | 10.227 | |
| Base helix angle (°) | [betab] | 9.391 | |
| Reference centre distance (mm) | [ad] | 78.188 | |
| Sum of profile shift coefficients | [Summexi] | 0.7109 | |
| Profile shift coefficient | [x] | 0.3828 | 0.3281 |
| Tooth thickness (Arc) (module) (module) | [sn*] | 1.8495 | 1.8096 |
| Tip alteration (mm) | [k*mn] | -0.143 | -0.143 |
| Reference diameter (mm) | [d] | 67.018 | 89.358 |

| | | | |
|---|---|---|---|
| Base diameter (mm) | [db] | 62.862 | 83.816 |
| Tip diameter (mm) | [da] | 74.338 | 96.376 |
| (mm) | [da.e/i] | 74.338 / 74.328 | 96.376 / 96.366 |
| Tip diameter allowances (mm) | [Ada.e/i] | 0.000 / -0.010 | 0.000 / -0.010 |
| Tip form diameter (mm) | [dFa] | 74.338 | 96.376 |
| (mm) | [dFa.e/i] | 74.338 / 74.328 | 96.376 / 96.366 |
| Active tip diameter (mm) | [dNa] | 74.338 | 96.376 |
| Active tip diameter (mm) | [dNa.e/i] | 74.338 / 74.328 | 96.376 / 96.366 |
| Operating pitch diameter (mm) | [dw] | 68.571 | 91.429 |
| (mm) | [dw.e/i] | 68.584 / 68.559 | 91.446 / 91.411 |
| Root diameter (mm) | [df] | 62.249 | 84.287 |
| Generating Profile shift coefficient | [xE.e/i] | 0.3479/ 0.3279 | 0.2931/ 0.2732 |
| Manufactured root diameter with xE (mm) | [df.e/i] | 62.056 / 61.946 | 84.095 / 83.985 |
| Theoretical tip clearance (mm) | [c] | 0.688 | 0.688 |
| Effective tip clearance (mm) | [c.e/i] | 0.859 / 0.769 | 0.859 / 0.769 |
| Active root diameter (mm) | [dNf] | 64.952 | 87.251 |
| (mm) | [dNf.e/i] | 64.976 / 64.933 | 87.277 / 87.230 |
| Root form diameter (mm) | [dFf] | 64.283 | 86.244 |
| (mm) | [dFf.e/i] | 64.170 / 64.107 | 86.115 / 86.043 |
| Reserve (dNf-dFf)/2 (mm) | [cF.e/i] | 0.435 / 0.382 | 0.617 / 0.557 |
| Height of bolt head (mm) | [ha=mn*(haP*+x+k)] | 3.660 | 3.509 |
| (mm) | [ha.e/i] | 3.660 / 3.655 | 3.509 / 3.504 |
| Dedendum (mm) | [hf=mn*(hfP*-x)] | 2.385 | 2.535 |
| (mm) | [hf.e/i] | 2.481 / 2.536 | 2.631 / 2.686 |
| Roll angle at dFa (°) | [xsi_dFa.e/i] | 36.165 / 36.148 | 32.520 / 32.506 |
| Roll angle to dNa (°) | [xsi_dNa.e/i] | 36.165 / 36.148 | 32.520 / 32.506 |
| Roll angle to dNf (°) | [xsi_dNf.e/i] | 14.984 / 14.829 | 16.633 / 16.517 |
| Roll angle at dFf (°) | [xsi_dFf.e/i] | 11.746 / 11.457 | 13.510 / 13.293 |
| Tooth height (mm) | [h] | 6.044 | 6.044 |
| Virtual gear no. of teeth | [zn] | 25.037 | 33.383 |
| Normal tooth thickness at tip circle (mm) | [san] | 1.786 | 1.967 |
| (mm) | [san.e/i] | 1.714 / 1.664 | 1.898 / 1.849 |
| Normal-tooth thickness on tip form circle (mm) | [sFan] | 1.786 | 1.967 |
| (mm) | [sFan.e/i] | 1.714 / 1.664 | 1.898 / 1.849 |
| Normal space width at root circle (mm) | [efn] | 0.000 | 2.199 |
| (mm) | [efn.e/i] | 0.000 / 0.000 | 2.242 / 2.269 |
| Max. sliding velocity at tip (m/s) | [vga] | 3.996 | 3.594 |
| Specific sliding at the tip | [zetaa] | 0.542 | 0.542 |
| Specific sliding at the root | [zetaf] | -1.183 | -1.183 |
| Mean specific sliding | [zetam] | 0.542 | |
| Sliding factor on tip | [Kga] | 0.314 | 0.282 |
| Sliding factor on root | [Kgf] | -0.282 | -0.314 |
| Pitch on reference circle (mm) | [pt] | 8.773 | |
| Base pitch (mm) | [pbt] | 8.229 | |
| Transverse pitch on contact-path (mm) | [pet] | 8.229 | |
| Lead height (mm) | [pz] | 1194.053 | 1592.071 |
| Axial pitch (mm) | [px] | 49.752 | |
| Length of path of contact (mm) | [ga, e/i] | 11.667 ( 11.705 / 11.610) | |
| Length T1-A, T2-A (mm) | [T1A, T2A] | 8.172( 8.135/ 8.220) | 23.786( 23.786/ 23.776) |
| Length T1-B (mm) | [T1B, T2B] | 11.611( 11.611/ 11.601) | 20.348( 20.310/ 20.395) |
| Length T1-C (mm) | [T1C, T2C] | 13.697( 13.680/ 13.713) | 18.262( 18.241/ 18.283) |
| Length T1-D (mm) | [T1D, T2D] | 16.401( 16.363/ 16.448) | 15.558( 15.558/ 15.548) |
| Length T1-E (mm) | [T1E, T2E] | 19.840( 19.840/ 19.830) | 12.119( 12.081/ 12.166) |
| Length T1-T2 (mm) | [T1T2] | 31.959 ( 31.921 / 31.996) | |
| Diameter of single contact point B (mm) | [d-B] | 67.014( 67.014/ 67.008) | 93.173( 93.141/ 93.214) |
| Diameter of single contact point D (mm) | [d-D] | 70.906( 70.871/ 70.950) | 89.406( 89.406/ 89.399) |
| Addendum contact ratio | [eps] | 0.747( 0.748/ 0.743) | 0.671( 0.674/ 0.668) |
| Minimal length of contact line (mm) | [Lmin] | 47.678 | |

| | | | |
|---|---|---|---|
| Transverse contact ratio | [eps_a] | 1.418 | |
| Transverse contact ratio with allowances | [eps_a.e/m/i] | 1.422 / 1.417 / 1.411 | |
| Overlap ratio | [eps_b] | 0.764 | |
| Total contact ratio | [eps_g] | 2.182 | |
| Total contact ratio with allowances | [eps_g.e/m/i] | 2.186 / 2.181 / 2.175 | |

