| Program : MDESIGN 2020 - | User : | Customer : Student |
|---|---|---|
| Module version : 18.0.12 | Date : 11.12.2023 | Project : |

# Shaft, Standard

This program allows to prove the bearing ability for shafts and axles. The calculation base is provided by DIN 743, edition of December 2012 .

The proof of the bearing ability for shafts an axles is produced by defining a calculated safety. This safety is divided in the safety against fatigue fracture and the residual deformation (and flaw or forced break).

When calculating the avoidance of fatigue fracture, constant stress amplitudes being equivalent to damaging loads are taken as a basis. These ones are resulting from the predetermined loads. When proving against the residual deformation or forced break, designated as a safety against yielding, only the maximum occurring load is determinant. This one is resulting from the predetermined loads, too.

The calculation of factors of safety is related only to the point of a clear notch effect. For it, 9 calculable notches are at your disposal due to the graphical selection, principally.

The scope is limited to steels. Welded members should be calculated separately. But the utilized standard or the present program is ineffective for this purpose!

The calculation base for the module Shaft Calculation is provided by DIN 743, edition of December 2012, part 1-4 " Tragfähigkeitsberechnung von Wellen and Achsen" ("Calculation of bearing capacity of shafts and axles").

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**Input data:**

**Shaft calculation in accordance with DIN 743 - standard version**

| | |
|---|---|
| Geometry scheme | General shaft geometry |
| Calculation process | Dynamic and static strength proof |

**Geometry**

**Shaft geometry**

| Nr. | $D_{a\,l}$ mm | $D_{i\,l}$ mm | $D_{a\,r}$ mm | $D_{i\,r}$ mm | L mm | $R_z$ µm | r mm | d: mm | t: mm | $\alpha_{\sigma}$ zd: | $\alpha_{\sigma b}$ : | $\alpha_{\tau t}$: | n zd : | n b : | n t : | $\beta_{\sigma}$ zddBK : | $\beta_{\sigma}$ bdBK : | $\beta_{\tau}$ dBK: | d BK : mm |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 60 | 0 | 60 | 0 | 30 | 1,6 | 1 | 59,6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2 | 66 | 0 | 66 | 0 | 51,5 | 6,3 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 3 | 70 | 0 | 70 | 0 | 8 | 1,6 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 4 | 73,868 | 0 | 73,868 | 0 | 88 | 1,6 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 5 | 68 | 0 | 68 | 0 | 12 | 1,6 | 1 | 64,9 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 6 | 65 | 0 | 65 | 0 | 90 | 1,6 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7 | 60 | 0 | 60 | 0 | 30 | 1,6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

# Shaft, Standard

**Notch**

| Nr. | Type = | x mm | d: mm | t: mm | r mm | 2r mm | m mm | L mm | $\alpha_{\sigma zd}$: | $\alpha_{\sigma b}$: | $\alpha_{\tau t}$: | $n_{zd}$: | $n_b$: | $n_t$: | $\beta_{\sigma zdBK}$: | $\beta_{\sigma bdBK}$: | $\beta_{\tau dBK}$: | $d_{BK}$: mm |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Feather key joint, 2 grooves | 195 | 0 | 0 | 0 | 0 | 0 | 45 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2 | Toothed shaft (evolvent) | 89,5 | 73,86 | 0 | 0 | 0 | 0 | 88 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

Predetermine the diameter determinant for the heat treatment ? no

| | | |
|---|---|---|
| Calculation of the deflection for point | x = 0 | mm |
| Shaft speed | n : 0 | 1/min |
| Considering weight - horizontal or vertical | horizontal shaft | |

**Bearing**

| Nr. | Type = | Position x = mm | Radial bearing stiffness $c_r$ = N/m | Torsional bearing stiffness $c_\alpha$ = N·m | Bending bearing stiffness $c_\beta$ = N·m |
|---|---|---|---|---|---|
| 1 | Locating bearing -> | 30 | 1e+015 | 0 | 0 |
| 2 | Locating bearing <- | 309 | 1e+015 | 0 | 0 |

**Masses**

| Nr. | Position x = mm | Mass moment of inertia $J_{xx}$ = kg·m² | Mass moment of inertia $J_{yy}$ = kg·m² | Additional masses m = kg |
|---|---|---|---|---|
| 1 | 193 | 0 | 0 | 3,164 |

**Loading Data**

Type of loading: tension-pressure Dynamically pure cyclic

# Shaft, Standard

Type of loading: bending — Dynamically pure cyclic

Type of loading: torsion — Dynamically pure cyclic

Factor for maximum loading (tension-pressure) — 1

Factor for maximum loading (bending) — 1

**Axial forces $F_{ax}$**

| Nr. | Position x = mm | Amount = N | Radius = mm | Angle $\alpha$ = ° |
|---|---|---|---|---|
| 1 | 133,5 | -5177,22 | 35,58 | 180 |

**Radial forces $F_r$**

| Nr. | Position x = mm | Amount = N | Angle $\alpha$ = ° |
|---|---|---|---|
| 1 | 133,5 | -8021,5 | 180 |
| 2 | 133,5 | -19321,6 | 270 |
| 3 | 208,7 | -3519 | 270 |
| 4 | 208,7 | -6035 | 180 |

**Bending moments $M_b$**

| Nr. | Position x = mm | Amount = N·mm | Angle $\alpha$ = ° |
|---|---|---|---|
| 1 | 208,7 | -550195,5 | 270 |

**Torsion**

| Nr. | Position x = mm | Torsion moments $M_t$: N·mm | Power P: kW | Transition part = |
|---|---|---|---|---|
| 1 | 208,7 | 880144,06 | 0 | drive |
| 2 | 309 | 880144,06 | 0 | takeoff |

**Specifications about the load/loadings**

| | |
|---|---|
| Loading case | Constant mean stress (loading case 1) |
| Calculation of finite-life fatique strength ? | yes |
| Load cycles until fatique strength | $N_D$ = 1000000 |
| Required load cycles | $N_L$ = 10000000 |
| Slope exponent of S-N curve normal stress | $q_\sigma$ : 5 |
| Slope exponent of S-N curve shear stress | $q_\tau$ : 8 |
| Minimum safety against fatigue fracture | $S_{Dmin}$ = 1,2 |
| Minimum safety against residual deformation | $S_{Fmin}$ = 1,2 |

**Material Data**

| | | |
|---|---|---|
| Strength values according to | MDESIGN database | |
| Material designation | S275JOC | |
| Material number | 1.0140 | |
| Gage diameter | $d_B$ = 16 | mm |
| For the gage diameter | | |
| Tensile strength | $\sigma_{B'}$ ($R_m$) = 430 | N/mm² |
| Yield stress | $\sigma_{S'}$ ($R_e$) = 275 | N/mm² |
| Cyclic fatigue strength under bending stress | $\sigma_{bW'}$ = 215 | N/mm² |
| Cyclic tension and pressure fatigue strength | $\sigma_{zdW'}$ = 170 | N/mm² |
| Cyclic torsional fatigue strength | $\tau_{tW'}$ = 125 | N/mm² |
| Young's modulus | E = 215000 | N/mm² |
| Shear modulus | G = 83000 | N/mm² |
| Density | $\rho$ = 7850 | kg/m³ |
| Apply surface hardening to | Total shaft | |
| Material group | Common constructive steels | |
| Heat treatment | no any | |
| Surface hardening | no | |

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**Results:**

# Shaft, Standard

Calculation process: Dynamic and static strength proof

**Geometry**

| | | | | |
|---|---|---|---|---|
| Total shaft length | L | = | 309,5 | mm |
| Total shaft mass | m | = | 8,603 | kg |
| Mass moment of inertia of the shaft | J | = | 0,00496 | kg·m² |
| Geometrical moment of inertia of the shaft | I | = | 676,964 | cm⁴ |
| Position of the centre of gravity in the X-axis | $x_s$ | = | 152,452 | mm |
| Angle of torsion | φ | = | 0,039 | ° |

**Additional shaft data:**

| Shaft fillet number | l mm | $I_p$ cm⁴ | $W_t$ cm³ | m kg | J kg·m² | I cm⁴ | $W_b$ cm³ |
|---|---|---|---|---|---|---|---|
| 1 | 30 | 127,235 | 42,412 | 0,666 | 0,0003 | 63,617 | 21,206 |
| 2 | 51,5 | 186,284 | 56,45 | 1,383 | 0,0008 | 93,142 | 28,225 |
| 3 | 8 | 235,718 | 67,348 | 0,242 | 0,0001 | 117,859 | 33,674 |
| 4 | 88 | 292,298 | 79,141 | 2,96 | 0,002 | 146,149 | 39,57 |
| 5 | 12 | 209,911 | 61,739 | 0,342 | 0,0002 | 104,956 | 30,869 |
| 6 | 90 | 175,248 | 53,922 | 2,344 | 0,0012 | 87,624 | 26,961 |
| 7 | 30 | 127,235 | 42,412 | 0,666 | 0,0003 | 63,617 | 21,206 |

**Loading Data**

| | | | | |
|---|---|---|---|---|
| **Calculation results for point** | **x** | = | 0 | mm |
| Trend of curve of the transverse force | $Q_x$ | = | 0 | N |
| deflection | $y_x$ | = | 0,013388 | mm |
| Angle of deflection | Θ | = | 0,025569 | ° |

# Shaft, Standard

**Supporting forces:**

| No. | Type | Position x mm | Radial force in the Y-axis $R_y$ N | Radial force in the Z-axis $R_z$ N | Result. radial force R N | Axial force in the X-axis $R_{ax}$ N | Tilting moment in the Y-axis N·m | Tilting moment in the Z-axis N·m | Result. tilting moment N·m |
|---|---|---|---|---|---|---|---|---|---|
| 1 | Locating bearing -> | 30 | -7815,347 | -11446,957 | 13860,464 | 5177,22 | 0 | 0 | 0 |
| 2 | Locating bearing <- | 309 | -6125,754 | -11393,643 | 12935,995 | 0 | 0 | 0 | 0 |

| | | | | |
|---|---|---|---|---|
| Resulting maximum bending moment: | | | | |
| Position | x | = | 133,5 | mm |
| Amount | $M_{bmax}$ | = | 1435,834 | N·m |
| Resulting maximum torsional moment: | | | | |
| Position | x | = | 208,7 | mm |
| Amount | $M_{tmax}$ | = | 880,144 | N·m |
| Resulting maximum tension-pressure-force: | | | | |
| Position | x | = | 30 | mm |
| Amount | $F_{zdmax}$ | = | -5177,22 | N |
| Resulting maximum tension-pressure-stress: | | | | |
| Position | x | = | 30 | mm |
| Amount | $\sigma_{zdmax}$ | = | -1,831 | N/mm² |
| Resulting maximum bending stress: | | | | |
| Position | x | = | 208,7 | mm |
| Amount | $\sigma_{bmax}$ | = | 48,145 | N/mm² |
| Resulting maximum torsional stress: | | | | |
| Position | x | = | 309 | mm |
| Amount | $\tau_{tmax}$ | = | 20,752 | N/mm² |
| Resulting maximum equivalent stress: | | | | |
| Position | x | = | 208,7 | mm |
| Amount | $\sigma_{vmax}$ | = | 55,832 | N/mm² |
| Resulting maximum deflection: | | | | |
| Position | x | = | 178,626 | mm |
| Amount | $y_{max}$ | = | 0,03926 | mm |
| Angle of the maximum deflection: | | | | |

| | | | | |
|---|---|---|---|---|
| Position | x | = | 309,5 | mm |
| Amount | $\Theta$ | = | 0,028342 | ° |

