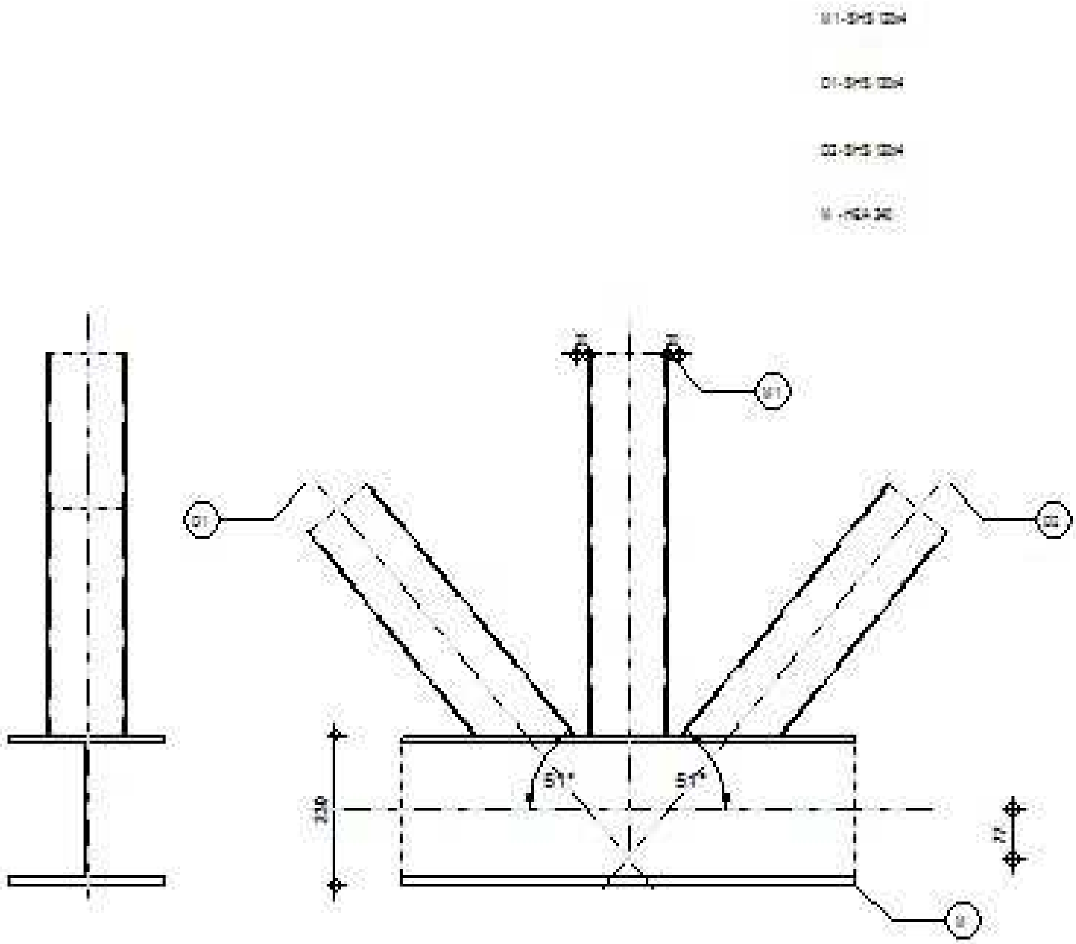
Autodesk Robot Structural Analysis Professional 2014

Design of truss node connection

NF EN 1993-1-8:2005/NA:2007/AC:2009

OK

Ratio
0.27



GENERAL

Connection no.: 4
Connection name: Tube
Structure node: 50
Structure bars: 2, 350, 349, 48

GEOMETRY

BARS

		Chord	Diagonal 1	Diagonal 2	Post	
Bar no.:		2	349	350	48	
Section:		HEA 240	SHS 120x4	SHS 120x4	SHS 120x4	
	h	230	120	120	120	mm

		Chord	Diagonal 1	Diagonal 2	Post	
	b_f	240	120	120	120	mm
	t_w	8	4	4	4	mm
	t_f	12	4	4	4	mm
	r	21	0	0	0	mm
Material:		STEEL	STEEL	STEEL	STEEL	
	f_y	248.21	248.21	248.21	248.21	MPa
	f_u	399.90	399.90	399.90	399.90	MPa
Angle	θ	0.0	50.5	50.5	90.0	Deg
Length	l	34500	5506	5506	4250	mm

