Project data

Project name	Amsterdam industrial
Project number	20239010
Author	Dave the Engineer
Description	Bracing
Date	10.03.2023
Code	EN

Material

Steel	S 235

Project item CON1

Design

Name	CON1
Description	
Analysis	Stress, strain/ loads in equilibrium

Members

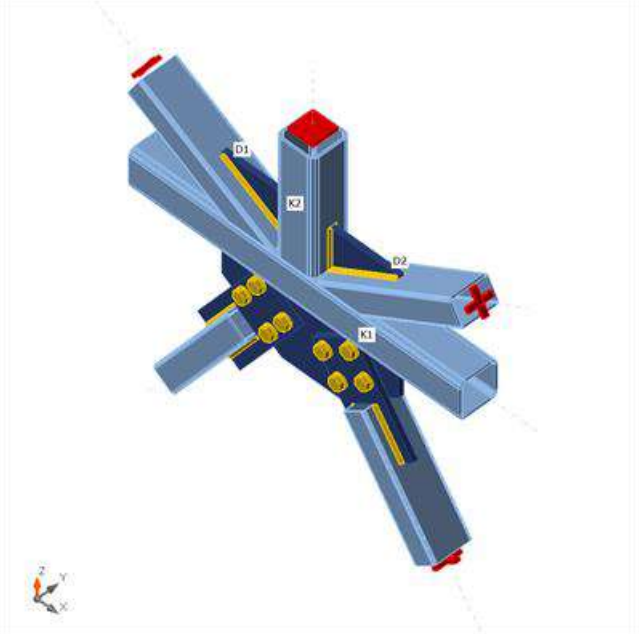
Geometry

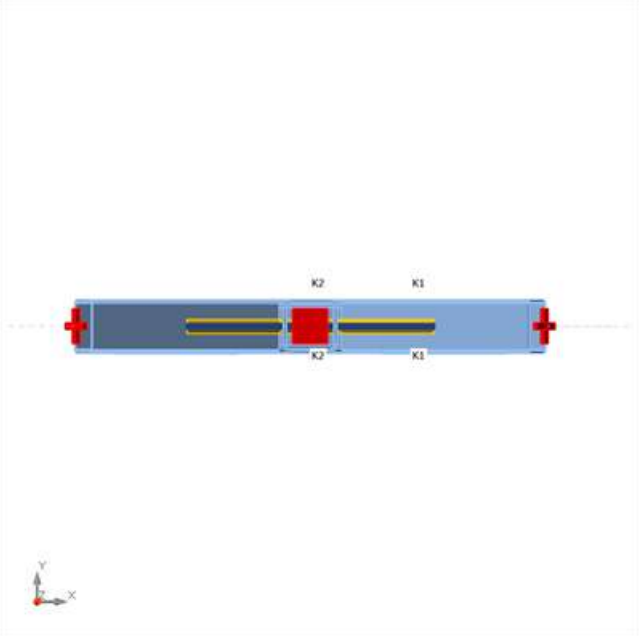
Name	Cross-section	β – Direction [°]	γ - Pitch [°]	α - Rotation [°]	Offset ex [mm]	Offset ey [mm]	Offset ez [mm]
K1	5 - K120/120/8	180,0	0,0	0,0	0	0	0
K2	5 - K120/120/8	0,0	90,0	180,0	0	0	0
D1	6 - AC120/80/6	180,0	30,0	90,0	0	-20	0
D2	6 - AC120/80/6	0,0	30,0	90,0	0	-20	0
D3	6 - AC120/80/6	180,0	-55,0	90,0	0	0	0
D4	6 - AC120/80/6	0,0	-55,0	90,0	0	0	0

Supports and forces

Name	Support	Forces in	X [mm]
K1 / begin		Position	0
K1 / end		Position	0
K2 / end	N-Vy-Vz-Mx-My-Mz	Position	0
D1 / end	Mx-My-Mz	Position	0

D2 / end	Mx-My-Mz	Position	0
D3 / end	Mx-My-Mz	Position	0
D4 / end	Mx-My-Mz	Position	0





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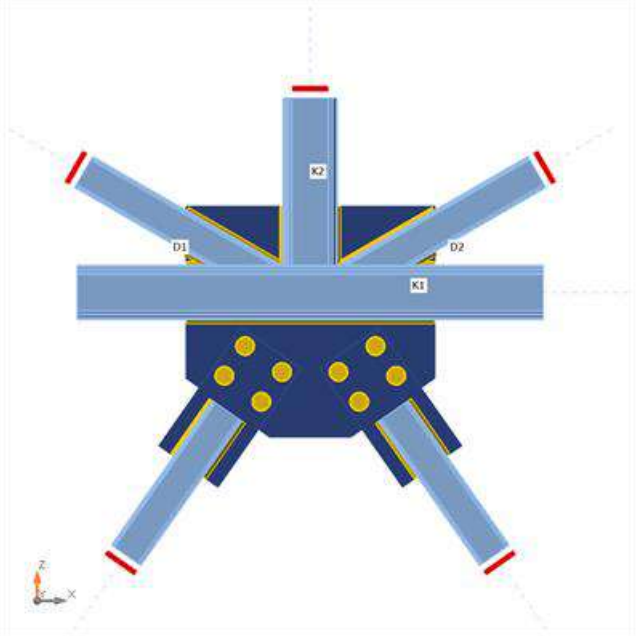
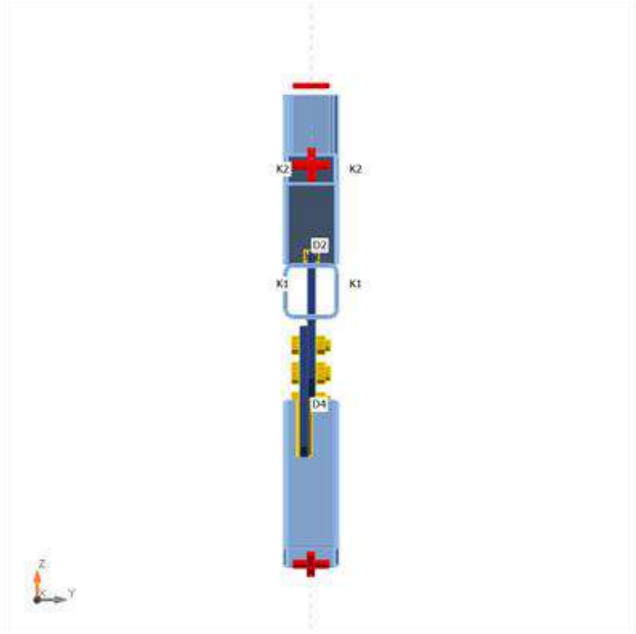


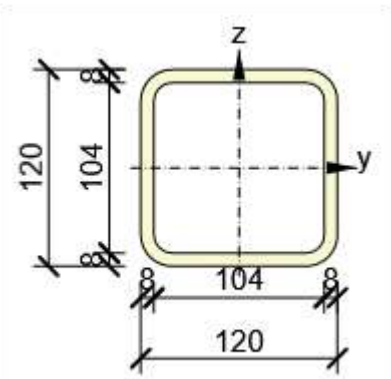
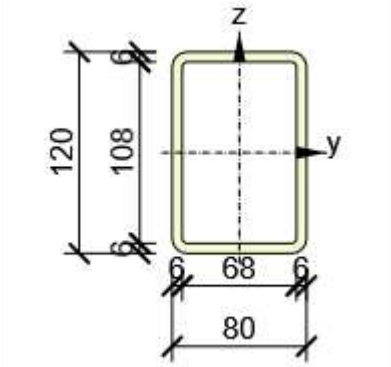


Cross-sections

Name	Material
5 - K120/120/8	S 235
6 - AC120/80/6	S 235

Cross-sections

Name	Material	Drawing

5 - K120/120/8	S 235	
6 - AC120/80/6	S 235	

Bolts

Name	Bolt assembly	Diameter [mm]	f_u [MPa]	Gross area [mm^2]
M24 8.8	M24 8.8	24	800,0	452

Load effects (forces in equilibrium)

Name	Member	N [kN]	Vy [kN]	Vz [kN]	Mx [kNm]	My [kNm]	Mz [kNm]
LE1	K1 / End	-250,0	0,0	0,0	0,0	0,0	0,0
	K2 / End	134,6	0,0	0,0	0,0	0,0	0,0
	D1 / End	300,0	0,0	0,0	0,0	0,0	0,0
	D2 / End	250,0	0,0	0,0	0,0	0,0	0,0
	D3 / End	250,0	0,0	0,0	0,0	0,0	0,0
	D4 / End	250,0	0,0	0,0	0,0	0,0	0,0
	K1 / Begin	206,7	0,0	0,0	0,0	0,0	0,0

Unbalanced forces

Name	X [kN]	Y [kN]	Z [kN]	Mx [kNm]	My [kNm]	Mz [kNm]
LE1	0,0	0,0	0,0	0,2	1,0	0,0

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Check

Summary

Name	Value	Check status
Analysis	100,0%	OK
Plates	1,3 < 5,0%	OK
Bolts	97,2 < 100%	OK
Welds	99,0 < 100%	OK
Buckling	Not calculated	
GMNA	Calculated	

Plates

Name	t_p [mm]	Loads	σ_{Ed} [MPa]	ε_{Pl} [%]	$\sigma_{c,Ed}$ [MPa]	Status
K1	8,0	LE1	200,7	0,0	0,0	OK
K2	8,0	LE1	134,4	0,0	0,0	OK
D1	6,0	LE1	237,8	1,3	0,0	OK
D2	6,0	LE1	236,1	0,5	0,0	OK
D3	6,0	LE1	236,0	0,5	0,0	OK
D4	6,0	LE1	236,0	0,5	0,0	OK
Algemene plaat1	15,0	LE1	235,2	0,1	21,9	OK
Gesneden plaat1	16,0	LE1	236,9	0,9	23,8	OK
Gesneden plaat2	16,0	LE1	236,9	0,9	24,2	OK

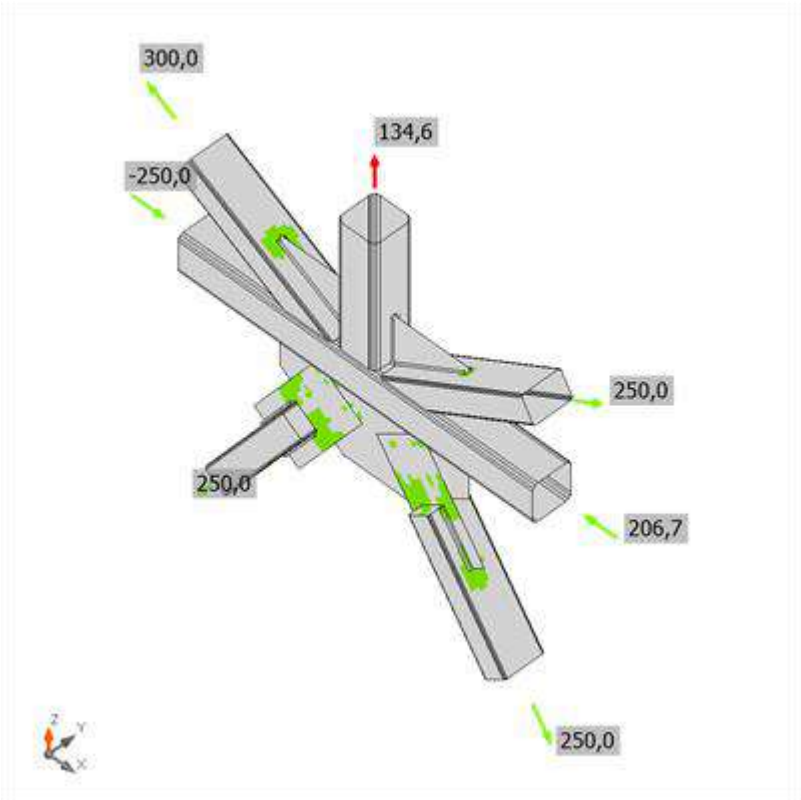
Design data

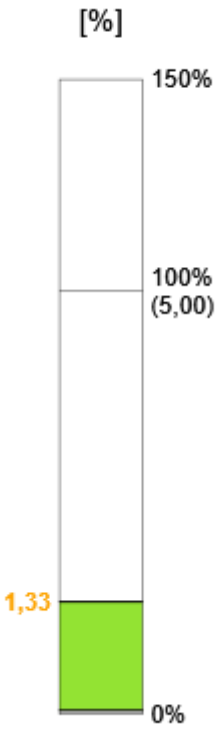
Material	f_y [MPa]	ε_{lim} [%]
S 235	235,0	5,0