Minimum safety against yielding:

| | | | | |
|---|---|---|---|---|
| Position | x | = | 208,7 | mm |
| Amount | $S_F$ | = | 5,438 | |

Minimum safety against fatigue fracture:

| | | | | |
|---|---|---|---|---|
| Position | x | = | 208,7 | mm |
| Amount | $S_D$ | = | 1,423 | |

**Parameter of cross-sections:**

Tension-pressure force $F_{zd}$ and tension/pressure stress $\sigma_{zd}$

| No. | Type | Position x mm | Result. $F_{zdx}$ N | Amplitude $F_{zda}$ N | Mean $F_{zdm}$ N | Maximum $F_{zdmax}$ N | Amplitude $\sigma_{zda}$ N/mm² | Mean $\sigma_{zdm}$ N/mm² | Maximum $\sigma_{zdmax}$ N/mm² |
|---|---|---|---|---|---|---|---|---|---|
| 1 | Fillet with recess | 30 | -5177,22 | -5177,22 | 0 | -5177,22 | -1,856 | 0 | -1,856 |
| 2 | Shaft fillet | 81,5 | -5177,22 | -5177,22 | 0 | -5177,22 | -1,513 | 0 | -1,513 |
| 3 | Shaft fillet | 89,5 | -5177,22 | -5177,22 | 0 | -5177,22 | -1,345 | 0 | -1,345 |
| 4 | Toothed shaft (evolvent) | 89,5 | -5177,22 | -5177,22 | 0 | -5177,22 | -1,208 | 0 | -1,208 |
| 5 | Shaft fillet | 177,5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 6 | Fillet with recess | 189,5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7 | Feather key joint, 2 grooves | 195 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 8 | Shaft fillet | 279,5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 9 | Calculation results for point x | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Program : MDESIGN 2020 - | User : | Customer : Student |
|---|---|---|
| Module version : 18.0.12 | Date : 11.12.2023 | Project : |

# Shaft, Standard

Bending moment $M_b$ and bending stress $\sigma_b$

| No. | Type | Position x mm | Result. $M_{bx}$ N·m | Amplitude $M_{ba}$ N·m | Mean $M_{bm}$ N·m | Maximum $M_{bmax}$ N·m | Amplitude $\sigma_{ba}$ N/mm² | Mean $\sigma_{bm}$ N/mm² | Maximum $\sigma_{bmax}$ N/mm² |
|---|---|---|---|---|---|---|---|---|---|
| 1 | Fillet with recess | 30 | 0,098 | 0,098 | 0 | 0,098 | 0,005 | 0 | 0,005 |
| 2 | Shaft fillet | 81,5 | 714,256 | 714,256 | 0 | 714,256 | 25,306 | 0 | 25,306 |
| 3 | Shaft fillet | 89,5 | 825,236 | 825,236 | 0 | 825,236 | 24,507 | 0 | 24,507 |
| 4 | Toothed shaft (evolvent) | 89,5 | 825,236 | 825,236 | 0 | 825,236 | 20,862 | 0 | 20,862 |
| 5 | Shaft fillet | 177,5 | 1042,537 | 1042,537 | 0 | 1042,537 | 33,773 | 0 | 33,773 |
| 6 | Fillet with recess | 189,5 | 967,013 | 967,013 | 0 | 967,013 | 36,033 | 0 | 36,033 |
| 7 | Feather key joint, 2 grooves | 195 | 933,604 | 933,604 | 0 | 933,604 | 34,628 | 0 | 34,628 |
| 8 | Shaft fillet | 279,5 | 381,658 | 381,658 | 0 | 381,658 | 17,998 | 0 | 17,998 |
| 9 | Calculation results for point x | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

# Shaft, Standard

Torsional moment $M_t$ und Torsional stress $\tau_t$

| No. | Type | Position x mm | Result. $M_{tx}$ N·m | Amplitude $M_{ta}$ N·m | Mean $M_{tm}$ N·m | Maximum $M_{tmax}$ N·m | Amplitude $\tau_{ta}$ N/mm² | Mean $\tau_{tm}$ N/mm² | Maximum $\tau_{tmax}$ N/mm² |
|---|---|---|---|---|---|---|---|---|---|
| 1 | Fillet with recess | 30 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2 | Shaft fillet | 81,5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 3 | Shaft fillet | 89,5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 4 | Toothed shaft (evolvent) | 89,5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 5 | Shaft fillet | 177,5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 6 | Fillet with recess | 189,5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7 | Feather key joint, 2 grooves | 195 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 8 | Shaft fillet | 279,5 | 880,144 | 880,144 | 0 | 880,144 | 20,752 | 0 | 20,752 |
| 9 | Calculation results for point x | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

**Material Data**

| | | | | |
|---|---|---|---|---|
| Material parameter for | $d_{max}$ | = | 73,868 | mm |
| Material designation | | S275JOC | | |
| Material number | | 1.0140 | | |
| Tensile strength | $\sigma_B$ | = | 430 | N/mm² |
| Yield stress | $\sigma_S$ | = | 249,024 | N/mm² |
| Cyclic tension and pressure fatigue strength | $\sigma_{zdW}$ | = | 170 | N/mm² |
| Cyclic fatigue strength under bending stress | $\sigma_{bW}$ | = | 215 | N/mm² |
| Cyclic torsional fatigue strength | $\tau_{tW}$ | = | 125 | N/mm² |
| Technological dimension factor (tensile strength) | $K_{1B}(d_{max})$ | = | 1 | |
| Technological dimension factor (yield stress) | $K_{1S}(d_{max})$ | = | 0,906 | |

# Shaft, Standard

**Proof of Strength**

$K_1(d)$ - Technological dimension factor
$K_2(d)$ - Geometrical dimension factor
$K_F$ - Influence factor of surface roughness
$\alpha_{\sigma,\tau}$ - Form factors

| No. | Type | Position x mm | $K_{1B}$ (d) | $K_{1S}(d)$ | Tension-pressure $K_2(d)$ | Bending and torsion $K_2(d)$ | Tension-pressure, bending $K_{F\sigma}$ | Torsion $K_{F\tau}$ | Tension-pressure $\alpha_{\sigma zd}$ | Bending $\alpha_{\sigma b}$ | Torsion $\alpha_\tau$ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Fillet with recess | 30 | 1 | 0,92 | 1 | 0,86 | 0,99 | 0,99 | 2,77 | 2,57 | 1,74 |
| 2 | Shaft fillet | 81,5 | 1 | 0,91 | 1 | 0,85 | 0,94 | 0,97 | 2,08 | 1,91 | 1,42 |
| 3 | Shaft fillet | 89,5 | 1 | 0,91 | 1 | 0,85 | 0,99 | 0,99 | 2,53 | 2,38 | 1,62 |
| 4 | Toothed shaft (evolvent) | 89,5 | 1 | 0,91 | 1 | 0,85 | 1 | 1 | - | - | - |
| 5 | Shaft fillet | 177,5 | 1 | 0,91 | 1 | 0,85 | 0,99 | 0,99 | 2,77 | 2,58 | 1,73 |
| 6 | Fillet with recess | 189,5 | 1 | 0,91 | 1 | 0,86 | 0,99 | 0,99 | 2,39 | 2,25 | 1,56 |
| 7 | Feather key joint, 2 grooves | 195 | 1 | 0,92 | 1 | 0,86 | 1 | 1 | - | - | - |
| 8 | Shaft fillet | 279,5 | 1 | 0,92 | 1 | 0,86 | 0,99 | 0,99 | 2,64 | 2,46 | 1,68 |
| 9 | Calculation results for point x | 0 | 1 | 0,93 | 1 | 0,86 | 0,99 | 0,99 | - | - | - |

| Program : MDESIGN 2020 - | User : | Customer : Student |
|---|---|---|
| Module version : 18.0.12 | Date : 11.12.2023 | Project : |

# Shaft, Standard

G′ - Relative stress drop

$n_{\sigma, \tau}$ - Bearing factor

| No. | Type | Position x mm | Tension-pressure $G'_{zd}$ 1/mm | Bending $G'_b$ 1/mm | Torsion $G'_t$ 1/mm | Tension-pressure $n\sigma_{zd}$ | Bending $n_{\sigma b}$ | Torsion $n_\tau$ |
|---|---|---|---|---|---|---|---|---|
| 1 | Fillet with recess | 30 | 2,55 | 2,55 | 1,15 | 1,33 | 1,33 | 1,22 |
| 2 | Shaft fillet | 81,5 | 1,34 | 1,34 | 0,57 | 1,24 | 1,24 | 1,16 |
| 3 | Shaft fillet | 89,5 | 2,6 | 2,6 | 1,15 | 1,34 | 1,34 | 1,22 |
| 4 | Toothed shaft (evolvent) | 89,5 | - | - | - | - | - | - |
| 5 | Shaft fillet | 177,5 | 2,56 | 2,56 | 1,15 | 1,33 | 1,33 | 1,22 |
| 6 | Fillet with recess | 189,5 | 2,63 | 2,63 | 1,15 | 1,34 | 1,34 | 1,22 |
| 7 | Feather key joint, 2 grooves | 195 | - | - | - | - | - | - |
| 8 | Shaft fillet | 279,5 | 2,58 | 2,58 | 1,15 | 1,33 | 1,33 | 1,22 |
| 9 | Calculation results for point x | 0 | - | - | - | - | - | - |

## Shaft, Standard

$\beta_{\sigma zddBK}$, $\beta_{\sigma bdBK}$, $\beta_{\tau dBK}$ - Stress concentration factor at $d_{BK}$
$\beta_{\sigma zd}$, $\beta_{\sigma b}$, $\beta_{\tau}$ - Stress concentration factors
$K_v$ - Influence factor of surface hardening

| No. | Type | Position x mm | Tension - pressure $\beta_{\sigma zddBK}$ | Bending $\beta_{\sigma bdBK}$ | Torsion $\beta_{\tau dBK}$ | Tension - pressure $\beta_{\sigma zd}$ | Bending $\beta_{\sigma b}$ | Torsion $\beta_{\tau}$ | Tension - pressure $K_{vzd}$ | Bending $K_{vb}$ | Torsion $K_{v\tau}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Fillet with recess | 30 | - | - | - | 2,08 | 1,93 | 1,42 | 1 | 1 | 1 |
| 2 | Shaft fillet | 81,5 | - | - | - | 1,68 | 1,54 | 1,23 | 1 | 1 | 1 |
| 3 | Shaft fillet | 89,5 | - | - | - | 1,89 | 1,78 | 1,32 | 1 | 1 | 1 |
| 4 | Toothed shaft (evolvent) | 89,5 | 1,04 | 1,04 | 1,06 | 1,04 | 1,04 | 1,06 | 1 | 1 | 1 |
| 5 | Shaft fillet | 177,5 | - | - | - | 2,07 | 1,94 | 1,42 | 1 | 1 | 1 |
| 6 | Fillet with recess | 189,5 | - | - | - | 1,79 | 1,68 | 1,27 | 1 | 1 | 1 |
| 7 | Feather key joint, 2 grooves | 195 | 2,5 | 2,5 | 1,5 | 2,54 | 2,54 | 1,51 | 1 | 1 | 1 |
| 8 | Shaft fillet | 279,5 | - | - | - | 1,98 | 1,85 | 1,37 | 1 | 1 | 1 |
| 9 | Calculation results for point x | 0 | - | - | - | 1 | 1 | 1 | 1 | 1 | 1 |