## 2. FACTORS OF GENERAL INFLUENCE

| | | GEAR 1 | GEAR 2 | |
|---|---|---|---|---|
| Nominal circum. force at pitch circle (N) | [Ft] | 16413.5 | | |
| Axial force (N) | [Fa] | 2894.1 | | |
| Radial force (N) | [Fr] | 6066.2 | | |
| Normal force (N) | [Fnorm] | 17736.3 | | |
| Nominal circumferential force per mm (N/mm) | [w] | 431.93 | | |
| Only as information: Forces at operating pitch circle: | | | | |
| Nominal circumferential force (N) | [Ftw] | 16041.7 | | |
| Axial force (N) | [Faw] | 2894.1 | | |
| Radial force (N) | [Frw] | 6990.4 | | |
| Circumferential speed reference circle (m/s) | [v] | 12.46 | | |
| Circumferential speed operating pitch circle (m/s) | [v(dw)] | 12.75 | | |
| Running-in value (µm) | [yp] | 0.6 | | |
| Running-in value (µm) | [yf] | 0.6 | | |
| Correction coefficient | [CM] | 0.800 | | |
| Gear body coefficient | [CR, bs/b, sr/mn] | 0.875 | (0.250, 3.990) | |
| Reference profile coefficient | [CBS] | 0.975 | | |
| Material coefficient | [E/Est] | 1.000 | | |
| Singular tooth stiffness (N/mm/µm) | [c'] | 12.242 | | |
| Meshing stiffness (N/mm/µm) | [cg] | 16.079 | | |
| Reduced mass (kg/mm) | [mRed] | 0.00913 | | |
| Resonance speed (min-1) | [nE1] | 16701 | | |
| Resonance ratio (-) | [N] | 0.213 | | |
| Subcritical range | | | | |
| Running-in value (µm) | [ya] | 0.6 | | |
| Bearing distance l of pinion shaft (mm) | [l] | 80.000 | | |
| Distance s of pinion shaft (mm) | [s] | 8.000 | | |
| Outside diameter of pinion shaft (mm) | [dsh] | 40.000 | | |
| Load according to Figure 6.8, DIN 3990-1:1987 (0:6.8a, 1:6.8b, 2:6.8c, 3:6.8d, 4:6.8e) | [-] | 4 | | |
| Coefficient K' according to Figure 6.8, DIN 3990-1:1987 | [K'] | -1.00 | | |
| Without support effect | | | | |
| Tooth trace deviation (active) (µm) | [Fby] | 3.83 | | |
| from deformation of shaft (µm) | [fsh*B1] | 3.04 | | |
| (fsh (µm) = 3.04, B1= 1.00, fHb5 (µm) = 6.50) | | | | |
| Tooth without tooth trace modification | | | | |
| Position of Contact pattern: favorable | | | | |
| from production tolerances (µm) | [fma*B2] | 9.00 | | |
| (B2= 1.00) | | | | |
| Tooth trace deviation, theoretical (µm) | [Fbx] | 4.50 | | |
| Running-in value (µm) | [yb] | 0.67 | | |
| Dynamic factor | [KV] | 1.054 | | |
| Face load factor - flank | [KHb] | 1.054 | | |
| - Tooth root | [KFb] | 1.045 | | |

| | | | |
|---|---|---|---|
| - Scuffing | [KBb] | 1.054 | |
| Transverse load factor - flank | [KHa] | 1.000 | |
| - Tooth root | [KFa] | 1.000 | |
| - Scuffing | [KBa] | 1.000 | |
| Helical load factor scuffing | [Kbg] | 1.143 | |
| Number of load cycles (in mio.) | [NL] | 5325.000 | 3993.750 |

## 3. TOOTH ROOT STRENGTH

Calculation of Tooth form coefficients according method: B

| | | ------- GEAR 1 | -------- GEAR 2 -- |
|---|---|---|---|
| Calculated with profile shift | [x] | 0.3828 | 0.3281 |
| Tooth form factor | [YF] | 1.34 | 1.38 |
| Stress correction factor | [YS] | 2.13 | 2.11 |
| Working angle (°) | [alfFen] | 23.96 | 23.14 |
| Bending moment arm (mm) | [hF] | 3.03 | 3.15 |
| Tooth thickness at root (mm) | [sFn] | 6.02 | 6.08 |
| Tooth root radius (mm) | [roF] | 1.23 | 1.24 |

(hF* = 1.102/ 1.146 sFn* = 2.189/ 2.211 roF* = 0.447/ 0.451)
(dsFn (mm) = 63.196/ 85.283 alfsFn(°) = 30.00/ 30.00 qs = 2.450/ 2.450)

| | | | | |
|---|---|---|---|---|
| Contact ratio factor | [Yeps] | | 1.000 | |
| Helix angle factor | [Ybet] | | 0.936 | |
| Effective facewidth (mm) | [beff] | 40.00 | | 38.00 |
| Nominal stress at tooth root (N/mm²) | [sigF0] | 398.98 | | 426.53 |
| Tooth root stress (N/mm²) | [sigF] | 549.24 | | 587.16 |
| Permissible bending stress at root of Test-gear | | | | |
| Notch sensitivity factor | [YdrelT] | 1.000 | | 1.000 |
| Surface factor | [YRrelT] | 0.957 | | 0.957 |
| size factor (Tooth root) | [YX] | 1.000 | | 1.000 |
| Finite life factor | [YNT] | 1.000 | | 1.000 |
| [YdrelT*YRrelT*YX*YNT] | | 0.956 | | 0.956 |
| Alternating bending factor (mean stress influence coefficient) | [YM] | | 1.000 | 1.000 |
| Stress correction factor | [Yst] | | 2.00 | |
| Yst*sigFlim (N/mm²) | [sigFE] | 860.00 | | 860.00 |
| Permissible tooth root stress (N/mm²) | [sigFP=sigFG/SFmin] | 587.43 | | 587.43 |
| Limit strength tooth root (N/mm²) | [sigFG] | 822.40 | | 822.40 |
| Required safety | [SFmin] | 1.40 | | 1.40 |
| Safety for Tooth root stress | [SF=sigFG/sigF] | 1.50 | | 1.40 |
| Transmittable power (kW) | [kWRating] | 218.68 | | 204.56 |

## 4. SAFETY AGAINST PITTING (TOOTH FLANK)

| | | ------- GEAR 1 | -------- GEAR 2 -- |
|---|---|---|---|
| Zone factor | [ZH] | | 2.269 |
| Elasticity coefficient (√N/mm) | [ZE] | | 189.812 |
| Contact ratio factor | [Zeps] | | 0.861 |
| Helix angle factor | [Zbet] | | 0.992 |
| Effective facewidth (mm) | [beff] | | 38.00 |
| Nominal contact stress (N/mm²) | [sigH0] | | 1236.20 |

| | | | |
|---|---|---|---|
| Contact stress at operating pitch circle (N/mm²) | [sigHw] | 1456.48 | |
| Single tooth contact factor | [ZB,ZD] | 1.01 | 1.00 |
| Contact stress (N/mm²) | [sigHB, sigHD] | 1466.44 | 1456.48 |
| | | | |
| Lubrication coefficient at NL | [ZL] | 1.020 | 1.020 |
| Speed coefficient at NL | [ZV] | 1.006 | 1.006 |
| Roughness coefficient at NL | [ZR] | 0.957 | 0.957 |
| Material pairing coefficient at NL | [ZW] | 1.000 | 1.000 |
| Finite life factor | [ZNT] | 1.000 | 1.000 |
| | [ZL*ZV*ZR*ZNT] | 0.983 | 0.983 |
| Small no. of pittings permissible: | no | | |
| Size factor (flank) | [ZX] | 1.000 | 1.000 |
| Permissible contact stress (N/mm²) | [sigHP=sigHG/SHmin] | 1473.99 | 1473.99 |
| Pitting stress limit (N/mm²) | [sigHG] | 1473.99 | 1473.99 |
| Required safety | [SHmin] | 1.00 | 1.00 |
| Safety factor for contact stress at operating pitch circle | | | |
| | [SHw] | 1.01 | 1.01 |
| Safety for stress at single tooth contact | [SHBD=sigHG/sigHBD] | 1.01 | 1.01 |
| (Safety regarding transmittable torque) | [(SHBD)^2] | 1.01 | 1.02 |
| Transmittable power (kW) | [kWRating] | 206.58 | 209.41 |