OFFSET

e_0 = 77 [mm] Offset

SPACINGS

g_1 = 20 [mm] Spacing of 1st diagonal
g_2 = 20 [mm] Spacing of 2nd diagonal

WELDS

a_d = 6 [mm] Thickness of welds of diagonals and posts

LOADS

Case: 12: ULS /9/ 1*1.35 + 2*1.35 + 3*1.35 + 4*1.35 + 5*1.05 + 6*1.50

CHORD

$N_{01,Ed}$ = 588.30 [kN] Axial force
$M_{01,Ed}$ = 1.29 [kN*m] Bending moment
$N_{02,Ed}$ = 364.36 [kN] Axial force
$M_{02,Ed}$ = 2.86 [kN*m] Bending moment

DIAGONAL 1

N_1 = -189.82 [kN] Axial force
M_1 = -0.59 [kN*m] Bending moment

DIAGONAL 2

N_2 = 163.78 [kN] Axial force
M_2 = -0.36 [kN*m] Bending moment

POST

N_3 = 11.16 [kN] Axial force
M_3 = -0.88 [kN*m] Bending moment

RESULTS

CONSIDER NON-AXIAL CONNECTION OF MEMBERS IN THE NODE

M_0 = 17.14 [kN*m] Additional moment from eccentric connection of members $M_0 = (N_{02}-N_{01}) * e_0$

M_0 =	17.14	[kN*m]	Additional moment from eccentric connection of members	$M_0 = (N_{02}-N_{01}) * e_0$
$\Sigma E_i J_i/L_i$ =	2298436.82	[kN*m]	Overall connection stiffness	
ΔM_{01} =	6.71	[kN*m]	Additional moment in the chord	
ΔM_{02} =	6.71	[kN*m]	Additional moment in the chord	
ΔM_2 =	1.13	[kN*m]	Additional moment in the diagonal	
ΔM_1 =	1.13	[kN*m]	Additional moment in the diagonal	
ΔM_3 =	1.46	[kN*m]	Additional moment in the diagonal	

CAPACITY VERIFICATION EUROCODE 3: EN 1993-1-8:2005

γ_{M5} = 1.00 Partial safety factor [Table 2.1]

FAILURE MODES FOR JOINTS (I OR H SECTION CHORD MEMBERS)

[Table 7.21] for $N_{i,Rd}$ and [Table 7.22] for $M_{i,Rd}$

GEOMETRICAL PARAMETERS

β =	0.50	Coefficient taking account of geometry of connection bars	$\beta = (b_2+h_2+b_1+h_1+b_3+h_3)/(6*b_0)$ [1.5 (6)]
γ =	10.00	Coefficient taking account of geometry of the chord	$\gamma = b_0/2*t_{f0}$

TUBE BRACE FAILURE

DIAGONAL 2

p_{eff} =	134	[mm]	Effective width in the connection of the diagonal to the chord	$p_{eff} = t_w+2*r+7*t_f*f_{y0}/f_{y2}$
$M_{2,Rd}$ =	15.91	[kN*m]	Bending resistance	$M_{2,Rd} = [f_{y2}*t_2*p_{eff}*h_2] / \gamma_{M5}$
$\lvert M_2+\Delta M_2\rvert \le M_{2,Rd}$		|0.77| < 15.91	verified	(0.05)

DIAGONAL 1

p_{eff} =	134	[mm]	Effective width in the connection of the diagonal to the chord	$p_{eff} = t_w+2*r+7*t_f*f_{y0}/f_{y1}$
$M_{1,Rd}$ =	15.91	[kN*m]	Bending resistance	$M_{1,Rd} = [f_{y1}*t_1*p_{eff}*h_1] / \gamma_{M5}$
$\lvert M_1+\Delta M_1\rvert \le M_{1,Rd}$		|0.54| < 15.91	verified	(0.03)

POST

p_{eff} =	134	[mm]	Effective width in the connection of the post to the chord	$p_{eff} = t_w+2*r+7*t_f*f_{y0}/f_{y3}$
$M_{3,Rd}$ =	15.91	[kN*m]	Bending resistance	$M_{3,Rd} = [f_{y3}*t_3*p_{eff}*h_3] / \gamma_{M5}$
$\lvert M_3+\Delta M_3\rvert \le M_{3,Rd}$		|0.58| < 15.91	verified	(0.04)

CHORD SHEAR

DIAGONAL 2

A_v =	38.46	[cm^2]	Shear area of the chord	$A_v = A_0-(2-\alpha)*b_f*t_f+(t_w+2*r)*t_f$
$N_{2,Rd}$ =	713.98	[kN]	Tension capacity	$N_{2,Rd} = f_{y0}*A_v/\sqrt{3} *\sin(\theta_2) / \gamma_{M5}$
$\lvert N_2\rvert \le N_{2,Rd}$		|163.78| < 713.98	verified	(0.23)