# Shaft, Standard

$K_\sigma$, $K_\tau$ - Total influence factor

$\sigma_{zdWK}$, $\sigma_{bWK}$, $\tau_{tWK}$ - Cyclic fatigue strength of the notched part

$K_{2F}$ - Static bearing effect

| No. | Type | Position x mm | Tension-pressure $K_\sigma$ | Bending $K_\sigma$ | Torsion $K_\tau$ | Tension-pressure $\sigma_{zdWK}$ N/mm² | Bending $\sigma_{bWK}$ N/mm² | Torsions $\tau_{tWK}$ N/mm² | Tension-pressure $K_{2Fzd}$ | Bending $K_{2Fb}$ | Torsion $K_{2Ft}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Fillet with recess | 30 | 2,1 | 2,26 | 1,66 | 81,05 | 95,34 | 75,27 | 1 | 1,2 | 1,2 |
| 2 | Shaft fillet | 81,5 | 1,74 | 1,86 | 1,47 | 97,83 | 115,34 | 84,98 | 1 | 1,2 | 1,2 |
| 3 | Shaft fillet | 89,5 | 1,91 | 2,11 | 1,57 | 89,1 | 101,89 | 79,84 | 1 | 1,2 | 1,2 |
| 4 | Toothed shaft (evolvent) | 89,5 | 1,04 | 1,23 | 1,25 | 163,36 | 175,05 | 99,7 | 1 | 1,2 | 1,2 |
| 5 | Shaft fillet | 177,5 | 2,09 | 2,28 | 1,67 | 81,4 | 94,12 | 74,88 | 1 | 1,2 | 1,2 |
| 6 | Fillet with recess | 189,5 | 1,81 | 1,98 | 1,5 | 94,09 | 108,5 | 83,46 | 1 | 1,2 | 1,2 |
| 7 | Feather key joint, 2 grooves | 195 | 2,54 | 2,96 | 1,76 | 67 | 72,51 | 70,88 | 1 | 1,2 | 1,2 |
| 8 | Shaft fillet | 279,5 | 2 | 2,16 | 1,6 | 85,13 | 99,31 | 77,99 | 1 | 1,2 | 1,2 |
| 9 | Calculation results for point x | 0 | 1,02 | 1,18 | 1,17 | 167,46 | 182,77 | 106,85 | 1 | 1,2 | 1,2 |

$\gamma_F$ - Yield point rise

$\sigma_{zdFK}$, $\sigma_{bFK}$, $\tau_{tFK}$ - Yield point of the part

| No. | Type | Position x mm | Tension-pressure $\gamma_{Fzd}$ | Bending $\gamma_{Fb}$ | Torsion $\gamma_{Ft}$ | Tension-pressure $\sigma_{zdFK}$ N/mm² | Bending $\sigma_{bFK}$ N/mm² | Torsion $\tau_{tFK}$ N/mm² |
|---|---|---|---|---|---|---|---|---|
| 1 | Fillet with recess | 30 | 1,1 | 1,1 | 1 | 277,77 | 333,33 | 174,95 |
| 2 | Shaft fillet | 81,5 | 1,1 | 1,05 | 1 | 275,76 | 315,87 | 173,69 |
| 3 | Shaft fillet | 89,5 | 1,1 | 1,1 | 1 | 273,93 | 328,71 | 172,53 |
| 4 | Toothed shaft (evolvent) | 89,5 | 1 | 1 | 1 | 249,02 | 298,83 | 172,53 |
| 5 | Shaft fillet | 177,5 | 1,1 | 1,1 | 1 | 273,93 | 328,71 | 172,53 |
| 6 | Fillet with recess | 189,5 | 1,1 | 1,1 | 1 | 276,75 | 332,1 | 174,31 |
| 7 | Feather key joint, 2 grooves | 195 | 1 | 1 | 1 | 252,99 | 303,59 | 175,28 |
| 8 | Shaft fillet | 279,5 | 1,1 | 1,1 | 1 | 278,29 | 333,95 | 175,28 |
| 9 | Calculation results for point x | 0 | 1 | 1 | 1 | 255,48 | 306,58 | 177 |

Static safety

| No. | Type | Position x mm | $S_F$ | In Point1 $S_{F1}$ | in Point2 $S_{F2}$ |
|---|---|---|---|---|---|
| 1 | Fillet with recess | 30 | 149,37 | - | - |
| 2 | Shaft fillet | 81,5 | 11,68 | - | - |
| 3 | Shaft fillet | 89,5 | 12,58 | - | - |
| 4 | Toothed shaft (evolvent) | 89,5 | - | 13,39 | 11,34 |
| 5 | Shaft fillet | 177,5 | 9,73 | - | - |
| 6 | Fillet with recess | 189,5 | 9,22 | - | - |
| 7 | Feather key joint, 2 grooves | 195 | - | 8,77 | 6,97 |
| 8 | Shaft fillet | 279,5 | 7,69 | - | - |
| 9 | Calculation results for point x | 0 | 10000 | - | - |

# Shaft, Standard

$\psi$ - Influence factor of the mean stress sensitivitz

$\sigma_{mv}$, $\tau_{mv}$ - Comparative mean stress

| No. | Type | Position x mm | Tension - pressure $\psi_{zd\sigma K}$ | Bending $\psi_{b\sigma K}$ | Torsion $\psi_{\tau K}$ | $\sigma_{mv}$ N/mm² | $\tau_{mv}$ N/mm² | $\sigma_{mv1}$ N/mm² | $\tau_{mv1}$ N/mm² | $\sigma_{mv2}$ N/mm² | $\tau_{mv2}$ N/mm² |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Fillet with recess | 30 | 0,1 | 0,12 | - | 0 | 0 | - | - | - | - |
| 2 | Shaft fillet | 81,5 | 0,13 | 0,15 | - | 0 | 0 | - | - | - | - |
| 3 | Shaft fillet | 89,5 | 0,12 | 0,13 | - | 0 | 0 | - | - | - | - |
| 4 | Toothed shaft (evolvent) | 89,5 | - | 0,26 | - | - | - | 0 | 0 | 0 | 0 |
| 5 | Shaft fillet | 177,5 | - | 0,12 | - | 0 | 0 | - | - | - | - |
| 6 | Fillet with recess | 189,5 | - | 0,14 | - | 0 | 0 | - | - | - | - |
| 7 | Feather key joint, 2 grooves | 195 | - | 0,09 | 0,09 | - | - | 0 | 0 | 0 | 0 |
| 8 | Shaft fillet | 279,5 | - | 0,13 | 0,1 | 0 | 0 | - | - | - | - |
| 9 | Calculation results for point x | 0 | - | - | - | 0 | 0 | - | - | - | - |

# Shaft, Standard

Alternating fatigue strength of the part (rated fatigue limit)

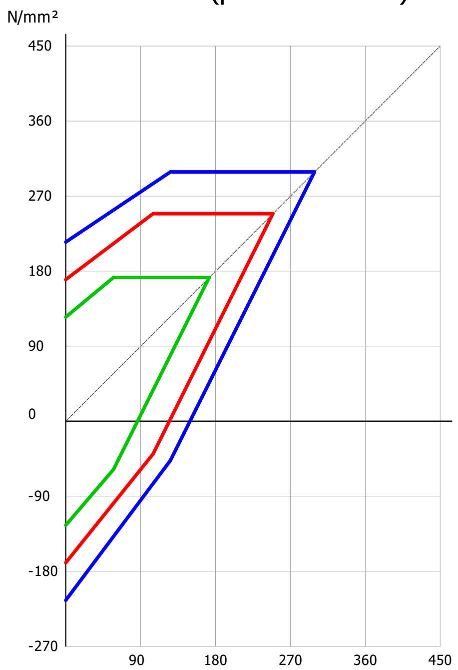
| No. | Type | Position x mm | Tension-pressure $\sigma_{zdADK}$ N/mm² | Bending $\sigma_{bADK}$ N/mm² | Torsion $\tau_{tADK}$ N/mm² | Tension-pressure in Point1 $\sigma_{zdADK1}$ N/mm² | Bending in Point1 $\sigma_{bADK1}$ N/mm² | Torsion in Point1 $\tau_{tADK1}$ N/mm² | Tension-pressure in Point2 $\sigma_{zdADK2}$ N/mm² | Bending in Point2 $\sigma_{bADK2}$ N/mm² | Torsion in Point2 $\tau_{tADK2}$ N/mm² |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Fillet with recess | 30 | 81,05 | 95,34 | - | - | - | - | - | - | - |
| 2 | Shaft fillet | 81,5 | 97,83 | 115,34 | - | - | - | - | - | - | - |
| 3 | Shaft fillet | 89,5 | 89,1 | 101,89 | - | - | - | - | - | - | - |
| 4 | Toothed shaft (evolvent) | 89,5 | - | - | - | 163,36 | 175,05 | - | - | 175,05 | - |
| 5 | Shaft fillet | 177,5 | - | 94,12 | - | - | - | - | - | - | - |
| 6 | Fillet with recess | 189,5 | - | 108,5 | - | - | - | - | - | - | - |
| 7 | Feather key joint, 2 grooves | 195 | - | - | - | - | 72,51 | - | - | 72,51 | 70,88 |
| 8 | Shaft fillet | 279,5 | - | 99,31 | 77,99 | - | - | - | - | - | - |
| 9 | Calculation results for point x | 0 | - | - | - | - | - | - | - | - | - |

# Shaft, Standard

Dynamic safety

| No. | Type | Position x mm | $S_D$ | in Point1 $S_{D1}$ | in Point2 $S_{D2}$ |
|---|---|---|---|---|---|
| 1 | Fillet with recess | 30 | 43,58 | - | - |
| 2 | Shaft fillet | 81,5 | 4,26 | - | - |
| 3 | Shaft fillet | 89,5 | 3,91 | - | - |
| 4 | Toothed shaft (evolvent) | 89,5 | - | 7,9 | 6,64 |
| 5 | Shaft fillet | 177,5 | 2,79 | - | - |
| 6 | Fillet with recess | 189,5 | 3,01 | - | - |
| 7 | Feather key joint, 2 grooves | 195 | - | 2,09 | 1,96 |
| 8 | Shaft fillet | 279,5 | 3,11 | - | - |
| 9 | Calculation results for point x | 0 | 10000 | - | - |