Symbol explanation

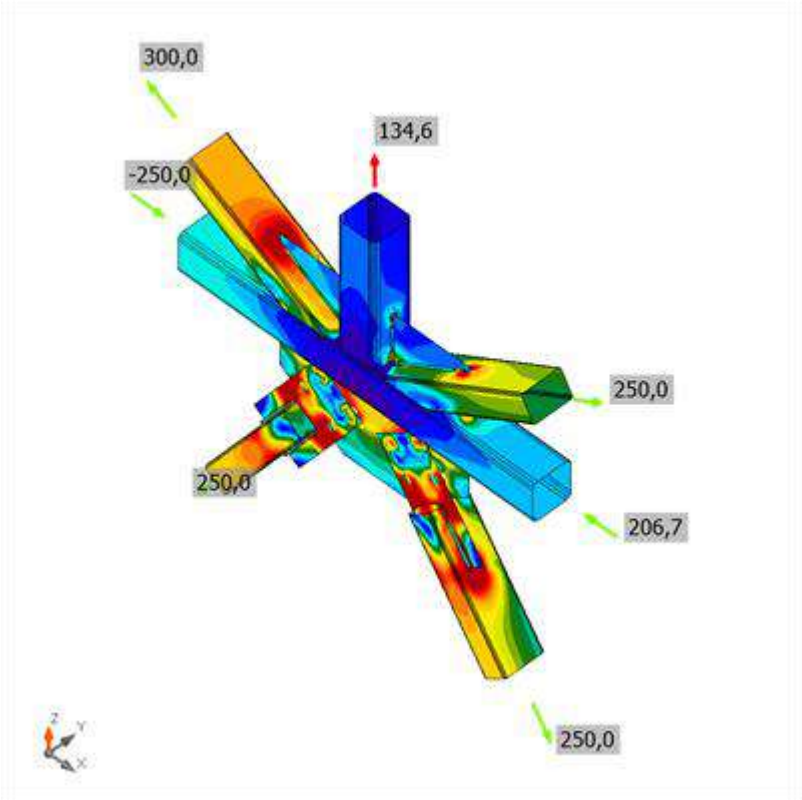
t_p	Plate thickness
σ_{Ed}	Equivalent stress
ε_{Pl}	Plastic strain
$\sigma_{c,Ed}$	Contact stress
f_y	Yield strength
ε_{lim}	Limit of plastic strain

Overall check, LE1



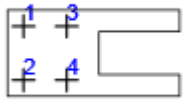
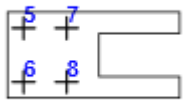


Strain check, LE1



Equivalent stress, LE1

Bolts

Shape	Item	Grade	Loads	$F_{t,Ed}$ [kN]	$F_{v,Ed}$ [kN]	$F_{b,Rd}$ [kN]	Ut_t [%]	Ut_s [%]	Ut_{ts} [%]	Status
	B1	M24 8.8 - 1	LE1	17,7	61,5	65,1	8,7	94,4	51,6	OK
	B2	M24 8.8 - 1	LE1	23,6	63,2	65,1	11,6	97,1	54,9	OK
	B3	M24 8.8 - 1	LE1	20,0	63,2	131,3	9,8	48,1	53,6	OK
	B4	M24 8.8 - 1	LE1	9,3	62,1	131,3	4,6	47,3	49,1	OK
	B5	M24 8.8 - 1	LE1	23,7	63,3	65,1	11,6	97,2	55,0	OK
	B6	M24 8.8 - 1	LE1	17,6	61,4	65,1	8,7	94,3	51,5	OK
	B7	M24 8.8 - 1	LE1	9,2	62,2	131,3	4,5	47,4	49,2	OK
	B8	M24 8.8 - 1	LE1	19,9	63,1	131,3	9,8	48,0	53,5	OK

Design data

Grade	$F_{t,Rd}$ [kN]	$B_{p,Rd}$ [kN]	$F_{v,Rd}$ [kN]
M24 8.8 - 1	203,3	309,4	135,6

Symbol explanation

$F_{t,Ed}$ Tension force
$F_{v,Ed}$ Resultant of bolt shear forces Vy and Vz in shear planes
$F_{b,Rd}$ Plate bearing resistance EN 1993-1-8 – Tab. 3.4

Ut_t	Utilization in tension
Ut_s	Utilization in shear
Ut_{ts}	Interaction of tension and shear EN 1993-1-8 – Tab. 3.4
$F_{t,Rd}$	Bolt tension resistance EN 1993-1-8 – Tab. 3.4
$B_{p,Rd}$	Punching shear resistance EN 1993-1-8 – Tab. 3.4
$F_{v,Rd}$	Bolt shear resistance EN 1993-1-8 – Tab. 3.4

Detailed result for B1

Tension resistance check (EN 1993-1-8 – Tab. 3.4)

$F_{t,Rd} = \frac{k_2 f_{ub} A_s}{\gamma_{M2}} =$ 203,3 kN ≥ $F_{t,Ed} =$ 17,7 kN

Where:

$k_2 =$ 0,90 – Factor

$f_{ub} =$ 800,0 MPa – Ultimate tensile strength of the bolt

$A_s =$ 353 mm^2 – Tensile stress area of the bolt

$\gamma_{M2} =$ 1,25 – Safety factor

Punching resistance check (EN 1993-1-8 – Tab. 3.4)

$B_{p,Rd} = \frac{0,6 \pi d_m t_p f_u}{\gamma_{M2}} =$ 309,4 kN ≥ $F_{t,Ed} =$ 17,7 kN

Where:

$d_m =$ 38 mm – The mean of the across points and across flats dimensions of the bolt head or the nut, whichever is smaller

$t_p =$ 15 mm – Plate thickness

$f_u =$ 360,0 MPa – Ultimate strength

$\gamma_{M2} =$ 1,25 – Safety factor

Shear resistance check (EN 1993-1-8 – Tab. 3.4)

$F_{v,Rd} = \frac{\beta_p \alpha_v f_{ub} A}{\gamma_{M2}} =$ 135,6 kN ≥ $F_{v,Ed} =$ 61,5 kN

Where:

$\beta_p =$ 1,00 – Reduction factor for packing

$\alpha_v =$ 0,60 – Reduction factor for shear stress

$f_{ub} =$ 800,0 MPa – Ultimate tensile strength of the bolt

$A =$ 353 mm^2 – Gross cross-section area of the bolt

$\gamma_{M2} =$ 1,25 – Safety factor

Bearing resistance check (EN 1993-1-8 – Tab. 3.4)

$F_{b,Rd} = \frac{k_1 \alpha_b f_u dt}{\gamma_{M2}} =$ 65,1 kN ≥ $F_{b,Ed} =$ 61,5 kN

Where:

$k_1 = \min(2.8\frac{e_2}{d_0} - 1.7, 1.4\frac{p_2}{d_0} - 1.7, 2.5) =$ 1,53 – Factor for edge distance and bolt spacing perpendicular to the direction of load transfer

$\alpha_b = \min(\frac{e_1}{3d_0}, \frac{p_1}{3d_0} - \frac{1}{4}, \frac{f_{ub}}{f_u}, 1) =$ 0,38 – Factor for end distance and bolt spacing in direction of load transfer

$e_2 = 30$ mm – Distance to the plate edge perpendicular to the shear force

$p_2 = 100$ mm – Distance between bolts perpendicular to the shear force

$d_0 = 26$ mm – Bolt hole diameter

$e_1 = 30$ mm – Distance to the plate edge in the direction of the shear force

$p_1 = \infty$ mm – Distance between bolts in the direction of the shear force

$f_{ub} = 800{,}0$ MPa – Ultimate tensile strength of the bolt

$f_u = 360{,}0$ MPa – Ultimate strength of the plate

$d = 24$ mm – Nominal diameter of the fastener

$t = 16$ mm – Thickness of the plate

$\gamma_{M2} = 1{,}25$ – Safety factor

Utilization in tension

$$\frac{F_{t,Ed}}{\min(F_{t,Rd}\,;\,B_{p,Rd})} = 0{,}09 \leq 1{,}0$$

Where:

$F_{t,Ed} = 17{,}7$ kN – Tensile force

$F_{t,Rd} = 203{,}3$ kN – Tension resistance

$B_{p,Rd} = 309{,}4$ kN – Punching resistance

Utilization in shear

$$\max\left(\frac{F_{v,Ed}}{F_{v,Rd}}\,;\,\frac{F_{b,Ed}}{F_{b,Rd}}\right) = 0{,}94 \leq 1{,}0$$

Where:

$F_{v,Ed} = 61{,}5$ kN – Shear force (in decisive shear plane)

$F_{v,Rd} = 135{,}6$ kN – Shear resistance

$F_{b,Ed} = 61{,}5$ kN – Bearing force (for decisive plate)

$F_{b,Rd} = 65{,}1$ kN – Bearing resistance

Interaction of tension and shear (EN 1993-1-8 – Tab. 3.4)

$$\frac{F_{v,Ed}}{F_{v,Rd}} + \frac{F_{t,Ed}}{1{,}4\,F_{t,Rd}} = 0{,}52 \leq 1{,}0$$

Where:

$F_{v,Ed} = 61{,}5$ kN – Shear force (in decisive shear plane)

$F_{v,Rd} = 135{,}6$ kN – Shear resistance

$F_{t,Ed} = 17{,}7$ kN – Tensile force

$F_{t,Rd} = 203{,}3$ kN – Tension resistance

Detailed result for B2

Tension resistance check (EN 1993-1-8 – Tab. 3.4)

$F_{t,Rd} = \frac{k_2 f_{ub} A_s}{\gamma_{M2}} =$ 203,3 kN ≥ $F_{t,Ed} =$ 23,6 kN

Where:

$k_2 =$ 0,90 – Factor

$f_{ub} =$ 800,0 MPa – Ultimate tensile strength of the bolt

$A_s =$ 353 mm^2 – Tensile stress area of the bolt

$\gamma_{M2} =$ 1,25 – Safety factor

Punching resistance check (EN 1993-1-8 – Tab. 3.4)

$B_{p,Rd} = \frac{0{,}6\,\pi\, d_m\, t_p f_u}{\gamma_{M2}} =$ 309,4 kN ≥ $F_{t,Ed} =$ 23,6 kN

Where:

$d_m =$ 38 mm – The mean of the across points and across flats dimensions of the bolt head or the nut, whichever is smaller

$t_p =$ 15 mm – Plate thickness

$f_u =$ 360,0 MPa – Ultimate strength

$\gamma_{M2} =$ 1,25 – Safety factor

Shear resistance check (EN 1993-1-8 – Tab. 3.4)

$F_{v,Rd} = \frac{\beta_p\, \alpha_v f_{ub} A}{\gamma_{M2}} =$ 135,6 kN ≥ $F_{v,Ed} =$ 63,2 kN

Where:

$\beta_p =$ 1,00 – Reduction factor for packing

$\alpha_v =$ 0,60 – Reduction factor for shear stress

$f_{ub} =$ 800,0 MPa – Ultimate tensile strength of the bolt

$A =$ 353 mm^2 – Gross cross-section area of the bolt

$\gamma_{M2} =$ 1,25 – Safety factor

Bearing resistance check (EN 1993-1-8 – Tab. 3.4)

$F_{b,Rd} = \frac{k_1\, \alpha_b f_u\, dt}{\gamma_{M2}} =$ 65,1 kN ≥ $F_{b,Ed} =$ 63,2 kN

Where:

$k_1 = \min(2.8\frac{e_2}{d_0} - 1.7, 1.4\frac{p_2}{d_0} - 1.7, 2.5) =$ 1,53 – Factor for edge distance and bolt spacing perpendicular to the direction of load transfer

$\alpha_b = \min(\frac{e_1}{3d_0}, \frac{p_1}{3d_0} - \frac{1}{4}, \frac{f_{ub}}{f_u}, 1) =$ 0,38 – Factor for end distance and bolt spacing in direction of load transfer

$e_2 =$ 30 mm – Distance to the plate edge perpendicular to the shear force

$p_2 =$ 100 mm – Distance between bolts perpendicular to the shear force

$d_0 =$ 26 mm – Bolt hole diameter

$e_1 =$ 30 mm – Distance to the plate edge in the direction of the shear force

$p_1 =$ ∞ mm – Distance between bolts in the direction of the shear force

$f_{ub} =$ 800,0 MPa – Ultimate tensile strength of the bolt

f_u = 360,0 MPa – Ultimate strength of the plate
d = 24 mm – Nominal diameter of the fastener
t = 16 mm – Thickness of the plate
γ_{M2} = 1,25 – Safety factor

Utilization in tension

$$\frac{F_{t,Ed}}{\min(F_{t,Rd}\,;\,B_{p,Rd})} = \quad 0,12 \quad \leq \quad 1,0$$

Where:

$F_{t,Ed}$ = 23,6 kN – Tensile force
$F_{t,Rd}$ = 203,3 kN – Tension resistance
$B_{p,Rd}$ = 309,4 kN – Punching resistance

Utilization in shear

$$\max\left(\frac{F_{v,Ed}}{F_{v,Rd}}\,;\,\frac{F_{b,Ed}}{F_{b,Rd}}\right) = \quad 0,97 \quad \leq \quad 1,0$$

Where:

$F_{v,Ed}$ = 63,2 kN – Shear force (in decisive shear plane)
$F_{v,Rd}$ = 135,6 kN – Shear resistance
$F_{b,Ed}$ = 63,2 kN – Bearing force (for decisive plate)
$F_{b,Rd}$ = 65,1 kN – Bearing resistance

Interaction of tension and shear (EN 1993-1-8 – Tab. 3.4)

$$\frac{F_{v,Ed}}{F_{v,Rd}} + \frac{F_{t,Ed}}{1,4\,F_{t,Rd}} = \quad 0,55 \quad \leq \quad 1,0$$

Where:

$F_{v,Ed}$ = 63,2 kN – Shear force (in decisive shear plane)
$F_{v,Rd}$ = 135,6 kN – Shear resistance
$F_{t,Ed}$ = 23,6 kN – Tensile force
$F_{t,Rd}$ = 203,3 kN – Tension resistance

Detailed result for B3

Tension resistance check (EN 1993-1-8 – Tab. 3.4)

$$F_{t,Rd} = \frac{k_2 f_{ub} A_s}{\gamma_{M2}} = \quad 203,3 \text{ kN} \quad \geq \quad F_{t,Ed} = \quad 20,0 \text{ kN}$$

