Calculation Notice:

Mitgeliefertes Beispiel TEDATA GmbH

This calculation module offers the calculation of welded joints loaded with static and dynamic loads. The base of the calculation of safety (utilization) are four different calculation standards and is chosen by the user. Base for this selection is generally the field of application or directly recommended by customer or certifier. It is possible to select between DVS 1612 and DVS 0705. The calculation of welds according the FKM guideline is only part of the extended version MDESIGN weld. The same applies for calculation of welds used in steel constructions according Eurocode 3. All these calculation standards based on stress concept for static and dynamic stress. The determination of working stress is not part of the calculation standards but it's part of the calculation module. Stress will be calculated in by using the nominal stress concept for known cross sections. The cross section of weld is determined by input of weld position and weld thickness. So of course, the calculation is limited to known cases. But with combination of the type of welded joint and geometry, lots of cases can be calculate. Only the weld seem will be taken into consideration.

Determination of working stress:
The determination of working stress doesn't differ by different calculation standards because it is not part of them. Stress will be calculated by general methods of applied mechanics. The input of working forces and moments must be in the plane of weld of course and are used directly for the calculation of stress utilization factor. Specially for beamed components often bending moments must be calculated before. So first calculate all the working loads in plane of weld, therefore also the calculation module "Beam" is useful. Model the beam situation with the welded joint as fix bearing and read all loadings and bearing conditions at weld.

Material database:
There are different material databases for the material of weld for the different calculation standards. The standard DVS 1612 offers only the standard materials S235 and S355. The largest number of materials exist in database of the FKM guideline. This database is used for standard DVS 0705.

Base of calculation

All used calculation standards for calculation module:

- DVS 1612	Edition August 2014	Design and fatigue strength assessment of welded connections with steels in rail vehicle construction
- DVS 0705	Edition February 2012	Recommendation for assigning evaluation groups according to DIN EN ISO 5817
- DIN EN ISO 5817	Edition October 2006	Welding - Fusion connections on steel - Assessment groups
- Hobbacher, IIW	Edition July 1996	Recommendations for the fatigue strength of welded connections and components

Input data:

Weld, Standard

Weld, Standard

Calculation procedure	static strength proof
Calculation method	DVS 0705
Internal stresses	no/low internal stress

Geometry

Connection form of the weld	Connection of a girder	
Girder geometry	Standard profiles	
Weld type	Fillet weld	
Profile	Square, cold hollow sections DIN EN 10219-2	
Letter symbol	50x5	
Maximum part thickness at the weld	t_{max} = 5	mm

Girder cross sections and thickness of the welds

Width				b = 50	mm
Height				h = 50	mm
	above	below	right	left	
Part thickness	t = 5	5	5	5	mm
Weld thickness	a = 4	4	4	4	mm

Loading Data

Load specifications

Axial force	F_x = 150	N
Shear load	F_y = -350	N
Shear load	F_z = 750	N
Bending moment	M_y = 457500	N·mm
Bending moment	M_z = -37500	N·mm
Torsional moment	T_x = 292500	N·mm

Factors for maximum load

Axial force Fx	1,5
Shear load Fy	1,5
Shear load Fz	1,5
Bending moment My	1,5
Bending moment Mz	1,5
Torsional moment Tx	1,5

Material Data

Weld, Standard

Material according to	MDESIGN database	
Type of material	steel	
Material designation	S235	
Ultimate strength	R_m = 360	N/mm²
Yielding point	R_e = 240	N/mm²
Material factor	1,1	
Own input of review group	No	

Results:

Calculation procedure: static strength proof

Geometry

Cross section

Position of the centre of gravity of the part	y_S	=	25	mm
Position of the centre of gravity of the part	z_S	=	25	mm
Position of the centre of gravity of the welds	y_{wS}	=	25	mm
Position of the centre of gravity of the welds	z_{wS}	=	25	mm

Cross section values of the weld

Weld	Area A_w mm²	Moment of gyration y-axis, 2 order I_w cm⁴	Moment of gyration z-axis, 2 order I_w cm⁴
above	200	4,167	0,027
below	200	4,167	0,027
right	200	0,027	4,167
left	200	0,027	4,167