Unnotched (part dimension) for point x




Material = S275JOC
Number = 1.0140

$\sigma_B(d_{eff})$ = 430 N/mm²
$\sigma_{zdF}$ = 249 N/mm²
$\sigma_{bF}$ = 299 N/mm²
$\tau_{tF}$ = 173 N/mm²
$\sigma_{zdW}$ = 170 N/mm²
$\sigma_{bW}$ = 215 N/mm²
$\tau_{tW}$ = 125 N/mm²

Tension-pressure
Bending
Torsion

| Educational version | | |
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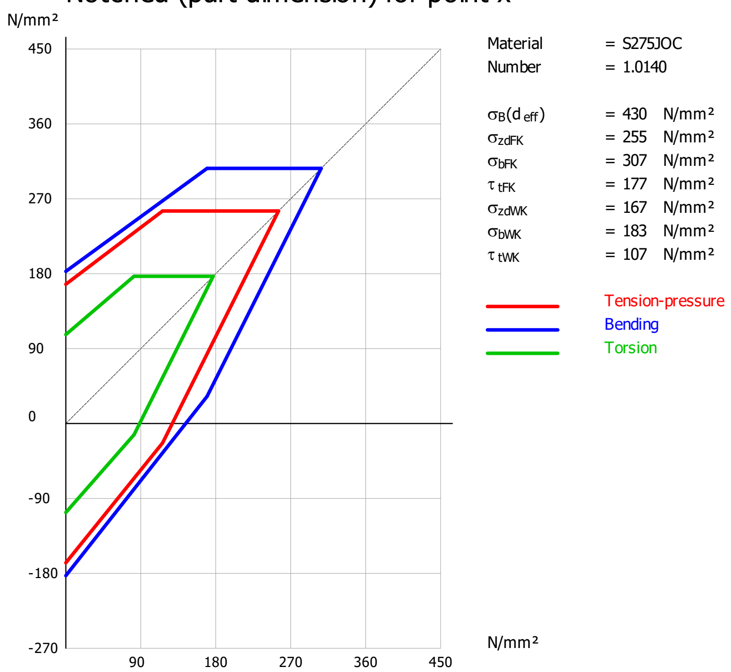
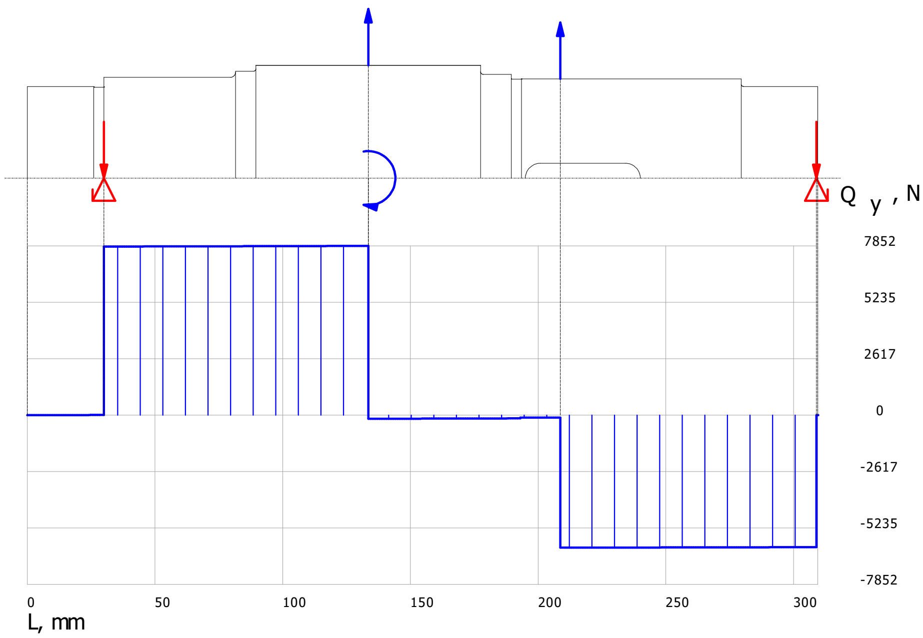
# Shaft, Standard

Notched (part dimension) for point x




Trend of curve of the transverse force in the Y-X-plane



| | | |
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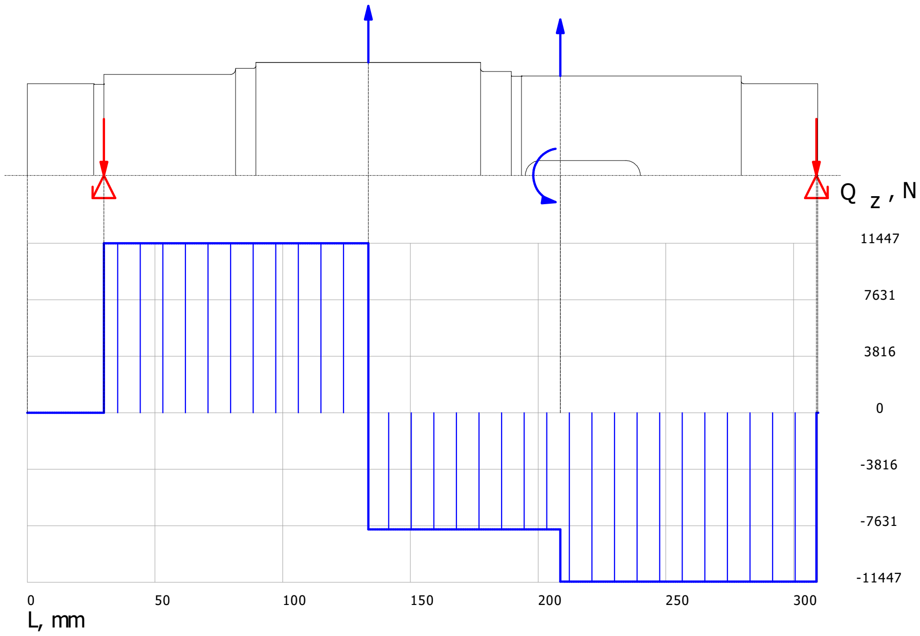
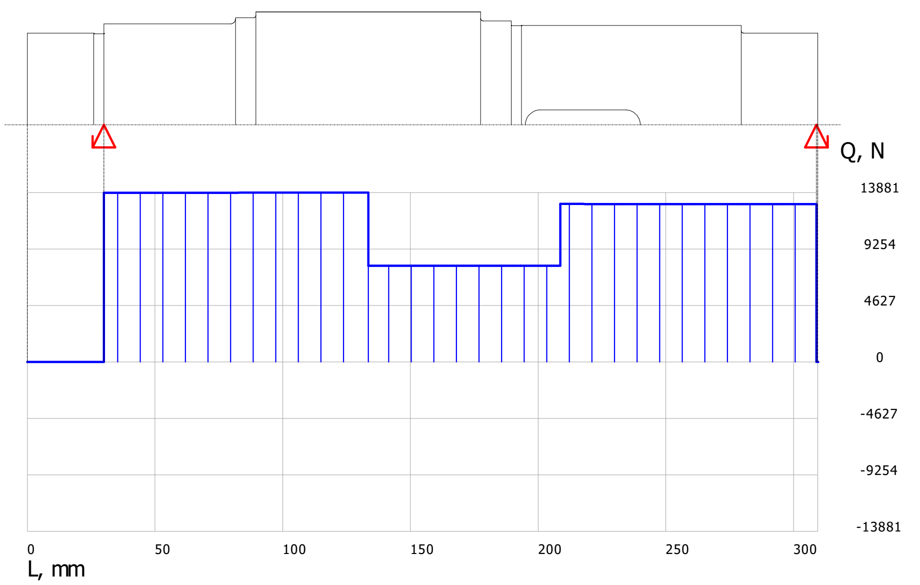
# Shaft, Standard

Trend of curve of the transverse force in the Z-X-plane

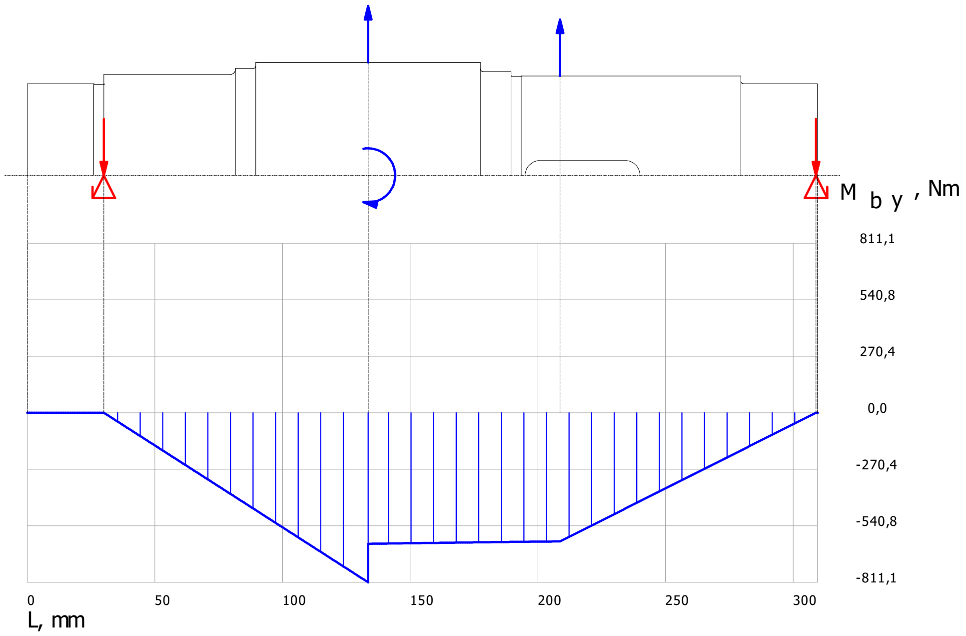



Trend of curve of the transverse force (combined characteristic)