Where:

k_2 = 0,90 – Factor
f_{ub} = 800,0 MPa – Ultimate tensile strength of the bolt
A_s = 353 mm^2 – Tensile stress area of the bolt
γ_{M2} = 1,25 – Safety factor

Punching resistance check (EN 1993-1-8 – Tab. 3.4)

$B_{p,Rd} = \frac{0,6\,\pi\,d_m\,t_p\,f_u}{\gamma_{M2}} =$ 309,4 kN ≥ $F_{t,Ed} =$ 20,0 kN

Where:

$d_m =$ 38 mm – The mean of the across points and across flats dimensions of the bolt head or the nut, whichever is smaller

$t_p =$ 15 mm – Plate thickness

$f_u =$ 360,0 MPa – Ultimate strength

$\gamma_{M2} =$ 1,25 – Safety factor

Shear resistance check (EN 1993-1-8 – Tab. 3.4)

$F_{v,Rd} = \frac{\beta_p\,\alpha_v f_{ub} A}{\gamma_{M2}} =$ 135,6 kN ≥ $F_{v,Ed} =$ 63,2 kN

Where:

$\beta_p =$ 1,00 – Reduction factor for packing

$\alpha_v =$ 0,60 – Reduction factor for shear stress

$f_{ub} =$ 800,0 MPa – Ultimate tensile strength of the bolt

$A =$ 353 mm^2 – Gross cross-section area of the bolt

$\gamma_{M2} =$ 1,25 – Safety factor

Bearing resistance check (EN 1993-1-8 – Tab. 3.4)

$F_{b,Rd} = \frac{k_1\,\alpha_b f_u\,dt}{\gamma_{M2}} =$ 131,3 kN ≥ $F_{b,Ed} =$ 63,2 kN

Where:

$k_1 = \min(2.8\frac{e_2}{d_0} - 1.7, 1.4\frac{p_2}{d_0} - 1.7, 2.5) =$ 1,53 – Factor for edge distance and bolt spacing perpendicular to the direction of load transfer

$\alpha_b = \min(\frac{e_1}{3d_0}, \frac{p_1}{3d_0} - \frac{1}{4}, \frac{f_{ub}}{f_u}, 1) =$ 0,78 – Factor for end distance and bolt spacing in direction of load transfer

$e_2 =$ 30 mm – Distance to the plate edge perpendicular to the shear force

$p_2 =$ 100 mm – Distance between bolts perpendicular to the shear force

$d_0 =$ 26 mm – Bolt hole diameter

$e_1 =$ 110 mm – Distance to the plate edge in the direction of the shear force

$p_1 =$ 80 mm – Distance between bolts in the direction of the shear force

$f_{ub} =$ 800,0 MPa – Ultimate tensile strength of the bolt

$f_u =$ 360,0 MPa – Ultimate strength of the plate

$d =$ 24 mm – Nominal diameter of the fastener

$t =$ 16 mm – Thickness of the plate

$\gamma_{M2} =$ 1,25 – Safety factor

Utilization in tension

$\frac{F_{t,Ed}}{\min(F_{t,Rd}\,;\,B_{p,Rd})} =$ 0,10 ≤ 1,0

Where:

$F_{t,Ed}$ = 20,0 kN – Tensile force

$F_{t,Rd}$ = 203,3 kN – Tension resistance

$B_{p,Rd}$ = 309,4 kN – Punching resistance

Utilization in shear

$\max(\frac{F_{v,Ed}}{F_{v,Rd}}; \frac{F_{b,Ed}}{F_{b,Rd}}) =$ 0,48 ≤ 1,0

Where:

$F_{v,Ed}$ = 63,2 kN – Shear force (in decisive shear plane)

$F_{v,Rd}$ = 135,6 kN – Shear resistance

$F_{b,Ed}$ = 63,2 kN – Bearing force (for decisive plate)

$F_{b,Rd}$ = 131,3 kN – Bearing resistance

Interaction of tension and shear (EN 1993-1-8 – Tab. 3.4)

$\frac{F_{v,Ed}}{F_{v,Rd}} + \frac{F_{t,Ed}}{1,4\,F_{t,Rd}} =$ 0,54 ≤ 1,0

Where:

$F_{v,Ed}$ = 63,2 kN – Shear force (in decisive shear plane)

$F_{v,Rd}$ = 135,6 kN – Shear resistance

$F_{t,Ed}$ = 20,0 kN – Tensile force

$F_{t,Rd}$ = 203,3 kN – Tension resistance

Detailed result for B4

Tension resistance check (EN 1993-1-8 – Tab. 3.4)

$F_{t,Rd} = \frac{k_2 f_{ub} A_s}{\gamma_{M2}} =$ 203,3 kN ≥ $F_{t,Ed} =$ 9,3 kN

Where:

k_2 = 0,90 – Factor

f_{ub} = 800,0 MPa – Ultimate tensile strength of the bolt

A_s = 353 mm^2 – Tensile stress area of the bolt

γ_{M2} = 1,25 – Safety factor

Punching resistance check (EN 1993-1-8 – Tab. 3.4)

$B_{p,Rd} = \frac{0,6\,\pi\,d_m\,t_p\,f_u}{\gamma_{M2}} =$ 309,4 kN ≥ $F_{t,Ed} =$ 9,3 kN

Where:

d_m = 38 mm – The mean of the across points and across flats dimensions of the bolt head or the nut, whichever is smaller

t_p = 15 mm – Plate thickness

f_u = 360,0 MPa – Ultimate strength

γ_{M2} = 1,25 – Safety factor

Shear resistance check (EN 1993-1-8 – Tab. 3.4)

$F_{v,Rd} = \frac{\beta_p \alpha_v f_{ub} A}{\gamma_{M2}} =$ 135,6 kN ≥ $F_{v,Ed} =$ 62,1 kN

Where:

$\beta_p =$ 1,00 – Reduction factor for packing

$\alpha_v =$ 0,60 – Reduction factor for shear stress

$f_{ub} =$ 800,0 MPa – Ultimate tensile strength of the bolt

$A =$ 353 mm^2 – Gross cross-section area of the bolt

$\gamma_{M2} =$ 1,25 – Safety factor

Bearing resistance check (EN 1993-1-8 – Tab. 3.4)

$F_{b,Rd} = \frac{k_1 \alpha_b f_u d t}{\gamma_{M2}} =$ 131,3 kN ≥ $F_{b,Ed} =$ 62,1 kN

Where:

$k_1 = \min(2.8\frac{e_2}{d_0} - 1.7, 1.4\frac{p_2}{d_0} - 1.7, 2.5) =$ 1,53 – Factor for edge distance and bolt spacing perpendicular to the direction of load transfer

$\alpha_b = \min(\frac{e_1}{3d_0}, \frac{p_1}{3d_0} - \frac{1}{4}, \frac{f_{ub}}{f_u}, 1) =$ 0,78 – Factor for end distance and bolt spacing in direction of load transfer

$e_2 =$ 30 mm – Distance to the plate edge perpendicular to the shear force

$p_2 =$ 100 mm – Distance between bolts perpendicular to the shear force

$d_0 =$ 26 mm – Bolt hole diameter

$e_1 =$ 110 mm – Distance to the plate edge in the direction of the shear force

$p_1 =$ 80 mm – Distance between bolts in the direction of the shear force

$f_{ub} =$ 800,0 MPa – Ultimate tensile strength of the bolt

$f_u =$ 360,0 MPa – Ultimate strength of the plate

$d =$ 24 mm – Nominal diameter of the fastener

$t =$ 16 mm – Thickness of the plate

$\gamma_{M2} =$ 1,25 – Safety factor

Utilization in tension

$\frac{F_{t,Ed}}{\min(F_{t,Rd}; B_{p,Rd})} =$ 0,05 ≤ 1,0

Where:

$F_{t,Ed} =$ 9,3 kN – Tensile force

$F_{t,Rd} =$ 203,3 kN – Tension resistance

$B_{p,Rd} =$ 309,4 kN – Punching resistance

Utilization in shear

$\max(\frac{F_{v,Ed}}{F_{v,Rd}}; \frac{F_{b,Ed}}{F_{b,Rd}}) =$ 0,47 ≤ 1,0

Where:

$F_{v,Ed} =$ 62,1 kN – Shear force (in decisive shear plane)

$F_{v,Rd}$ = 135,6 kN – Shear resistance

$F_{b,Ed}$ = 62,1 kN – Bearing force (for decisive plate)

$F_{b,Rd}$ = 131,3 kN – Bearing resistance

Interaction of tension and shear (EN 1993-1-8 – Tab. 3.4)

$\frac{F_{v,Ed}}{F_{v,Rd}} + \frac{F_{t,Ed}}{1,4\,F_{t,Rd}} =$ 0,49 ≤ 1,0

Where:

$F_{v,Ed}$ = 62,1 kN – Shear force (in decisive shear plane)

$F_{v,Rd}$ = 135,6 kN – Shear resistance

$F_{t,Ed}$ = 9,3 kN – Tensile force

$F_{t,Rd}$ = 203,3 kN – Tension resistance

Detailed result for B5

Tension resistance check (EN 1993-1-8 – Tab. 3.4)

$F_{t,Rd} = \frac{k_2 f_{ub} A_s}{\gamma_{M2}} =$ 203,3 kN ≥ $F_{t,Ed} =$ 23,7 kN

Where:

k_2 = 0,90 – Factor

f_{ub} = 800,0 MPa – Ultimate tensile strength of the bolt

A_s = 353 mm^2 – Tensile stress area of the bolt

γ_{M2} = 1,25 – Safety factor

Punching resistance check (EN 1993-1-8 – Tab. 3.4)

$B_{p,Rd} = \frac{0,6\,\pi\,d_m\,t_p\,f_u}{\gamma_{M2}} =$ 309,4 kN ≥ $F_{t,Ed} =$ 23,7 kN

Where:

d_m = 38 mm – The mean of the across points and across flats dimensions of the bolt head or the nut, whichever is smaller

t_p = 15 mm – Plate thickness

f_u = 360,0 MPa – Ultimate strength

γ_{M2} = 1,25 – Safety factor

Shear resistance check (EN 1993-1-8 – Tab. 3.4)

$F_{v,Rd} = \frac{\beta_p\,\alpha_v f_{ub} A}{\gamma_{M2}} =$ 135,6 kN ≥ $F_{v,Ed} =$ 63,3 kN

Where:

β_p = 1,00 – Reduction factor for packing

α_v = 0,60 – Reduction factor for shear stress

f_{ub} = 800,0 MPa – Ultimate tensile strength of the bolt

A = 353 mm^2 – Gross cross-section area of the bolt

γ_{M2} = 1,25 – Safety factor

Bearing resistance check (EN 1993-1-8 – Tab. 3.4)

$F_{b,Rd} = \frac{k_1 \alpha_b f_u dt}{\gamma_{M2}}$ = 65,1 kN ≥ $F_{b,Ed}$ = 63,3 kN

Where:

$k_1 = \min(2.8\frac{e_2}{d_0} - 1.7, 1.4\frac{p_2}{d_0} - 1.7, 2.5)$ = 1,53 – Factor for edge distance and bolt spacing perpendicular to the direction of load transfer

$\alpha_b = \min(\frac{e_1}{3d_0}, \frac{p_1}{3d_0} - \frac{1}{4}, \frac{f_{ub}}{f_u}, 1)$ = 0,38 – Factor for end distance and bolt spacing in direction of load transfer

e_2 = 30 mm – Distance to the plate edge perpendicular to the shear force

p_2 = 100 mm – Distance between bolts perpendicular to the shear force

d_0 = 26 mm – Bolt hole diameter

e_1 = 30 mm – Distance to the plate edge in the direction of the shear force

p_1 = ∞ mm – Distance between bolts in the direction of the shear force

f_{ub} = 800,0 MPa – Ultimate tensile strength of the bolt

f_u = 360,0 MPa – Ultimate strength of the plate

d = 24 mm – Nominal diameter of the fastener

t = 16 mm – Thickness of the plate

γ_{M2} = 1,25 – Safety factor

Utilization in tension

$\frac{F_{t,Ed}}{\min(F_{t,Rd}; B_{p,Rd})}$ = 0,12 ≤ 1,0

Where:

$F_{t,Ed}$ = 23,7 kN – Tensile force

$F_{t,Rd}$ = 203,3 kN – Tension resistance

$B_{p,Rd}$ = 309,4 kN – Punching resistance

Utilization in shear

$\max(\frac{F_{v,Ed}}{F_{v,Rd}}; \frac{F_{b,Ed}}{F_{b,Rd}})$ = 0,97 ≤ 1,0

Where:

$F_{v,Ed}$ = 63,3 kN – Shear force (in decisive shear plane)

$F_{v,Rd}$ = 135,6 kN – Shear resistance

$F_{b,Ed}$ = 63,3 kN – Bearing force (for decisive plate)

$F_{b,Rd}$ = 65,1 kN – Bearing resistance

Interaction of tension and shear (EN 1993-1-8 – Tab. 3.4)

$\frac{F_{v,Ed}}{F_{v,Rd}} + \frac{F_{t,Ed}}{1,4\,F_{t,Rd}}$ = 0,55 ≤ 1,0

Where:

$F_{v,Ed}$ = 63,3 kN – Shear force (in decisive shear plane)

