Autodesk Robot Structural Analysis Professional 2020

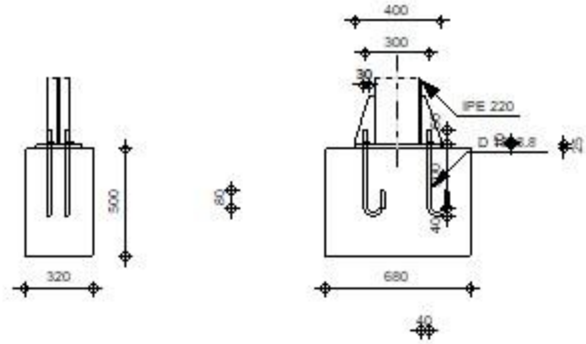
Fixed column base design

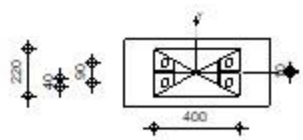
Eurocode 3: NF EN 1993-1-8:2005/NA:2007/AC:2009 + CEB

Design Guide: Design of fastenings in concrete

OK

Ratio
0.57





GENERAL

Connection no.:	23
Connection name:	Fixed column base
Structure node:	97
Structure bars:	91

GEOMETRY

COLUMN

Section: IPE 220

Bar no.: 91

L_c =	5.38	[m]	Column length
α =	0.0	[Deg]	Inclination angle
h_c =	220	[mm]	Height of column section
b_{fc} =	110	[mm]	Width of column section
t_{wc} =	6	[mm]	Thickness of the web of column section
t_{fc} =	9	[mm]	Thickness of the flange of column section
r_c =	12	[mm]	Radius of column section fillet
A_c =	33.37	[cm^2]	Cross-sectional area of a column
I_{yc} =	2771.84	[cm^4]	Moment of inertia of the column section

Material: ACIER

f_{yc} =	235.00	[MPa]	Resistance
f_{uc} =	365.00	[MPa]	Yield strength of a material

COLUMN BASE

l_{pd} =	400	[mm]	Length
b_{pd} =	220	[mm]	Width
t_{pd} =	25	[mm]	Thickness
Material:	ACIER E24		
f_{ypd} =	235.00	[MPa]	Resistance
f_{upd} =	365.00	[MPa]	Yield strength of a material

ANCHORAGE

The shear plane passes through the UNTHREADED portion of the bolt.

Class =	8.8		Anchor class
f_{yb} =	550.00	[MPa]	Yield strength of the anchor material
f_{ub} =	800.00	[MPa]	Tensile strength of the anchor material
d =	18	[mm]	Bolt diameter
A_s =	1.92	[cm^2]	Effective section area of a bolt
A_v =	2.54	[cm^2]	Area of bolt section
n_H =	2		Number of bolt columns
n_V =	2		Number of bolt rows

Horizontal spacing e_{Hi} = 300 [mm]

Vertical spacing e_{Vi} = 90 [mm]

Anchor dimensions

L_1 =	60	[mm]
L_2 =	300	[mm]
L_3 =	80	[mm]
L_4 =	80	[mm]

Washer

l_{wd} =	30	[mm]	Length
b_{wd} =	40	[mm]	Width
t_{wd} =	10	[mm]	Thickness

STIFFENER

l_s =	400	[mm]	Length
h_s =	220	[mm]	Height
t_s =	10	[mm]	Thickness
d_1 =	20	[mm]	Cut
d_2 =	20	[mm]	Cut

MATERIAL FACTORS

γ_{M0} =	1.00	Partial safety factor
γ_{M2} =	1.25	Partial safety factor
γ_C =	1.50	Partial safety factor

SPREAD FOOTING

L =	680	[mm]	Spread footing length
B =	320	[mm]	Spread footing width
H =	500	[mm]	Spread footing height

