Part 11 - FEM-Calculation of a Pedal Crank and a Bottom Bracket Shaft

Request further Informations or Demo-Versionen:

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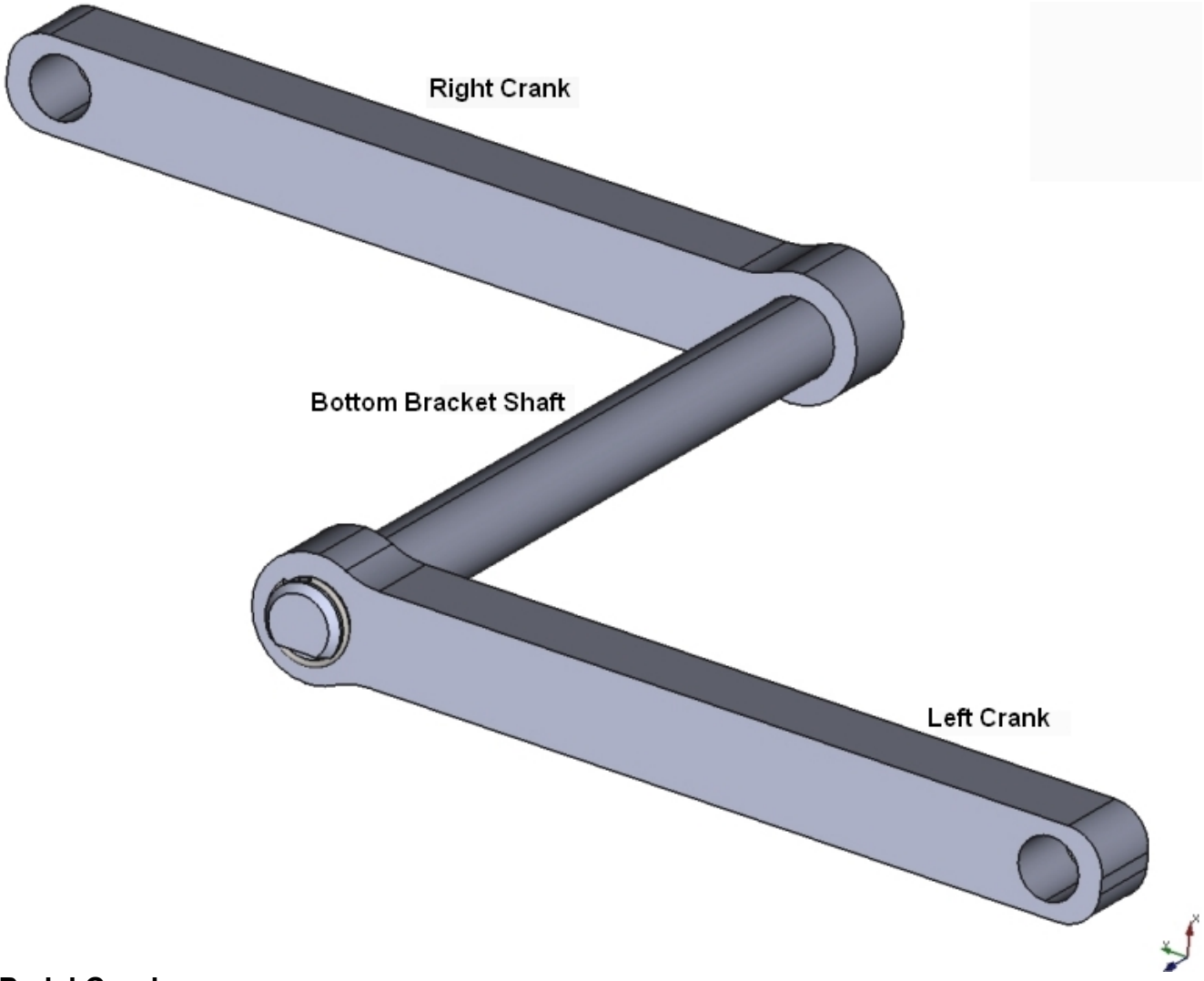
1. FEM Calculation of a Pedal Crank

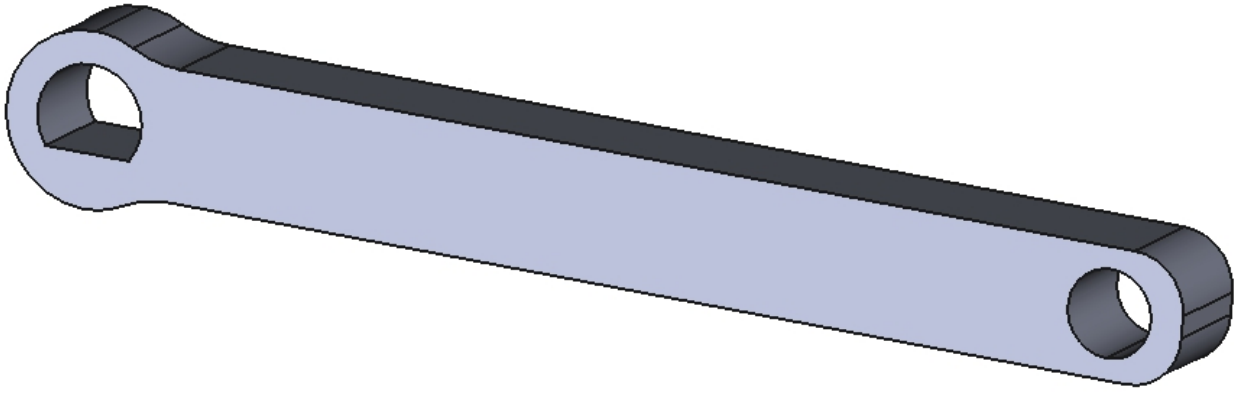
1.1 CAD Model

A CAD assembly in STEP format served as a template for generating the FEM mesh.