## 5. STRENGTH AGAINST SCUFFING

Calculation method according to DIN 3990:1987

| | | | |
|---|---|---|---|
| Lubrication coefficient (for lubrication type) | [XS] | 1.000 | |
| Scuffing test and load stage | [FZGtest] | FZG - Test A / 8.3 / 90 (ISO 14635 - 1) | 12 |
| Relative structure coefficient (Scuffing) | [XWrelT] | 1.000 | |
| Thermal contact factor (N/mm/s^.5/K) | [BM] | 13.780 | 13.780 |
| Relevant tip relief (µm) | [Ca] | 2.00 | 2.00 |
| Optimal tip relief (µm) | [Ceff] | 33.58 | |
| Ca taken as optimal in the calculation (0=no, 1=yes) | | 0 | 0 |
| Effective facewidth (mm) | [beff] | 38.000 | |
| Applicable circumferential force/facewidth (N/mm) | [wBt] | 685.390 | |
| Angle factor | [Xalfbet] | 1.026 | |
| (ε1:0.747, ε2:0.671) | | | |

| | | |
|---|---|---|
| Flash temperature-criteria | | |
| Tooth mass temperature (°C) | [theMB] | 118.37 |
| theMB = theoil + XS*0.47*theflamax | [theflamax] | 102.91 |
| Scuffing temperature (°C) | [theS] | 408.58 |
| Coordinate gamma (point of highest temp.) | [Gamma] | 0.197 |
| [Gamma.A]=-0.403 [Gamma.E]=0.449 | | |
| Highest contact temp. (°C) | [theB] | 221.28 |
| Flash factor (°K*N^-.75*s^.5*m^-.5*mm) | [XM] | 50.058 |
| Geometry factor | [XB] | 0.124 |
| Load sharing factor | [XGam] | 1.000 |
| Dynamic viscosity (mPa*s) | [etaM] | 9.33 ( 70.0 °C) |
| Coefficient of friction | [mym] | 0.103 |
| Required safety | [SBmin] | 2.000 |
| Safety factor for scuffing (flash temperature) | [SB] | 2.238 |

| | | |
|---|---|---|
| Integral temperature-criteria | | |
| Tooth mass temperature (°C) | [theMC ] | 103.07 |
| theMC = theoil + XS*0.70*theflaint | [theflaint] | 47.24 |

| | | |
|---|---|---|
| Integral scuffing temperature (°C) | [theSint] | 408.58 |
| Flash factor (°K*N^-.75*s^.5*m^-.5*mm) | [XM] | 50.058 |
| Contact ratio factor | [Xeps] | 0.290 |
| Dynamic viscosity (mPa*s) | [etaOil] | 41.90 ( 70.0 °C) |
| Mean coefficient of friction | [mym] | 0.071 |
| Geometry factor | [XBE] | 0.285 |
| Meshing factor | [XQ] | 1.000 |
| Tip relief factor | [XCa] | 1.010 |
| Integral tooth flank temperature (°C) | [theint] | 173.92 |
| Required safety | [SSmin] | 1.800 |
| Safety factor for scuffing (intg.-temp.) | [SSint] | 2.349 |
| Safety referring to transmittable torque | [SSL] | 3.258 |

## 6. MEASUREMENTS FOR TOOTH THICKNESS

| | | ------- Gear 1 ------ | Gear 2 -- |
|---|---|---|---|
| Tooth thickness deviation | | DIN 3967 cd25 | DIN 3967 cd25 |
| Tooth thickness allowance (normal section) (mm) | [As.e/i] | -0.070 / -0.110 | -0.070 / -0.110 |
| Number of teeth spanned | [k] | 4.000 | 5.000 |
| Base tangent length (no backlash) (mm) | [Wk] | 30.100 | 38.437 |
| Actual base tangent length ('span') (mm) | [Wk.e/i] | 30.034 / 29.997 | 38.372 / 38.334 |
| (mm) | [ΔWk.e/i] | -0.066 / -0.103 | -0.066 / -0.103 |
| Diameter of contact point (mm) | [dMWk.m] | 69.488 | 91.962 |
| Theoretical diameter of ball/pin (mm) | [DM] | 5.123 | 4.930 |
| Effective Diameter of ball/pin (mm) | [DMeff] | 5.250 | 5.000 |
| Theor. dim. centre to ball (mm) | [MrK] | 38.446 | 49.171 |
| Radial one ball mass (mm) | [MrK.e/i] | 38.376 / 38.336 | 49.095 / 49.052 |
| Diameter of contact point (mm) | [dMMr.m] | 69.149 | 91.103 |
| Diametral measurement over two balls without clearance (mm) | [MdK] | 76.892 | 98.343 |
| Diametral two ball measure (mm) | [MdK.e/i] | 76.752 / 76.672 | 98.191 / 98.103 |
| Diametral measurement over rolls without clearance (mm) | [MdR] | 76.892 | 98.343 |
| Measurement over pins according to DIN 3960 (mm) | [MdR.e/i] | 76.752 / 76.672 | 98.191 / 98.103 |
| Measurement over 3 pins (axial) according to AGMA 2002 (mm) | [dk3A.e/i] | 76.752 / 76.672 | 98.191 / 98.103 |
| Chordal tooth thickness (no backlash) (mm) | [sc] | 5.081 | 4.974 |
| Actual chordal tooth thickness (mm) | [sc.e/i] | 5.011 / 4.971 | 4.904 / 4.864 |
| Reference chordal height from da.m (mm) | [ha] | 3.751 | 3.574 |
| Tooth thickness (Arc) (mm) | [sn] | 5.086 | 4.976 |
| (mm) | [sn.e/i] | 5.016 / 4.976 | 4.906 / 4.866 |
| Backlash free center distance (mm) | [aControl.e/i] | 79.832 / 79.735 | |
| Backlash free center distance, allowances (mm) | [jta] | -0.168 / -0.265 | |
| dNf.i with aControl (mm) | [dNf0.i] | 64.629 | 86.889 |
| Reserve (dNf0.i-dFf.e)/2 (mm) | [cF0.i] | 0.230 | 0.387 |
| Tip clearance | [c0.i(aControl)] | 0.519 | 0.519 |
| Centre distance allowances (mm) | [Aa.e/i] | 0.015 / -0.015 | |
| Circumferential backlash from Aa (mm) | [jtw_Aa.e/i] | 0.013 / -0.013 | |
| Radial clearance (mm) | [jrw] | 0.280 / 0.153 | |
| Circumferential backlash (transverse section) (mm) | [jtw] | 0.242 / 0.132 | |
| Torsional angle for fixed gear 1 (°) | | 0.3029 / 0.1659 | |
| Normal backlash (mm) | [jnw] | 0.224 / 0.123 | |

## 7. GEAR ACCURACY

| | | ------- GEAR 1 | -------- GEAR 2 -- |
|---|---|---|---|
| According to DIN 3961:1978 | | | |
| Accuracy grade | [Q-DIN3961] | 6 | 6 |
| Profile form deviation (µm) | [ff] | 8.00 | 8.00 |
| Profile slope deviation (µm) | [fHa] | 6.00 | 6.00 |
| Total profile deviation (µm) | [Ff] | 10.00 | 10.00 |
| Helix form deviation (µm) | [fbf] | 5.50 | 5.50 |
| Helix slope deviation (µm) | [fHb] | 9.00 | 9.00 |
| Total helix deviation (µm) | [Fb] | 10.00 | 10.00 |
| Normal base pitch deviation (µm) | [fpe] | 8.00 | 8.00 |
| Single pitch deviation (µm) | [fp] | 8.00 | 8.00 |
| Adjacent pitch difference (µm) | [fu] | 10.00 | 10.00 |
| Total cumulative pitch deviation (µm) | [Fp] | 27.00 | 27.00 |
| Sector pitch deviation over z/8 pitches (µm) | [Fpz/8] | 17.00 | 17.00 |
| Runout (µm) | [Fr] | 19.00 | 19.00 |
| Tooth Thickness Variation (µm) | [Rs] | 11.00 | 11.00 |
| Single flank composite, total (µm) | [Fi'] | 30.00 | 30.00 |
| Single flank composite, tooth-to-tooth (µm) | [fi'] | 13.00 | 13.00 |
| Radial composite, total (µm) | [Fi''] | 22.00 | 22.00 |
| Radial composite, tooth-to-tooth (µm) | [fi''] | 9.00 | 9.00 |
| | | | |
| According to DIN 58405:1972 (Feinwerktechnik): | | | |
| Tooth-to-tooth composite error (µm) | [fi''] | 9.00 | 9.00 |
| Composite error (µm) | [Fi''] | 25.00 | 25.00 |
| Axis alignment error (µm) | [fp] | 13.60 | 13.60 |
| Flank direction error (µm) | [fbeta] | 8.40 | 7.98 |
| Runout (µm) | [Trk, Fr] | 24.00 | 24.00 |

| | | |
|---|---|---|
| Axis alignment tolerances (recommendation acc. ISO TR 10064:1992, Quality 6) | | |
| Maximum value for deviation error of axis (µm) | [fSigbet] | 12.63 (Fb=12.00) |
| Maximum value for inclination error of axes (µm) | [fSigdel] | 25.26 |