Concrete

Class BETON25

f_{ck} =	25.00	[MPa]	Characteristic resistance for compression

Grout layer

t_g =	0	[mm]	Thickness of leveling layer (grout)
$f_{ck,g}$ =	12.00	[MPa]	Characteristic resistance for compression
$C_{f,d}$ =	0.30		Coeff. of friction between the base plate and concrete

WELDS

a_p =	8	[mm]	Footing plate of the column base
a_s =	8	[mm]	Stiffeners

LOADS

Case: 16: ULS /101/ 1*1.35 + 2*1.35 + 3*1.35 + 4*1.35 + 5*1.35 + 6*1.35 + 7*1.05 + 8*1.05 + 9*1.05 +

$N_{j,Ed}$ =	-20.96	[kN]	Axial force
$V_{j,Ed,y}$ =	-0.03	[kN]	Shear force
$V_{j,Ed,z}$ =	10.41	[kN]	Shear force
$M_{j,Ed,y}$ =	-14.57	[kN*m]	Bending moment
$M_{j,Ed,z}$ =	-0.08	[kN*m]	Bending moment

RESULTS

COMPRESSION ZONE

COMPRESSION OF CONCRETE

f_{cd} =	16.67	[MPa]	Design compressive resistance	EN 1992-1:[3.1.6.(1)]
f_j =	17.47	[MPa]	Design bearing resistance under the base plate	[6.2.5.(7)]

$c = t_p \sqrt{(f_{yp}/(3*f_j*\gamma_{M0}))}$

c =	53	[mm]	Additional width of the bearing pressure zone	[6.2.5.(4)]
b_{eff} =	115	[mm]	Effective width of the bearing pressure zone under the flange	[6.2.5.(3)]
l_{eff} =	216	[mm]	Effective length of the bearing pressure zone under the flange	[6.2.5.(3)]
A_{c0} =	248.40	[cm^2]	Area of the joint between the base plate and the foundation	EN 1992-1:[6.7.(3)]
A_{c1} =	1104.67	[cm^2]	Maximum design area of load distribution	EN 1992-1:[6.7.(3)]

$F_{rdu} = A_{c0}*f_{cd}*\sqrt{(A_{c1}/A_{c0})} \leq 3*A_{c0}*f_{cd}$

F_{rdu} =	873.05	[kN]	Bearing resistance of concrete	EN 1992-1:[6.7.(3)]
β_j =	0.67		Reduction factor for compression	[6.2.5.(7)]

$f_{jd} = \beta_j*F_{rdu}/(b_{eff}*l_{eff})$

f_{jd} =	23.43	[MPa]	Design bearing resistance	[6.2.5.(7)]
$A_{c,n}$ =	683.65	[cm^2]	Bearing area for compression	[6.2.8.2.(1)]
$A_{c,y}$ =	289.17	[cm^2]	Bearing area for bending My	[6.2.8.3.(1)]
$A_{c,z}$ =	341.82	[cm^2]	Bearing area for bending Mz	[6.2.8.3.(1)]

$F_{c,Rd,i} = A_{C,i}*f_{jd}$

$F_{c,Rd,n}$ =	1601.88	[kN]	Bearing resistance of concrete for compression	[6.2.8.2.(1)]
$F_{c,Rd,y}$ =	677.57	[kN]	Bearing resistance of concrete for bending My	[6.2.8.3.(1)]
$F_{c,Rd,z}$ =	800.94	[kN]	Bearing resistance of concrete for bending Mz	[6.2.8.3.(1)]

COLUMN FLANGE AND WEB IN COMPRESSION

CL =	1.00		Section class	EN 1993-1-1:[5.5.2]
$W_{pl,y}$ =	564.43	[cm^3]	Plastic section modulus	EN1993-1-1:[6.2.5.(2)]
$M_{c,Rd,y}$ =	132.64	[kN*m]	Design resistance of the section for bending	EN1993-1-1:[6.2.5]
$h_{f,y}$ =	232	[mm]	Distance between the centroids of flanges	[6.2.6.7.(1)]