$F_{v,Rd}$ = 135,6 kN – Shear resistance

$F_{t,Ed}$ = 23,7 kN – Tensile force

$F_{t,Rd}$ = 203,3 kN – Tension resistance

Detailed result for B6

Tension resistance check (EN 1993-1-8 – Tab. 3.4)

$F_{t,Rd} = \frac{k_2 f_{ub} A_s}{\gamma_{M2}} =$ 203,3 kN ≥ $F_{t,Ed} =$ 17,6 kN

Where:

k_2 = 0,90 – Factor

f_{ub} = 800,0 MPa – Ultimate tensile strength of the bolt

A_s = 353 mm^2 – Tensile stress area of the bolt

γ_{M2} = 1,25 – Safety factor

Punching resistance check (EN 1993-1-8 – Tab. 3.4)

$B_{p,Rd} = \frac{0,6 \pi d_m t_p f_u}{\gamma_{M2}} =$ 309,4 kN ≥ $F_{t,Ed} =$ 17,6 kN

Where:

d_m = 38 mm – The mean of the across points and across flats dimensions of the bolt head or the nut, whichever is smaller

t_p = 15 mm – Plate thickness

f_u = 360,0 MPa – Ultimate strength

γ_{M2} = 1,25 – Safety factor

Shear resistance check (EN 1993-1-8 – Tab. 3.4)

$F_{v,Rd} = \frac{\beta_p \alpha_v f_{ub} A}{\gamma_{M2}} =$ 135,6 kN ≥ $F_{v,Ed} =$ 61,4 kN

Where:

β_p = 1,00 – Reduction factor for packing

α_v = 0,60 – Reduction factor for shear stress

f_{ub} = 800,0 MPa – Ultimate tensile strength of the bolt

A = 353 mm^2 – Gross cross-section area of the bolt

γ_{M2} = 1,25 – Safety factor

Bearing resistance check (EN 1993-1-8 – Tab. 3.4)

$F_{b,Rd} = \frac{k_1 \alpha_b f_u dt}{\gamma_{M2}} =$ 65,1 kN ≥ $F_{b,Ed} =$ 61,4 kN

Where:

$k_1 = \min(2.8\frac{e_2}{d_0} - 1.7, 1.4\frac{p_2}{d_0} - 1.7, 2.5) =$ 1,53 – Factor for edge distance and bolt spacing perpendicular to the direction of load transfer

$\alpha_b = \min(\frac{e_1}{3d_0}, \frac{p_1}{3d_0} - \frac{1}{4}, \frac{f_{ub}}{f_u}, 1) = 0{,}38$ – Factor for end distance and bolt spacing in direction of load transfer

$e_2 = 30$ mm – Distance to the plate edge perpendicular to the shear force

$p_2 = 100$ mm – Distance between bolts perpendicular to the shear force

$d_0 = 26$ mm – Bolt hole diameter

$e_1 = 30$ mm – Distance to the plate edge in the direction of the shear force

$p_1 = \infty$ mm – Distance between bolts in the direction of the shear force

$f_{ub} = 800{,}0$ MPa – Ultimate tensile strength of the bolt

$f_u = 360{,}0$ MPa – Ultimate strength of the plate

$d = 24$ mm – Nominal diameter of the fastener

$t = 16$ mm – Thickness of the plate

$\gamma_{M2} = 1{,}25$ – Safety factor

Utilization in tension

$$\frac{F_{t,Ed}}{\min(F_{t,Rd}; B_{p,Rd})} = 0{,}09 \leq 1{,}0$$

Where:

$F_{t,Ed} = 17{,}6$ kN – Tensile force

$F_{t,Rd} = 203{,}3$ kN – Tension resistance

$B_{p,Rd} = 309{,}4$ kN – Punching resistance

Utilization in shear

$$\max(\frac{F_{v,Ed}}{F_{v,Rd}}; \frac{F_{b,Ed}}{F_{b,Rd}}) = 0{,}94 \leq 1{,}0$$

Where:

$F_{v,Ed} = 61{,}4$ kN – Shear force (in decisive shear plane)

$F_{v,Rd} = 135{,}6$ kN – Shear resistance

$F_{b,Ed} = 61{,}4$ kN – Bearing force (for decisive plate)

$F_{b,Rd} = 65{,}1$ kN – Bearing resistance

Interaction of tension and shear (EN 1993-1-8 – Tab. 3.4)

$$\frac{F_{v,Ed}}{F_{v,Rd}} + \frac{F_{t,Ed}}{1{,}4\,F_{t,Rd}} = 0{,}51 \leq 1{,}0$$

Where:

$F_{v,Ed} = 61{,}4$ kN – Shear force (in decisive shear plane)

$F_{v,Rd} = 135{,}6$ kN – Shear resistance

$F_{t,Ed} = 17{,}6$ kN – Tensile force

$F_{t,Rd} = 203{,}3$ kN – Tension resistance

Detailed result for B7

Tension resistance check (EN 1993-1-8 – Tab. 3.4)

$F_{t,Rd} = \frac{k_2 f_{ub} A_s}{\gamma_{M2}} =$ 203,3 kN ≥ $F_{t,Ed} =$ 9,2 kN

Where:

$k_2 =$ 0,90 – Factor

$f_{ub} =$ 800,0 MPa – Ultimate tensile strength of the bolt

$A_s =$ 353 mm^2 – Tensile stress area of the bolt

$\gamma_{M2} =$ 1,25 – Safety factor

Punching resistance check (EN 1993-1-8 – Tab. 3.4)

$B_{p,Rd} = \frac{0,6 \pi d_m t_p f_u}{\gamma_{M2}} =$ 309,4 kN ≥ $F_{t,Ed} =$ 9,2 kN

Where:

$d_m =$ 38 mm – The mean of the across points and across flats dimensions of the bolt head or the nut, whichever is smaller

$t_p =$ 15 mm – Plate thickness

$f_u =$ 360,0 MPa – Ultimate strength

$\gamma_{M2} =$ 1,25 – Safety factor

Shear resistance check (EN 1993-1-8 – Tab. 3.4)

$F_{v,Rd} = \frac{\beta_p \alpha_v f_{ub} A}{\gamma_{M2}} =$ 135,6 kN ≥ $F_{v,Ed} =$ 62,2 kN

Where:

$\beta_p =$ 1,00 – Reduction factor for packing

$\alpha_v =$ 0,60 – Reduction factor for shear stress

$f_{ub} =$ 800,0 MPa – Ultimate tensile strength of the bolt

$A =$ 353 mm^2 – Gross cross-section area of the bolt

$\gamma_{M2} =$ 1,25 – Safety factor

Bearing resistance check (EN 1993-1-8 – Tab. 3.4)

$F_{b,Rd} = \frac{k_1 \alpha_b f_u dt}{\gamma_{M2}} =$ 131,3 kN ≥ $F_{b,Ed} =$ 62,2 kN

Where:

$k_1 = \min(2.8\frac{e_2}{d_0} - 1.7, 1.4\frac{p_2}{d_0} - 1.7, 2.5) =$ 1,53 – Factor for edge distance and bolt spacing perpendicular to the direction of load transfer

$\alpha_b = \min(\frac{e_1}{3d_0}, \frac{p_1}{3d_0} - \frac{1}{4}, \frac{f_{ub}}{f_u}, 1) =$ 0,78 – Factor for end distance and bolt spacing in direction of load transfer

$e_2 =$ 30 mm – Distance to the plate edge perpendicular to the shear force

$p_2 =$ 100 mm – Distance between bolts perpendicular to the shear force

$d_0 =$ 26 mm – Bolt hole diameter

$e_1 =$ 110 mm – Distance to the plate edge in the direction of the shear force

p_1 = 80 mm – Distance between bolts in the direction of the shear force

f_{ub} = 800,0 MPa – Ultimate tensile strength of the bolt

f_u = 360,0 MPa – Ultimate strength of the plate

d = 24 mm – Nominal diameter of the fastener

t = 16 mm – Thickness of the plate

γ_{M2} = 1,25 – Safety factor

Utilization in tension

$\frac{F_{t,Ed}}{\min(F_{t,Rd}\,;\,B_{p,Rd})}$ = 0,05 ≤ 1,0

Where:

$F_{t,Ed}$ = 9,2 kN – Tensile force

$F_{t,Rd}$ = 203,3 kN – Tension resistance

$B_{p,Rd}$ = 309,4 kN – Punching resistance

Utilization in shear

$\max(\frac{F_{v,Ed}}{F_{v,Rd}}\,;\,\frac{F_{b,Ed}}{F_{b,Rd}})$ = 0,47 ≤ 1,0

Where:

$F_{v,Ed}$ = 62,2 kN – Shear force (in decisive shear plane)

$F_{v,Rd}$ = 135,6 kN – Shear resistance

$F_{b,Ed}$ = 62,2 kN – Bearing force (for decisive plate)

$F_{b,Rd}$ = 131,3 kN – Bearing resistance

Interaction of tension and shear (EN 1993-1-8 – Tab. 3.4)

$\frac{F_{v,Ed}}{F_{v,Rd}} + \frac{F_{t,Ed}}{1{,}4\,F_{t,Rd}}$ = 0,49 ≤ 1,0

Where:

$F_{v,Ed}$ = 62,2 kN – Shear force (in decisive shear plane)

$F_{v,Rd}$ = 135,6 kN – Shear resistance

$F_{t,Ed}$ = 9,2 kN – Tensile force

$F_{t,Rd}$ = 203,3 kN – Tension resistance

Detailed result for B8

Tension resistance check (EN 1993-1-8 – Tab. 3.4)

$F_{t,Rd} = \frac{k_2 f_{ub} A_s}{\gamma_{M2}}$ = 203,3 kN ≥ $F_{t,Ed}$ = 19,9 kN

Where:

k_2 = 0,90 – Factor

f_{ub} = 800,0 MPa – Ultimate tensile strength of the bolt

A_s = 353 mm^2 – Tensile stress area of the bolt

γ_{M2} = 1,25 – Safety factor

Punching resistance check (EN 1993-1-8 – Tab. 3.4)

$B_{p,Rd} = \frac{0,6 \pi d_m t_p f_u}{\gamma_{M2}} =$ 309,4 kN ≥ $F_{t,Ed} =$ 19,9 kN

Where:

d_m = 38 mm – The mean of the across points and across flats dimensions of the bolt head or the nut, whichever is smaller

t_p = 15 mm – Plate thickness

f_u = 360,0 MPa – Ultimate strength

γ_{M2} = 1,25 – Safety factor

Shear resistance check (EN 1993-1-8 – Tab. 3.4)

$F_{v,Rd} = \frac{\beta_p \alpha_v f_{ub} A}{\gamma_{M2}} =$ 135,6 kN ≥ $F_{v,Ed} =$ 63,1 kN

Where:

β_p = 1,00 – Reduction factor for packing

α_v = 0,60 – Reduction factor for shear stress

f_{ub} = 800,0 MPa – Ultimate tensile strength of the bolt

A = 353 mm^2 – Gross cross-section area of the bolt

γ_{M2} = 1,25 – Safety factor

Bearing resistance check (EN 1993-1-8 – Tab. 3.4)

$F_{b,Rd} = \frac{k_1 \alpha_b f_u dt}{\gamma_{M2}} =$ 131,3 kN ≥ $F_{b,Ed} =$ 63,1 kN

Where:

$k_1 = \min(2.8\frac{e_2}{d_0} - 1.7, 1.4\frac{p_2}{d_0} - 1.7, 2.5) =$ 1,53 – Factor for edge distance and bolt spacing perpendicular to the direction of load transfer

$\alpha_b = \min(\frac{e_1}{3d_0}, \frac{p_1}{3d_0} - \frac{1}{4}, \frac{f_{ub}}{f_u}, 1) =$ 0,78 – Factor for end distance and bolt spacing in direction of load transfer

e_2 = 30 mm – Distance to the plate edge perpendicular to the shear force

p_2 = 100 mm – Distance between bolts perpendicular to the shear force

d_0 = 26 mm – Bolt hole diameter

e_1 = 110 mm – Distance to the plate edge in the direction of the shear force

p_1 = 80 mm – Distance between bolts in the direction of the shear force

f_{ub} = 800,0 MPa – Ultimate tensile strength of the bolt

f_u = 360,0 MPa – Ultimate strength of the plate

d = 24 mm – Nominal diameter of the fastener

t = 16 mm – Thickness of the plate

γ_{M2} = 1,25 – Safety factor

Utilization in tension

$$\frac{F_{t,Ed}}{\min(F_{t,Rd}\,;\,B_{p,Rd})} = \quad 0{,}10 \quad \leq \quad 1{,}0$$

Where:

$F_{t,Ed}$ = 19,9 kN – Tensile force

$F_{t,Rd}$ = 203,3 kN – Tension resistance

$B_{p,Rd}$ = 309,4 kN – Punching resistance

Utilization in shear

$$\max\left(\frac{F_{v,Ed}}{F_{v,Rd}}\,;\,\frac{F_{b,Ed}}{F_{b,Rd}}\right) = \quad 0{,}48 \quad \leq \quad 1{,}0$$

Where:

$F_{v,Ed}$ = 63,1 kN – Shear force (in decisive shear plane)

$F_{v,Rd}$ = 135,6 kN – Shear resistance

$F_{b,Ed}$ = 63,1 kN – Bearing force (for decisive plate)