## 8. ADDITIONAL DATA

| | | | | |
|---|---|---|---|---|
| Maximal possible centre distance (eps_a=1.0) | [aMAX] | | 81.435 | |
| Mass - calculated with da (kg) | [Mass] | 0.966 | | 1.329 |
| Total mass (kg) | [Mass] | | 2.295 | |
| Moment of inertia (System referenced to wheel 1): | | | | |
| calculation without consideration of the exact tooth shape | | | | |
| single gears ((da+df)/2...di) (kg*m²) | [TraeghMom] | 0.0005852 | | 0.001556 |
| System ((da+df)/2...di) (kg*m²) | [TraeghMom] | | 0.00146 | |
| Torsional stiffness (MNm/rad) | [cr] | 0.6 | | 1.1 |
| Mean coeff. of friction (acc. Niemann) | [mum] | | 0.065 | |
| Wear sliding coef. by Niemann | [zetw] | | 0.768 | |
| Gear power loss (kW) | [PVZ] | | 1.819 | |
| (Meshing efficiency (%) | [etaz] | | 99.110) | |

## 9. DETERMINATION OF TOOTH FORM

Data for the tooth form calculation :
Data not available.

## 10. SERVICE LIFE, DAMAGE

| | | | |
|---|---|---|---|
| Required safety for tooth root | [SFmin] | 1.40 | |
| Required safety for tooth flank | [SHmin] | 1.00 | |

Service life (calculated with required safeties):

| | | | |
|---|---|---|---|
| System service life (h) | [Hatt] | > 1000000 | |
| Tooth root service life (h) | [HFatt] | 1e+006 | 1e+006 |
| Tooth flank service life (h) | [HHatt] | 1e+006 | 1e+006 |

Note: The entry 1e+006 h means that the Service life > 1,000,000 h.

Damage calculated on the basis of the required service life [H] ( 25000.0 h)

| F1% | F2% | H1% | H2% |
|---|---|---|---|
| 0.00 | 0.00 | 0.00 | 0.00 |

## REMARKS:

- Specifications with [.e/i] imply: Maximum [e] and Minimal value [i] with consideration of all tolerances
  Specifications with [.m] imply: Mean value within tolerance
- For the backlash tolerance, the center distance tolerances and the tooth thickness deviation are taken into account. Shown is the maximal and the minimal backlash corresponding the largest resp. the smallest allowances
  The calculation is done for the Operating pitch circle..
- Details of calculation method:
  cg according to method B
  KV according to method B
  KHb, KFb according method C
  KHa, KFa according to method B

End of Report lines: 502

# _O.GB.Shaft1.ShaftCalc1

## Analysis of shafts, axle and beams

**Input data**

Coordinate system shaft: see picture W-002

| | | |
|---|---|---|
| Label | | Shaft1 |
| Drawing | | |
| Initial position (mm) | | 0.000 |
| Length (mm) | | 150.000 |
| Speed (1/min) | | 3550.00 |
| Sense of rotation: clockwise | | |
| | | |
| Material | | C45 (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) | | 1.038 |
| Weight of shaft, including additional masses (kg) | | 1.038 |
| Mass moment of inertia (kg*mm²) | | 379.430 |
| Momentum of mass GD2 (Nm²) | | 0.015 |
| | | |
| The direction of the weight is not considered | | |
| 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 |

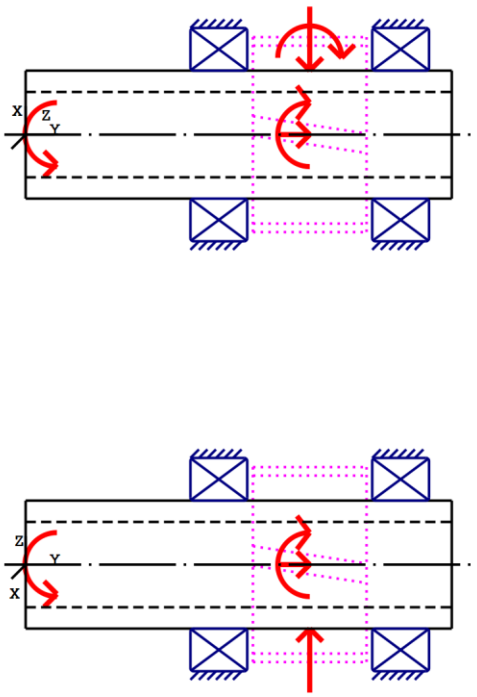



Figure: Load applications

**Shaft definition (Shaft1)**

**Outer contour**

| Cylinder (Cylinder) | | | 0.000mm ... | 150.000mm |
|---|---|---|---|---|
| Diameter (mm) | [d] | 45.0000 | | |
| Length (mm) | [l] | 150.0000 | | |
| Surface roughness (µm) | [Rz] | 8.0000 | | |

**Inner contour**

| Cylinder inside (Cylindrical bore) | | | 0.000mm ... | 150.000mm |
|---|---|---|---|---|
| Diameter (mm) | [d] | 30.0000 | | |
| Length (mm) | [l] | 150.0000 | | |
| Surface roughness (µm) | [Rz] | 8.0000 | | |

**Forces**

| Type of force element | | **Centric force** |
|---|---|---|
| Label in the model | | CentricalLoad1 |
| Position on shaft (mm) | [$y_{local}$] | 11.0000 |
| Position in global system (mm) | [$y_{global}$] | 11.0000 |
| Length of load application (mm) | | 0.0000 |
| Power (kW) | | 0.0000 |
| Torque (Nm) | | -0.0000 |
| 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 |

| | | |
|---|---|---|
| Type of force element | | **Cylindrical gear** |
| Label in the model | | Gear1(GearPairConst1) |
| Position on shaft (mm) | [$y_{local}$] | 100.0000 |
| Position in global system (mm) | [$y_{global}$] | 100.0000 |
| Operating pitch diameter (mm) | | 68.5714 |
| Helix angle (°) | | 10.2269 right |
| Working pressure angle at normal section (°) | | 23.2116 |
| Position of contact (°) | | 0.0000 |
| Length of load application (mm) | | 40.0000 |
| Power (kW) | | 204.4653 driving (Output) |
| Torque (Nm) | | -550.0000 |
| Axial force (N) | | 2894.1363 |
| Shearing force X (N) | | -6990.3591 |
| Shearing force Z (N) | | 16041.6663 |
| Bending moment X (Nm) | | -0.0000 |
| Bending moment Z (Nm) | | 99.2275 |

| | | |
|---|---|---|
| Type of force element | | **Coupling** |
| Label in the model | | input(motor) |
| Position on shaft (mm) | [$y_{local}$] | 11.0000 |
| Position in global system (mm) | [$y_{global}$] | 11.0000 |
| Effective diameter (mm) | | 40.0000 |
| Radial force factor (-) | | 0.0000 |
| Direction of the radial force (°) | | 0.0000 |
| Axial force factor (-) | | 0.0000 |
| Length of load application (mm) | | 15.0000 |
| Power (kW) | | 204.4653 driven (Input) |
| Torque (Nm) | | 550.0000 |
| 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 |