$F_{c,fc,Rd,y} = M_{c,Rd,y} / h_{f,y}$

$F_{c,fc,Rd,y}$ =	571.11	[kN]	Resistance of the compressed flange and web	[6.2.6.7.(1)]
$W_{pl,z}$ =	62.61	[cm^3]	Plastic section modulus	EN1993-1-1:[6.2.5.(2)]
$M_{c,Rd,z}$ =	14.71	[kN*m]	Design resistance of the section for bending	EN1993-1-1:[6.2.5]

$W_{pl,z}$ =	62.61	[cm^3]	Plastic section modulus	EN1993-1-1:[6.2.5.(2)]
$h_{f,z}$ =	93	[mm]	Distance between the centroids of flanges	[6.2.6.7.(1)]

$F_{c,fc,Rd,z} = M_{c,Rd,z} / h_{f,z}$

$F_{c,fc,Rd,z}$ =	157.42	[kN]	Resistance of the compressed flange and web	[6.2.6.7.(1)]

RESISTANCES OF SPREAD FOOTING IN THE COMPRESSION ZONE

$N_{j,Rd} = F_{c,Rd,n}$

$N_{j,Rd}$ =	1601.88	[kN]	Resistance of a spread footing for axial compression	[6.2.8.2.(1)]

$F_{C,Rd,y} = \min(F_{c,Rd,y},F_{c,fc,Rd,y})$

$F_{C,Rd,y}$ =	571.11	[kN]	Resistance of spread footing in the compression zone	[6.2.8.3]

$F_{C,Rd,z} = \min(F_{c,Rd,z},F_{c,fc,Rd,z})$

$F_{C,Rd,z}$ =	157.42	[kN]	Resistance of spread footing in the compression zone	[6.2.8.3]

TENSION ZONE

STEEL FAILURE

A_b =	1.92	[cm^2]	Effective anchor area	[Table 3.4]
f_{ub} =	800.00	[MPa]	Tensile strength of the anchor material	[Table 3.4]
Beta =	0.85		Reduction factor of anchor resistance	[3.6.1.(3)]

$F_{t,Rd,s1} = beta*0.9*f_{ub}*A_b/\gamma_{M2}$

$F_{t,Rd,s1}$ =	94.00	[kN]	Anchor resistance to steel failure	[Table 3.4]
γ_{Ms} =	1.20		Partial safety factor	CEB [3.2.3.2]
f_{yb} =	550.00	[MPa]	Yield strength of the anchor material	CEB [9.2.2]

$F_{t,Rd,s2} = f_{yb}*A_b/\gamma_{Ms}$

$F_{t,Rd,s2}$ =	88.00	[kN]	Anchor resistance to steel failure	CEB [9.2.2]

$F_{t,Rd,s} = \min(F_{t,Rd,s1},F_{t,Rd,s2})$

$F_{t,Rd,s}$ =	88.00	[kN]	Anchor resistance to steel failure	

PULL-OUT FAILURE

f_{ck} =	25.00	[MPa]	Characteristic compressive strength of concrete	EN 1992-1:[3.1.2]

$f_{ctd} = 0.7*0.3*f_{ck}^{2/3}/\gamma_C$

f_{ctd} =	1.20	[MPa]	Design tensile resistance	EN 1992-1:[8.4.2.(2)]
η_1 =	1.00		Coeff. related to the quality of the bond conditions and concreting conditions	EN 1992-1:[8.4.2.(2)]
η_2 =	1.00		Coeff. related to the bar diameter	EN 1992-1:[8.4.2.(2)]

$f_{bd} = 2.25*\eta_1*\eta_2*f_{ctd}$

f_{bd} =	2.69	[MPa]	Design value of the ultimate bond stress	EN 1992-1:[8.4.2.(2)]
h_{ef} =	300	[mm]	Effective anchorage depth	EN 1992-1:[8.4.2.(2)]