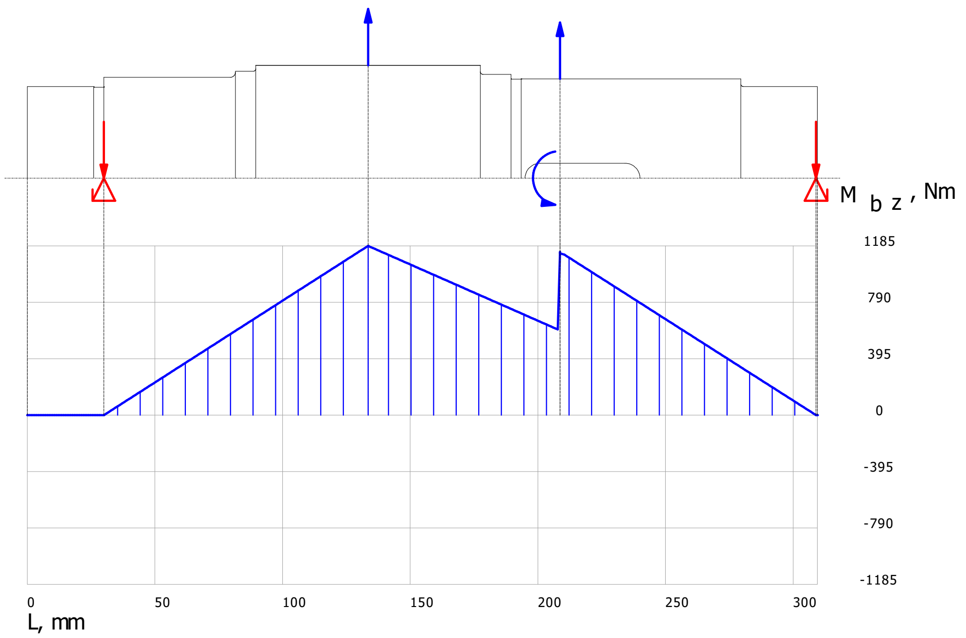


# Shaft, Standard

Bending moment in the Y-X-plane

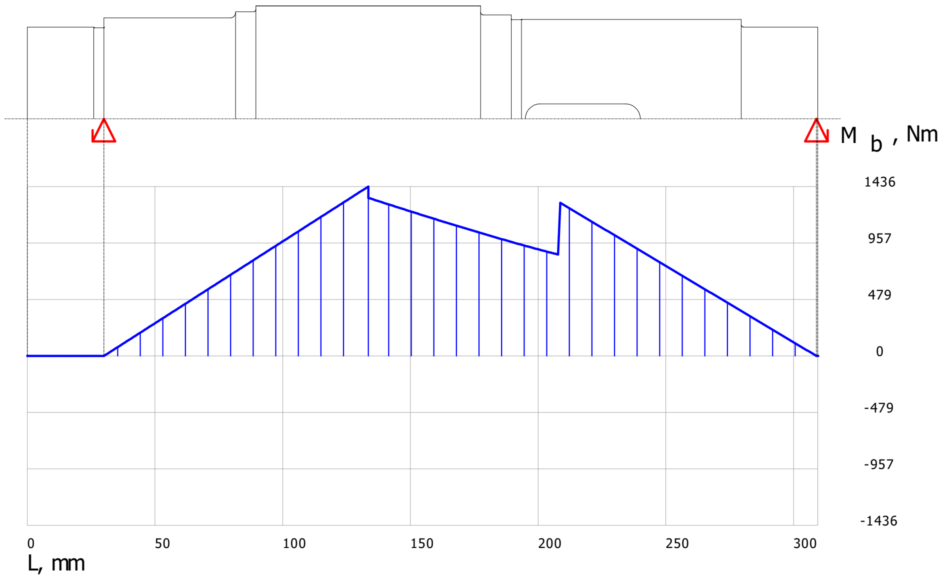



Trend of curve of the bending moment curve in the Z-X plane

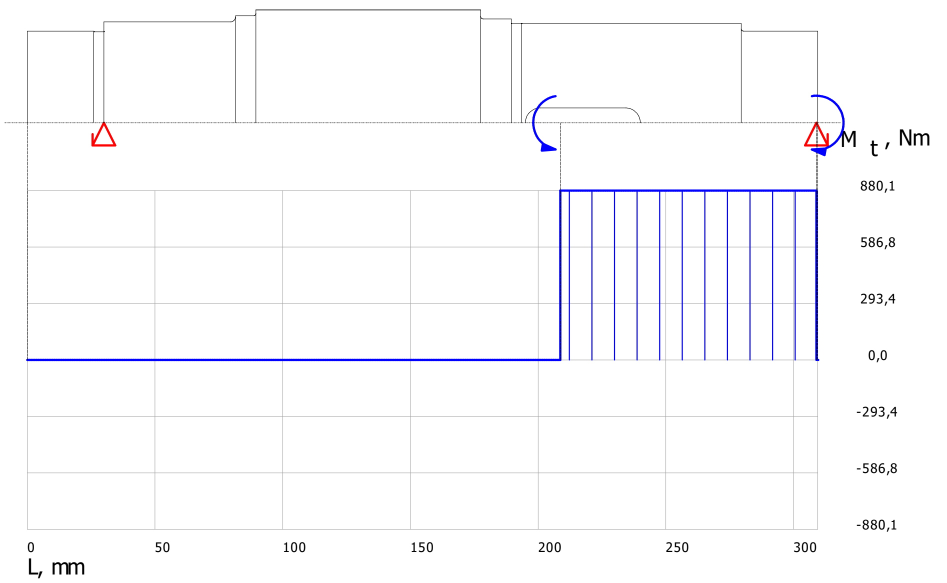


## Shaft, Standard

Trend of curve of the bending moment (combined characteristic)