**Bearing**

| | | | |
|---|---|---|---|
| Label in the model | | RollerBearing5 | |
| Bearing type | | Koyo 32009JR | |
| Bearing type | | Taper roller bearing (single row) | |
| Bearing position (mm) | [$y_{lokal}$] | 68.000 | |
| Bearing position (mm) | [$y_{global}$] | 68.000 | |
| Attachment of external ring | | Set fixed bearing left | |
| Inner diameter (mm) | [d] | 45.000 | |
| External diameter (mm) | [D] | 75.000 | |
| Width (mm) | [b] | 20.000 | |
| Corner radius (mm) | [r] | 1.000 | |
| The bearing pressure angle will be considered in the calculation | | | |
| Position (center of pressure) | | | (mm) 74.5000 |
| Basic static load rating | [$C_0$] | 86.500 | |
| Basic dynamic load rating | [C] | 78.800 | |
| Fatigue load rating | [$C_U$] | 12.600 | |

Values for approximated geometry:

| | | |
|---|---|---|
| Basic dynamic load rating (kN) | [$C_{theo}$] | 0.000 |
| Basic static load rating (kN) | [$C_{0theo}$] | 0.000 |

| | | | |
|---|---|---|---|
| Label in the model | | RollerBearing6 | |
| Bearing type | | Koyo 32009JR | |
| Bearing type | | Taper roller bearing (single row) | |
| Bearing position (mm) | [$y_{lokal}$] | 132.000 | |
| Bearing position (mm) | [$y_{global}$] | 132.000 | |
| Attachment of external ring | | Set fixed bearing right | |
| Inner diameter (mm) | [d] | 45.000 | |
| External diameter (mm) | [D] | 75.000 | |
| Width (mm) | [b] | 20.000 | |
| Corner radius (mm) | [r] | 1.000 | |
| The bearing pressure angle will be considered in the calculation | | | |
| Position (center of pressure) | | | (mm) 125.5000 |
| Basic static load rating | [$C_0$] | 86.500 | |
| Basic dynamic load rating | [C] | 78.800 | |
| Fatigue load rating | [$C_U$] | 12.600 | |
| Values for approximated geometry: | | | |
| Basic dynamic load rating (kN) | [$C_{theo}$] | 0.000 | |
| Basic static load rating (kN) | [$C_{0theo}$] | 0.000 | |

**Results**

**Shaft**

| | | |
|---|---|---|
| Maximum deflection (mm) | | 0.005 |
| Position of the maximum (mm) | | 0.000 |
| Mass center of gravity (mm) | | 75.000 |
| Total axial load (N) | | 2894.136 |
| Torsion under torque (°) | | -0.110 |

---

**Bearing**

| | | | |
|---|---|---|---|
| Probability of failure | [n] | 10.00 | % |
| Axial clearance | [$u_A$] | 10.00 | µm |

Rolling bearings, classical calculation (contact angle considered)

**Shaft 'Shaft1' Rolling bearing 'RollerBearing5'**

| | | | | |
|---|---|---|---|---|
| Position (Y-coordinate) | [y] | 68.00 | mm | |
| Equivalent load | [P] | 8.17 | kN | |
| Equivalent load | [$P_0$] | 8.17 | kN | |
| Life modification factor for reliability | [$a_1$] | 1.000 | | |
| Nominal bearing service life | [$L_{nh}$] | 8969.88 | h | |
| Static safety factor | [$S_0$] | 10.59 | | |
| Bearing reaction force | [Fx] | 1.550 | kN | |
| Bearing reaction force | [Fy] | 2.670 | kN | |
| Bearing reaction force | [Fz] | -8.021 | kN | |
| Bearing reaction force | [Fr] | 8.169 | kN | (-79.07°) |

| | | | |
|---|---|---|---|
| Bearing reaction moment | [Mx] | -52.14 | Nm |
| Bearing reaction moment | [My] | 0.00 | Nm |
| Bearing reaction moment | [Mz] | -10.07 | Nm |
| Bearing reaction moment | [Mr] | 53.10 | Nm (-169.07°) |
| Oil level | [H] | 0.000 | mm |
| Load-independent moment of friction | [$M_0$] | 0.202 | Nm |
| Load-dependent moment of friction | [$M_1$] | 0.196 | Nm |
| Moment of friction, cylindrical roller bearing | [$M_2$] | 0.000 | Nm |

Moment of friction for seals determined according to SKF main catalog 4000/IV T DE:1994

| | | | |
|---|---|---|---|
| Torque of friction | [$M_{loss}$] | 0.398 | Nm |
| Power loss | [$P_{loss}$] | 147.834 | W |

The moment of friction is calculated according to the details in SKF Catalog 1994.

| | | | |
|---|---|---|---|
| Displacement of bearing | [$u_x$] | 0.000 | µm |
| Displacement of bearing | [$u_y$] | 11.448 | µm |
| Displacement of bearing | [$u_z$] | -0.000 | µm |
| Displacement of bearing | [$u_r$] | 0.000 | µm |
| Misalignment of bearing | [$r_x$] | 0.056 | mrad (0.19') |
| Misalignment of bearing | [$r_y$] | -1.225 | mrad (-4.21') |
| Misalignment of bearing | [$r_z$] | 0.054 | mrad (0.19') |
| Misalignment of bearing | [$r_r$] | 0.078 | mrad (0.27') |

**Shaft 'Shaft1' Rolling bearing 'RollerBearing6'**

| | | | |
|---|---|---|---|
| Position (Y-coordinate) | [y] | 132.00 | mm |
| Equivalent load | [P] | 12.39 | kN |
| Equivalent load | [$P_0$] | 9.69 | kN |
| Life modification factor for reliability | [$a_1$] | 1.000 | |
| Nominal bearing service life | [$L_{nh}$] | 2238.05 | h |
| Static safety factor | [$S_0$] | 8.92 | |
| Bearing reaction force | [Fx] | 5.441 | kN |
| Bearing reaction force | [Fy] | -5.564 | kN |
| Bearing reaction force | [Fz] | -8.021 | kN |
| Bearing reaction force | [Fr] | 9.692 | kN (-55.85°) |
| Bearing reaction moment | [Mx] | 52.14 | Nm |
| Bearing reaction moment | [My] | 0.00 | Nm |
| Bearing reaction moment | [Mz] | 35.37 | Nm |
| Bearing reaction moment | [Mr] | 63.00 | Nm (34.15°) |
| Oil level | [H] | 0.000 | mm |
| Load-independent moment of friction | [$M_0$] | 0.202 | Nm |
| Load-dependent moment of friction | [$M_1$] | 0.409 | Nm |
| Moment of friction, cylindrical roller bearing | [$M_2$] | 0.000 | Nm |

Moment of friction for seals determined according to SKF main catalog 4000/IV T DE:1994

| | | | |
|---|---|---|---|
| Torque of friction | [$M_{loss}$] | 0.610 | Nm |
| Power loss | [$P_{loss}$] | 226.849 | W |

The moment of friction is calculated according to the details in SKF Catalog 1994.

| | | | |
|---|---|---|---|
| Displacement of bearing | [$u_x$] | 0.000 | µm |
| Displacement of bearing | [$u_y$] | 10.000 | µm |
| Displacement of bearing | [$u_z$] | -0.000 | µm |
| Displacement of bearing | [$u_r$] | 0.000 | µm |
| Misalignment of bearing | [$r_x$] | -0.056 | mrad (-0.19') |
| Misalignment of bearing | [$r_y$] | -1.912 | mrad (-6.57') |
| Misalignment of bearing | [$r_z$] | 0.005 | mrad (0.02') |
| Misalignment of bearing | [$r_r$] | 0.056 | mrad (0.19') |