Total area of the welds	A_{wges}	=	800	mm²
Total moment of gyration, y-axis	I_{wges}	=	33,387	cm⁴
Total moment of gyration, z-axis	I_{wges}	=	33,387	cm⁴

Cut sizes

			Amplitude	Mmean value	Upper load	Maximum load	Breaking equivalent load	
Axial load	F_x	=	-	-	-	0,225	-	kN

Shear load	F_y	=	-	-	-	-0,525	-	kN
Shear load	F_z	=	-	-	-	1,125	-	kN
Bending moment	M_y	=	-	-	-	686,25	-	N·m
Bending moment	M_z	=	-	-	-	-56,25	-	N·m
Torsional moment	T_x	=	-	-	-	438,75	-	N·m

Loading Data

Stresses in the welds

	Des.	Maximum load N/mm²
Stresses caused by axial force F_x	$\sigma_\perp$	0,281
Stresses caused by shear force F_y	$\tau\|\|$	-1,474
Stresses caused by shear force F_z	$\tau\|\|$	3,159
Stresses caused by bending moment M_y	$\sigma_\perp$	51,387
Stresses caused by bending moment M_z	$\sigma_\perp$	4,212
Stresses caused by torsional moment T_x	$\tau\|\|$	21,938

Normal stresses caused by axial force F_x (row 1 under nominal load, row 2 under maximum load)

Point 1 N/mm²	Point 2 N/mm²	Point 3 N/mm²	Point 3* N/mm²	Point 4 N/mm²	Point 5* N/mm²	Point 5 N/mm²	Point 6 N/mm²	Point 7 N/mm²	Point 7* N/mm²	Point 8 N/mm²	Point 1* N/mm²
0,188	0,188	0,188	0,188	0,188	0,188	0,188	0,188	0,188	0,188	0,188	0,188
0,281	0,281	0,281	0,281	0,281	0,281	0,281	0,281	0,281	0,281	0,281	0,281

Shear stresses caused by shear load F_y (row 1 under nominal load, row 2 under maximum load)

Point 1 N/mm²	Point 2 N/mm²	Point 3 N/mm²	Point 3* N/mm²	Point 4 N/mm²	Point 5* N/mm²	Point 5 N/mm²	Point 6 N/mm²	Point 7 N/mm²	Point 7* N/mm²	Point 8 N/mm²	Point 1* N/mm²
-0,655	-0,983	-0,655	-0,655	0	0,655	-0,655	-0,983	-0,655	-0,655	0	0,655
-0,983	-1,474	-0,983	-0,983	0	0,983	-0,983	-1,474	-0,983	-0,983	0	0,983

Shear stresses caused by shear force F_z (row 1 under nominal load, row 2 under maximum load)

Point 1 N/mm²	Point 2 N/mm²	Point 3 N/mm²	Point 3* N/mm²	Point 4 N/mm²	Point 5* N/mm²	Point 5 N/mm²	Point 6 N/mm²	Point 7 N/mm²	Point 7* N/mm²	Point 8 N/mm²	Point 1* N/mm²
-1,404	0	1,404	1,404	2,106	1,404	-1,404	0	1,404	1,404	2,106	1,404
-2,106	0	2,106	2,106	3,159	2,106	-2,106	0	2,106	2,106	3,159	2,106

Normal stresses caused by bending moment M_y (row 1 under nominal load, row 2 under maximum load)

Point 1 N/mm²	Point 2 N/mm²	Point 3 N/mm²	Point 3* N/mm²	Point 4 N/mm²	Point 5* N/mm²	Point 5 N/mm²	Point 6 N/mm²	Point 7 N/mm²	Point 7* N/mm²	Point 8 N/mm²	Point 1* N/mm²
34,258	34,258	34,258	34,258	0	-34,258	-34,258	-34,258	-34,258	-34,258	0	34,258
51,387	51,387	51,387	51,387	0	-51,387	-51,387	-51,387	-51,387	-51,387	0	51,387