$F_{b,Rd}$ = 131,3 kN – Bearing resistance

Interaction of tension and shear (EN 1993-1-8 – Tab. 3.4)

$$\frac{F_{v,Ed}}{F_{v,Rd}} + \frac{F_{t,Ed}}{1{,}4\,F_{t,Rd}} = \quad 0{,}54 \quad \leq \quad 1{,}0$$

Where:

$F_{v,Ed}$ = 63,1 kN – Shear force (in decisive shear plane)

$F_{v,Rd}$ = 135,6 kN – Shear resistance

$F_{t,Ed}$ = 19,9 kN – Tensile force

$F_{t,Rd}$ = 203,3 kN – Tension resistance

Welds

Item	Edge	T_w [mm]	L [mm]	Loads	$\sigma_{w,Ed}$ [MPa]	ε_{Pl} [%]	$\sigma_\perp$ [MPa]	$\tau_\parallel$ [MPa]	$\tau_\perp$ [MPa]	Ut [%]	Ut_c [%]	Status
D3-w 2	Gesneden plaat1	◢ 6,0 ◣	149	LE1	353,9	0,8	-10,1	111,2	171,3	98,3	35,1	OK
		◢ 6,0 ◣	149	LE1	355,9	2,1	81,3	-200,0	-5,1	98,9	37,6	OK
D3-w 4	Gesneden plaat1	◢ 6,0 ◣	149	LE1	353,8	0,7	55,1	-164,4	117,0	98,3	42,8	OK
		◢ 6,0 ◣	149	LE1	354,7	1,3	77,7	195,7	-40,5	98,5	30,2	OK
D4-w 4	Gesneden plaat2	◢ 6,0 ◣	149	LE1	353,8	0,7	55,7	163,4	118,4	98,3	42,8	OK
		◢ 6,0 ◣	149	LE1	354,7	1,3	78,2	-195,6	-40,7	98,5	30,1	OK
D4-w 2	Gesneden plaat2	◢ 6,0 ◣	149	LE1	353,9	0,8	-10,7	-112,4	170,6	98,3	35,2	OK
		◢ 6,0 ◣	149	LE1	355,9	2,1	81,1	200,0	-5,0	98,9	37,6	OK
Algemene plaat1	K1-w 1	◢ 6,0	547	LE1	319,0	0,0	89,0	164,1	65,8	88,6	18,6	OK
Algemene plaat1	K1-w 1	◢ 6,0	547	LE1	352,9	0,0	-81,4	-157,0	-121,0	98,0	10,5	OK

Algemene plaat1	K1-w 3	◢ 6,0	547	LE1	352,9	0,0	-11,7	188,4	-77,1	98,0	17,5	OK
Algemene plaat1	K1-w 3	◢ 6,0	547	LE1	352,8	0,0	62,8	-195,2	45,8	98,0	16,4	OK
Algemene plaat1	D1-w 2	◢ 6,0	236	LE1	353,3	0,3	-48,6	-201,5	-14,6	98,1	32,3	OK
Algemene plaat1	D1-w 2	◢ 6,0	236	LE1	353,2	0,3	-56,1	200,9	-12,8	98,1	35,0	OK
Algemene plaat1	D1-w 4	◢ 6,0	66	LE1	356,3	2,4	2,4	-204,3	24,1	99,0	77,4	OK
Algemene plaat1	D1-w 4	◢ 6,0	66	LE1	355,9	2,2	7,3	205,1	11,3	98,9	75,3	OK
Algemene plaat1	D2-w 2	◢ 6,0	236	LE1	352,9	0,0	-51,0	-201,1	14,1	98,0	26,6	OK
Algemene plaat1	D2-w 2	◢ 6,0	236	LE1	352,9	0,1	-40,3	202,1	11,3	98,0	24,1	OK
Algemene plaat1	D2-w 4	◢ 6,0	66	LE1	353,9	0,8	2,4	-204,2	6,8	98,3	72,5	OK
Algemene plaat1	D2-w 4	◢ 6,0	66	LE1	354,2	1,0	-4,5	202,5	28,6	98,4	75,4	OK
Algemene plaat1	K2-w 1	◢ 5,0	129	LE1	352,8	0,0	133,6	-136,4	-130,2	98,0	34,8	OK
Algemene plaat1	K2-w 1	◢ 5,0	129	LE1	290,5	0,0	-10,6	165,8	24,6	80,7	28,3	OK
Algemene plaat1	K2-w 3	◢ 5,0	129	LE1	283,2	0,0	-10,8	-161,7	23,1	78,7	27,8	OK
Algemene plaat1	K2-w 3	◢ 5,0	129	LE1	341,7	0,0	132,5	129,9	-127,3	94,9	34,9	OK

Design data

Material	β_w [-]	$\sigma_{w,Rd}$ [MPa]	0.9 σ [MPa]
S 235	0,80	360,0	259,2

Symbol explanation

T_w	Throat thickness a
L	Length
$\sigma_{w,Ed}$	Equivalent stress
ε_{Pl}	Strain
$\sigma_\perp$	Perpendicular stress
$\tau_\parallel$	Shear stress parallel to weld axis
$\tau_\perp$	Shear stress perpendicular to weld axis
Ut	Utilization
Ut_c	Weld capacity utilization
β_w	Correlation factor EN 1993-1-8 – Tab. 4.1
$\sigma_{w,Rd}$	Equivalent stress resistance
0.9 σ	Perpendicular stress resistance: 0.9*fu/γM2
◢	Fillet weld

Detailed result for D3-w 2 / Gesneden plaat1 - 1

Weld resistance check (EN 1993-1-8 – Cl. 4.5.3.2)

$\sigma_{w,Rd} = f_u/(\beta_w \gamma_{M2}) =$ 360,0 MPa ≥ $\sigma_{w,Ed} = [\sigma_\perp^2 + 3(\tau_\perp^2 + \tau_\parallel^2)]^{0.5} =$ 353,9 MPa

$\sigma_{\perp,Rd} = 0,9 f_u / \gamma_{M2} =$ 259,2 MPa ≥ $|\sigma_\perp| =$ 10,1 MPa

where:

$f_u =$ 360,0 MPa – Ultimate strength

$\beta_w =$ 0,80 – Correlation factor EN 1993-1-8 – Tab. 4.1

$\gamma_{M2} =$ 1,25 – Safety factor

Stress utilization

$U_t = \max(\frac{\sigma_{w,Ed}}{\sigma_{w,Rd}} ; \frac{|\sigma_\perp|}{\sigma_{\perp,Rd}}) =$ 0,98 ≤ 1,0

Where:

$\sigma_{w,Ed} =$ 353,9 MPa – Maximum normal stress transverse to the axis of the weld

$\sigma_{w,Rd} =$ 360,0 MPa – Equivalent stress resistance

$|\sigma_\perp| =$ -10,1 MPa – Normal stress perpendicular to the throat

$\sigma_{\perp,Rd} =$ 259,2 MPa – Perpendicular stress resistance

Detailed result for D3-w 2 / Gesneden plaat1 - 2

Weld resistance check (EN 1993-1-8 – Cl. 4.5.3.2)

$\sigma_{w,Rd} = f_u/(\beta_w \gamma_{M2}) =$ 360,0 MPa ≥ $\sigma_{w,Ed} = [\sigma_\perp^2 + 3(\tau_\perp^2 + \tau_\parallel^2)]^{0.5} =$ 355,9 MPa

$\sigma_{\perp,Rd} = 0,9 f_u / \gamma_{M2} =$ 259,2 MPa ≥ $|\sigma_\perp| =$ 81,3 MPa

where:

$f_u =$ 360,0 MPa – Ultimate strength

$\beta_w =$ 0,80 – Correlation factor EN 1993-1-8 – Tab. 4.1

$\gamma_{M2} =$ 1,25 – Safety factor

Stress utilization

$U_t = \max(\frac{\sigma_{w,Ed}}{\sigma_{w,Rd}} ; \frac{|\sigma_\perp|}{\sigma_{\perp,Rd}}) =$ 0,99 ≤ 1,0

Where:

$\sigma_{w,Ed} =$ 355,9 MPa – Maximum normal stress transverse to the axis of the weld

$\sigma_{w,Rd} =$ 360,0 MPa – Equivalent stress resistance

$|\sigma_\perp| =$ 81,3 MPa – Normal stress perpendicular to the throat

$\sigma_{\perp,Rd} =$ 259,2 MPa – Perpendicular stress resistance

Detailed result for D3-w 4 / Gesneden plaat1 - 1

Weld resistance check (EN 1993-1-8 – Cl. 4.5.3.2)

$\sigma_{w,Rd} = f_u/(\beta_w \gamma_{M2}) =$ 360,0 MPa ≥ $\sigma_{w,Ed} = [\sigma_\perp^2 + 3(\tau_\perp^2 + \tau_\parallel^2)]^{0.5} =$ 353,8 MPa

$\sigma_{\perp,Rd} = 0,9 f_u / \gamma_{M2} =$ 259,2 MPa ≥ $|\sigma_\perp| =$ 55,1 MPa

where:

f_u = 360,0 MPa – Ultimate strength

β_w = 0,80 – Correlation factor EN 1993-1-8 – Tab. 4.1

γ_{M2} = 1,25 – Safety factor

Stress utilization

$U_t = \max(\frac{\sigma_{w,Ed}}{\sigma_{w,Rd}} ; \frac{|\sigma_\perp|}{\sigma_{\perp,Rd}}) =$ 0,98 ≤ 1,0

Where:

$\sigma_{w,Ed}$ = 353,8 MPa – Maximum normal stress transverse to the axis of the weld

$\sigma_{w,Rd}$ = 360,0 MPa – Equivalent stress resistance

$|\sigma_\perp|$ = 55,1 MPa – Normal stress perpendicular to the throat

$\sigma_{\perp,Rd}$ = 259,2 MPa – Perpendicular stress resistance

Detailed result for D3-w 4 / Gesneden plaat1 - 2

Weld resistance check (EN 1993-1-8 – Cl. 4.5.3.2)

$\sigma_{w,Rd} = f_u/(\beta_w \gamma_{M2}) =$ 360,0 MPa ≥ $\sigma_{w,Ed} = [\sigma_\perp^2 + 3(\tau_\perp^2 + \tau_\parallel^2)]^{0.5} =$ 354,7 MPa

$\sigma_{\perp,Rd} = 0,9 f_u / \gamma_{M2} =$ 259,2 MPa ≥ $|\sigma_\perp| =$ 77,7 MPa

where:

f_u = 360,0 MPa – Ultimate strength

β_w = 0,80 – Correlation factor EN 1993-1-8 – Tab. 4.1

γ_{M2} = 1,25 – Safety factor

Stress utilization

$U_t = \max(\frac{\sigma_{w,Ed}}{\sigma_{w,Rd}} ; \frac{|\sigma_\perp|}{\sigma_{\perp,Rd}}) =$ 0,99 ≤ 1,0

Where:

$\sigma_{w,Ed}$ = 354,7 MPa – Maximum normal stress transverse to the axis of the weld

$\sigma_{w,Rd}$ = 360,0 MPa – Equivalent stress resistance

$|\sigma_\perp|$ = 77,7 MPa – Normal stress perpendicular to the throat

$\sigma_{\perp,Rd}$ = 259,2 MPa – Perpendicular stress resistance

Detailed result for D4-w 4 / Gesneden plaat2 - 1

Weld resistance check (EN 1993-1-8 – Cl. 4.5.3.2)

$\sigma_{w,Rd} = f_u/(\beta_w \gamma_{M2}) =$ 360,0 MPa ≥ $\sigma_{w,Ed} = [\sigma_\perp^2 + 3(\tau_\perp^2 + \tau_\parallel^2)]^{0.5} =$ 353,8 MPa

$\sigma_{\perp,Rd} = 0,9 f_u / \gamma_{M2} =$ 259,2 MPa ≥ $|\sigma_\perp| =$ 55,7 MPa

where:

f_u = 360,0 MPa – Ultimate strength

β_w = 0,80 – Correlation factor EN 1993-1-8 – Tab. 4.1

γ_{M2} = 1,25 – Safety factor

Stress utilization

$U_t = \max(\frac{\sigma_{w,Ed}}{\sigma_{w,Rd}} ; \frac{|\sigma_\perp|}{\sigma_{\perp,Rd}}) =$ 0,98 ≤ 1,0

Where:

$\sigma_{w,Ed}$ = 353,8 MPa – Maximum normal stress transverse to the axis of the weld

$\sigma_{w,Rd}$ = 360,0 MPa – Equivalent stress resistance

$|\sigma_\perp|$ = 55,7 MPa – Normal stress perpendicular to the throat

$\sigma_{\perp,Rd}$ = 259,2 MPa – Perpendicular stress resistance

Detailed result for D4-w 4 / Gesneden plaat2 - 2

Weld resistance check (EN 1993-1-8 – Cl. 4.5.3.2)

$\sigma_{w,Rd} = f_u/(\beta_w \gamma_{M2}) =$ 360,0 MPa ≥ $\sigma_{w,Ed} = [\sigma_\perp^2 + 3(\tau_\perp^2 + \tau_\parallel^2)]^{0.5} =$ 354,7 MPa

$\sigma_{\perp,Rd} = 0,9 f_u / \gamma_{M2} =$ 259,2 MPa ≥ $|\sigma_\perp| =$ 78,2 MPa

where:

f_u = 360,0 MPa – Ultimate strength

β_w = 0,80 – Correlation factor EN 1993-1-8 – Tab. 4.1

γ_{M2} = 1,25 – Safety factor

Stress utilization

$U_t = \max(\frac{\sigma_{w,Ed}}{\sigma_{w,Rd}} ; \frac{|\sigma_\perp|}{\sigma_{\perp,Rd}}) =$ 0,99 ≤ 1,0