Damage (%) [H] ( 0.000)

| No. | B1 | B2 |
|---|---|---|
| 1 | 0.00 | 0.00 |

---
Σ 0.00 0.00

Utilization (%) [H] ( 0.000)

| B1 | B2 |
|---|---|
| 0.00 | 0.00 |

B1: RollerBearing5
B2: RollerBearing6

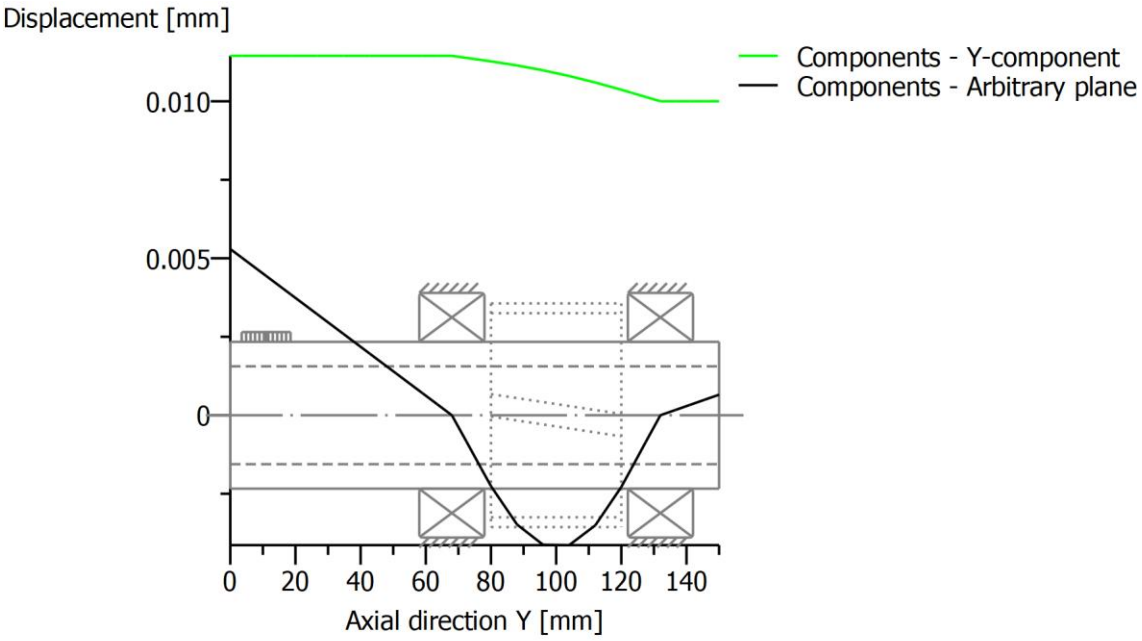
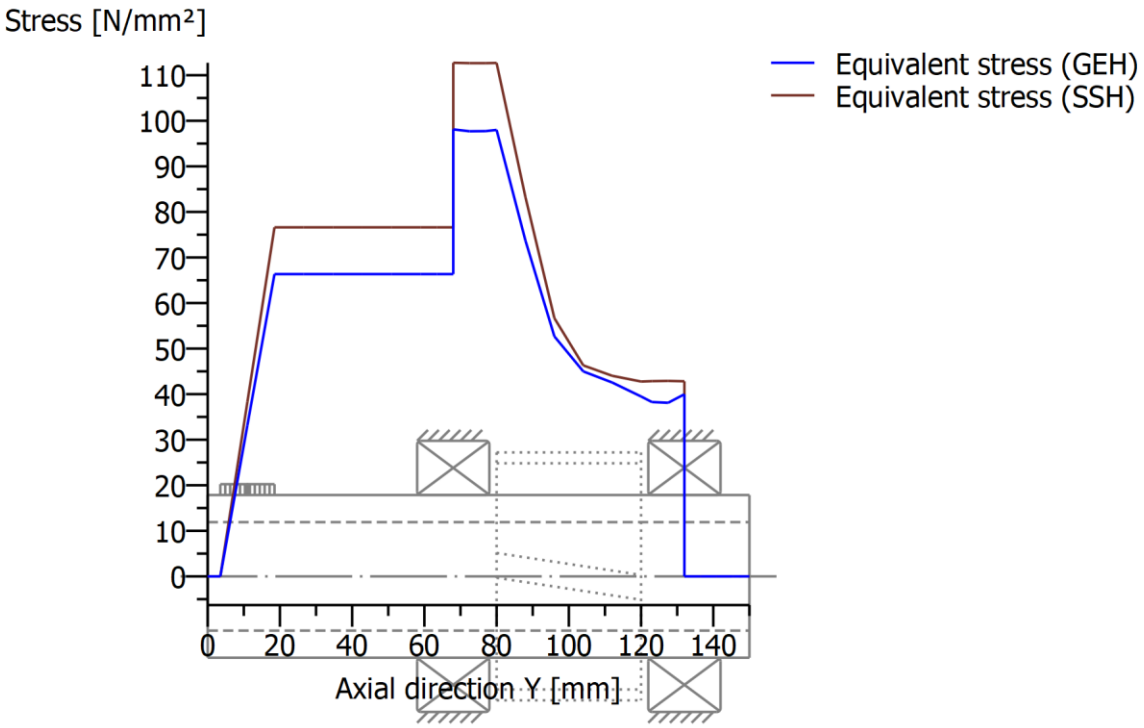



Figure: Deformation (bending etc.) (Arbitrary plane 314.0882368 120)




Nominal stresses, without taking into account stress concentrationsGEH(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

End of Report lines: 262

# _O.GB.Shaft2.ShaftCalc2

## Analysis of shafts, axle and beams

**Input data**

Coordinate system shaft: see picture W-002

| | | |
|---|---|---|
| Label | | Shaft2 |
| Drawing | | |
| Initial position (mm) | | 0.000 |
| Length (mm) | | 250.000 |
| Speed (1/min) | | 2662.50 |
| Sense of rotation: clockwise | | |
| | | |
| Material | | C45 (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) | | 1.384 |
| Weight of shaft, including additional masses (kg) | | 1.384 |
| Mass moment of inertia (kg*mm²) | | 155.663 |
| Momentum of mass GD2 (Nm²) | | 0.006 |
| | | |
| The direction of the weight is not considered | | |
| 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 |

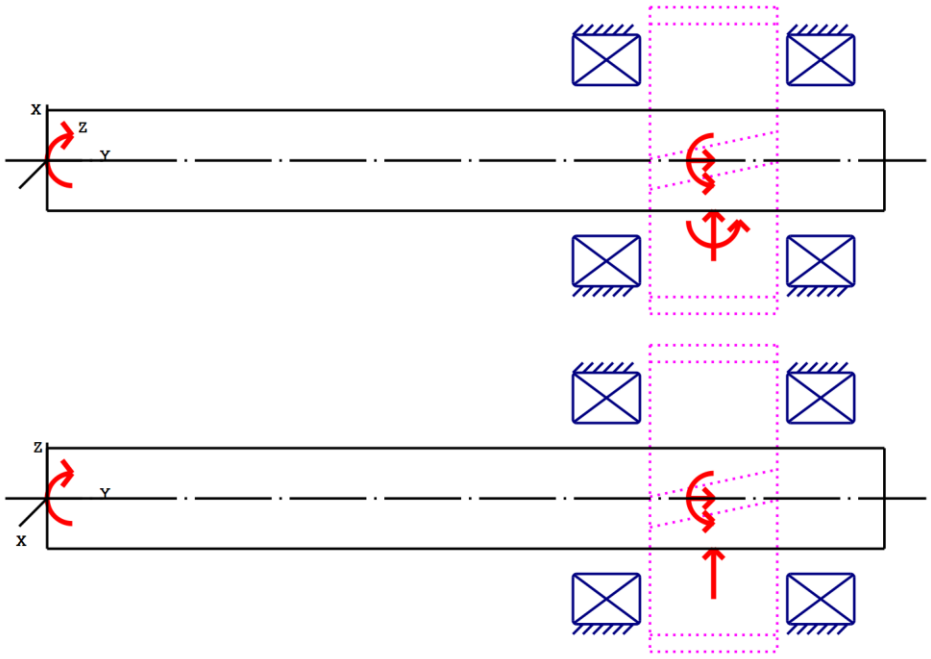



Figure: Load applications

**Shaft definition (Shaft2)**

**Outer contour**

| Cylinder (Zylinder) | | | 0.000mm ... 250.000mm |
|---|---|---|---|
| Diameter (mm) | [d] | 30.0000 | |
| Length (mm) | [l] | 250.0000 | |
| Surface roughness (µm) | [Rz] | 8.0000 | |

