Strength Assessment

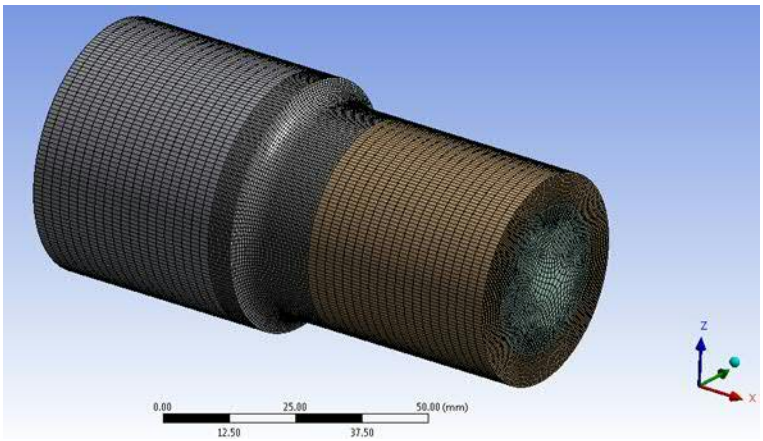
In accordance with "FKM Guideline ANALYTICAL STRENGTH ASSESSMENT OF COMPONENTS" 7th revised Edition, 2020

Input Values

General Information

designation	FMK2012 Bsp61
kind of component	base material
Load specification	stress spectrum

Bild Nachweisgebiet



Characteristic Service Stresses

stress state	plane stress state oder principle 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

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
principle 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	0.0			
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
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
critical total strain	ε_{ertr}	0.1289
section factor, acc. to tolerable strain		6.346
section factor, used	n_{pl}	1.702

Component Strength

component static strength [MPa]	σ_{SK}	1145

Safety Factors

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

Assessment

maximum degree of utilization	a_{SK}	0.450

The static degree of utilization is 45.0 %

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
principle 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	0.0			
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
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
critical total strain	ε_{ertr}	0.1289
section factor, acc. to tolerable strain		6.346
section factor, used	n_{pl}	1.702

Component Strength

component static strength [MPa]	σ_{SK}	1145

Safety Factors

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

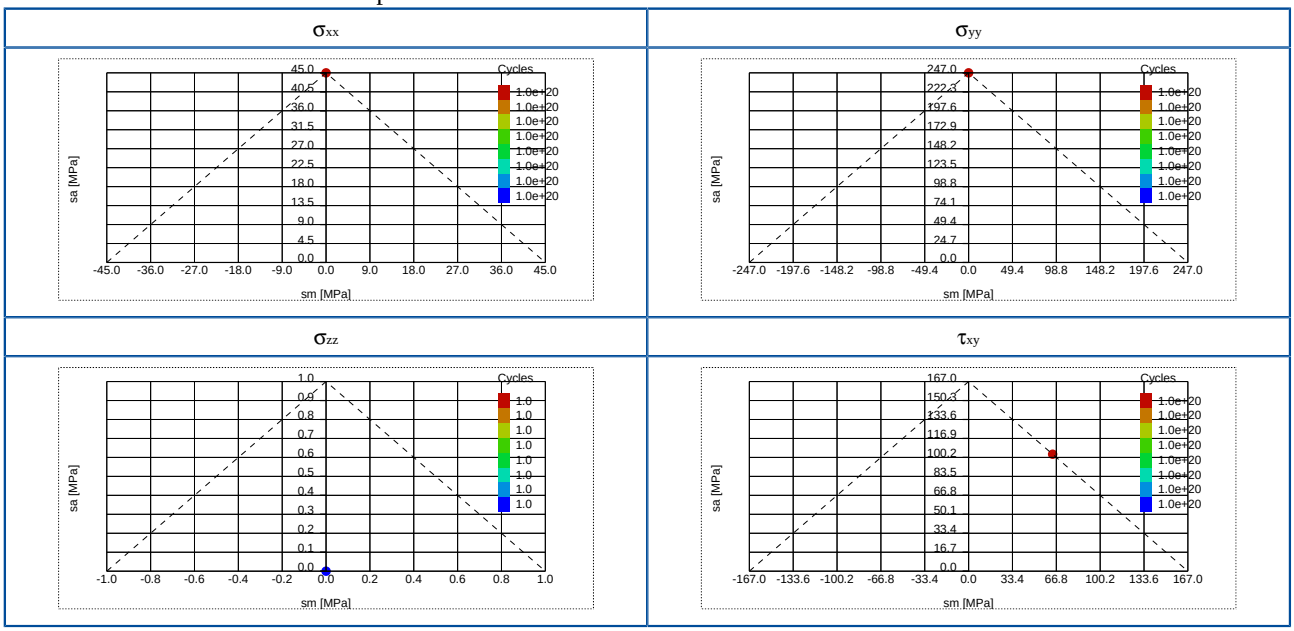
Assessment

maximum degree of utilization	a_{SK}	0.291

The static degree of utilization is 29.1 %

Assessment of the fatigue Strength - stress section 0

Characteristic Service Stresses - Input



			σ_{xx}	σ_{yy}	σ_{zz}	τ_{xy}
Characteristic Service Stresses						
stress at neighbouring point [MPa], Δs = 0.373 mm			39.0	215.0	0.0	95.0
related stress gradient [mm^{-1}]			0.357	0.347	0	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	$K\tilde{}_f$		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						
residual stress factor [MPa]	σ_{WK}		408	407	403	245
mean stress sensitivity	M_σ		0.213	0.213	0.213	0.123
Maximum of alternating amplitude [MPa]	σ_{max}		45.0	247.0	0.0	110.9
Equivalentamplitude [MPa]	$\sigma_{äqu}$		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 %