$F_{t,Rd,p} = \pi*d*h_{ef}*f_{bd}$

$F_{t,Rd,p}$ =	45.69	[kN]	Design uplift capacity	EN 1992-1:[8.4.2.(2)]

TENSILE RESISTANCE OF AN ANCHOR

$F_{t,Rd} = \min(F_{t,Rd,s} , F_{t,Rd,p})$

$F_{t,Rd}$ =	45.69	[kN]	Tensile resistance of an anchor	

BENDING OF THE BASE PLATE

Bending moment $M_{j,Ed,y}$

$l_{eff,1}$ =	194	[mm]	Effective length for a single bolt for mode 1	[6.2.6.5]
$l_{eff,2}$ =	205	[mm]	Effective length for a single bolt for mode 2	[6.2.6.5]
m =	31	[mm]	Distance of a bolt from the stiffening edge	[6.2.6.5]
$M_{pl,1,Rd}$ =	7.14	[kN*m]	Plastic resistance of a plate for mode 1	[6.2.4]
$M_{pl,2,Rd}$ =	7.53	[kN*m]	Plastic resistance of a plate for mode 2	[6.2.4]
$F_{T,1,Rd}$ =	922.84	[kN]	Resistance of a plate for mode 1	[6.2.4]
$F_{T,2,Rd}$ =	255.84	[kN]	Resistance of a plate for mode 2	[6.2.4]
$F_{T,3,Rd}$ =	91.38	[kN]	Resistance of a plate for mode 3	[6.2.4]

$F_{t,pl,Rd,y} = \min(F_{T,1,Rd} , F_{T,2,Rd} , F_{T,3,Rd})$

$F_{t,pl,Rd,y}$ =	91.38	[kN]	Tension resistance of a plate	[6.2.4]

Bending moment $M_{j,Ed,z}$

$l_{eff,1}$ =	194	[mm]	Effective length for a single bolt for mode 1	[6.2.6.5]
$l_{eff,2}$ =	205	[mm]	Effective length for a single bolt for mode 2	[6.2.6.5]
m =	31	[mm]	Distance of a bolt from the stiffening edge	[6.2.6.5]
$M_{pl,1,Rd}$ =	7.14	[kN*m]	Plastic resistance of a plate for mode 1	[6.2.4]
$M_{pl,2,Rd}$ =	7.53	[kN*m]	Plastic resistance of a plate for mode 2	[6.2.4]
$F_{T,1,Rd}$ =	922.84	[kN]	Resistance of a plate for mode 1	[6.2.4]
$F_{T,2,Rd}$ =	255.84	[kN]	Resistance of a plate for mode 2	[6.2.4]
$F_{T,3,Rd}$ =	91.38	[kN]	Resistance of a plate for mode 3	[6.2.4]

$F_{t,pl,Rd,z} = \min(F_{T,1,Rd}, F_{T,2,Rd}, F_{T,3,Rd})$

$F_{t,pl,Rd,z}$ =	91.38	[kN]	Tension resistance of a plate	[6.2.4]

RESISTANCES OF SPREAD FOOTING IN THE TENSION ZONE

$F_{T,Rd,y} = F_{t,pl,Rd,y}$

$F_{T,Rd,y}$ =	91.38	[kN]	Resistance of a column base in the tension zone	[6.2.8.3]

$F_{T,Rd,z} = F_{t,pl,Rd,z}$

$F_{T,Rd,z}$ =	91.38	[kN]	Resistance of a column base in the tension zone	[6.2.8.3]

