

KISSsoft evaluation

File

Name : Bolts (VDI 2230, Example 1)
 Description: KISSsoft example
 Changed by: kspl on: 07.03.2016 at: 10:57:00

Bolt calculation according to VDI 2230:2014

INPUTS:

Configuration: Bolted connection under axial load (single bolt)
 Calculation using assembly temperature

| | | |
|---|--------------------|----------|
| Assembly temperature (°C) | [TM] | 20.00 |
| Thread standard | Standard thread | |
| Label | M12 | |
| Pitch (mm) | [P] | 1.75 |
| Flank angle (°) | [β] | 60.00 |
| Reference diameter (mm) | [d] | 12.00 |
| Flank diameter (mm) | [d2] | 10.86 |
| Core diameter (mm) | [d3] | 9.85 |
| Nominal cross section of thread (mm ²) | [AN] | 113.10 |
| Core cross section of the thread (mm ²) | [Ad3] | 76.25 |
| Thread manufacturing | Final heat treated | |
| Surface roughness (µm) | [Rz] | 16.00 |
| Axial force (N) | [FA] | 24900.00 |
| Required clamping force: | | |
| For shearing force transmission (N) | [FKQ] | 1000.00 |
| For sealing (N) | [FKP] | 0.00 |
| Tightening technique: Own Input | | |
| Tightening factor | [αA] | 1.80 |
| Minim. tightening factor (scattering coef. of friction) | [αmin] | 1.00 |
| Load application factor | [n] | 0.35 |
| Bolting type: SV 4 | | |
| Length of connected solid (mm) | [IA] | 0.00 |
| Distance of connected solid (mm) | [ak] | 3.89 |

| | | |
|---|----------|------------------|
| Force application height (mm) | [Ik] | 14.53<...< 42.00 |
| (A more precise estimation can be executed according to VDI 2230, Image 5.2/5.) | | |
| Coef. of friction in thread | [μG] | 0.100/ 0.100 |
| Coef. of friction at head support | [μK] | 0.100/ 0.100 |
| Coef. of friction at nut support | [μM] | 0.100/ 0.100 |
| Bolt type: Cylindrical screw with socket head bolt DIN EN ISO 4762:2004 | | |
| Reference diameter (mm) | [d] | 12.00 |
| Bolt length (mm) | [l] | 60.00 |
| Shank diameter (mm) | [d1] | 12.00 |
| Shank length (mm) | [l1] | 24.00 |
| Thread length (mm) | [b] | 36.00 |
| Outer diameter of head support (mm) | [dw] | 17.23 |
| Inner diameter of head support (mm) | [da] | 13.70 |
| Surface roughness (tip support) (μm) | [Rz] | 16.00 |
| | | |
| Stressed cross section of screw (mm ²) | [As] | 84.27 |
| Height of bolt head (mm) | [k] | 12.00 |
| Diameter of screw head (mm) | [dk] | 18.00 |
| Free thread length (mm) | [l3] | 18.00 |
| Width across flats (mm) | [s] | 10.00 |
| Reduction coefficient | [kT] | 0.50 |
| | | |
| Strength class | | 10.9 |
| Tensile strength (N/mm ²) | [Rm] | 1040.00 |
| Yield point (N/mm ²) | [Rp0.2] | 940.00 |
| Maximum yield point (N/mm ²) | [Rp,max] | 940.00 |
| Young's modulus screw (N/mm ²) | [ES] | 205000.00 |
| | | |
| Clamped parts: Cylinder | | |
| Outside diameter of bush (mm) | [DA] | 80.00 |
| Outer diameter of the support effect (mm) | [DA'] | 80.00 |
| Number of parts | [iP] | 1 |
| | | |
| Part | A | |
| Material | | 16 MnCr 5 (1) |
| Depth of Layer (mm) | [hi] | 42.00 |
| Young's modulus (N/mm ²) | [Ep] | 206000.00 |
| Permissible surface pressure (N/mm ²) | [pG] | 1300.00 |
| Surface roughness (μm) | [Rz] | 16.00 |
| | | |
| Through thread | | |
| Clamping length (mm) | [Ik] | 42.00 |

| | | |
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| Through hole standard | ISO 273:1979 (DIN 273) medium | |
| Diameter through hole (mm) | [dh] | 13.50 |
| Chamfer at head (mm) | [cK] | 0.00 |
| Chamfer at nut (mm) | [cM] | 0.00 |