Where:

$\sigma_{w,Ed}$ = 354,7 MPa – Maximum normal stress transverse to the axis of the weld

$\sigma_{w,Rd}$ = 360,0 MPa – Equivalent stress resistance

$|\sigma_\perp|$ = 78,2 MPa – Normal stress perpendicular to the throat

$\sigma_{\perp,Rd}$ = 259,2 MPa – Perpendicular stress resistance

Detailed result for D4-w 2 / Gesneden plaat2 - 1

Weld resistance check (EN 1993-1-8 – Cl. 4.5.3.2)

$\sigma_{w,Rd} = f_u/(\beta_w \gamma_{M2}) =$ 360,0 MPa ≥ $\sigma_{w,Ed} = [\sigma_\perp^2 + 3(\tau_\perp^2 + \tau_\parallel^2)]^{0.5} =$ 353,9 MPa

$\sigma_{\perp,Rd} = 0,9 f_u / \gamma_{M2} =$ 259,2 MPa ≥ $|\sigma_\perp| =$ 10,7 MPa

where:

f_u = 360,0 MPa – Ultimate strength

β_w = 0,80 – Correlation factor EN 1993-1-8 – Tab. 4.1

γ_{M2} = 1,25 – Safety factor

Stress utilization

$U_t = \max(\frac{\sigma_{w,Ed}}{\sigma_{w,Rd}} ; \frac{|\sigma_\perp|}{\sigma_{\perp,Rd}}) =$ 0,98 ≤ 1,0

Where:

$\sigma_{w,Ed}$ = 353,9 MPa – Maximum normal stress transverse to the axis of the weld

$\sigma_{w,Rd}$ = 360,0 MPa – Equivalent stress resistance

$|\sigma_\perp|$ = -10,7 MPa – Normal stress perpendicular to the throat

$\sigma_{\perp,Rd}$ = 259,2 MPa – Perpendicular stress resistance

Detailed result for D4-w 2 / Gesneden plaat2 - 2

Weld resistance check (EN 1993-1-8 – Cl. 4.5.3.2)

$\sigma_{w,Rd} = f_u/(\beta_w \gamma_{M2}) =$ 360,0 MPa ≥ $\sigma_{w,Ed} = [\sigma_\perp^2 + 3(\tau_\perp^2 + \tau_\parallel^2)]^{0.5} =$ 355,9 MPa

$\sigma_{\perp,Rd} = 0,9 f_u / \gamma_{M2} =$ 259,2 MPa ≥ $|\sigma_\perp| =$ 81,1 MPa

where:

f_u = 360,0 MPa – Ultimate strength

β_w = 0,80 – Correlation factor EN 1993-1-8 – Tab. 4.1

γ_{M2} = 1,25 – Safety factor

Stress utilization

$U_t = \max(\frac{\sigma_{w,Ed}}{\sigma_{w,Rd}} ; \frac{|\sigma_\perp|}{\sigma_{\perp,Rd}}) =$ 0,99 ≤ 1,0

Where:

$\sigma_{w,Ed}$ = 355,9 MPa – Maximum normal stress transverse to the axis of the weld

$\sigma_{w,Rd}$ = 360,0 MPa – Equivalent stress resistance

$|\sigma_\perp|$ = 81,1 MPa – Normal stress perpendicular to the throat

$\sigma_{\perp,Rd}$ = 259,2 MPa – Perpendicular stress resistance

Detailed result for Algemene plaat1 / K1-w 1 - 1

Weld resistance check (EN 1993-1-8 – Cl. 4.5.3.2)

$\sigma_{w,Rd} = f_u/(\beta_w \gamma_{M2}) =$ 360,0 MPa ≥ $\sigma_{w,Ed} = [\sigma_\perp^2 + 3(\tau_\perp^2 + \tau_\parallel^2)]^{0.5} =$ 319,0 MPa

$\sigma_{\perp,Rd} = 0,9 f_u / \gamma_{M2} =$ 259,2 MPa ≥ $|\sigma_\perp| =$ 89,0 MPa

where:

f_u = 360,0 MPa – Ultimate strength

β_w = 0,80 – Correlation factor EN 1993-1-8 – Tab. 4.1

γ_{M2} = 1,25 – Safety factor

Stress utilization

$U_t = \max(\frac{\sigma_{w,Ed}}{\sigma_{w,Rd}} ; \frac{|\sigma_\perp|}{\sigma_{\perp,Rd}}) =$ 0,89 ≤ 1,0

Where:

$\sigma_{w,Ed}$ = 319,0 MPa – Maximum normal stress transverse to the axis of the weld

$\sigma_{w,Rd}$ = 360,0 MPa – Equivalent stress resistance

$|\sigma_\perp|$ = 89,0 MPa – Normal stress perpendicular to the throat

$\sigma_{\perp,Rd}$ = 259,2 MPa – Perpendicular stress resistance

Detailed result for Algemene plaat1 / K1-w 1 - 1

Weld resistance check (EN 1993-1-8 – Cl. 4.5.3.2)

$\sigma_{w,Rd} = f_u/(\beta_w \gamma_{M2}) =$ 360,0 MPa ≥ $\sigma_{w,Ed} = [\sigma_\perp^2 + 3(\tau_\perp^2 + \tau_\parallel^2)]^{0.5} =$ 352,9 MPa

$\sigma_{\perp,Rd} = 0,9 f_u / \gamma_{M2} =$ 259,2 MPa ≥ $|\sigma_\perp| =$ 81,4 MPa

where:

f_u = 360,0 MPa – Ultimate strength

β_w = 0,80 – Correlation factor EN 1993-1-8 – Tab. 4.1

γ_{M2} = 1,25 – Safety factor

Stress utilization

$U_t = \max(\frac{\sigma_{w,Ed}}{\sigma_{w,Rd}} ; \frac{|\sigma_\perp|}{\sigma_{\perp,Rd}}) =$ 0,98 ≤ 1,0

Where:

$\sigma_{w,Ed}$ = 352,9 MPa – Maximum normal stress transverse to the axis of the weld

$\sigma_{w,Rd}$ = 360,0 MPa – Equivalent stress resistance

$|\sigma_\perp|$ = -81,4 MPa – Normal stress perpendicular to the throat

$\sigma_{\perp,Rd}$ = 259,2 MPa – Perpendicular stress resistance

Detailed result for Algemene plaat1 / K1-w 3 - 1

Weld resistance check (EN 1993-1-8 – Cl. 4.5.3.2)

$\sigma_{w,Rd} = f_u/(\beta_w \gamma_{M2}) =$ 360,0 MPa ≥ $\sigma_{w,Ed} = [\sigma_\perp^2 + 3(\tau_\perp^2 + \tau_\parallel^2)]^{0.5} =$ 352,9 MPa

$\sigma_{\perp,Rd} = 0,9 f_u / \gamma_{M2} =$ 259,2 MPa ≥ $|\sigma_\perp| =$ 11,7 MPa

where:

f_u = 360,0 MPa – Ultimate strength

β_w = 0,80 – Correlation factor EN 1993-1-8 – Tab. 4.1

γ_{M2} = 1,25 – Safety factor

Stress utilization

$U_t = \max\left(\frac{\sigma_{w,Ed}}{\sigma_{w,Rd}} ; \frac{|\sigma_\perp|}{\sigma_{\perp,Rd}}\right) =$ 0,98 ≤ 1,0

Where:

$\sigma_{w,Ed}$ = 352,9 MPa – Maximum normal stress transverse to the axis of the weld

$\sigma_{w,Rd}$ = 360,0 MPa – Equivalent stress resistance

$|\sigma_\perp|$ = -11,7 MPa – Normal stress perpendicular to the throat

$\sigma_{\perp,Rd}$ = 259,2 MPa – Perpendicular stress resistance

Detailed result for Algemene plaat1 / K1-w 3 - 1

Weld resistance check (EN 1993-1-8 – Cl. 4.5.3.2)

$\sigma_{w,Rd} = f_u/(\beta_w \gamma_{M2}) =$ 360,0 MPa ≥ $\sigma_{w,Ed} = [\sigma_\perp^2 + 3(\tau_\perp^2 + \tau_\parallel^2)]^{0.5} =$ 352,8 MPa

$\sigma_{\perp,Rd} = 0,9 f_u / \gamma_{M2} =$ 259,2 MPa ≥ $|\sigma_\perp| =$ 62,8 MPa

where:

f_u = 360,0 MPa – Ultimate strength

β_w = 0,80 – Correlation factor EN 1993-1-8 – Tab. 4.1

γ_{M2} = 1,25 – Safety factor

Stress utilization

$U_t = \max\left(\frac{\sigma_{w,Ed}}{\sigma_{w,Rd}} ; \frac{|\sigma_\perp|}{\sigma_{\perp,Rd}}\right) =$ 0,98 ≤ 1,0

Where:

$\sigma_{w,Ed}$ = 352,8 MPa – Maximum normal stress transverse to the axis of the weld

$\sigma_{w,Rd}$ = 360,0 MPa – Equivalent stress resistance

$|\sigma_\perp|$ = 62,8 MPa – Normal stress perpendicular to the throat

$\sigma_{\perp,Rd}$ = 259,2 MPa – Perpendicular stress resistance

Detailed result for Algemene plaat1 / D1-w 2 - 1

Weld resistance check (EN 1993-1-8 – Cl. 4.5.3.2)

$\sigma_{w,Rd} = f_u/(\beta_w \gamma_{M2}) =$ 360,0 MPa ≥ $\sigma_{w,Ed} = [\sigma_\perp^2 + 3(\tau_\perp^2 + \tau_\parallel^2)]^{0.5} =$ 353,3 MPa

$\sigma_{\perp,Rd} = 0,9 f_u / \gamma_{M2} =$ 259,2 MPa ≥ $|\sigma_\perp| =$ 48,6 MPa

where:

f_u = 360,0 MPa – Ultimate strength

β_w = 0,80 – Correlation factor EN 1993-1-8 – Tab. 4.1

γ_{M2} = 1,25 – Safety factor

Stress utilization

$U_t = \max\left(\frac{\sigma_{w,Ed}}{\sigma_{w,Rd}} ; \frac{|\sigma_\perp|}{\sigma_{\perp,Rd}}\right) =$ 0,98 ≤ 1,0

Where:

$\sigma_{w,Ed}$ = 353,3 MPa – Maximum normal stress transverse to the axis of the weld

$\sigma_{w,Rd}$ = 360,0 MPa – Equivalent stress resistance

$|\sigma_\perp|$ = -48,6 MPa – Normal stress perpendicular to the throat

$\sigma_{\perp,Rd}$ = 259,2 MPa – Perpendicular stress resistance

Detailed result for Algemene plaat1 / D1-w 2 - 1

Weld resistance check (EN 1993-1-8 – Cl. 4.5.3.2)

$\sigma_{w,Rd} = f_u/(\beta_w \gamma_{M2}) =$ 360,0 MPa ≥ $\sigma_{w,Ed} = [\sigma_\perp^2 + 3(\tau_\perp^2 + \tau_\parallel^2)]^{0.5} =$ 353,2 MPa

$\sigma_{\perp,Rd} = 0,9 f_u / \gamma_{M2} =$ 259,2 MPa ≥ $|\sigma_\perp| =$ 56,1 MPa

where:

f_u = 360,0 MPa – Ultimate strength

β_w = 0,80 – Correlation factor EN 1993-1-8 – Tab. 4.1

γ_{M2} = 1,25 – Safety factor

Stress utilization

$U_t = \max\left(\frac{\sigma_{w,Ed}}{\sigma_{w,Rd}} ; \frac{|\sigma_\perp|}{\sigma_{\perp,Rd}}\right) =$ 0,98 ≤ 1,0

Where:

$\sigma_{w,Ed}$ = 353,2 MPa – Maximum normal stress transverse to the axis of the weld

$\sigma_{w,Rd}$ = 360,0 MPa – Equivalent stress resistance

$|\sigma_\perp|$ = -56,1 MPa – Normal stress perpendicular to the throat

$\sigma_{\perp,Rd}$ = 259,2 MPa – Perpendicular stress resistance

Detailed result for Algemene plaat1 / D1-w 4 - 1

Weld resistance check (EN 1993-1-8 – Cl. 4.5.3.2)

$\sigma_{w,Rd} = f_u/(\beta_w \gamma_{M2}) =$ 360,0 MPa ≥ $\sigma_{w,Ed} = [\sigma_\perp^2 + 3(\tau_\perp^2 + \tau_\parallel^2)]^{0.5} =$ 356,3 MPa

$\sigma_{\perp,Rd} = 0,9 f_u / \gamma_{M2} =$ 259,2 MPa ≥ $|\sigma_\perp| =$ 2,4 MPa

where:

f_u = 360,0 MPa – Ultimate strength

β_w = 0,80 – Correlation factor EN 1993-1-8 – Tab. 4.1

γ_{M2} = 1,25 – Safety factor

Stress utilization

$U_t = \max\left(\frac{\sigma_{w,Ed}}{\sigma_{w,Rd}} ; \frac{|\sigma_\perp|}{\sigma_{\perp,Rd}}\right) =$ 0,99 ≤ 1,0

Where:

$\sigma_{w,Ed}$ = 356,3 MPa – Maximum normal stress transverse to the axis of the weld

