

Strength Assessment

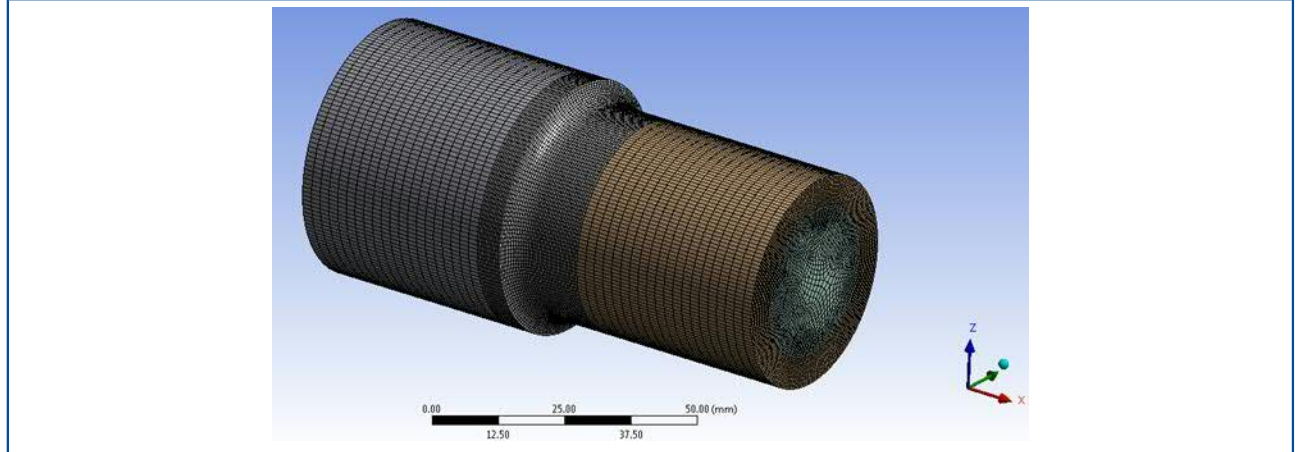
In accordance with "FKM Guideline ANALYTICAL STRENGTH ASSESSMENT OF COMPONENTS" 7th revised Edition, 2020

Input Values

General Information

designation	FKM2021 Bsp61 - FMK2012 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	$K_{NL,E}$	1.0
surface roughness	R_z	10.0 μm
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

	σ_{xx} [MPa]	σ_{yy} [MPa]	σ_{zz} [MPa]	τ_{xy} [MPa]	τ_{yz} [MPa]	τ_{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

σ_{xx}			σ_{yy}			σ_{zz}			τ_{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

	σ_{xx}	σ_{yy}	σ_{zz}	τ_{xy}	τ_{yz}	τ_{xz}
Characteristic Service Stresses [MPa]	45.0	247.0	0.0	167.0	0.0	0.0

Characteristic Service Stresses

		σ_1	σ_2	σ_3
principal stress (definition not acc. to FKM) [MPa]	σ_i	341.2	-0.0	-49.2
tension/compression strength factor	f_σ	1.0	1.0	1.0
Weighting factor	q	0.000		
degree of multiaxiality	h	0.264		
equivalent stress [MPa]	σ_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
	K_A	1.000
anisotropy factor	R_m	895
component strength values [MPa]	R_p	672
	A	12.6
elongation at break [%]		

Design Parameters

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

Component Strength

component static strength [MPa]	σ_{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
	Δj	0.000
	j_{ges}	1.400
total safety factor		

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

	σ_{xx}	σ_{yy}	σ_{zz}	τ_{xy}	τ_{yz}	τ_{xz}
Characteristic Service Stresses [MPa]	-45.0	-247.0	0.0	-39.0	0.0	0.0

Characteristic Service Stresses

		σ_1	σ_2	σ_3
principal stress (definition not acc. to FKM) [MPa]	σ_i	0.0	-37.7	-254.3
tension/compression strength factor	f_σ	1.0	1.0	1.0
Weighting factor	q	0.000		
degree of multiaxiality	h	-0.410		
equivalent stress [MPa]	σ_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
	K_A	1.000
anisotropy factor	R_m	895
component strength values [MPa]	R_p	672
	A	12.6
elongation at break [%]		