CAD Assembly

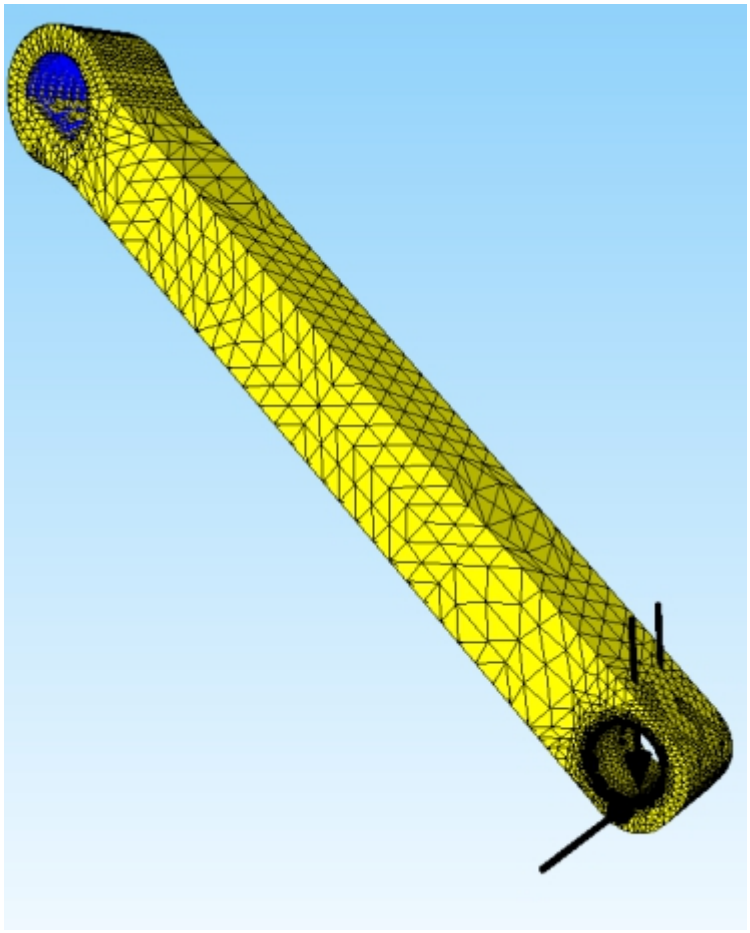


Pedal Crank



1.2 FEM Model

The 3D mesh generator of the FEM System MEANS V12 generated an FEM model with 108 384 tetrahedra elements and 171 675 nodes.



1.3 Material

The material AL7075 made of Aluminum with the following material datas was selected:

Modulus of Elasticity = 71,000 N/mm²
Poisson's Ratio = 0.34
Tensile Strength Rm = 540 N/mm²
Yield Strength = 580 N/mm²

1.4 Boundary Conditions

Since the two pedal cranks were firmly connected to the bottom bracket shaft, the crank was clamped fixed in the upper bore.

1.5 Pedal Forces

For the pedal forces, the FEM model first had to be rotated by -45 degrees in the XY plane. The pedal force was taken from the Crank test DIN EN, where a vertical pedal force of -1200 N at an angle to the YZ plane with 7.5 degrees was specified, from which the following force components were calculated:

Fy = -1 200 N * 0.925 = **- 1 110 N**

Fz = 1 200 N * 0.075 = **90 N**

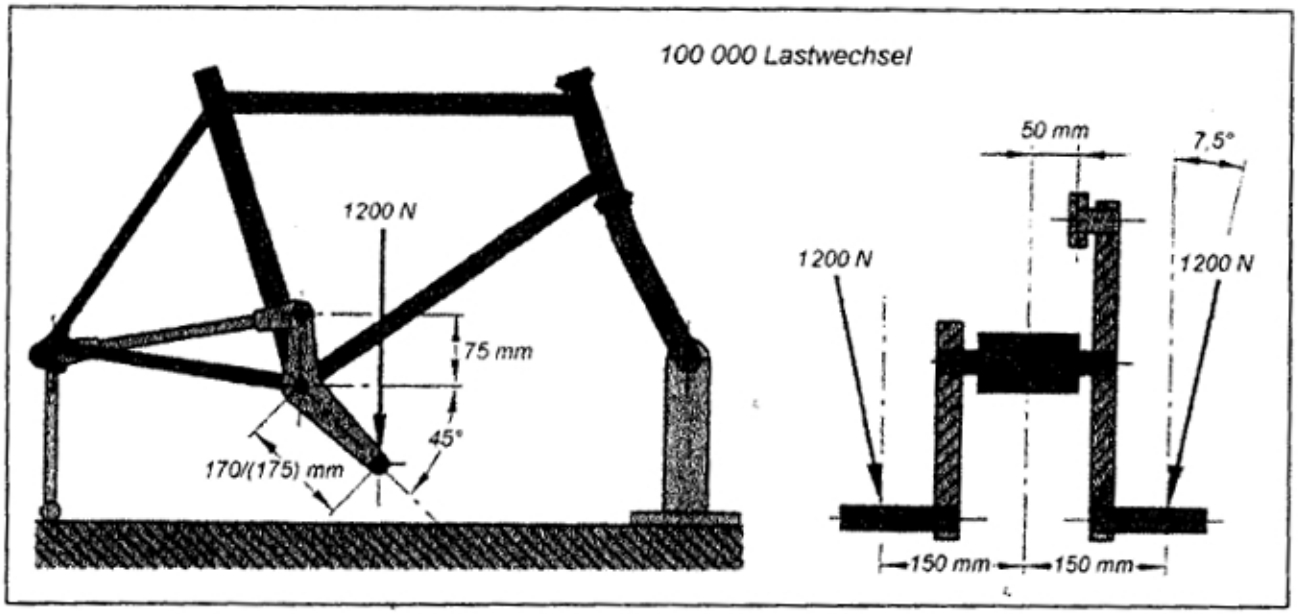
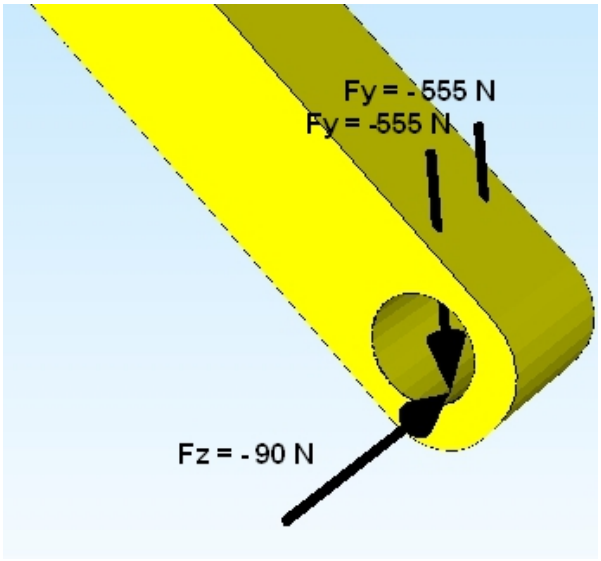


Bild 26: Kurbeltest nach DIN EN.