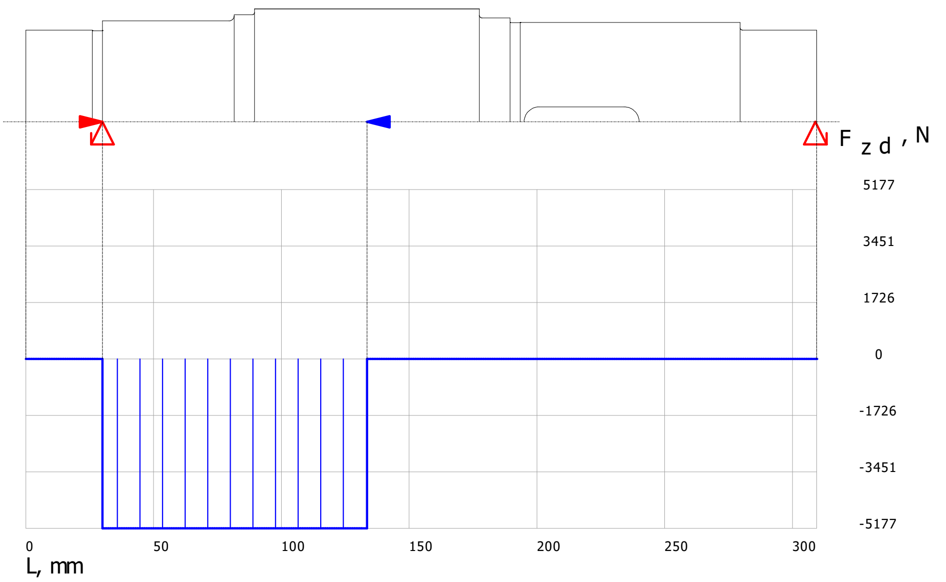



Trend of curve of the torsional moment

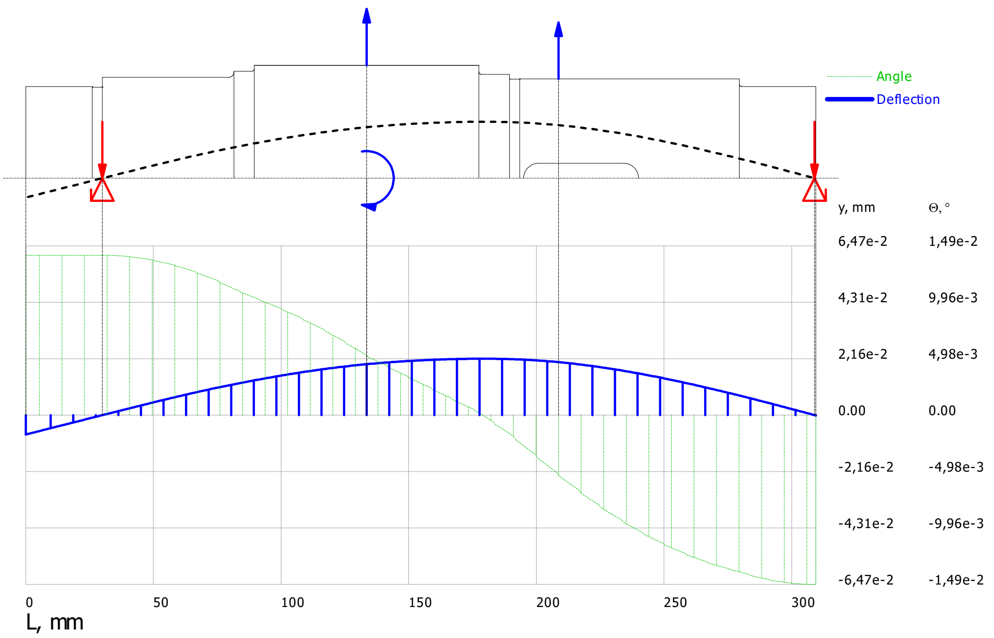


# Shaft, Standard

Trend of curve of the tension-pressure forces

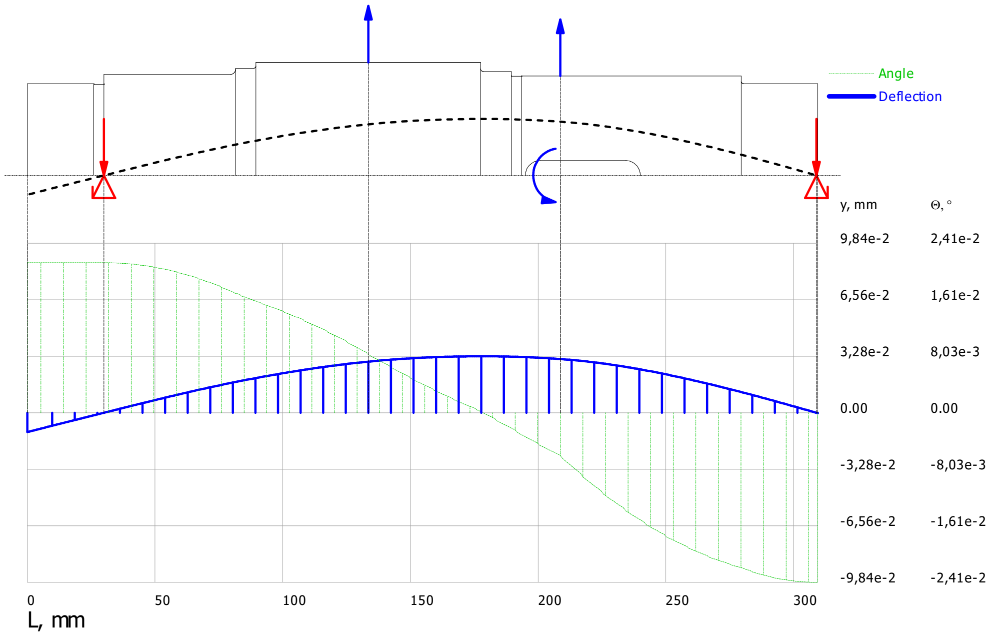



Deflection and angle of deflection in the Y-X-plane

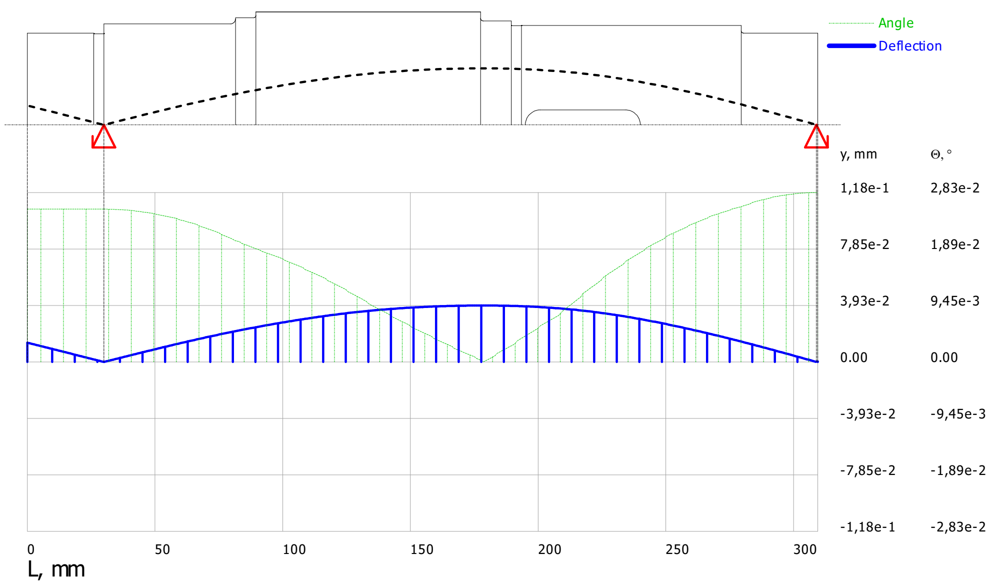


## Shaft, Standard

Deflection and angle of deflection in the Z-X-plane

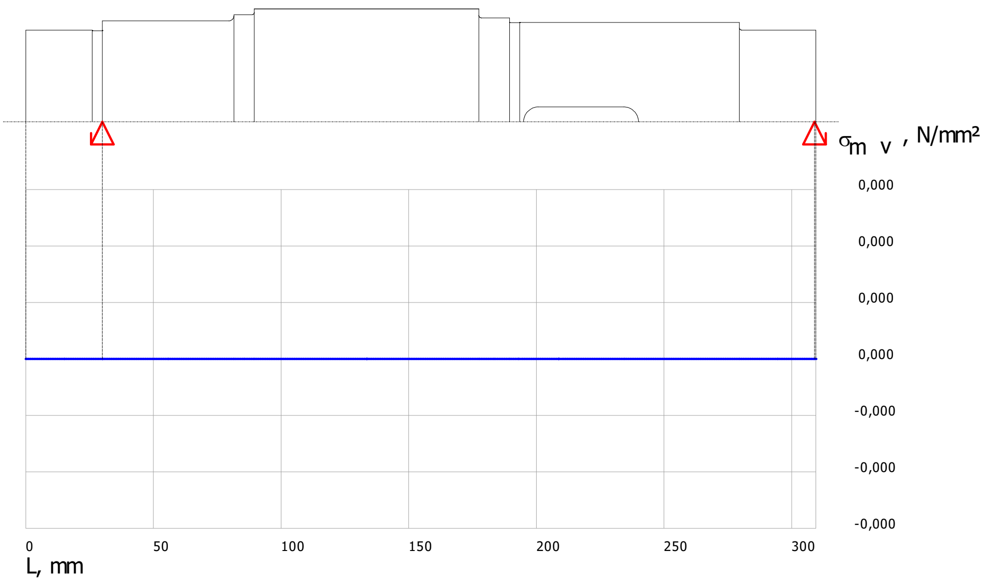



Deflection and angle of deflection (combined characteristic)

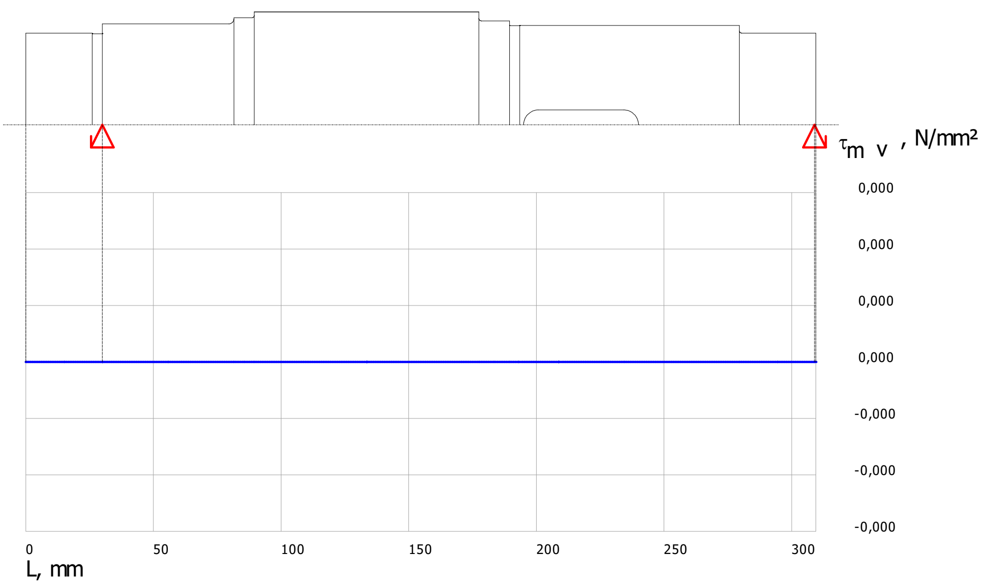


# Shaft, Standard

Equivalent mean stress (normal stress)




Equivalent mean stress (shear stress)



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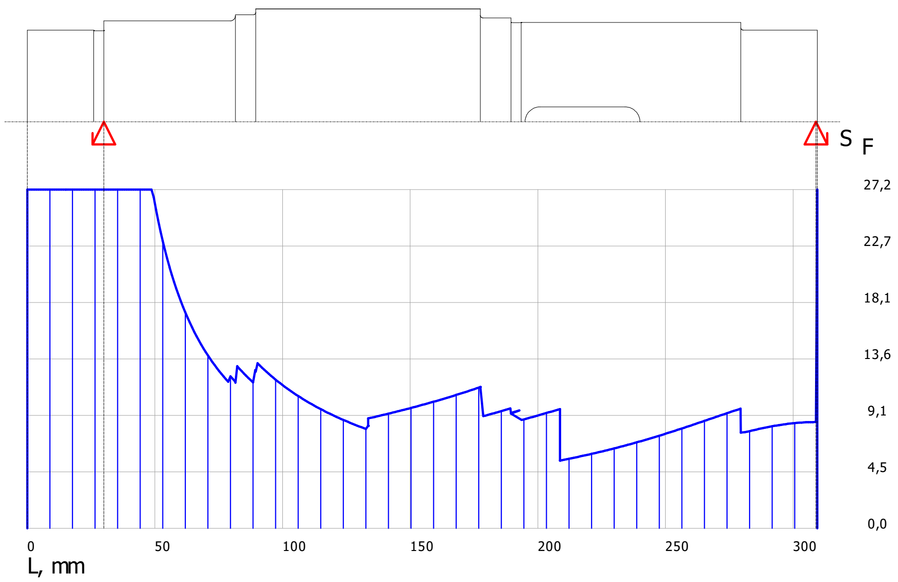
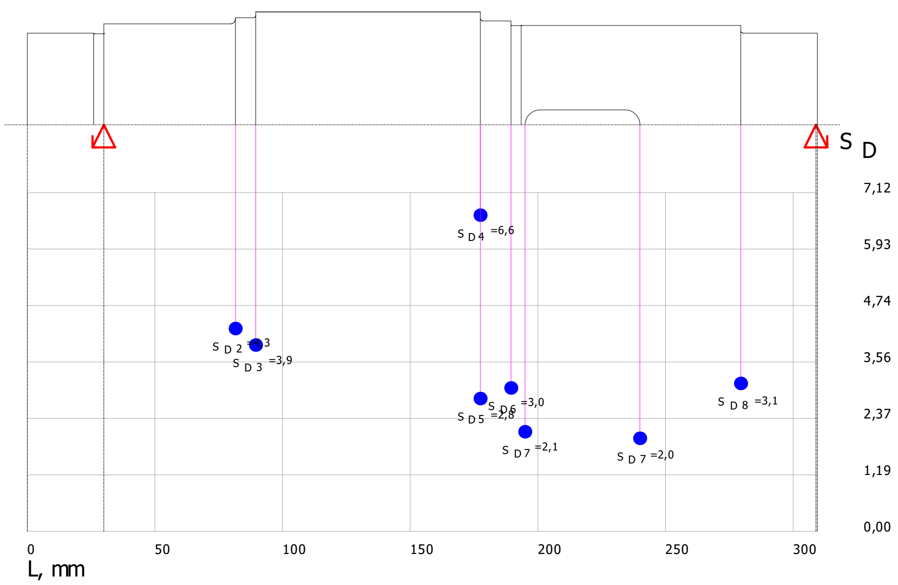
## Shaft, Standard

Safety factor against yielding
(diagram section up to 5*minimum safety)

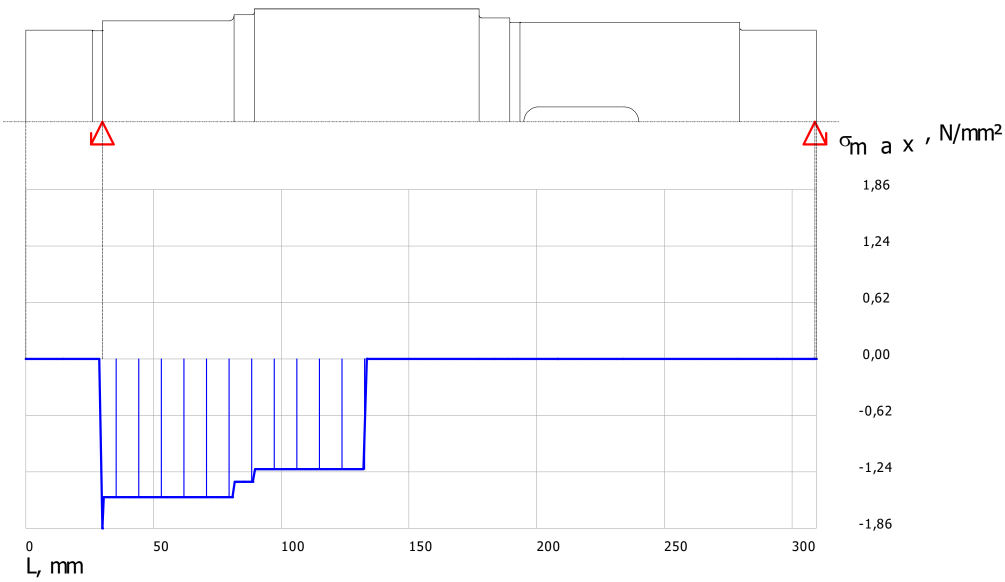



Safety against fatigue fracture
(diagram section up to 5*minimum safety)