Normal stresses caused by bending moment Mz (row 1 under nominal load, row 2 under maximum load)

Point 1 N/mm²	Point 2 N/mm²	Point 3 N/mm²	Point 3* N/mm²	Point 4 N/mm²	Point 5* N/mm²	Point 5 N/mm²	Point 6 N/mm²	Point 7 N/mm²	Point 7* N/mm²	Point 8 N/mm²	Point 1* N/mm²
-2,808	0	2,808	2,808	2,808	2,808	2,808	0	-2,808	-2,808	-2,808	-2,808
-4,212	0	4,212	4,212	4,212	4,212	4,212	0	-4,212	-4,212	-4,212	-4,212

Shear stresses caused by torsional moment T_x (row 1 under nominal load, row 2 under maximum load)

Point 1 N/mm²	Point 2 N/mm²	Point 3 N/mm²	Point 3* N/mm²	Point 4 N/mm²	Point 5* N/mm²	Point 5 N/mm²	Point 6 N/mm²	Point 7 N/mm²	Point 7* N/mm²	Point 8 N/mm²	Point 1* N/mm²
-14,625	-14,625	-14,625	-14,625	-14,625	-14,625	14,625	14,625	14,625	14,625	14,625	14,625
-21,938	-21,938	-21,938	-21,938	-21,938	-21,938	21,938	21,938	21,938	21,938	21,938	21,938

Resultant normal stresses (row 1 under nominal load, row 2 under maximum load)

Point 1 N/mm²	Point 2 N/mm²	Point 3 N/mm²	Point 3* N/mm²	Point 4 N/mm²	Point 5* N/mm²	Point 5 N/mm²	Point 6 N/mm²	Point 7 N/mm²	Point 7* N/mm²	Point 8 N/mm²	Point 1* N/mm²
31,637	34,445	37,253	37,253	2,996	-31,262	-31,262	-34,07	-36,878	-36,878	-2,621	31,637
47,456	51,668	55,88	55,88	4,493	-46,893	-46,893	-51,105	-55,317	-55,317	-3,931	47,456

Resultant shear stresses (row 1 under nominal load, row 2 under maximum load)

Point 1 N/mm²	Point 2 N/mm²	Point 3 N/mm²	Point 3* N/mm²	Point 4 N/mm²	Point 5* N/mm²	Point 5 N/mm²	Point 6 N/mm²	Point 7 N/mm²	Point 7* N/mm²	Point 8 N/mm²	Point 1* N/mm²
-16,684	-15,608	-13,876	-13,876	-12,519	-12,566	12,566	13,642	15,374	15,374	16,731	16,684
-25,026	-23,412	-20,814	-20,814	-18,778	-18,849	18,849	20,463	23,061	23,061	25,097	25,026

Static proof			weld above	weld below	weld right	weld left	
Max resultant normal stress	σ_{res}	=	55,88	-55,317	-55,317	55,88	N/mm²
Max resultant shear stress	τ_{res}	=	-20,814	25,097	23,061	-25,026	N/mm²
Allowable normal stress	σ_{zul}	=	106,364	106,364	106,364	106,364	N/mm²
Allowable shear stress	τ_{zul}	=	106,364	106,364	106,364	106,364	N/mm²

Material Data

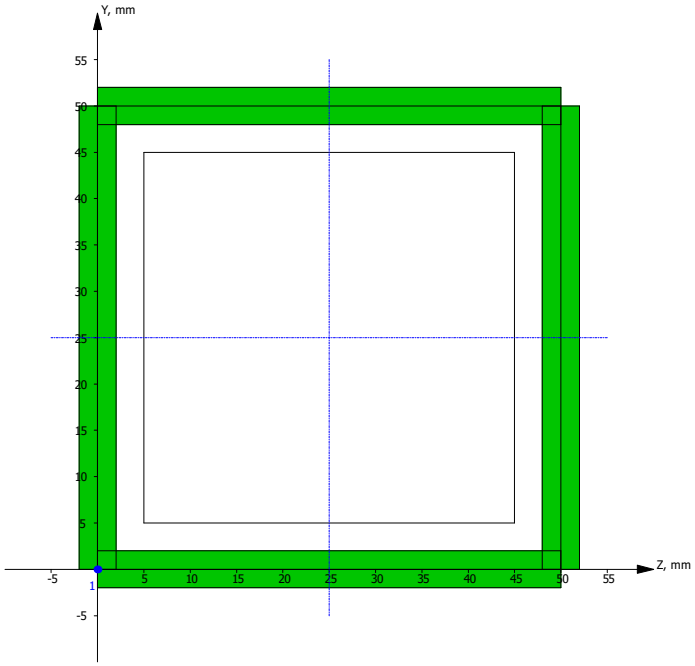
Material designation	S235			
Ultimate strength	R_m	=	360	N/mm²
Yielding point	R_e	=	240	N/mm²