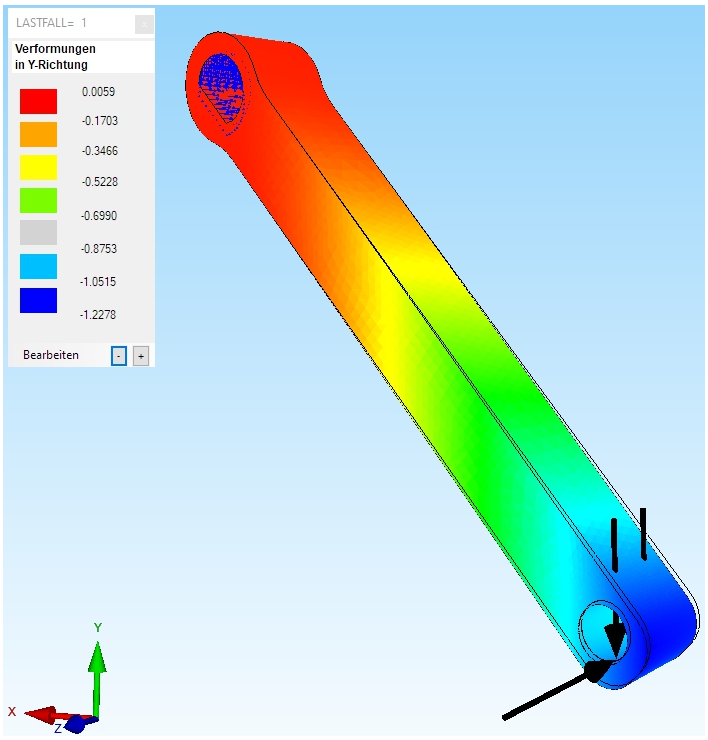
Pedal Forces



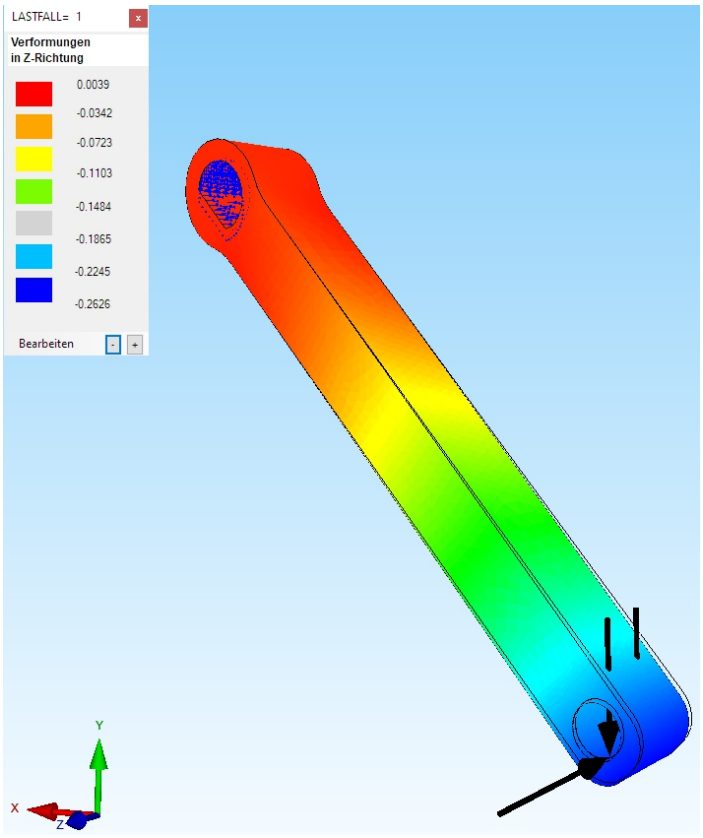
1.6 Results

1.6.1 Displacements

Max. Displacements in Y Direction = -1.22 mm

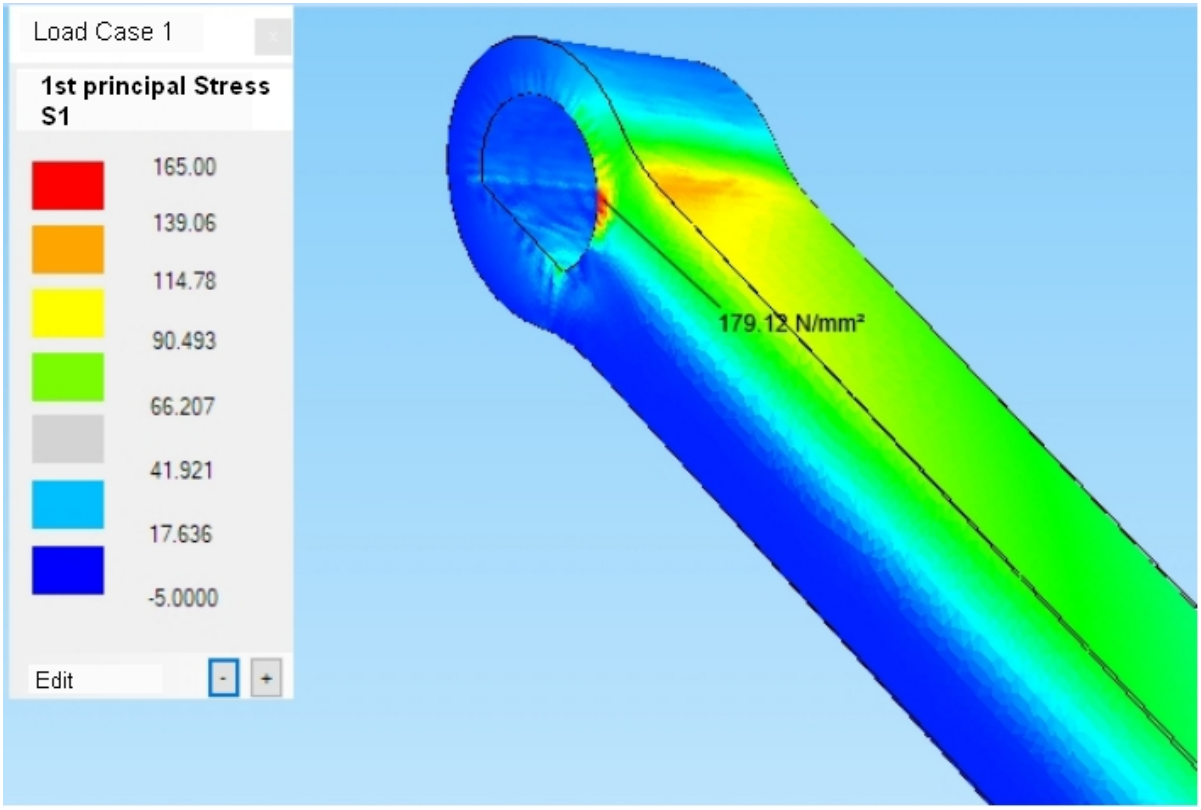