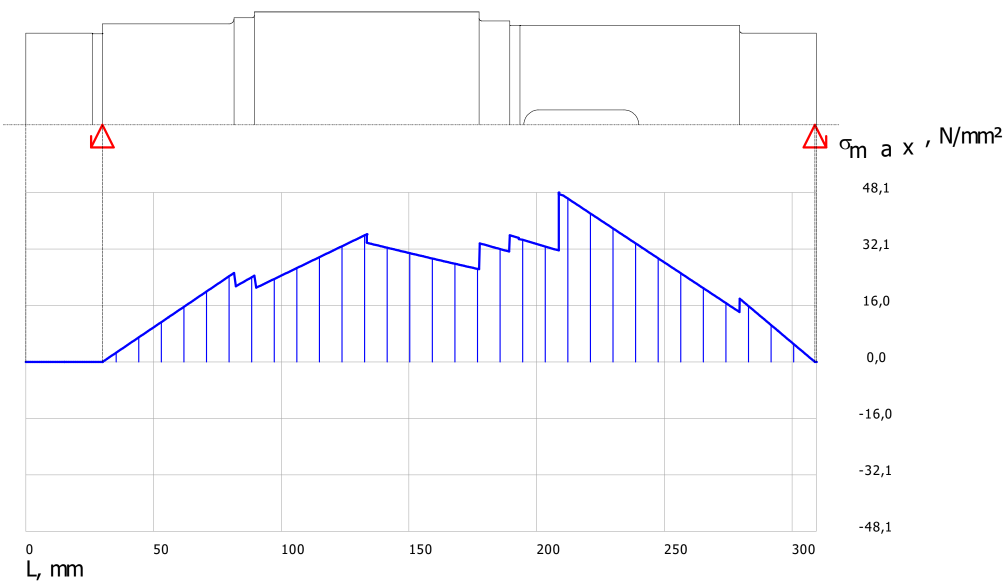


## Shaft, Standard

Maximum value of the tension-pressure stress (combined characteristic)




Maximum value of the bending stress (combined characteristic)



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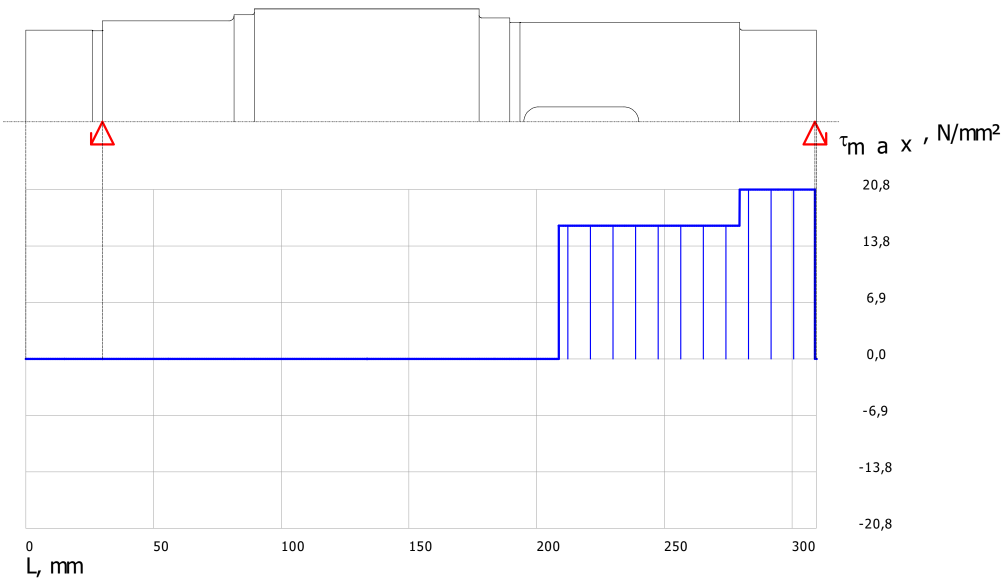
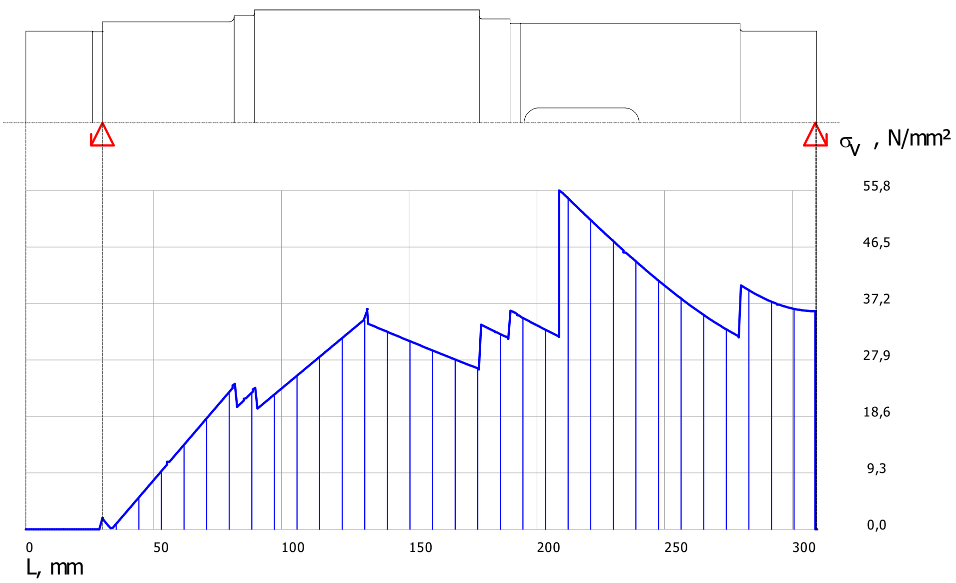
## Shaft, Standard

Maximum value of the torsional stress (combined characteristic)

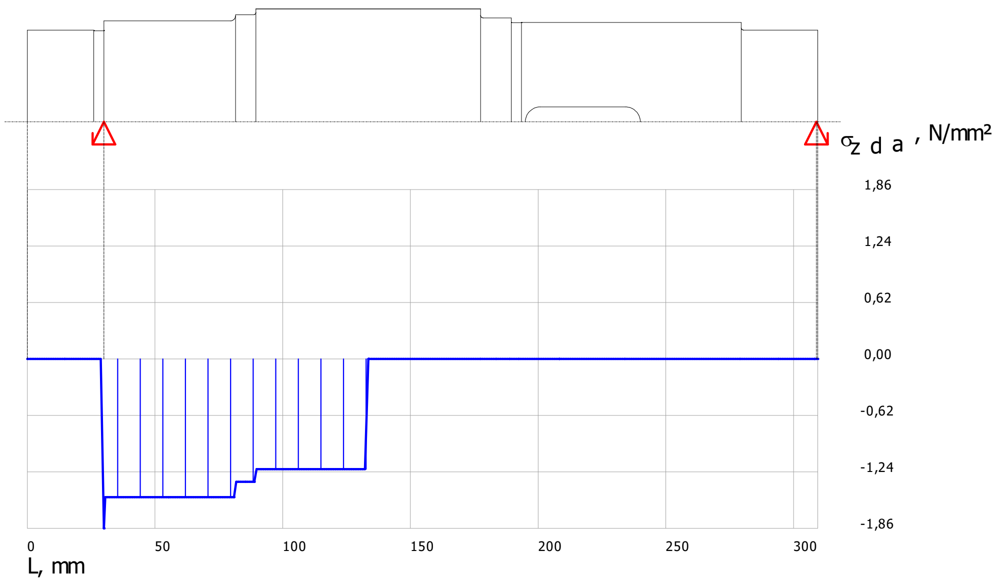



Equivalent stress development (resultant)

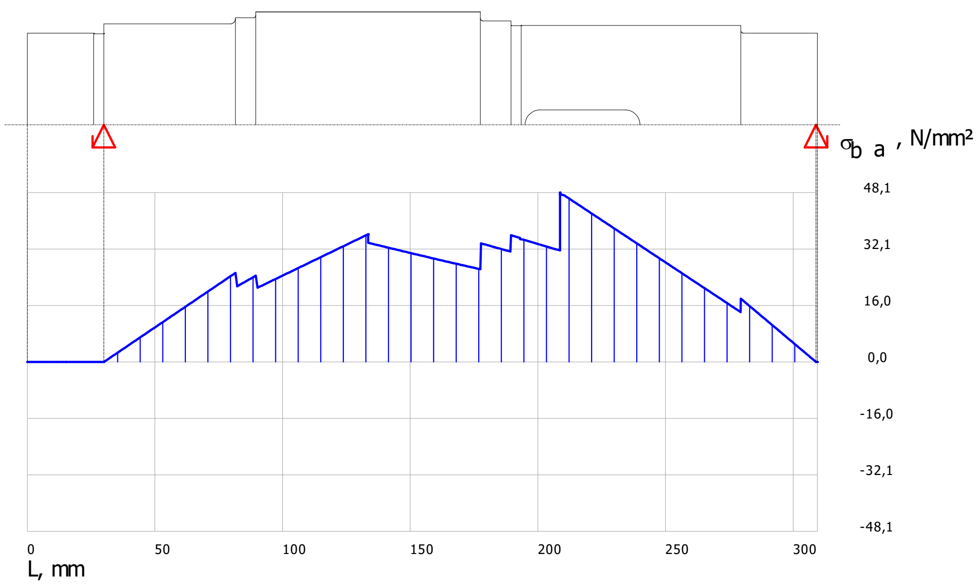


## Shaft, Standard

Amplitude value of the tension-pressure stress (combined characteristic)

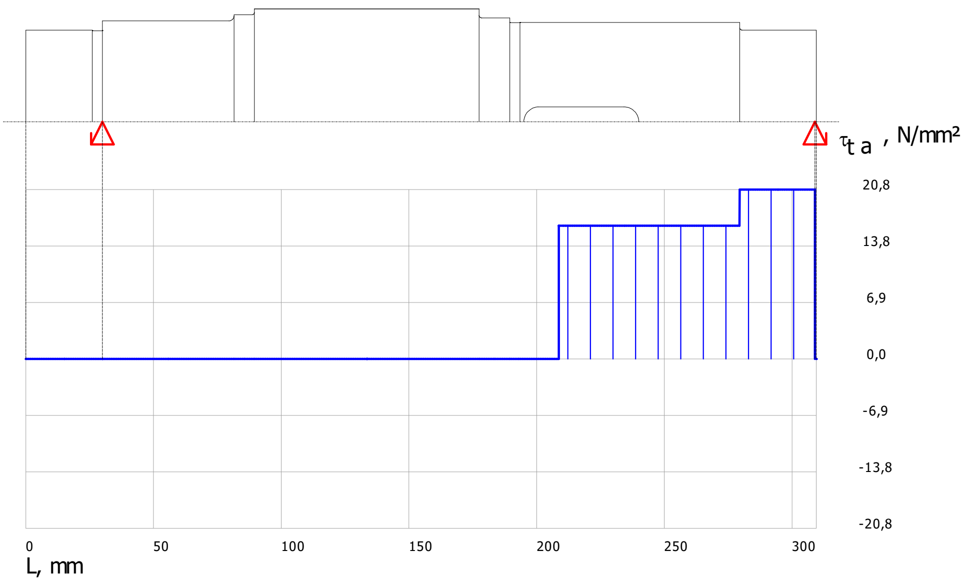



Amplitude value of the bending stress (combined characteristic)