CONNECTION CAPACITY CHECK

$N_{j,Ed} / N_{j,Rd} \leq 1,0$ (6.24)		0.01 < 1.00	verified	(0.01)
e_y =	695 [mm]	Axial force eccentricity		[6.2.8.3]
$z_{c,y}$ =	116 [mm]	Lever arm $F_{C,Rd,y}$		[6.2.8.1.(2)]
$z_{t,y}$ =	150 [mm]	Lever arm $F_{T,Rd,y}$		[6.2.8.1.(3)]
$M_{j,Rd,y}$ =	29.20 [kN*m]	Connection resistance for bending		[6.2.8.3]
$M_{j,Ed,y} / M_{j,Rd,y} \leq 1,0$ (6.23)		0.50 < 1.00	verified	(0.50)
e_z =	4 [mm]	Axial force eccentricity		[6.2.8.3]
$z_{c,z}$ =	47 [mm]	Lever arm $F_{C,Rd,z}$		[6.2.8.1.(2)]
$z_{t,z}$ =	45 [mm]	Lever arm $F_{T,Rd,z}$		[6.2.8.1.(3)]
$M_{j,Rd,z}$ =	1.16 [kN*m]	Connection resistance for bending		[6.2.8.3]
$M_{j,Ed,z} / M_{j,Rd,z} \leq 1,0$ (6.23)		0.07 < 1.00	verified	(0.07)
$M_{j,Ed,y} / M_{j,Rd,y} + M_{j,Ed,z} / M_{j,Rd,z} \leq 1,0$		0.57 < 1.00	verified	(0.57)

SHEAR

BEARING PRESSURE OF AN ANCHOR BOLT ONTO THE BASE PLATE

Shear force $V_{j,Ed,y}$

$\alpha_{d,y}$ =	1.08	Coeff. taking account of the bolt position - in the direction of shear	[Table 3.4]
$\alpha_{b,y}$ =	1.00	Coeff. for resistance calculation $F_{1,vb,Rd}$	[Table 3.4]
$k_{1,y}$ =	2.50	Coeff. taking account of the bolt position - perpendicularly to the direction of shear	[Table 3.4]

$F_{1,vb,Rd,y} = k_{1,y} * \alpha_{b,y} * f_{up} * d * t_p / \gamma_{M2}$

$F_{1,vb,Rd,y}$ =	328.50	[kN]	Resistance of an anchor bolt for bearing pressure onto the base plate	[6.2.2.(7)]

Shear force $V_{j,Ed,z}$

$\alpha_{d,z}$ =	0.83	Coeff. taking account of the bolt position - in the direction of shear	[Table 3.4]
$\alpha_{b,z}$ =	0.83	Coeff. for resistance calculation $F_{1,vb,Rd}$	[Table 3.4]
$k_{1,z}$ =	2.50	Coeff. taking account of the bolt position - perpendicularly to the direction of shear	[Table 3.4]

$F_{1,vb,Rd,z} = k_{1,z} * \alpha_{b,z} * f_{up} * d * t_p / \gamma_{M2}$

$F_{1,vb,Rd,z}$ =	273.75	[kN]	Resistance of an anchor bolt for bearing pressure onto the base plate	[6.2.2.(7)]

SHEAR OF AN ANCHOR BOLT

α_b =	0.28		Coeff. for resistance calculation $F_{2,vb,Rd}$	[6.2.2.(7)]
A_{vb} =	2.54	[cm^2]	Area of bolt section	[6.2.2.(7)]
f_{ub} =	800.00	[MPa]	Tensile strength of the anchor material	[6.2.2.(7)]
γ_{M2} =	1.25		Partial safety factor	[6.2.2.(7)]

$F_{2,vb,Rd} = \alpha_b * f_{ub} * A_{vb} / \gamma_{M2}$

$F_{2,vb,Rd}$ =	44.79	[kN]	Shear resistance of a bolt - without lever arm	[6.2.2.(7)]

CONCRETE PRY-OUT FAILURE

$N_{Rk,c}$ = 19.84 [kN] Design uplift capacity CEB [9.2.4]

k_3 = 2.00 Factor related to the anchor length CEB [9.3.3]