Max. Displacements in Z Directions = -0.26 mm

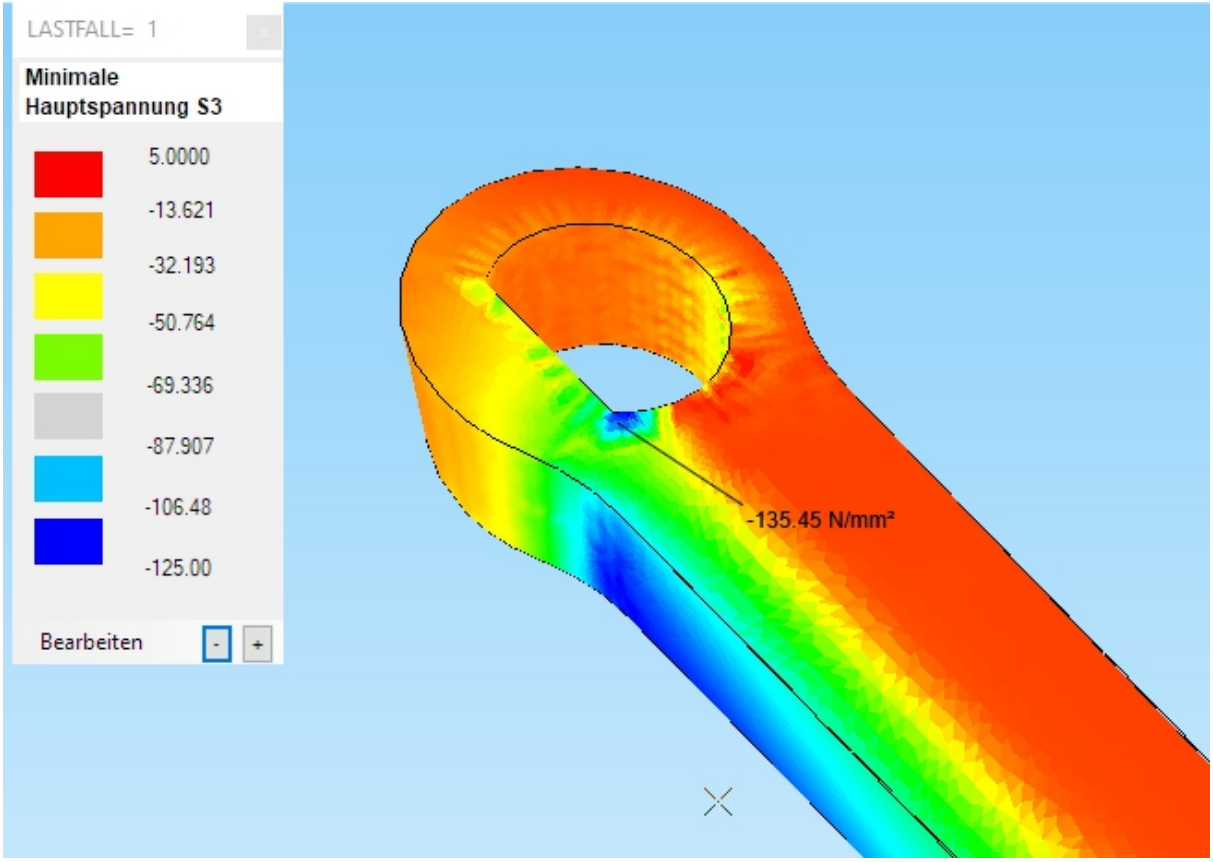


1.6.2 Tensile and Compressive Stresses

The 1st principal Stresses S1 = 179 N/mm²



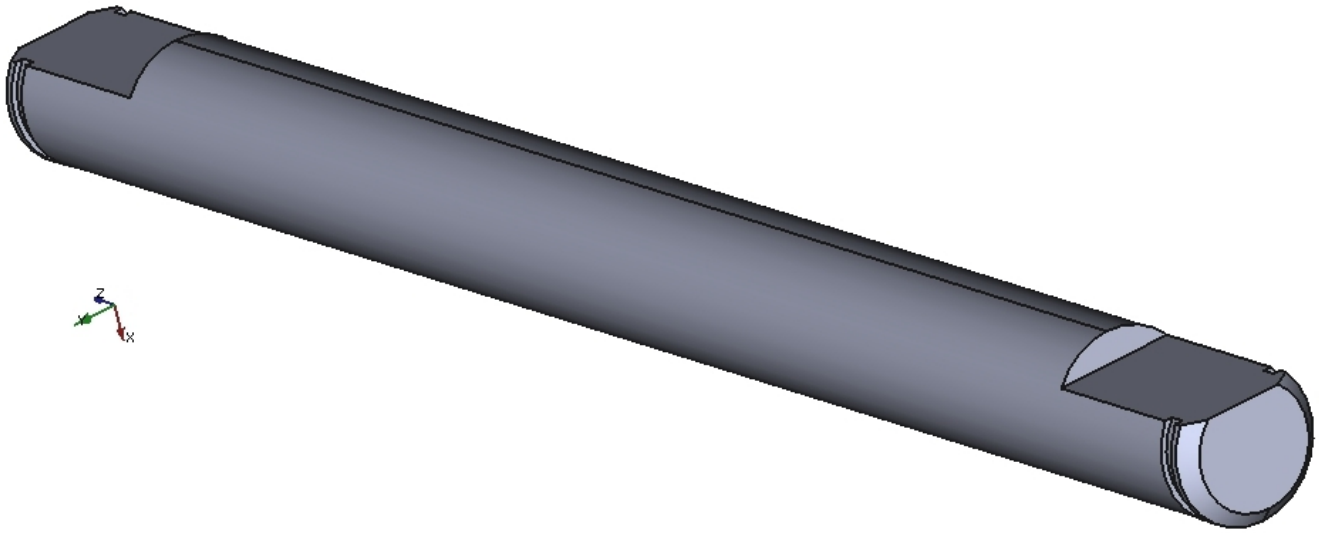
The 3rd principal Stresses S3 = -135 N/mm²