$\sigma_{w,Rd}$ = 360,0 MPa – Equivalent stress resistance

$|\sigma_{\perp}|$ = 2,4 MPa – Normal stress perpendicular to the throat

$\sigma_{\perp,Rd}$ = 259,2 MPa – Perpendicular stress resistance

Detailed result for Algemene plaat1 / D1-w 4 - 1

Weld resistance check (EN 1993-1-8 – Cl. 4.5.3.2)

$\sigma_{w,Rd} = f_u/(\beta_w \gamma_{M2}) =$ 360,0 MPa ≥ $\sigma_{w,Ed} = [\sigma_{\perp}^2 + 3(\tau_{\perp}^2 + \tau_{\parallel}^2)]^{0.5} =$ 355,9 MPa

$\sigma_{\perp,Rd} = 0,9 f_u / \gamma_{M2} =$ 259,2 MPa ≥ $|\sigma_{\perp}| =$ 7,3 MPa

where:

f_u = 360,0 MPa – Ultimate strength

β_w = 0,80 – Correlation factor EN 1993-1-8 – Tab. 4.1

γ_{M2} = 1,25 – Safety factor

Stress utilization

$U_t = \max(\frac{\sigma_{w,Ed}}{\sigma_{w,Rd}} ; \frac{|\sigma_{\perp}|}{\sigma_{\perp,Rd}}) =$ 0,99 ≤ 1,0

Where:

$\sigma_{w,Ed}$ = 355,9 MPa – Maximum normal stress transverse to the axis of the weld

$\sigma_{w,Rd}$ = 360,0 MPa – Equivalent stress resistance

$|\sigma_{\perp}|$ = 7,3 MPa – Normal stress perpendicular to the throat

$\sigma_{\perp,Rd}$ = 259,2 MPa – Perpendicular stress resistance

Detailed result for Algemene plaat1 / D2-w 2 - 1

Weld resistance check (EN 1993-1-8 – Cl. 4.5.3.2)

$\sigma_{w,Rd} = f_u/(\beta_w \gamma_{M2}) =$ 360,0 MPa ≥ $\sigma_{w,Ed} = [\sigma_{\perp}^2 + 3(\tau_{\perp}^2 + \tau_{\parallel}^2)]^{0.5} =$ 352,9 MPa

$\sigma_{\perp,Rd} = 0,9 f_u / \gamma_{M2} =$ 259,2 MPa ≥ $|\sigma_{\perp}| =$ 51,0 MPa

where:

f_u = 360,0 MPa – Ultimate strength

β_w = 0,80 – Correlation factor EN 1993-1-8 – Tab. 4.1

γ_{M2} = 1,25 – Safety factor

Stress utilization

$U_t = \max(\frac{\sigma_{w,Ed}}{\sigma_{w,Rd}} ; \frac{|\sigma_{\perp}|}{\sigma_{\perp,Rd}}) =$ 0,98 ≤ 1,0

Where:

$\sigma_{w,Ed}$ = 352,9 MPa – Maximum normal stress transverse to the axis of the weld

$\sigma_{w,Rd}$ = 360,0 MPa – Equivalent stress resistance

$|\sigma_{\perp}|$ = -51,0 MPa – Normal stress perpendicular to the throat

$\sigma_{\perp,Rd}$ = 259,2 MPa – Perpendicular stress resistance

Detailed result for Algemene plaat1 / D2-w 2 - 1

Weld resistance check (EN 1993-1-8 – Cl. 4.5.3.2)

$\sigma_{w,Rd} = f_u/(\beta_w \gamma_{M2}) =$ 360,0 MPa ≥ $\sigma_{w,Ed} = [\sigma_{\perp}^2 + 3(\tau_{\perp}^2 + \tau_{\parallel}^2)]^{0.5} =$ 352,9 MPa

$\sigma_{\perp,Rd} = 0,9 f_u / \gamma_{M2} =$ 259,2 MPa ≥ $|\sigma_{\perp}| =$ 40,3 MPa

where:

f_u = 360,0 MPa – Ultimate strength

β_w = 0,80 – Correlation factor EN 1993-1-8 – Tab. 4.1

γ_{M2} = 1,25 – Safety factor

Stress utilization

$U_t = \max(\frac{\sigma_{w,Ed}}{\sigma_{w,Rd}} ; \frac{|\sigma_{\perp}|}{\sigma_{\perp,Rd}}) =$ 0,98 ≤ 1,0

Where:

$\sigma_{w,Ed}$ = 352,9 MPa – Maximum normal stress transverse to the axis of the weld

$\sigma_{w,Rd}$ = 360,0 MPa – Equivalent stress resistance

$|\sigma_{\perp}|$ = -40,3 MPa – Normal stress perpendicular to the throat

$\sigma_{\perp,Rd}$ = 259,2 MPa – Perpendicular stress resistance

Detailed result for Algemene plaat1 / D2-w 4 - 1

Weld resistance check (EN 1993-1-8 – Cl. 4.5.3.2)

$\sigma_{w,Rd} = f_u/(\beta_w \gamma_{M2}) =$ 360,0 MPa ≥ $\sigma_{w,Ed} = [\sigma_{\perp}^2 + 3(\tau_{\perp}^2 + \tau_{\parallel}^2)]^{0.5} =$ 353,9 MPa

$\sigma_{\perp,Rd} = 0,9 f_u / \gamma_{M2} =$ 259,2 MPa ≥ $|\sigma_{\perp}| =$ 2,4 MPa

where:

f_u = 360,0 MPa – Ultimate strength

β_w = 0,80 – Correlation factor EN 1993-1-8 – Tab. 4.1

γ_{M2} = 1,25 – Safety factor

Stress utilization

$U_t = \max(\frac{\sigma_{w,Ed}}{\sigma_{w,Rd}} ; \frac{|\sigma_{\perp}|}{\sigma_{\perp,Rd}}) =$ 0,98 ≤ 1,0

Where:

$\sigma_{w,Ed}$ = 353,9 MPa – Maximum normal stress transverse to the axis of the weld

$\sigma_{w,Rd}$ = 360,0 MPa – Equivalent stress resistance

$|\sigma_{\perp}|$ = 2,4 MPa – Normal stress perpendicular to the throat

$\sigma_{\perp,Rd}$ = 259,2 MPa – Perpendicular stress resistance

Detailed result for Algemene plaat1 / D2-w 4 - 1

Weld resistance check (EN 1993-1-8 – Cl. 4.5.3.2)

$\sigma_{w,Rd} = f_u/(\beta_w \gamma_{M2}) =$ 360,0 MPa ≥ $\sigma_{w,Ed} = [\sigma_{\perp}^2 + 3(\tau_{\perp}^2 + \tau_{\parallel}^2)]^{0.5} =$ 354,2 MPa

$\sigma_{\perp,Rd} = 0,9 f_u / \gamma_{M2} =$ 259,2 MPa ≥ $|\sigma_{\perp}| =$ 4,5 MPa

where:

f_u = 360,0 MPa – Ultimate strength

β_w = 0,80 – Correlation factor EN 1993-1-8 – Tab. 4.1

γ_{M2} = 1,25 – Safety factor

Stress utilization

$U_t = \max(\frac{\sigma_{w,Ed}}{\sigma_{w,Rd}} ; \frac{|\sigma_{\perp}|}{\sigma_{\perp,Rd}}) =$ 0,98 ≤ 1,0

Where:

$\sigma_{w,Ed}$ = 354,2 MPa – Maximum normal stress transverse to the axis of the weld

$\sigma_{w,Rd}$ = 360,0 MPa – Equivalent stress resistance

$|\sigma_{\perp}|$ = -4,5 MPa – Normal stress perpendicular to the throat

$\sigma_{\perp,Rd}$ = 259,2 MPa – Perpendicular stress resistance

Detailed result for Algemene plaat1 / K2-w 1 - 1

Weld resistance check (EN 1993-1-8 – Cl. 4.5.3.2)

$\sigma_{w,Rd} = f_u/(\beta_w \gamma_{M2}) =$ 360,0 MPa ≥ $\sigma_{w,Ed} = [\sigma_{\perp}^2 + 3(\tau_{\perp}^2 + \tau_{\parallel}^2)]^{0.5} =$ 352,8 MPa

$\sigma_{\perp,Rd} = 0,9 f_u / \gamma_{M2} =$ 259,2 MPa ≥ $|\sigma_{\perp}| =$ 133,6 MPa

where:

f_u = 360,0 MPa – Ultimate strength

β_w = 0,80 – Correlation factor EN 1993-1-8 – Tab. 4.1

γ_{M2} = 1,25 – Safety factor

Stress utilization

$U_t = \max(\frac{\sigma_{w,Ed}}{\sigma_{w,Rd}} ; \frac{|\sigma_{\perp}|}{\sigma_{\perp,Rd}}) =$ 0,98 ≤ 1,0

Where:

$\sigma_{w,Ed}$ = 352,8 MPa – Maximum normal stress transverse to the axis of the weld

$\sigma_{w,Rd}$ = 360,0 MPa – Equivalent stress resistance

$|\sigma_\perp|$ = 133,6 MPa – Normal stress perpendicular to the throat

$\sigma_{\perp,Rd}$ = 259,2 MPa – Perpendicular stress resistance

Detailed result for Algemene plaat1 / K2-w 1 - 1

Weld resistance check (EN 1993-1-8 – Cl. 4.5.3.2)

$\sigma_{w,Rd} = f_u/(\beta_w \gamma_{M2}) =$ 360,0 MPa ≥ $\sigma_{w,Ed} = [\sigma_\perp^2 + 3(\tau_\perp^2 + \tau_\parallel^2)]^{0.5} =$ 290,5 MPa

$\sigma_{\perp,Rd} = 0,9 f_u / \gamma_{M2} =$ 259,2 MPa ≥ $|\sigma_\perp| =$ 10,6 MPa

where:

f_u = 360,0 MPa – Ultimate strength

β_w = 0,80 – Correlation factor EN 1993-1-8 – Tab. 4.1

γ_{M2} = 1,25 – Safety factor

Stress utilization

$U_t = \max(\frac{\sigma_{w,Ed}}{\sigma_{w,Rd}} ; \frac{|\sigma_\perp|}{\sigma_{\perp,Rd}}) =$ 0,81 ≤ 1,0

Where:

$\sigma_{w,Ed}$ = 290,5 MPa – Maximum normal stress transverse to the axis of the weld

$\sigma_{w,Rd}$ = 360,0 MPa – Equivalent stress resistance

$|\sigma_\perp|$ = -10,6 MPa – Normal stress perpendicular to the throat

$\sigma_{\perp,Rd}$ = 259,2 MPa – Perpendicular stress resistance

Detailed result for Algemene plaat1 / K2-w 3 - 1

Weld resistance check (EN 1993-1-8 – Cl. 4.5.3.2)

$\sigma_{w,Rd} = f_u/(\beta_w \gamma_{M2}) =$ 360,0 MPa ≥ $\sigma_{w,Ed} = [\sigma_\perp^2 + 3(\tau_\perp^2 + \tau_\parallel^2)]^{0.5} =$ 283,2 MPa

$\sigma_{\perp,Rd} = 0,9 f_u / \gamma_{M2} =$ 259,2 MPa ≥ $|\sigma_\perp| =$ 10,8 MPa

where:

f_u = 360,0 MPa – Ultimate strength

β_w = 0,80 – Correlation factor EN 1993-1-8 – Tab. 4.1

γ_{M2} = 1,25 – Safety factor

Stress utilization

$U_t = \max(\frac{\sigma_{w,Ed}}{\sigma_{w,Rd}} ; \frac{|\sigma_\perp|}{\sigma_{\perp,Rd}}) =$ 0,79 ≤ 1,0

Where:

$\sigma_{w,Ed}$ = 283,2 MPa – Maximum normal stress transverse to the axis of the weld

$\sigma_{w,Rd}$ = 360,0 MPa – Equivalent stress resistance

$|\sigma_\perp|$ = -10,8 MPa – Normal stress perpendicular to the throat

$\sigma_{\perp,Rd}$ = 259,2 MPa – Perpendicular stress resistance

Detailed result for Algemene plaat1 / K2-w 3 - 1

Weld resistance check (EN 1993-1-8 – Cl. 4.5.3.2)

$\sigma_{w,Rd} = f_u/(\beta_w \gamma_{M2}) =$ 360,0 MPa ≥ $\sigma_{w,Ed} = [\sigma_\perp^2 + 3(\tau_\perp^2 + \tau_\parallel^2)]^{0.5} =$ 341,7 MPa

$\sigma_{\perp,Rd} = 0,9 f_u / \gamma_{M2} =$ 259,2 MPa ≥ $|\sigma_\perp| =$ 132,5 MPa

where:

f_u = 360,0 MPa – Ultimate strength

β_w = 0,80 – Correlation factor EN 1993-1-8 – Tab. 4.1

γ_{M2} = 1,25 – Safety factor

Stress utilization

$U_t = \max(\frac{\sigma_{w,Ed}}{\sigma_{w,Rd}} ; \frac{|\sigma_\perp|}{\sigma_{\perp,Rd}}) =$ 0,95 ≤ 1,0

Where:

$\sigma_{w,Ed}$ = 341,7 MPa – Maximum normal stress transverse to the axis of the weld

$\sigma_{w,Rd}$ = 360,0 MPa – Equivalent stress resistance

$|\sigma_\perp|$ = 132,5 MPa – Normal stress perpendicular to the throat

$\sigma_{\perp,Rd}$ = 259,2 MPa – Perpendicular stress resistance

Buckling

Buckling analysis was not calculated.