γ_{Mc} = 2.16 Partial safety factor CEB [3.2.3.1]

$F_{v,Rd,cp} = k_3 * N_{Rk,c} / \gamma_{Mc}$

$F_{v,Rd,cp}$ = 18.37 [kN] Concrete resistance for pry-out failure CEB [9.3.1]

CONCRETE EDGE FAILURE

Shear force $V_{j,Ed,y}$

$V_{Rk,c,y}{}^0$ = 85.39 [kN] Characteristic resistance of an anchor CEB

$\psi_{A,V,y}$ = 1.00 Factor related to anchor spacing and edge distance C

$\psi_{h,V,y}$ = 1.00 Factor related to the foundation thickness CEB

$\psi_{s,V,y}$ = 1.00 Factor related to the influence of edges parallel to the shear load direction CEB

$\psi_{ec,V,y}$ = 1.00 Factor taking account a group effect when different shear loads are acting on the individual anchors in a group CEB

$\psi_{\alpha,V,y}$ = 1.00 Factor related to the angle at which the shear load is applied CEB

$\psi_{ucr,V,y}$ = 1.00 Factor related to the type of edge reinforcement used CEB

γ_{Mc} = 2.16 Partial safety factor CE

$F_{v,Rd,c,y} = V_{Rk,c,y}{}^0 * \psi_{A,V,y} * \psi_{h,V,y} * \psi_{s,V,y} * \psi_{ec,V,y} * \psi_{\alpha,V,y} * \psi_{ucr,V,y} / \gamma_{Mc}$

$F_{v,Rd,c,y}$ = 39.53 [kN] Concrete resistance for edge failure CEB [9.3.1]

Shear force $V_{j,Ed,z}$

$V_{Rk,c,z}{}^0$ = 181.35 [kN] Characteristic resistance of an anchor CE

$\psi_{A,V,z}$ = 0.40 Factor related to anchor spacing and edge distance

$\psi_{h,V,z}$ = 1.00 Factor related to the foundation thickness CE

$\psi_{s,V,z}$ = 0.82 Factor related to the influence of edges parallel to the shear load direction CE

$\psi_{ec,V,z}$ = 1.00 Factor taking account a group effect when different shear loads are acting on the individual anchors in a group CE

$\psi_{\alpha,V,z}$ = 1.00 Factor related to the angle at which the shear load is applied CE

$\psi_{ucr,V,z}$ = 1.00 Factor related to the type of edge reinforcement used CE

γ_{Mc} = 2.16 Partial safety factor C

$F_{v,Rd,c,z} = V_{Rk,c,z}{}^0 * \psi_{A,V,z} * \psi_{h,V,z} * \psi_{s,V,z} * \psi_{ec,V,z} * \psi_{\alpha,V,z} * \psi_{ucr,V,z} / \gamma_{Mc}$

$F_{v,Rd,c,z}$ = 27.82 [kN] Concrete resistance for edge failure CEB [9.3.1]

SPLITTING RESISTANCE

$C_{f,d}$ = 0.30 Coeff. of friction between the base plate and concrete [6.2.2.(6)]

$N_{c,Ed}$ = 20.96 [kN] Compressive force [6.2.2.(6)]

$F_{f,Rd} = C_{f,d} * N_{c,Ed}$

$F_{f,Rd}$ = 6.29 [kN] Slip resistance [6.2.2.(6)]

SHEAR CHECK

$V_{j,Rd,y} = n_b * \min(F_{1,vb,Rd,y}, F_{2,vb,Rd}, F_{v,Rd,cp}, F_{v,Rd,c,y}) + F_{f,Rd}$

$V_{j,Rd,y}$ = 79.78 [kN] Connection resistance for shear CEB [9.3.1]

$V_{j,Ed,y} / V_{j,Rd,y} \leq 1,0$	0.00 < 1.00	verified	(0.00)