DIAGONAL 1

A_v =	38.46	[cm^2]	Shear area of the chord	$A_v = A_0-(2-\alpha)*b_f*t_f+(t_w+2*r)*t_f$
$N_{1,Rd}$ =	713.98	[kN]	Compression capacity	$N_{1,Rd} = f_{y0}*A_v/\sqrt{3} *\sin(\theta_1) / \gamma_{M5}$
$\lvert N_1\rvert \le N_{1,Rd}$		|-189.82| < 713.98	verified	(0.27)

POST

A_v =	38.46	[cm^2]	Shear area of the chord	$A_v = A_0 - (2-\alpha) \cdot b_f \cdot t_f + (t_w + 2 \cdot r) \cdot t_f$
$N_{3,Rd}$ =	551.14	[kN]	Tension capacity	$N_{3,Rd} = f_{y0} \cdot A_v / \sqrt{3} \cdot \sin(\theta_3) / \gamma_{M5}$
$\lvert N_3 \rvert \le N_{3,Rd}$			|11.16| < 551.14 verified	(0.02)

CHORD

$N_{0,Rd}$ =	0.00	[kN]	Chord resistance	
$\lvert N_{01} \rvert \le N_{0,Rd}$			|588.30| > 0.00 verified	(0.00)

CHORD WEB YIELDING

DIAGONAL 2

b_w =	320	[mm]	Effective width for the chord web	$b_w = h_2/\sin(\theta_2) + 5 \cdot (t_f + r)$
$M_{2,Rd}$ =	34.60	[kN*m]	Bending resistance	$M_{2,Rd} = 0.5 \cdot f_{y0} \cdot t_w \cdot b_w \cdot (h_2 - t_2) / \gamma_{M5}$
$\lvert M_2 + \Delta M_2 \rvert \le M_{2,Rd}$			|0.77| < 34.60 verified	(0.02)

DIAGONAL 1

b_w =	320	[mm]	Effective width for the chord web	$b_w = h_1/\sin(\theta_1) + 5 \cdot (t_f + r)$
$M_{1,Rd}$ =	34.60	[kN*m]	Bending resistance	$M_{1,Rd} = 0.5 \cdot f_{y0} \cdot t_w \cdot b_w \cdot (h_1 - t_1) / \gamma_{M5}$
$\lvert M_1 + \Delta M_1 \rvert \le M_{1,Rd}$			|0.54| < 34.60 verified	(0.02)

POST

b_w =	285	[mm]	Effective width for the chord web	$b_w = h_3/\sin(\theta_3) + 5 \cdot (t_f + r)$
$M_{3,Rd}$ =	30.77	[kN*m]	Bending resistance	$M_{3,Rd} = 0.5 \cdot f_{y0} \cdot t_w \cdot b_w \cdot (h_3 - t_3) / \gamma_{M5}$
$\lvert M_3 + \Delta M_3 \rvert \le M_{3,Rd}$			|0.58| < 30.77 verified	(0.02)

VERIFICATION OF WELDS

DIAGONAL 2

β_w =	0.83		Correlation coefficient	[Table 4.1]
γ_{M2} =	1.25		Partial safety factor	[Table 2.1]
Longitudinal weld				
$\sigma_\perp$ =	26.57	[MPa]	Normal stress in a weld	
$\tau_\perp$ =	26.57	[MPa]	Perpendicular tangent stress	
τ_{II} =	31.86	[MPa]	Tangent stress	
$\lvert \sigma_\perp \rvert \le 0.9 \cdot f_u / \gamma_{M2}$			|26.57| < 287.93 verified	(0.09)
$\sqrt{[\sigma_\perp^2 + 3 \cdot (\tau_\perp^2 + \tau_{II}^2)]} \le f_u / (\beta_w \cdot \gamma_{M2})$			76.61 < 386.14 verified	(0.20)
Transverse inner weld				
$\sigma_\perp$ =	30.12	[MPa]	Normal stress in a weld	
$\tau_\perp$ =	6.20	[MPa]	Perpendicular tangent stress	
τ_{II} =	0.00	[MPa]	Tangent stress	
$\lvert \sigma_\perp \rvert \le 0.9 \cdot f_u / \gamma_{M2}$			|30.12| < 287.93 verified	(0.10)
$\sqrt{[\sigma_\perp^2 + 3 \cdot (\tau_\perp^2 + \tau_{II}^2)]} \le f_u / (\beta_w \cdot \gamma_{M2})$			31.98 < 386.14 verified	(0.08)
Transverse outer weld				
$\sigma_\perp$ =	8.89	[MPa]	Normal stress in a weld	
$\tau_\perp$ =	31.39	[MPa]	Perpendicular tangent stress	