No washer below screw head

| | | |
|-------------------------------------|---------------------|--------|
| Nut standard | Own Input | |
| Inner diameter nut support (mm) | [d1] | 12.00 |
| Outer diameter nut support (mm) | [d2] | 25.00 |
| Thickness of nut (mm) | [m] | 18.00 |
| Surface roughness (μm) | [Rz] | 16.00 |
| Material | C45 (1) | |
| Shearing strength | [τBM] | 460.00 |
| No washer below nut | | |

RESULTS:

Virtual outer diameter of base body:

| | | |
|---|-------------------------|---------------|
| Diameter (mm) | [DA'] | 80.00 |
| Diameter (mm) | [DA] | 80.00 |
| Diameter limit (mm) | [DA.Gr] | 44.87 |
| Cone angle ($^{\circ}$) | [φ] | 29.49 |
| Resilience of flange (mm/N) | [δP] | 3.410909e-007 |
| Addition for plate resilience (mm/N) | [δPzu] | 1.699713e-007 |
| Resilience of screw (mm/N) | [δS] | 2.947595e-006 |
| Load factor for centric load introduction | [φn] | 0.0538 |
| Amount of embedding (mm) | [fz] | 0.0080 |
| Preload loss (N) | [Fz] | 2432.58 |
| required assembly preload: | | |
| -minimum (N) | [FMmin] | 26994.12 |
| -maximum (N) | [FMmax] | 48589.41 |
| Pretension force according table (N) | [FMtab] | 65000.00 |
| Screw force at yield point (N) | [FM0.2] | 79000.00 |
| attained assembly preload: | | |
| -maximum (N) | [FM] | 64904.29 |
| (utilization of yield strength (%)) | [%Re] | 90.00 |
| Pretension force (N) | [FV] | 62471.71 |
| Additional bolt load (N) | [FSA] | 1338.47 |
| Additional plate load (N) | [FPA] | 23561.53 |
| Fatigue load (N/mm ²) | [σa] | 7.94 |
| Fatigue life (N/mm ²) | [σAzul] | 48.88 |
| Number of load cycles | [NZ] | >= 2000000 |

| | | |
|-------------------------------|---------|---------|
| Screw extension at FMmin (mm) | [fSmin] | 0.07957 |
| at FMmax (mm) | [fSmax] | 0.14322 |
| at FM (mm) | [fS] | 0.19131 |
| Part extension at FMmin (mm) | [fTmin] | 0.00921 |
| at FMmax (mm) | [fTmax] | 0.01657 |
| at FM (mm) | [fT] | 0.02214 |

Length of engagement, stripping force

Calculate the required nut height as specified in VDI 2230 (2014)
(also applies to the required length of engagement for a blind hole)

| | | |
|--|------------|-----------|
| Length of engagement (mm) | [m] | 18.00 |
| Effective length of engagement (mm) | [meff] | 14.50 |
| Coefficient C1 | [C1] | 0.900 |
| Coefficient C2 | [C2] | 0.897 |
| Coefficient C3 | [C3] | 0.910 |
| Bolt minimum flank diameter (mm) | [d2min] | 10.863 |
| Maximum core diameter internal thread (mm) | [D1max] | 10.106 |
| Bolt shear surface (mm ²) | [ASGS] | 345.27 |
| Tensile strength of bolt (N/mm ²) | [Rm] | 1040.00 |
| Bolt tensile strength coefficient (N/mm ²) | [Rmmax/Rm] | 1.20 |
| Bolt maximum tensile strength (N/mm ²) | [Rmmax] | 1248.00 |
| Bolt shearing strength | [τBS/Rm] | 0.62 |
| Shearing strength Screw (N/mm ²) | [τBS] | 644.80 |
| Minor diameter inner thread (mm) | [D1] | 10.106 |
| Flank diameter inner thread (mm) | [D2] | 10.863 |
| Minimum external diameter, bolt (mm) | [dmin] | 12.000 |
| Maximum flank diameter, inner thread (mm) | [D2max] | 10.863 |
| Internal thread shear surface (mm ²) | [ASGM] | 478.33 |
| Internal thread shearing strength (N/mm ²) | [τBM] | 460.00 |
| Strength ratio | [RS] | 0.93 |
| Stripping force, bolt thread (N) | [FmGS] | 179787.47 |
| Stripping force, internal thread (N) | [FmGM] | 180252.20 |
| Bolt breaking force (N) | [FmS] | 87637.17 |
| Safety against stripping force to breaking force | [SAE] | 2.05 |
| Minimum length of engagement Rm (mm) | [meffmin] | 12.80 |
| Minimum length of engagement Rmmax (mm) | [meffmax] | 14.20 |