Cost estimation

Steel

Steel grade	Total weight [kg]	Unit cost [€/kg]	Cost [€]
S 235	40,04	2,00	80,09

Bolts

Bolt assembly	Total weight [kg]	Unit cost [€/kg]	Cost [€]
M24 8.8	4,42	5,00	22,10

Welds

Weld type	Throat thickness [mm]	Leg size [mm]	Total weight [kg]	Unit cost [€/kg]	Cost [€]
Double fillet	6,0	8,5	1,30	40,00	52,12

Fillet rear	5,0	7,1	0,10	40,00	4,08

Hole drilling

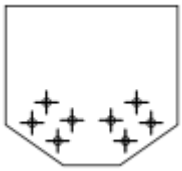
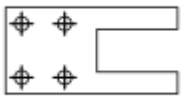
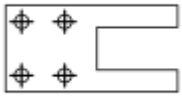
Bolt assembly cost [€]	Percentage of bolt assembly cost [%]	Cost [€]
22,10	30,0	6,63

Cost summary

Cost estimation summary	Cost [€]
Total estimated cost	165,02

Bill of material

Manufacturing operations

Name	Plates [mm]	Shape	Nr.	Welds [mm]	Length [mm]	Bolts	Nr.
Algemene plaat1	P15,0x550,0-510,0 (S 235)		1			M24 8.8	8
Gesneden plaat1	P16,0x320,0-160,0 (S 235)		1	Double fillet: a = 6,0	300,0	M24 8.8	4
Gesneden plaat2	P16,0x320,0-160,0 (S 235)		1	Double fillet: a = 6,0	300,0	M24 8.8	4
CUT1				Fillet: a = 6,0	2200,0		
CUT3							
CUT4							
CUT5				Fillet: a = 6,0	605,4		
CUT6				Fillet: a = 6,0	605,4		
CUT7							
CUT8				Fillet: a = 5,0	520,0		

Welds

Type	Material	Throat thickness [mm]	Leg size [mm]	Length [mm]
Double fillet	S 235	6,0	8,5	600,0
Fillet	S 235	6,0	8,5	3410,8

Fillet	S 235	5,0	7,1	520,0

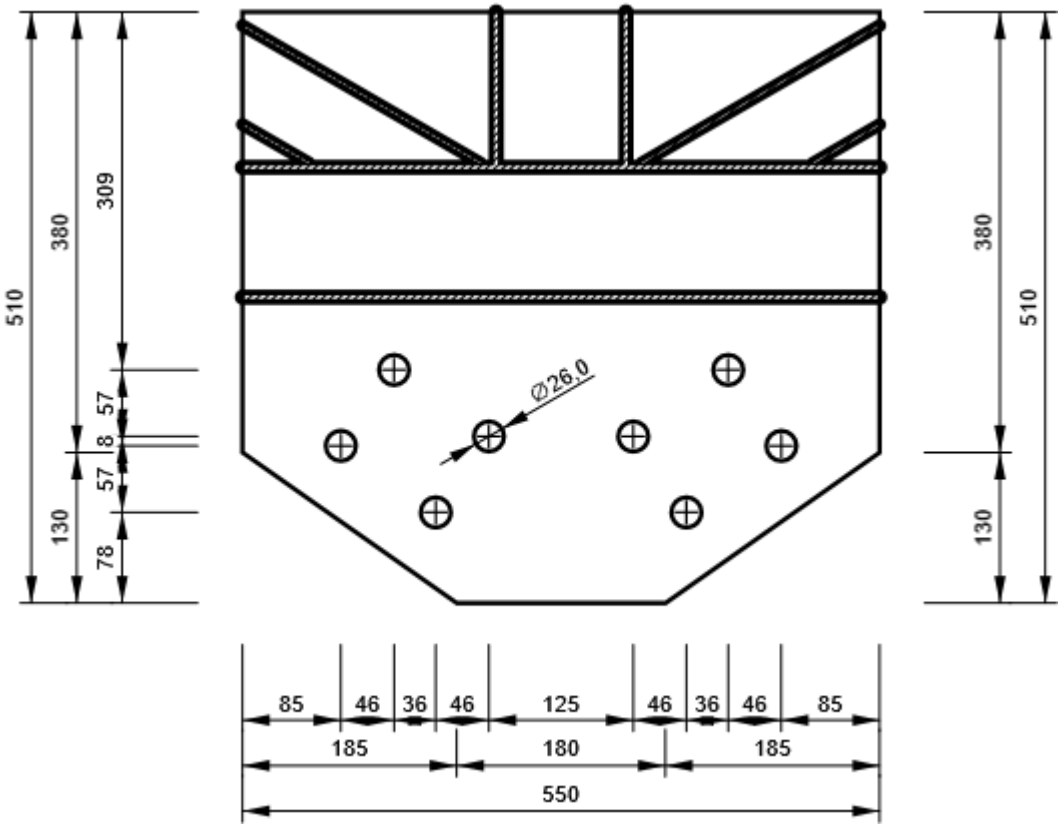
Bolts

Name	Grip length [mm]	Count
M24 8.8	31	8

Drawing

Algemene plaat1

P15,0x510-550 (S 235)



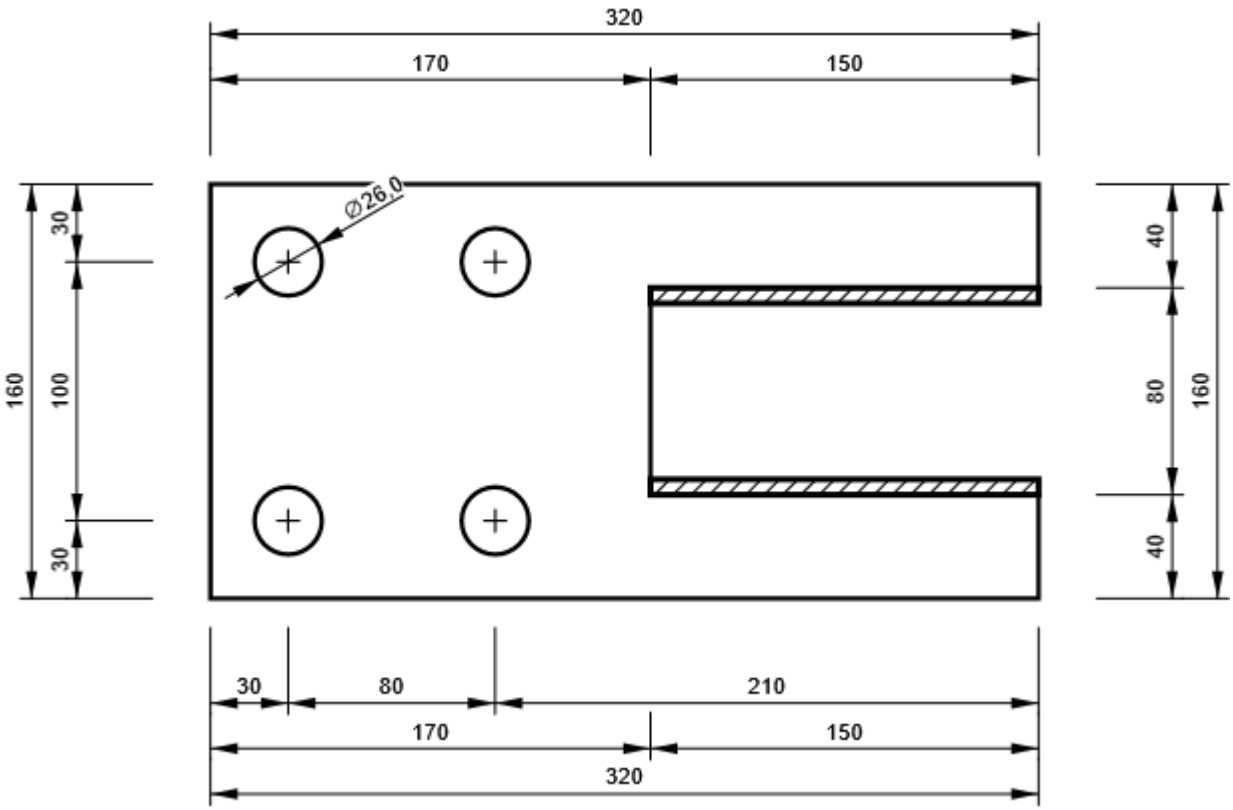
Project: Amsterdam industrial

Project no: 20239010

Author: Dave the Engineer

Gesneden plaat1

P16,0x160-320 (S 235)



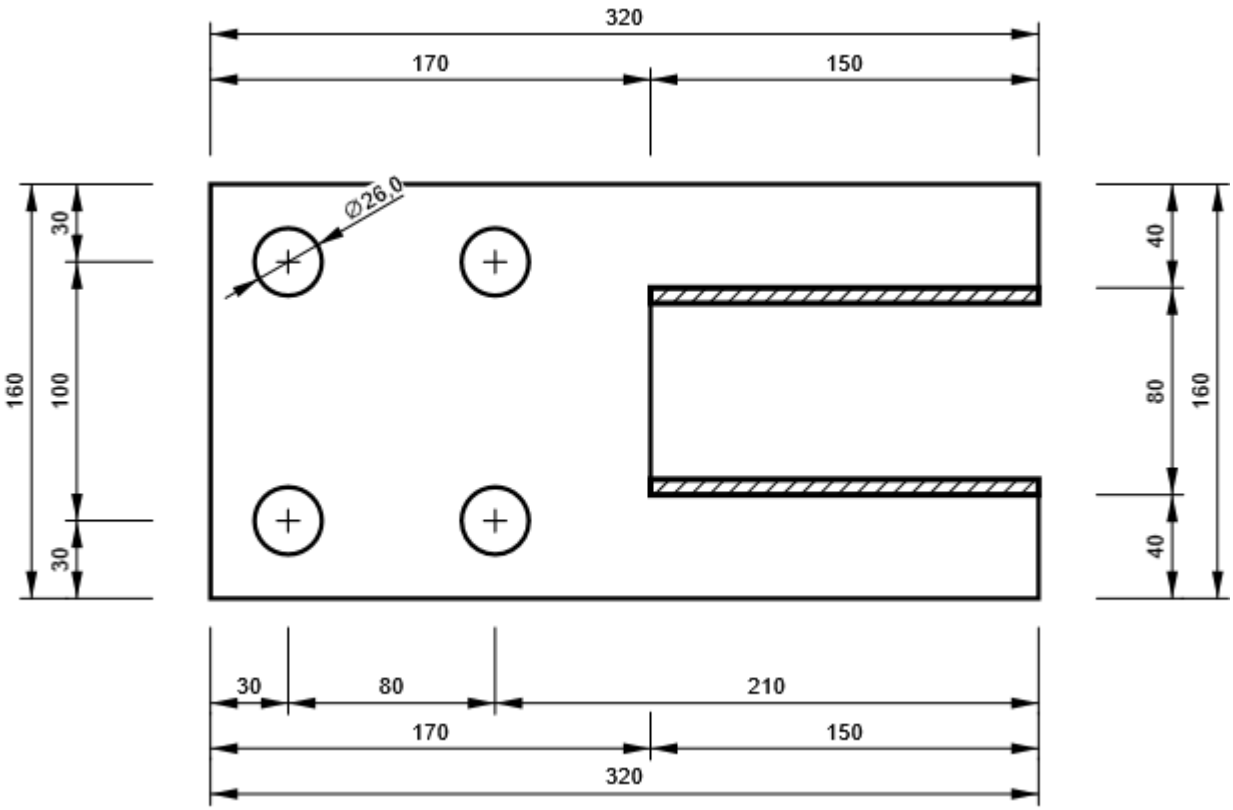
Project: Amsterdam industrial

Project no: 20239010

Author: Dave the Engineer

Gesneden plaat2

P16,0x160-320 (S 235)



Code settings

Item	Value	Unit	Reference
Safety factor γ_{M0}	1,00	-	EN 1993-1-1: 6.1
Safety factor γ_{M1}	1,00	-	EN 1993-1-1: 6.1
Safety factor γ_{M2}	1,25	-	EN 1993-1-1: 6.1
Safety factor γ_{M3}	1,25	-	EN 1993-1-8: 2.2
Safety factor γ_{C}	1,50	-	EN 1992-1-1: 2.4.2.4
Safety factor γ_{Inst}	1,20	-	EN 1992-4: Table 4.1
Joint coefficient βj	0,67	-	EN 1993-1-8: 6.2.5
Effective area - influence of mesh size	0,10	-	
Friction coefficient - concrete	0,25	-	EN 1993-1-8
Friction coefficient in slip-resistance	0,30	-	EN 1993-1-8 tab 3.7
Limit plastic strain	0,05	-	EN 1993-1-5
Detailing	No		
Distance between bolts [d]	2,20	-	EN 1993-1-8: tab 3.3
Distance between bolts and edge [d]	1,20	-	EN 1993-1-8: tab 3.3
Concrete breakout resistance check	Both		EN 1992-4: 7.2.1.4 and 7.2.2.5
Use calculated αb in bearing check.	Yes		EN 1993-1-8: tab 3.4
Cracked concrete	Yes		EN 1992-4
Local deformation check	No		CIDECT DG 1, 3 - 1.1
Local deformation limit	0,03	-	CIDECT DG 1, 3 - 1.1
Geometrical nonlinearity (GMNA)	Yes		Analysis with large deformations for hollow section joints

Braced system	No		EN 1993-1-8: 5.2.2.5