Note:

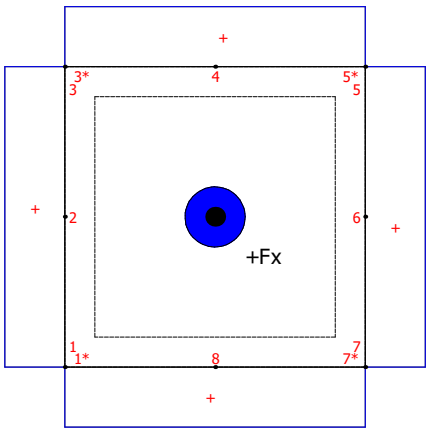
Static proof: 5,756e-1 < 1

Weld, Standard

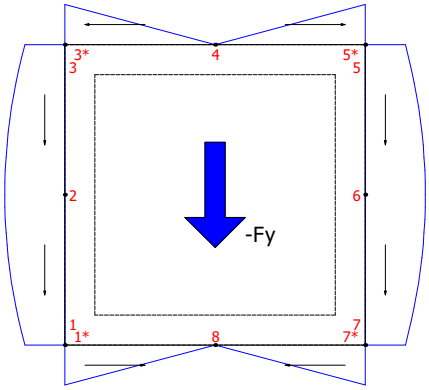
Rectangular profile



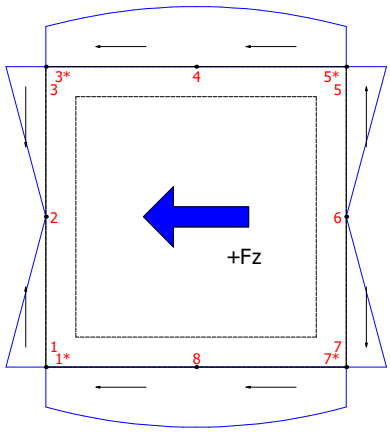
Normal stresses caused by axial force Fx



Shear stresses caused by shear force Fy

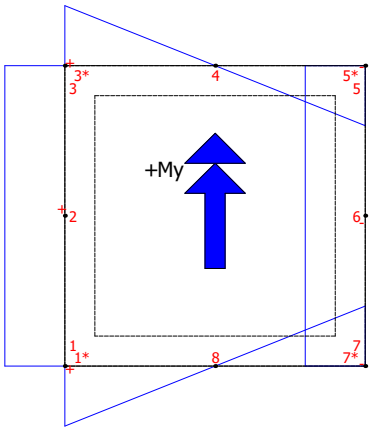


Shear stresses caused by shear force Fz

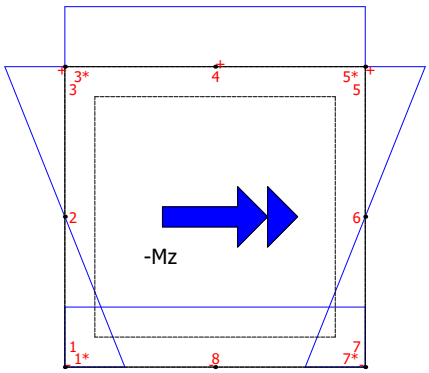


Weld, Standard

Normal stresses caused by bending moment My



Normal stresses caused by bending moment Mz



Shear stresses caused by torsional moment Tx