The internal thread is critical against stripping.

| | | |
|---------------------------------|------|-----------|
| (Mounting pretension force (N)) | [FM] | 64904.29) |
|---------------------------------|------|-----------|

Required safety against pretension force [SFM] 2.77

Calculation with maximum attained pretension force:

| | | |
|---|----------|----------|
| (utilization of yield strength (%)) | [%Re] | 90.00 |
| Mounting-Pretension force (N) | [FM] | 64904.29 |
| Pretension force (N) | [FV] | 62471.71 |
| Additional clamping force (reserve) (N) | [FKres] | 9063.82 |
| Equivalent stress (N/mm ²) | [σred.M] | 846.00 |
| Equivalent stress (N/mm ²) | [σred.B] | 820.00 |
| Tightening torque (Nm) | [MA] | 109.32 |
| Loose torque (Nm) | [ML] | 69.96 |
| Tightening torque (nut) (Nm) | [MAM] | 121.61 |
| Surface pressure | | |
| (below screw head) (N/mm ²) | [pK] | 772.49 |
| (below nut) (N/mm ²) | [pM] | 190.50 |

Calculation with the minimum required assembly preload, tightening factor:

1.00

| | | |
|---|----------------|----------|
| Mounting-Pretension force (N) | [FMmin] | 26994.12 |
| Equivalent stress (N/mm ²) | [σred.M_FMmin] | 351.86 |
| Equivalent stress (N/mm ²) | [σred.B_FMmin] | 349.95 |
| Tightening torque (Nm) | [MA_FMmin] | 45.47 |
| Loose torque (Nm) | [ML_FMmin] | 27.51 |
| Tightening torque (nut) (Nm) | [MAM_FMmin] | 50.58 |
| Surface pressure | | |
| (below screw head) (N/mm ²) | [pK_FMmin] | 330.40 |
| (below nut) (N/mm ²) | [pM_FMmin] | 81.48 |

Calculation with the maximum required assembly preload with tightening factor:

1.80

| | | |
|--|----------------|----------|
| Mounting-Pretension force (N) | [FMmax] | 48589.41 |
| Additional clamping force (reserve) (N) | [FKres] | 9063.82 |
| Equivalent stress (N/mm ²) | [σred.M_FMmax] | 633.34 |
| Equivalent stress (N/mm ²) | [σred.B_FMmax] | 617.71 |
| Tightening torque (Nm) | [MA_FMmax] | 81.84 |
| Loose torque (Nm) | [ML_FMmax] | 51.69 |
| Tightening torque (nut) (Nm) | [MAM_FMmax] | 91.04 |
| Surface pressure | | |
| (below screw head) (N/mm ²) | [pK_FMmax] | 582.24 |
| (below nut) (N/mm ²) | [pM_FMmax] | 143.58 |
| Remaining clamping force (N) | [FKR] | 1000.00 |
| Permissible equivalent stress (N/mm ²) | [σ.Mzul] | 846.00 |
| Permissible equivalent stress (N/mm ²) | [σ.Bzul] | 940.00 |
| Support area | | |
| (below screw head) (mm ²) | [ApK] | 85.75 |
| (below nut) (mm ²) | [ApM] | 347.74 |

| | | |
|---|---------|------|
| Permissible surface pressure (below screw head) (N/mm ²) | [pKzul] | 1300 |
| (below nut) (N/mm ²) | [pMzul] | 1300 |

SUMMARY:

It is not permitted to exceed the yield point.