Design Parameters

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

Component Strength

component static strength [MPa]	σ_{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
	Δj	0.000
	j_{ges}	1.400
total safety factor		

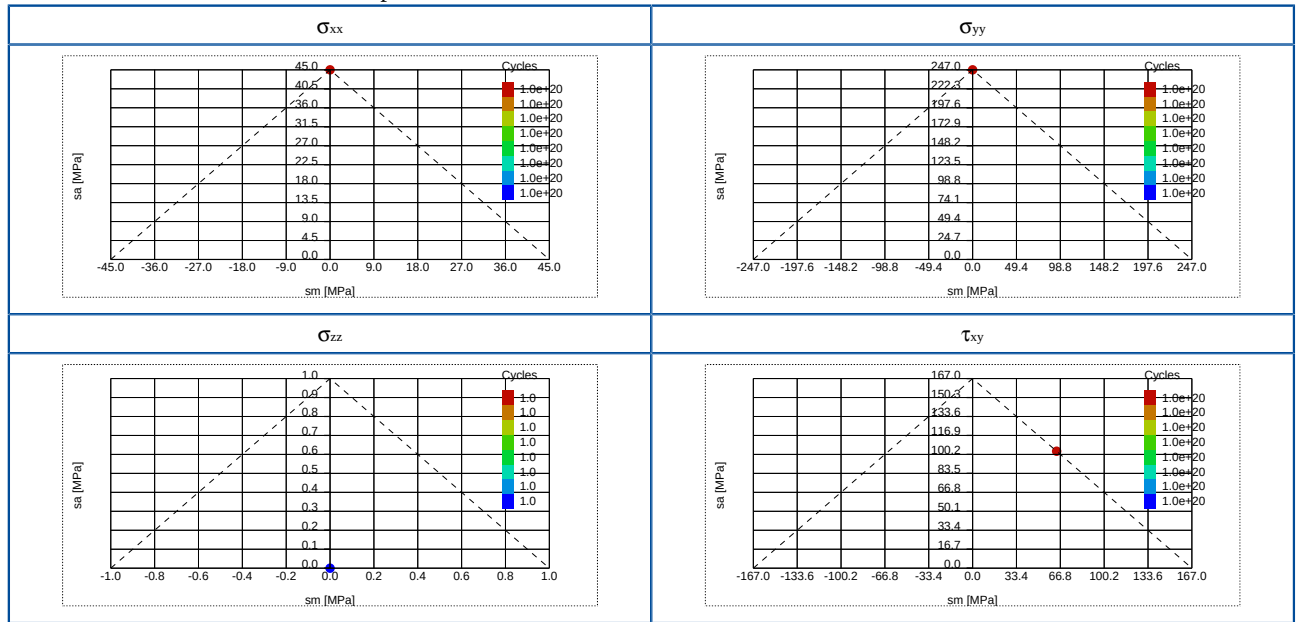
Assessment

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



	σ_{xx}	σ_{yy}	σ_{zz}	τ_{xy}
stress at neighbouring point [MPa], $\Delta s = 0.373$ mm	39.0	215.0	-	95.0
related stress gradient [mm ⁻¹]	0.357	0.347	-	0.208

Properties

fatigue limit [MPa]	σ_w	403	403	403	233
---------------------	------------	-----	-----	-----	-----

Design Parameters

K _t -K _f ratios according to Siebel and Stieler	n_s	1.088	1.087	1.000	1.093
statistical K _t -K _f ratio	n_{st}	1.022			
deformation-mechanical K _t -K _f ratio	n_{vm}	1.048			
fracture-mechanical K _t -K _f ratio	n_{bm}	1.000	1.000	1.000	1.000
K _t -K _f ratio	n_σ	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]	σ_{WK}	408	407	403	245
mean stress sensitivity	M_σ	0.213	0.213	0.213	0.123
Maximum stress amplitude at R=-1 [MPa]	$\sigma_{aW,1}$	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 %