2. FEM Calculation of the Bottom Bracket Shaft

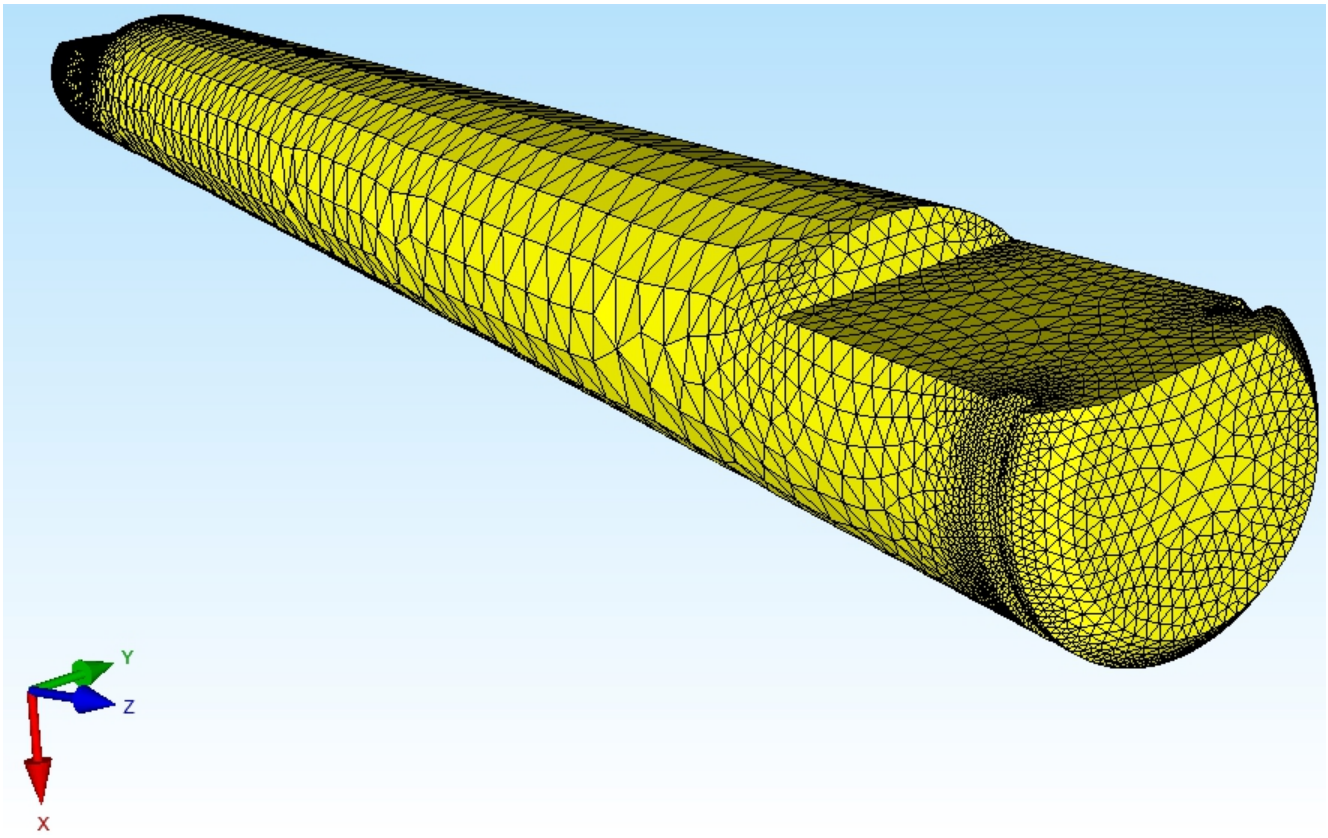
2.1 CAD Model

The bottom bracket shaft was 110 mm long with an outside diameter of 15 mm. A STEP file served as a template for generating the FEM mesh.



2.1 FEM-Modell

The 3D mesh generator of the FEM System MEANS V12 generated an FEM model with 158 921 tetrahedra elements and 31 379 nodes.



2.2 Material

The material AL7075 made of Aluminum with the following material datas was selected:

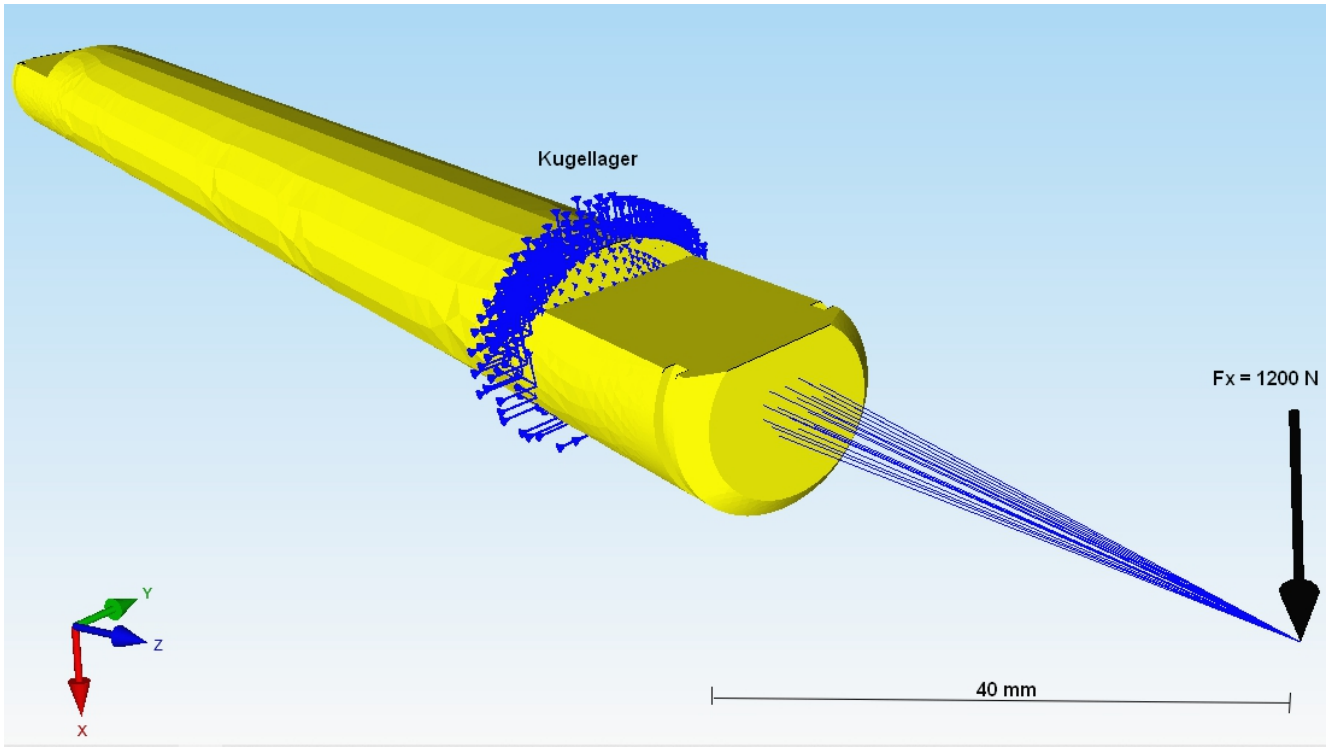
Modulus of Elasticity = 71,000 N / mm²
Poisson's Ratio = 0.34
Tensile Strength Rm = 540 N / mm²
Yield Strength = 580 N / mm²

2.3 Load

The CAD assembly could not be calculated because the crank, shaft and gear could not be combined into one part. However, the FEM system MEANS V12 made it possible to use MPC elements to simulate the lever arm of the bending and torsional moment on the shaft.

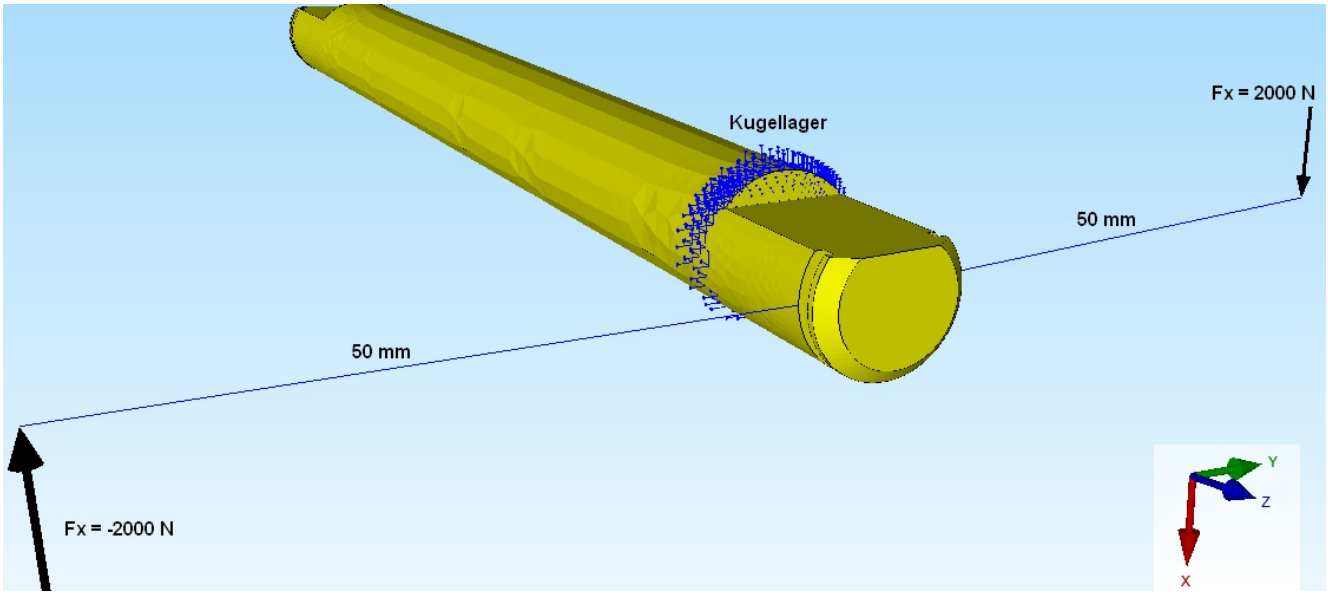
2.1.1 Bending Moment

The bending moment is created by the pedal force of 1200 N and the pedal distance of 40 mm.



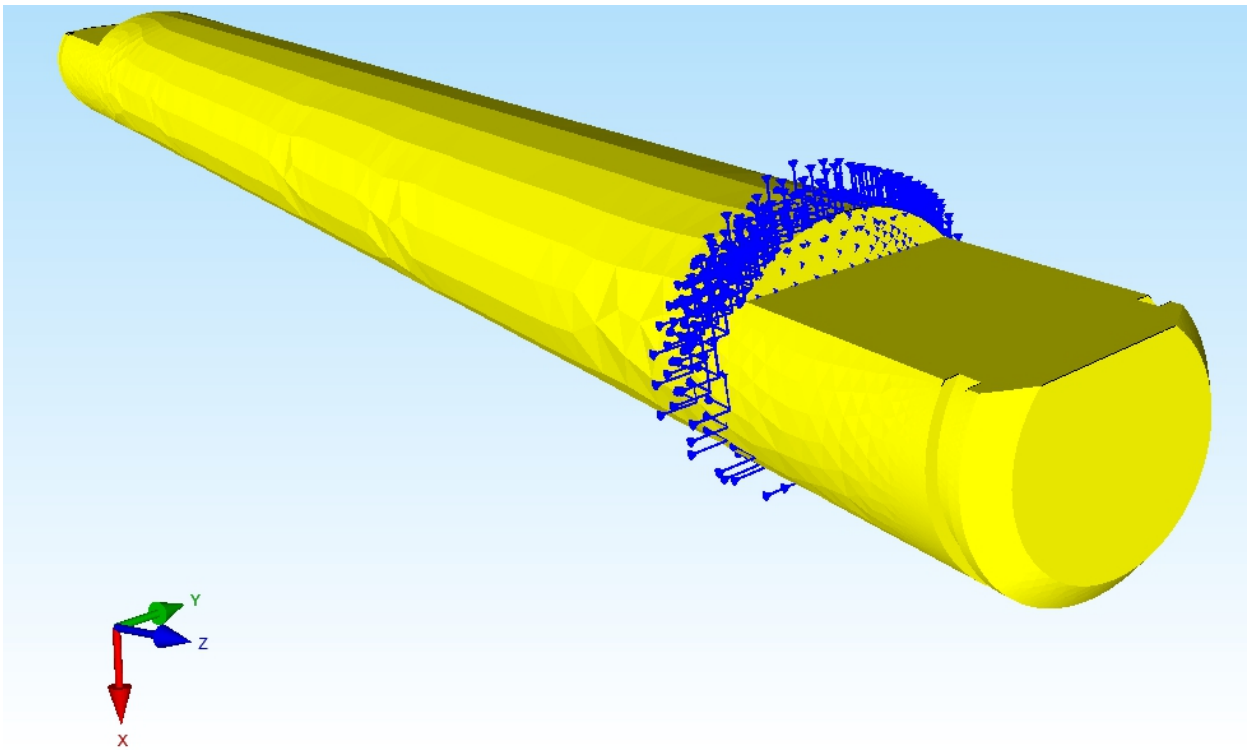
2.1.2 Torsional Moment

The Torsional Moment created by the gear force 2000 N and the gear radius of 50 mm.



2.2 Boundary Conditions

The shaft was firmly clamped at the shaft shoulder because the outer ball bearing was attached there.

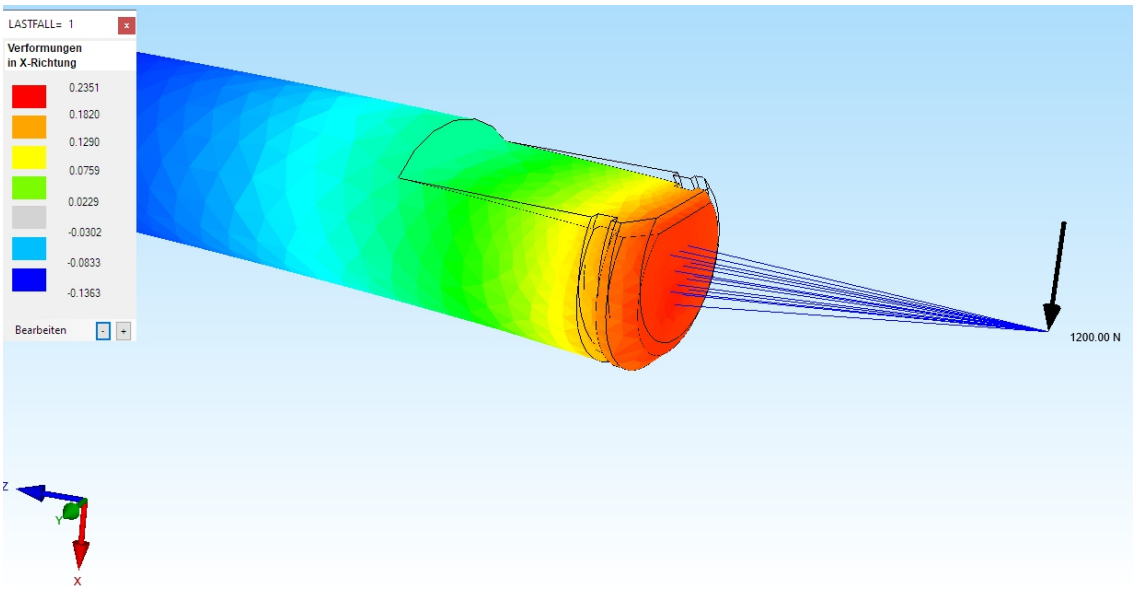


2.3 Results

2.3.1 Displacements

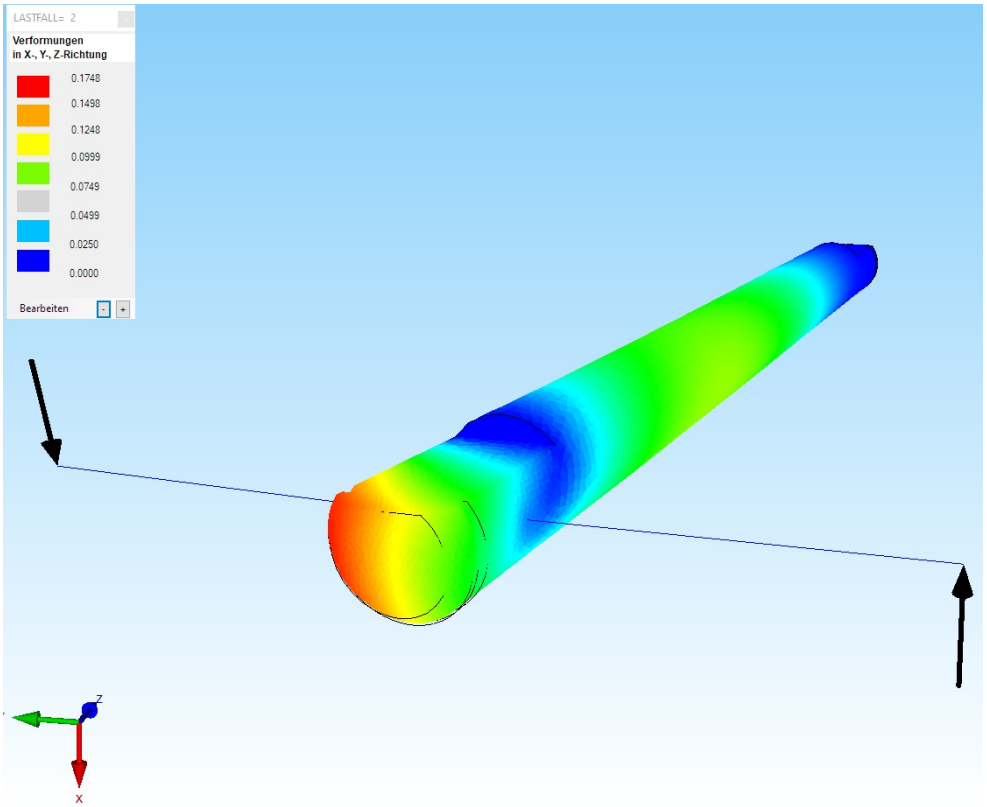
Displacements of the Bending Moment

Max. Displacements in X Direction = 0.235 mm



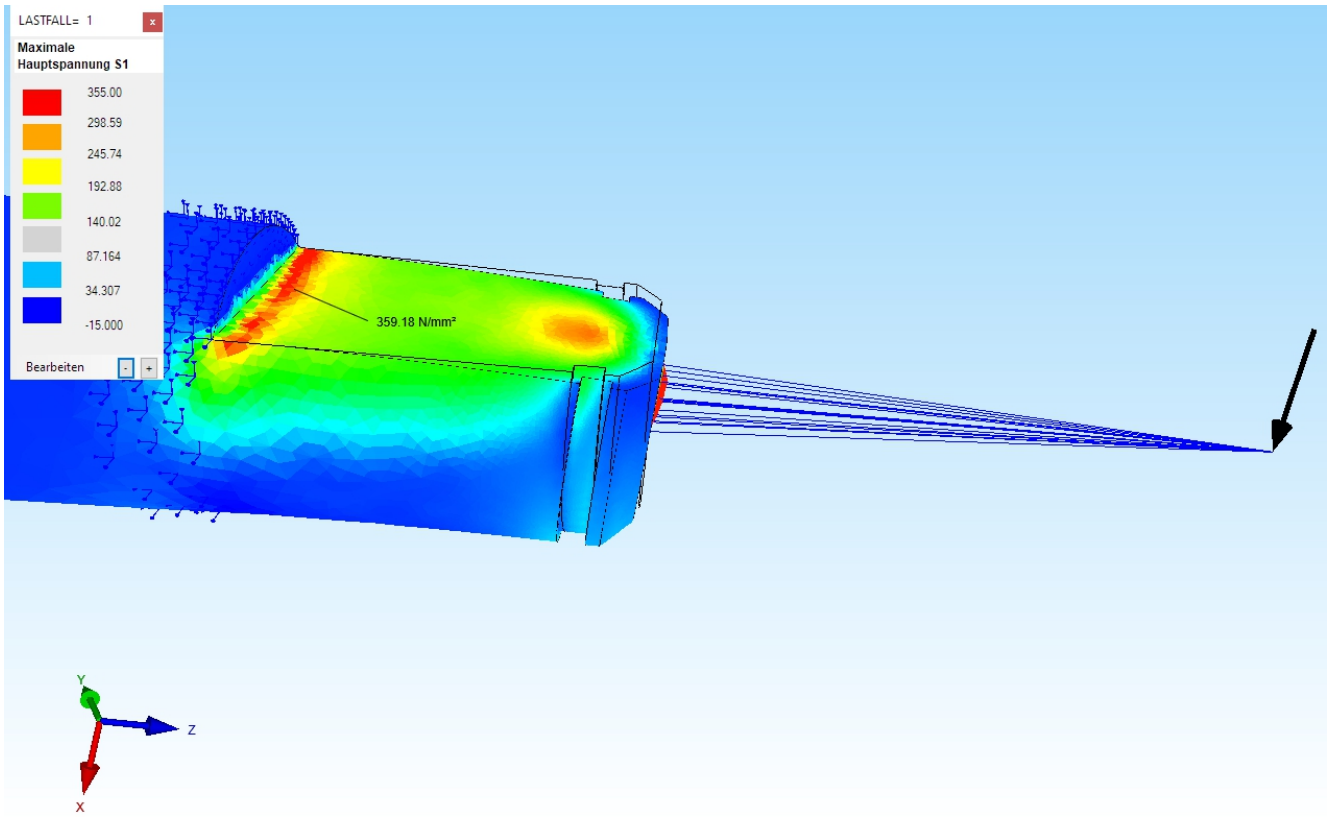
Displacements of the Torsional Moment

Max. Displacements in X Direction = 0.17 mm

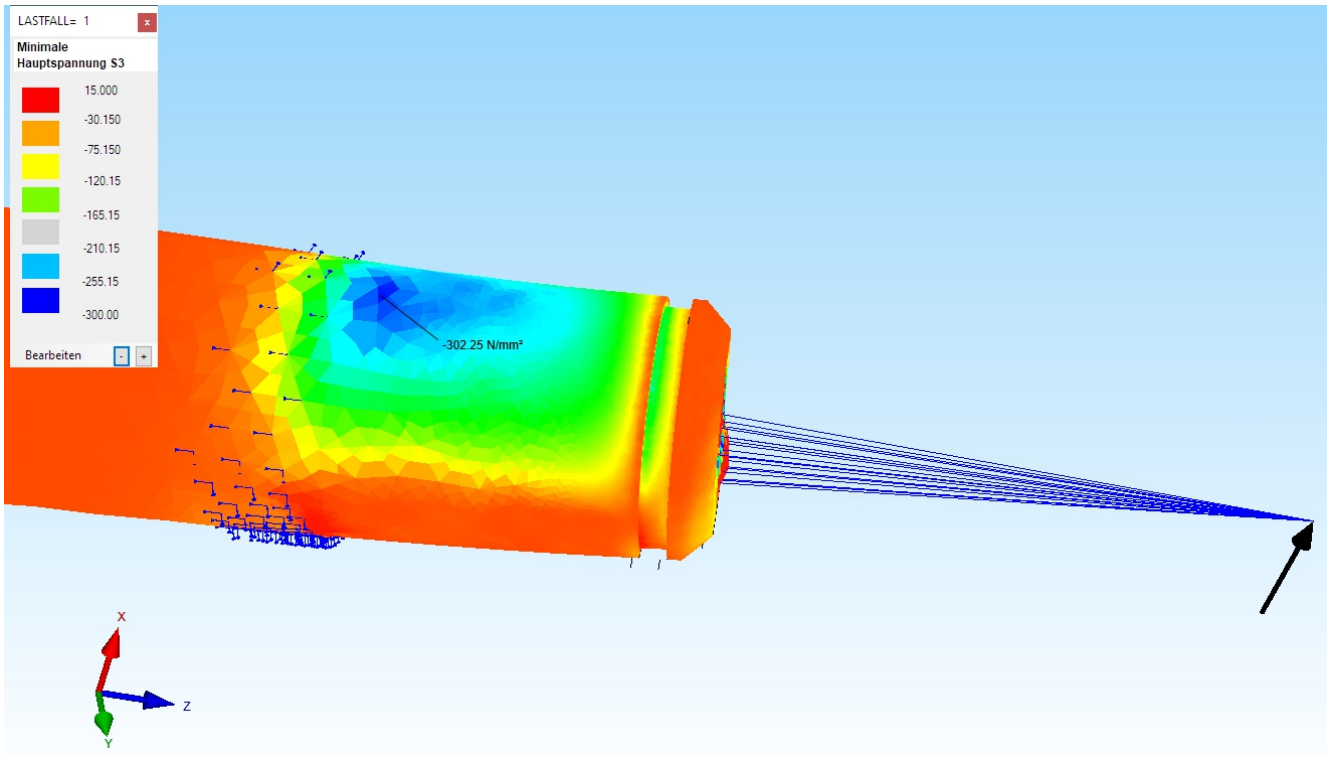


2.3.2 Tensile and Compressive Stresses of the Bending Moment

The 1st principal Stresses S1 = 359 N/mm²

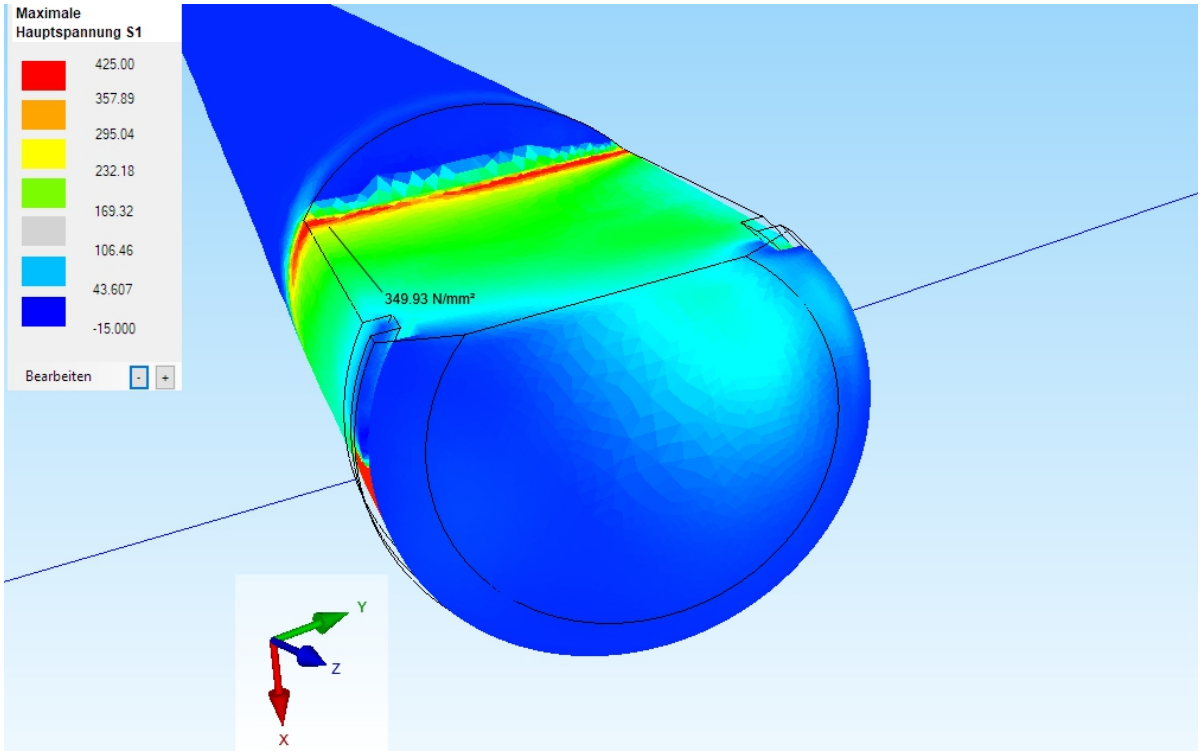


The 3rd principal Stresses S3 = -302 N/mm²



2.3.3 Tensile and Compressive Stresses of the Torsional Moment

The 1st principal Stresses S1 = 349 N/mm²



The 3rd principal Stresses S3 = -378 N/mm²