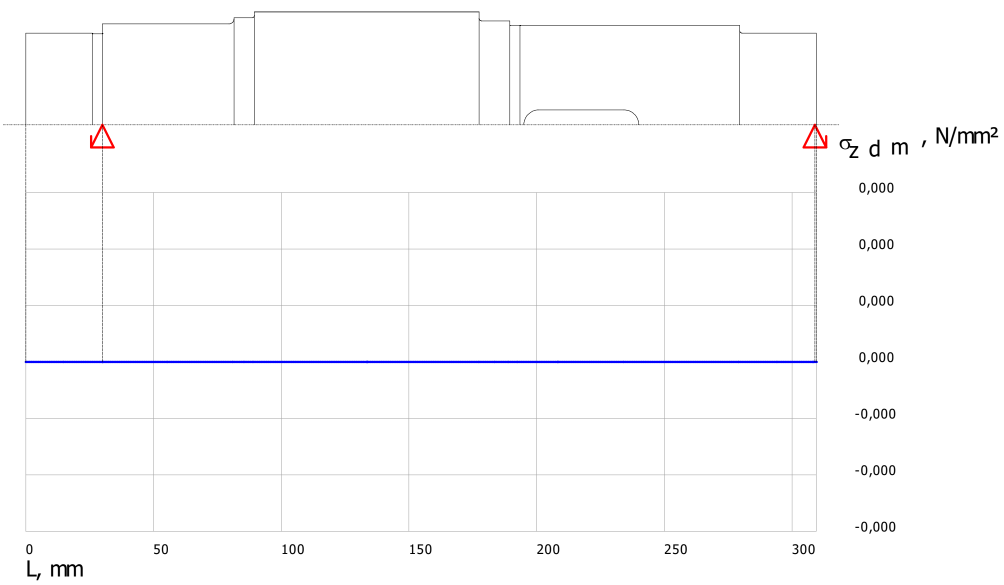


## Shaft, Standard

Amplitude value of the torsional stress (combined characteristic)




Mean value of the tension-pressure stress (combined characteristic)



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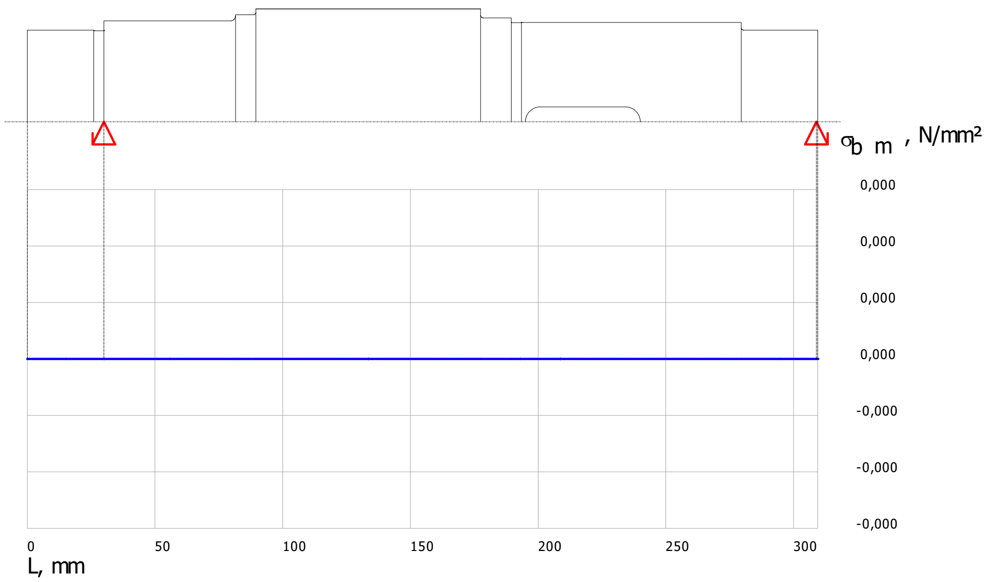
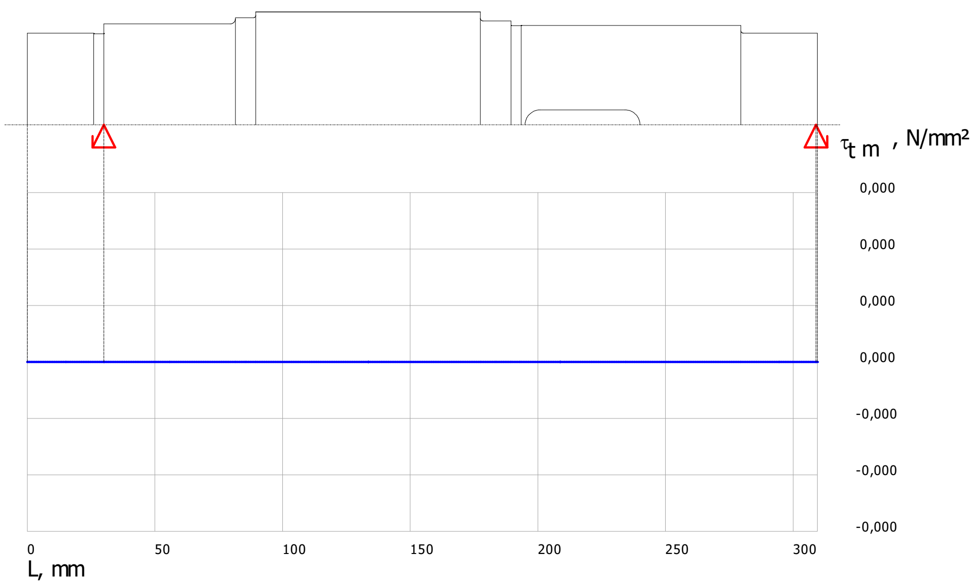
## Shaft, Standard

Mean value of the bending stress (combined characteristic)

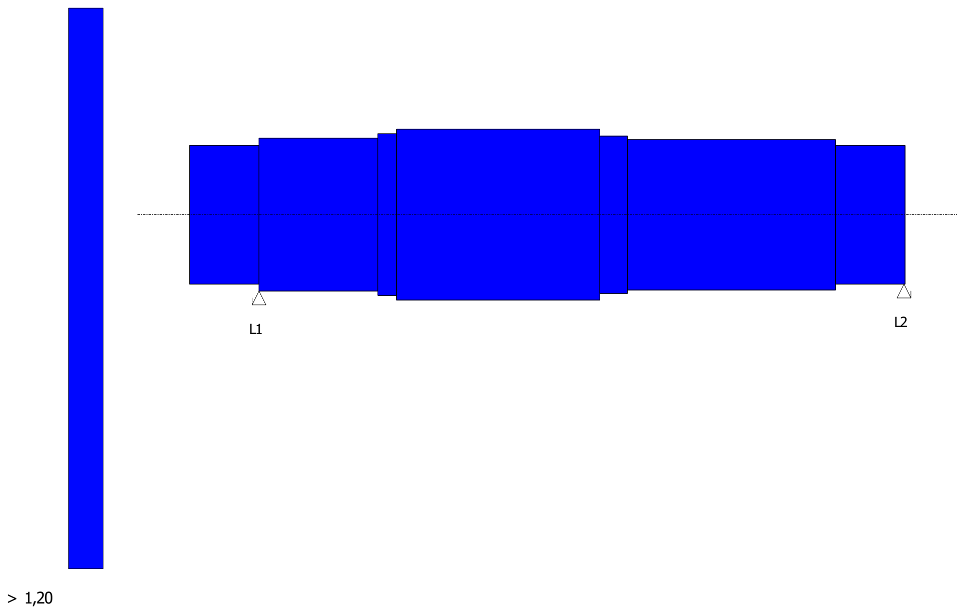



Mean value of the torsional stress (combined characteristic)

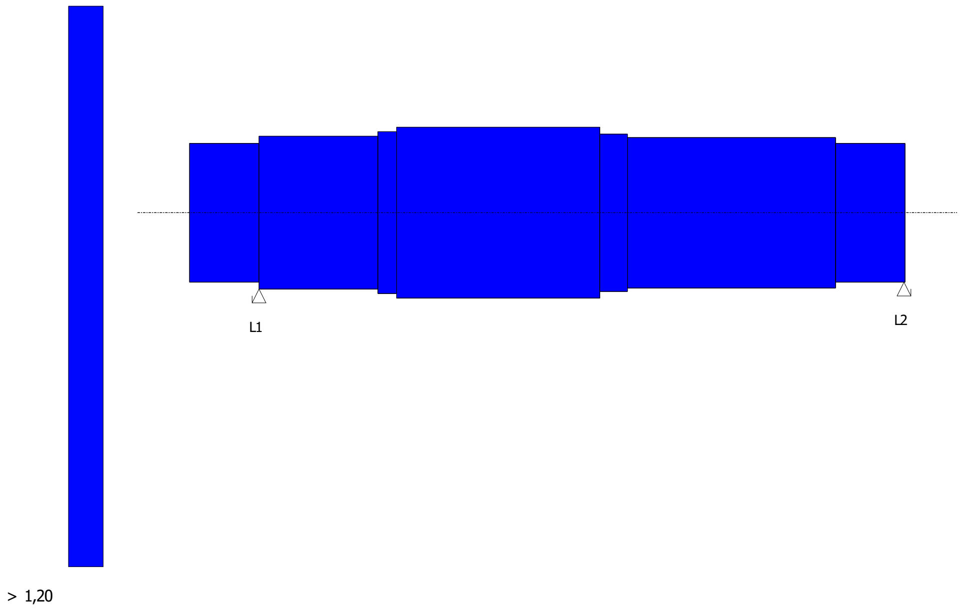


## Shaft, Standard

Safety factor against yielding




Safety against fatigue fracture



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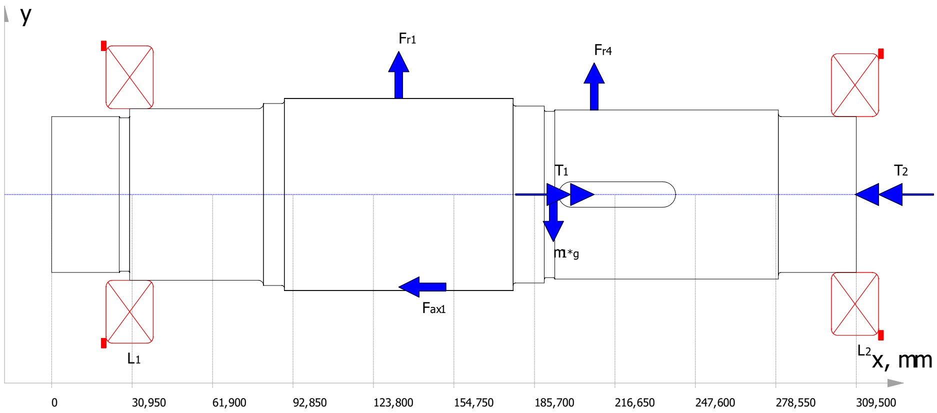
## Shaft, Standard

Calculation graphic Y-X-plane




Calculation graphic Z-X-plane