**Forces**

| Type of force element | | **Centric force** |
|---|---|---|
| Label in the model | | CentricalLoad1 |
| Position on shaft (mm) | [$y_{local}$] | 4.0000 |
| Position in global system (mm) | [$y_{global}$] | 4.0000 |
| Length of load application (mm) | | 0.0000 |
| Power (kW) | | 0.0000 |
| Torque (Nm) | | -0.0000 |
| 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 |

| Type of force element | | **Cylindrical gear** |
|---|---|---|
| Label in the model | | Gear2(GearPairConst1) |
| Position on shaft (mm) | [$y_{local}$] | 199.0000 |
| Position in global system (mm) | [$y_{global}$] | 199.0000 |
| Operating pitch diameter (mm) | | 91.4286 |
| Helix angle (°) | | 10.2269 left |

| | | |
|---|---|---|
| Working pressure angle at normal section (°) | | 23.2116 |
| Position of contact (°) | | 180.0000 |
| Length of load application (mm) | | 38.0000 |
| Power (kW) | | 204.4653 driven (Input) |
| Torque (Nm) | | 733.3333 |
| Axial force (N) | | 2894.1363 |
| Shearing force X (N) | | 6990.3591 |
| Shearing force Z (N) | | 16041.6663 |
| Bending moment X (Nm) | | -0.0000 |
| Bending moment Z (Nm) | | -132.3034 |

| | | |
|---|---|---|
| Type of force element | | **Coupling** |
| Label in the model | | output(kolo) |
| Position on shaft (mm) | [$y_{local}$] | 7.5000 |
| Position in global system (mm) | [$y_{global}$] | 7.5000 |
| Effective diameter (mm) | | 35.0000 |
| Radial force factor (-) | | 0.0000 |
| Direction of the radial force (°) | | 0.0000 |
| Axial force factor (-) | | 0.0000 |
| Length of load application (mm) | | 15.0000 |
| Power (kW) | | 204.4653 driving (Output) |
| Torque (Nm) | | -733.3333 |
| 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 |

**Bearing**

| | | | |
|---|---|---|---|
| Label in the model | | Bearing1 | |
| Bearing type | | Koyo 32009JR | |
| Bearing type | | Taper roller bearing (single row) | |
| Bearing position (mm) | [$y_{lokal}$] | 167.000 | |
| Bearing position (mm) | [$y_{global}$] | 167.000 | |
| Attachment of external ring | | Set fixed bearing left | |
| Inner diameter (mm) | [d] | 45.000 | |
| External diameter (mm) | [D] | 75.000 | |
| Width (mm) | [b] | 20.000 | |
| Corner radius (mm) | [r] | 1.000 | |
| The bearing pressure angle will be considered in the calculation | | | |
| Position (center of pressure) | | | (mm) 173.5000 |
| Basic static load rating | [$C_0$] | 86.500 | |
| Basic dynamic load rating | [C] | 78.800 | |
| Fatigue load rating | [$C_U$] | 12.600 | |
| Values for approximated geometry: | | | |
| Basic dynamic load rating (kN) | [$C_{theo}$] | 0.000 | |
| Basic static load rating (kN) | [$C_{0theo}$] | 0.000 | |

| | | |
|---|---|---|
| Label in the model | | Bearing2 |
| Bearing type | | Koyo 32009JR |

| | | | |
|---|---|---|---|
| Bearing type | | Taper roller bearing (single row) | |
| Bearing position (mm) | [$y_{lokal}$] | 231.000 | |
| Bearing position (mm) | [$y_{global}$] | 231.000 | |
| Attachment of external ring | | Set fixed bearing right | |
| Inner diameter (mm) | [d] | 45.000 | |
| External diameter (mm) | [D] | 75.000 | |
| Width (mm) | [b] | 20.000 | |
| Corner radius (mm) | [r] | 1.000 | |

The bearing pressure angle will be considered in the calculation

| | | | |
|---|---|---|---|
| Position (center of pressure) | | | (mm) |
| | | | 224.5000 |
| Basic static load rating | [$C_0$] | 86.500 | |
| Basic dynamic load rating | [C] | 78.800 | |
| Fatigue load rating | [$C_U$] | 12.600 | |
| Values for approximated geometry: | | | |
| Basic dynamic load rating (kN) | [$C_{theo}$] | 0.000 | |
| Basic static load rating (kN) | [$C_{0theo}$] | 0.000 | |

**Results**

**Shaft**

| | |
|---|---|
| Maximum deflection (mm) | 0.046 |
| Position of the maximum (mm) | 0.000 |
| Mass center of gravity (mm) | 125.000 |
| Total axial load (N) | 2894.136 |
| Torsion under torque (°) | 1.277 |

---

**Bearing**

| | | | |
|---|---|---|---|
| Probability of failure | [n] | 10.00 | % |
| Axial clearance | [$u_A$] | 10.00 | µm |

Rolling bearings, classical calculation (contact angle considered)

**Shaft 'Shaft2' Rolling bearing 'Bearing1'**

| | | | | |
|---|---|---|---|---|
| Position (Y-coordinate) | [y] | 167.00 | mm | |
| Equivalent load | [P] | 8.07 | kN | |
| Equivalent load | [$P_0$] | 8.07 | kN | |
| Life modification factor for reliability | [$a_1$] | 1.000 | | |
| Nominal bearing service life | [$L_{nh}$] | 12450.07 | h | |
| Static safety factor | [$S_0$] | 10.72 | | |
| Bearing reaction force | [Fx] | -0.901 | kN | |
| Bearing reaction force | [Fy] | 2.638 | kN | |
| Bearing reaction force | [Fz] | -8.021 | kN | |
| Bearing reaction force | [Fr] | 8.071 | kN | (-96.41°) |
| Bearing reaction moment | [Mx] | -52.14 | Nm | |
| Bearing reaction moment | [My] | 0.00 | Nm | |
| Bearing reaction moment | [Mz] | 5.86 | Nm | |
| Bearing reaction moment | [Mr] | 52.46 | Nm | (173.59°) |
| Oil level | [H] | 0.000 | mm | |
| Load-independent moment of friction | [$M_0$] | 0.166 | Nm | |

| | | | | |
|---|---|---|---|---|
| Load-dependent moment of friction | [$M_1$] | 0.194 | Nm | |
| Moment of friction, cylindrical roller bearing | [$M_2$] | 0.000 | Nm | |

Moment of friction for seals determined according to SKF main catalog 4000/IV T DE:1994

| | | | | |
|---|---|---|---|---|
| Torque of friction | [$M_{loss}$] | 0.360 | Nm | |
| Power loss | [$P_{loss}$] | 100.411 | W | |

The moment of friction is calculated according to the details in SKF Catalog 1994.

| | | | | |
|---|---|---|---|---|
| Displacement of bearing | [$u_x$] | 0.000 | µm | |
| Displacement of bearing | [$u_y$] | 11.795 | µm | |
| Displacement of bearing | [$u_z$] | -0.000 | µm | |
| Displacement of bearing | [$u_r$] | 0.000 | µm | |
| Misalignment of bearing | [$r_x$] | 0.236 | mrad | (0.81') |
| Misalignment of bearing | [$r_y$] | 18.565 | mrad | (63.82') |
| Misalignment of bearing | [$r_z$] | -0.148 | mrad | (-0.51') |
| Misalignment of bearing | [$r_r$] | 0.278 | mrad | (0.96') |