Calculation with the maximum required assembly preload with tightening factor: 1.80

| | | |
|----------------------------|------|------|
| Safety against yield point | [SF] | 1.52 |
| Safety against fatigue | [SD] | 6.15 |
| Safety against pressure | [SP] | 2.23 |

Calculation with maximum attained pretension force:

| | | |
|----------------------------|------|------|
| Safety against yield point | [SF] | 1.15 |
| Safety against fatigue | [SD] | 6.15 |
| Safety against pressure | [SP] | 1.68 |

Calculation with minimum attained pretension force:

| | | |
|------------------------|------|-------|
| Safety against sliding | [SG] | 10.06 |
|------------------------|------|-------|

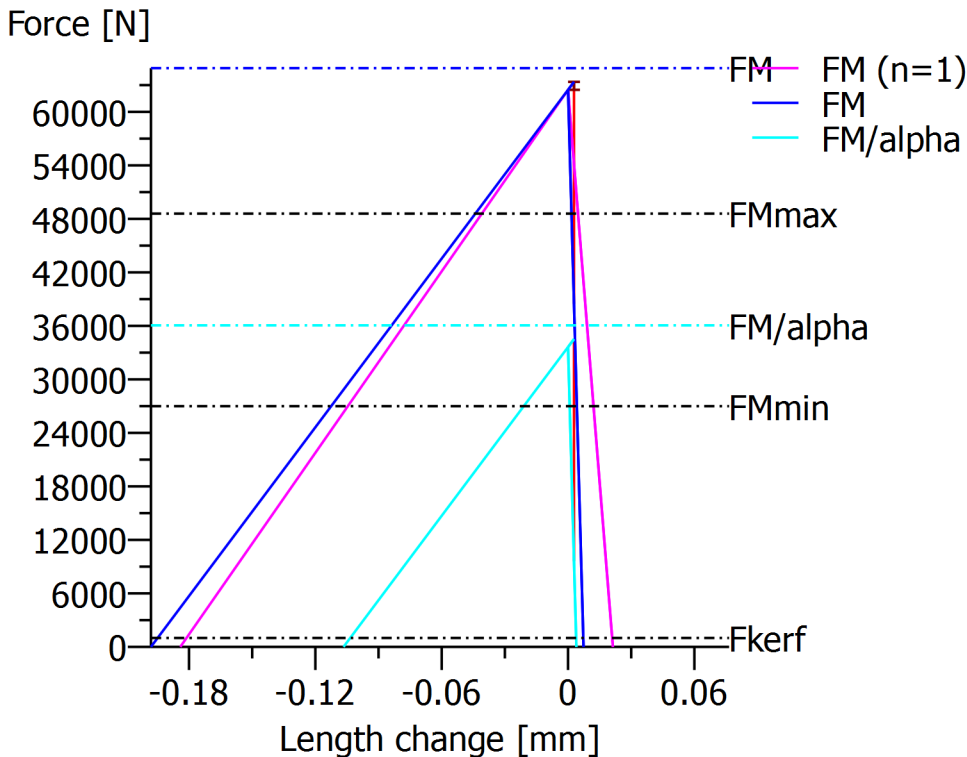


Figure: Display of restraint-diagram

Remarks:

-The safeties (SF, SD, SP) are calculated according to VDI2230.

- Calculating safeties with the maximal assembly preload (FMmax).
- Safety against sliding [SG = FKR/FKerf] is calculated with:
FKR: with FM / αA , FKerf = FKQ + FKP
- The calculation of the normal values for 90% usage (Preload and tightening torque) follows the corresponding equation according VDI 2230. These values correspond with the values in the tables in the VDI Standard. Small differences may however occur..
- The calculation of the length of engagement is theoretical (in accordance with VDI 2230) and must be checked in real life conditions.
- Note: The minimum length of engagement meffmax is calculated with Rmmax, dmin and D2max or d2min and D1max and is intended to represent the worst case scenario..
- Total required clamp load according to (R2/4): FKerf \geq Maxi(FKA + FKP, FKQ)

End of Report
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lines: