

## Strength Assessment

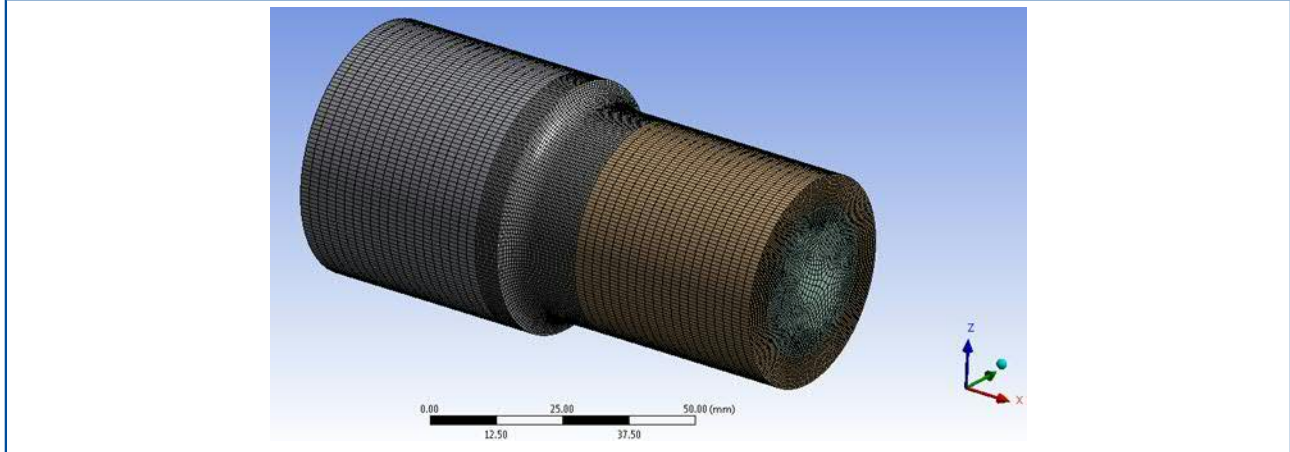
In accordance with "FKM Guideline ANALYTICAL STRENGTH ASSESSMENT OF COMPONENTS" 7th revised Edition, 2020

## Input Values

### General Information

designation	FKM2021 Bsp61
kind of component	base material
Load specification	stress spectrum

### Bild Nachweisgebiet



### Characteristic Service Stresses

stress state	plane stress state oder principal stress state
load acting	proportional
type of overloading	F2 (constant ratio of load-induced stresses)
calculation of the related stress gradient	stress at neighbouring point

### Material

designation	1.7035 (41Cr4)
group	heat treatable steel
anisotropy factor	$K_A$ 1.0
standard value for tensile strength	$R_{m,N}$ 1000.0 MPa
standard value for yield strength	$R_{p,N}$ 800.0 MPa
elongation at break	$A_N$ 11.0 %
effective diameter	$d_{eff}$ 42.0 mm
metal thickness	$t$ 42.0 mm

### S-N curve parameter

	$k_I$	$k_{II}$	$N_{D,I}$	$N_{D,II}$
Normal stress - Typ I	5.0	-	1.0e+06	-
Shear Stress - Typ I	8.0	-	1.0e+06	-

### Influences

temperature in operation	T	20.0°C
operating time	t	1000.0 h

## Structure

coating / surface treatment		none
surface treatment factor	$K_v$	1.0
Factor	$K_{NLE}$	1.0
surface roughness	$R_z$	10.0 $\mu\text{m}$
coating factor	$K_s$	1.0

## Safety Factors

in relation to tensile strength	$j_m$	1.85
in relation to yield stress	$j_p$	1.40
in relation to assessment of the creep strength	$j_{mt}$	1.40
in relation to assessment of the creep limit	$j_{pt}$	1.00
in relation to fatigue strength	$j_F$	1.25
load factor	$j_s$	1.00

## List static condition's

	$\sigma_{xx}$ [MPa]	$\sigma_{yy}$ [MPa]	$\sigma_{zz}$ [MPa]	$\tau_{xy}$ [MPa]	$\tau_{yz}$ [MPa]	$\tau_{xz}$ [MPa]
load case of 1	45.0	247.0	0.0	167.0	0.0	0.0
load case of 2	-45.0	-247.0	0.0	-39.0	0.0	0.0

## List load cycles

### region 1 - Assessment position 1 - Load case combination 0 - stress section 0

$\sigma_{xx}$			$\sigma_{yy}$			$\sigma_{zz}$			$\tau_{xy}$		
$s_m$ [MPa]	$s_a$ [MPa]	N	$s_m$ [MPa]	$s_a$ [MPa]	N	$s_m$ [MPa]	$s_a$ [MPa]	N	$s_m$ [MPa]	$s_a$ [MPa]	N
0.0	45.0	1.0e+20	0.0	247.0	1.0e+20				64.0	103.0	1.0e+20

## Assessment of the static Strength Loadcase 1

### Characteristic Service Stresses - Input

	$\sigma_{xx}$	$\sigma_{yy}$	$\sigma_{zz}$	$\tau_{xy}$	$\tau_{yz}$	$\tau_{xz}$
Characteristic Service Stresses [MPa]	45.0	247.0	0.0	167.0	0.0	0.0

### Characteristic Service Stresses

		$\sigma_1$	$\sigma_2$	$\sigma_3$
principal stress (definition not acc. to FKM) [MPa]	$\sigma_i$	341.2	-0.0	-49.2
tension/compression strength factor	$f_\sigma$	1.0	1.0	1.0
Weighting factor	q	0.000		
degree of multiaxiality	h	0.264		
equivalent stress [MPa]	$\sigma_v$	368.2		

### Properties

standard value for tensile strength [MPa]	$R_{m,N}$	1000.0
standard value for yield strength [MPa]	$R_{p,N}$	800.0
technological size factors	$K_{d,m}$	0.895
	$K_{d,p}$	0.841
	$K_{d,A}$	1.143
anisotropy factor	$K_A$	1.000
component strength values [MPa]	$R_m$	895
	$R_p$	672
elongation at break [%]	A	12.6

### Design Parameters

plastic notch factor (user defined)	$K_p$	1.702
Hardening factor	$f_R$	1.166
critical total strain	$\epsilon_{crit}$	0.1289
section factor, acc. to tolerable strain		6.346
section factor, used	$n_{pl}$	1.985

### Component Strength

component static strength [MPa]	$\sigma_{SK}$	1335
---------------------------------	---------------	------

### Safety Factors

temperature factors	$K_{T,m}$	1.000
	$K_{T,p}$	1.000
	$K_{T,Lm}$	1.000
	$K_{T,Lp}$	1.000
Partial safety factors	$j_G$	1.000
	$\Delta j$	0.000
total safety factor	$j_{ges}$	1.400

### Assessment

maximum degree of utilization	$a_{SK}$	0.386
-------------------------------	----------	-------

The static degree of utilization is 38.6 %

## Assessment of the static Strength Loadcase 2

### Characteristic Service Stresses - Input

Characteristic Service Stresses [MPa]	$\sigma_{xx}$	$\sigma_{yy}$	$\sigma_{zz}$	$\tau_{xy}$	$\tau_{yz}$	$\tau_{xz}$
	-45.0	-247.0	0.0	-39.0	0.0	0.0

### Characteristic Service Stresses

principal stress (definition not acc. to FKM) [MPa]	$\sigma_i$		$\sigma_1$	$\sigma_2$	$\sigma_3$
tension/compression strength factor	$f_\sigma$		1.0	1.0	1.0
Weighting factor	q	0.000			
degree of multiaxiality	h	-0.410			
equivalent stress [MPa]	$\sigma_v$	237.7			

### Properties

standard value for tensile strength [MPa]	$R_{m,N}$	1000.0
standard value for yield strength [MPa]	$R_{p,N}$	800.0
technological size factors	$K_{d,m}$	0.895
	$K_{d,p}$	0.841
	$K_{d,A}$	1.143
anisotropy factor	$K_A$	1.000
component strength values [MPa]	$R_m$	895
	$R_p$	672
elongation at break [%]	A	12.6

### Design Parameters

plastic notch factor (user defined)	$K_p$	1.702
Hardening factor	$f_R$	1.166
critical total strain	$\epsilon_{crit}$	0.1289
section factor, acc. to tolerable strain		6.346
section factor, used	$n_{pl}$	1.985

### Component Strength

component static strength [MPa]	$\sigma_{SK}$	1335
---------------------------------	---------------	------

### Safety Factors

temperature factors	$K_{T,m}$	1.000
	$K_{T,p}$	1.000
	$K_{T,m}$	1.000
	$K_{T,p}$	1.000
Partial safety factors	$j_G$	1.000
	$\Delta j$	0.000
total safety factor	$j_{ges}$	1.400

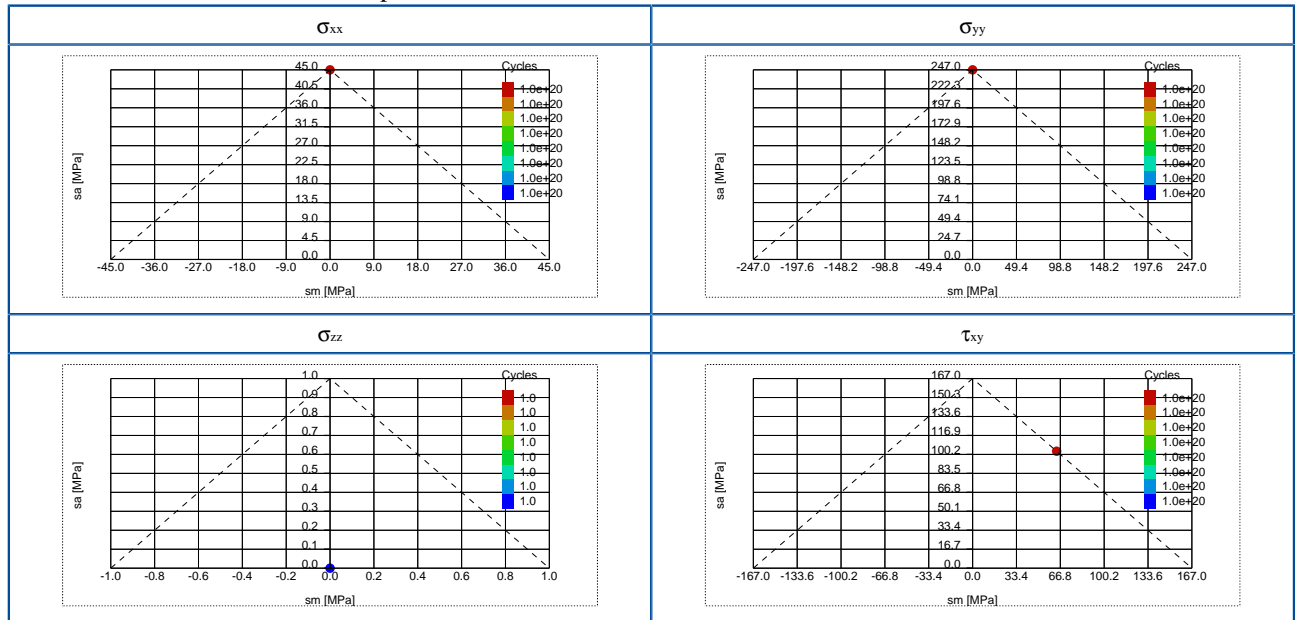
### Assessment

maximum degree of utilization	$a_{SK}$	0.249
-------------------------------	----------	-------

The static degree of utilization is 24.9 %

## Assessment of the fatigue Strength - stress section 0

### Characteristic Service Stresses - Input



	$\sigma_{xx}$	$\sigma_{yy}$	$\sigma_{zz}$	$\tau_{xy}$
<b>Characteristic Service Stresses</b>				
stress at neighbouring point [MPa], $\Delta s = 0.373$ mm	39.0	215.0	-	95.0
related stress gradient [ $\text{mm}^{-1}$ ]	0.357	0.347	-	0.208

### Properties

fatigue limit [MPa]	$\sigma_w$	403	403	403	233
---------------------	------------	-----	-----	-----	-----

### Design Parameters

K <sub>t</sub> -K <sub>f</sub> ratios according to Siebel and Stieler	$n_s$	1.088	1.087	1.000	1.093
statistical K <sub>t</sub> -K <sub>f</sub> ratio	$n_{st}$	1.022			
deformation-mechanical K <sub>t</sub> -K <sub>f</sub> ratio	$n_{vm}$	1.048			
fracture-mechanical K <sub>t</sub> -K <sub>f</sub> ratio	$n_{bm}$	1.000	1.000	1.000	1.000
K <sub>t</sub> -K <sub>f</sub> ratio	$n_\sigma$	1.088	1.087	1.000	1.093
estimate of the fatigue notch factor	$\tilde{K}_f$	2.210	2.190	1.000	2.325
roughness factor	$K_R$	0.857	0.857	0.857	0.917
design factor	$K_{WK}$	0.989	0.990	1.000	0.951

### Component Strength

Calculation method: assessment of the fatigue limit					
Component fatigue limit, completely reversed stress [MPa]	$\sigma_{wK}$	408	407	403	245
mean stress sensitivity	$M_\sigma$	0.213	0.213	0.213	0.123
Maximum stress amplitude at R=-1 [MPa]	$\sigma_{a,w,1}$	45.0	247.0	0.0	110.9
Equivalent amplitude [MPa]	$\sigma_{\text{äqu}}$	45.0	247.0	0.0	110.9

## Safety Factors

temperature factor	$K_{T,D}$	1.000
material safety factor	$j_F$	1.250
casting factor	$j_G$	1.000
total safety factor	$j_D$	1.250

## Assessment

cyclic degree of utilization [MPa]	$a_{BK}$	0.138	0.759	0.000	0.566
Weighting factor	$q$	0.000			
equivalent degree of utilization	$a_{BK,v}$	0.900			

The cyclic degree of utilization is 90.0 %