**Shaft 'Shaft2' Rolling bearing 'Bearing2'**

| | | | | |
|---|---|---|---|---|
| Position (Y-coordinate) | [y] | 231.00 | mm | |
| Equivalent load | [P] | 12.49 | kN | |
| Equivalent load | [$P_0$] | 10.07 | kN | |
| Life modification factor for reliability | [$a_1$] | 1.000 | | |
| Nominal bearing service life | [$L_{nh}$] | 2903.29 | h | |
| Static safety factor | [$S_0$] | 8.59 | | |
| Bearing reaction force | [Fx] | -6.089 | kN | |
| Bearing reaction force | [Fy] | -5.532 | kN | |
| Bearing reaction force | [Fz] | -8.021 | kN | |
| Bearing reaction force | [Fr] | 10.070 | kN | (-127.21°) |
| Bearing reaction moment | [Mx] | 52.14 | Nm | |
| Bearing reaction moment | [My] | 0.00 | Nm | |
| Bearing reaction moment | [Mz] | -39.58 | Nm | |
| Bearing reaction moment | [Mr] | 65.46 | Nm | (-37.21°) |
| Oil level | [H] | 0.000 | mm | |
| Load-independent moment of friction | [$M_0$] | 0.166 | Nm | |
| Load-dependent moment of friction | [$M_1$] | 0.406 | Nm | |
| Moment of friction, cylindrical roller bearing | [$M_2$] | 0.000 | Nm | |

Moment of friction for seals determined according to SKF main catalog 4000/IV T DE:1994

| | | | | |
|---|---|---|---|---|
| Torque of friction | [$M_{loss}$] | 0.573 | Nm | |
| Power loss | [$P_{loss}$] | 159.672 | W | |

The moment of friction is calculated according to the details in SKF Catalog 1994.

| | | | | |
|---|---|---|---|---|
| Displacement of bearing | [$u_x$] | -0.000 | µm | |
| Displacement of bearing | [$u_y$] | 10.000 | µm | |
| Displacement of bearing | [$u_z$] | -0.000 | µm | |
| Displacement of bearing | [$u_r$] | 0.000 | µm | |
| Misalignment of bearing | [$r_x$] | -0.236 | mrad | (-0.81') |
| Misalignment of bearing | [$r_y$] | 22.289 | mrad | (76.62') |
| Misalignment of bearing | [$r_z$] | 0.058 | mrad | (0.2') |
| Misalignment of bearing | [$r_r$] | 0.242 | mrad | (0.83') |

Damage (%) [H] ( 0.000)

| No. | B1 | B2 |
|---|---|---|
| 1 | 0.00 | 0.00 |
| Σ | 0.00 | 0.00 |

Utilization (%) [H] ( 0.000)

| B1 | B2 |
|---|---|
| 0.00 | 0.00 |

B1: Bearing1
B2: Bearing2

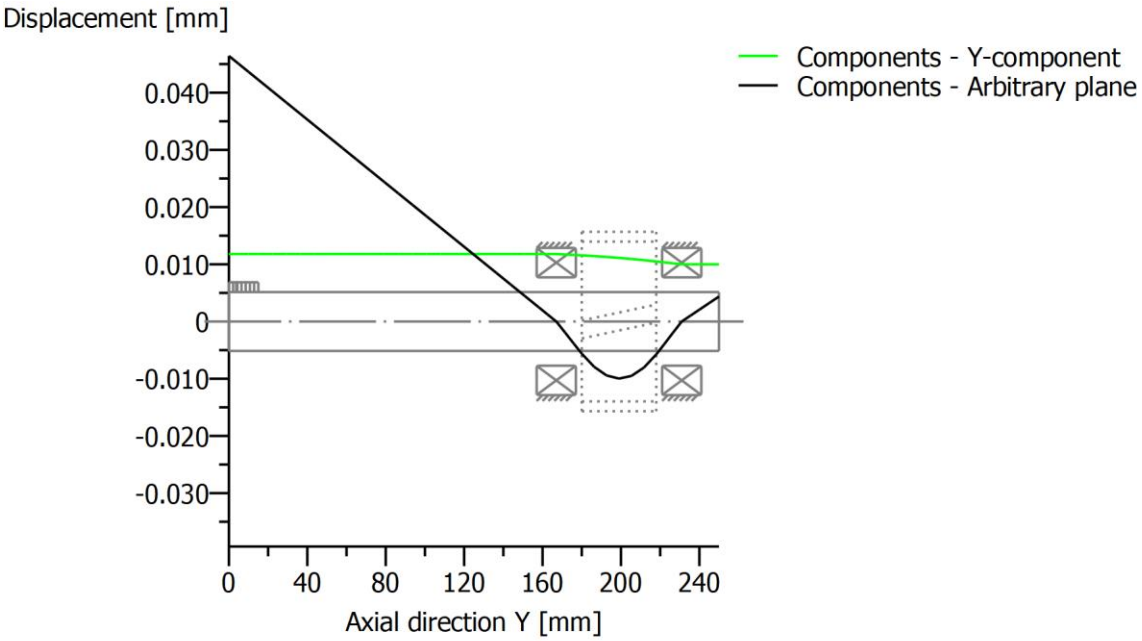
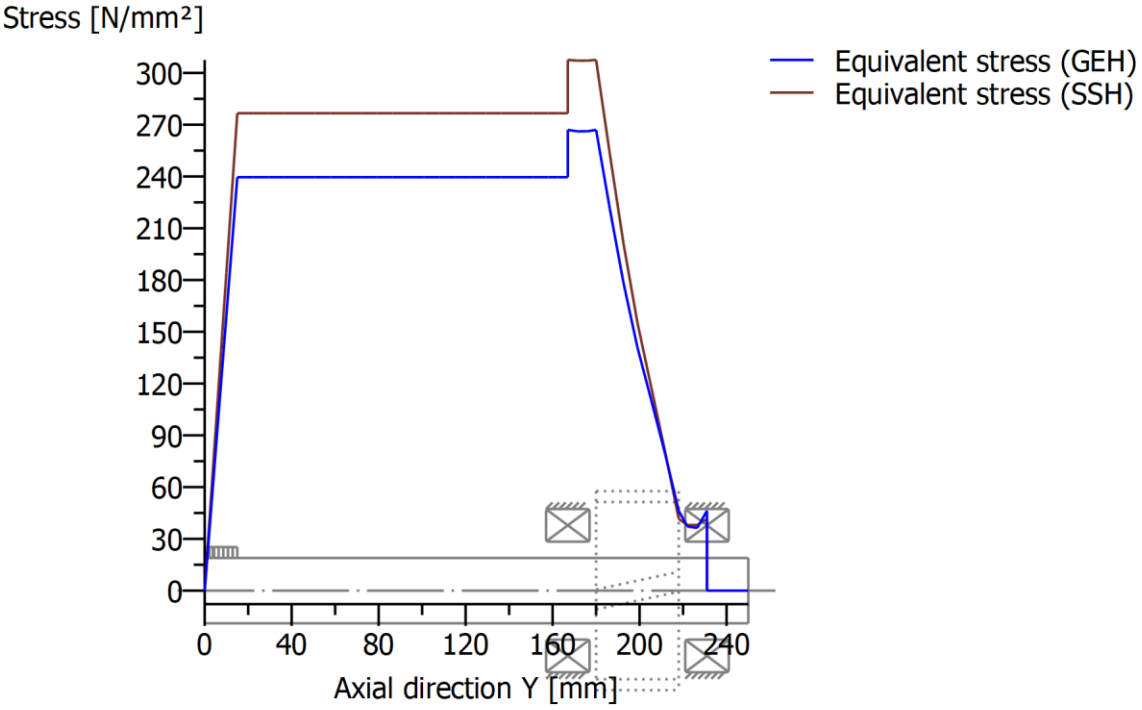



Figure: Deformation (bending etc.) (Arbitrary plane 237.9125033 120)




Nominal stresses, without taking into account stress concentrationsGEH(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

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