$\sigma_{\perp}$ =	8.89	[MPa]	Normal stress in a weld	
τ_{II} =	0.00	[MPa]	Tangent stress	

$\lvert\sigma_{\perp}\rvert \leq 0.9*f_u/\gamma_{M2}$	$\lvert 8.89 \rvert < 287.93$	verified	(0.03)
$\sqrt{[\sigma_{\perp}^2 + 3*(\tau_{\perp}^2+\tau_{II}^2)]} \leq f_u/(\beta_w*\gamma_{M2})$	55.09 < 386.14	verified	(0.14)

DIAGONAL 1

β_w =	0.83		Correlation coefficient	[Table 4.1]
γ_{M2} =	1.25		Partial safety factor	[Table 2.1]

Longitudinal weld

$\sigma_{\perp}$ =	-30.79	[MPa]	Normal stress in a weld
$\tau_{\perp}$ =	-30.79	[MPa]	Perpendicular tangent stress
τ_{II} =	-36.93	[MPa]	Tangent stress

$\lvert\sigma_{\perp}\rvert \leq 0.9*f_u/\gamma_{M2}$	$\lvert -30.79 \rvert < 287.93$	verified	(0.11)
$\sqrt{[\sigma_{\perp}^2 + 3*(\tau_{\perp}^2+\tau_{II}^2)]} \leq f_u/(\beta_w*\gamma_{M2})$	88.79 < 386.14	verified	(0.23)

Transverse inner weld

$\sigma_{\perp}$ =	-37.56	[MPa]	Normal stress in a weld
$\tau_{\perp}$ =	-12.79	[MPa]	Perpendicular tangent stress
τ_{II} =	0.00	[MPa]	Tangent stress

$\lvert\sigma_{\perp}\rvert \leq 0.9*f_u/\gamma_{M2}$	$\lvert -37.56 \rvert < 287.93$	verified	(0.13)
$\sqrt{[\sigma_{\perp}^2 + 3*(\tau_{\perp}^2+\tau_{II}^2)]} \leq f_u/(\beta_w*\gamma_{M2})$	43.61 < 386.14	verified	(0.11)

Transverse outer weld

$\sigma_{\perp}$ =	-4.56	[MPa]	Normal stress in a weld
$\tau_{\perp}$ =	-33.67	[MPa]	Perpendicular tangent stress
τ_{II} =	0.00	[MPa]	Tangent stress

$\lvert\sigma_{\perp}\rvert \leq 0.9*f_u/\gamma_{M2}$	$\lvert -4.56 \rvert < 287.93$	verified	(0.02)
$\sqrt{[\sigma_{\perp}^2 + 3*(\tau_{\perp}^2+\tau_{II}^2)]} \leq f_u/(\beta_w*\gamma_{M2})$	58.50 < 386.14	verified	(0.15)

POST

β_w =	0.83		Correlation coefficient	[Table 4.1]
γ_{M2} =	1.25		Partial safety factor	[Table 2.1]

Longitudinal weld

$\sigma_{\perp}$ =	3.56	[MPa]	Normal stress in a weld
$\tau_{\perp}$ =	3.56	[MPa]	Perpendicular tangent stress
τ_{II} =	0.00	[MPa]	Tangent stress

$\lvert\sigma_{\perp}\rvert \leq 0.9*f_u/\gamma_{M2}$	$\lvert 3.56 \rvert < 287.93$	verified	(0.01)
$\sqrt{[\sigma_{\perp}^2 + 3*(\tau_{\perp}^2+\tau_{II}^2)]} \leq f_u/(\beta_w*\gamma_{M2})$	7.12 < 386.14	verified	(0.02)

Transverse inner weld

$\sigma_{\perp}$ =	-1.42	[MPa]	Normal stress in a weld
$\tau_{\perp}$ =	-1.42	[MPa]	Perpendicular tangent stress
τ_{II} =	0.00	[MPa]	Tangent stress

$\lvert\sigma_{\perp}\rvert \leq 0.9*f_u/\gamma_{M2}$	$\lvert -1.42 \rvert < 287.93$	verified	(0.00)
$\sqrt{[\sigma_{\perp}^2 + 3*(\tau_{\perp}^2+\tau_{II}^2)]} \leq f_u/(\beta_w*\gamma_{M2})$	2.83 < 386.14	verified	(0.01)

Connection conforms to the code Ratio 0.27