$V_{j,Rd,z} = n_b * \min(F_{1,vb,Rd,z}, F_{2,vb,Rd}, F_{v,Rd,cp}, F_{v,Rd,c,z}) + F_{f,Rd}$

$V_{j,Rd,z}$ = 79.78 [kN] Connection resistance for shear CEB [9.3.1]

$V_{j,Ed,z} / V_{j,Rd,z} \leq 1,0$	0.13 < 1.00	verified	(0.13)
$V_{j,Ed,y} / V_{j,Rd,y} + V_{j,Ed,z} / V_{j,Rd,z} \leq 1,0$	0.13 < 1.00	verified	(0.13)

STIFFENER CHECK

Stiffener parallel to the web (along the extension of the column web)

M_1 = 1.82 [kN*m] Bending moment acting on a stiffener

Q_1 = 45.59 [kN] Shear force acting on a stiffener

z_s = 48 [mm] Location of the neutral axis (from the plate base)

I_s = 3274.10 [cm^4] Moment of inertia of a stiffener

σ_d = 1.25 [MPa] Normal stress on the contact surface between stiffener and plate EN 1993-1-1:[6.2.1.(5)]

σ_g = 11.00 [MPa] Normal stress in upper fibers EN 1993-1-1:[6.2.1.(5)]

M_1 =	1.82	[kN*m]	Bending moment acting on a stiffener	
τ =	20.72	[MPa]	Tangent stress in a stiffener	EN 1993-1-1:[6.2.1.(5)]
σ_z =	35.91	[MPa]	Equivalent stress on the contact surface between stiffener and plate	EN 1993-1-1:[6.2.1.(5)]
$\max(\sigma_g, \tau / (0.58), \sigma_z) / (f_{yp}/\gamma_{M0}) \le 1.0$ (6.1)	0.15 < 1.00		verified	(0.15)

WELDS BETWEEN THE COLUMN AND THE BASE PLATE

$\sigma_\perp$ =	12.21	[MPa]	Normal stress in a weld	[4.5.3.(7)]
$\tau_\perp$ =	12.21	[MPa]	Perpendicular tangent stress	[4.5.3.(7)]
τ_{yII} =	-0.01	[MPa]	Tangent stress parallel to $V_{j,Ed,y}$	[4.5.3.(7)]
τ_{zII} =	1.71	[MPa]	Tangent stress parallel to $V_{j,Ed,z}$	[4.5.3.(7)]
β_W =	0.85		Resistance-dependent coefficient	[4.5.3.(7)]
$\sigma_\perp / (0.9 f_u/\gamma_{M2}) \le 1.0$ (4.1)	0.05 < 1.00		verified	(0.05)
$\sqrt{\sigma_\perp^2 + 3.0 (\tau_{yII}^2 + \tau_\perp^2)} / (f_u/(\beta_W \gamma_{M2})) \le 1.0$ (4.1)	0.07 < 1.00		verified	(0.07)
$\sqrt{\sigma_\perp^2 + 3.0 (\tau_{zII}^2 + \tau_\perp^2)} / (f_u/(\beta_W \gamma_{M2})) \le 1.0$ (4.1)	0.06 < 1.00		verified	(0.06)

VERTICAL WELDS OF STIFFENERS

Stiffener parallel to the web (along the extension of the column web)

$\sigma_\perp$ =	9.99	[MPa]	Normal stress in a weld	[4.5.3.(7)]
$\tau_\perp$ =	9.99	[MPa]	Perpendicular tangent stress	[4.5.3.(7)]
τ_{II} =	12.95	[MPa]	Parallel tangent stress	[4.5.3.(7)]
σ_z =	30.04	[MPa]	Total equivalent stress	[4.5.3.(7)]
β_W =	0.85		Resistance-dependent coefficient	[4.5.3.(7)]
$\max(\sigma_\perp, \tau_{II} \cdot \sqrt{3}, \sigma_z) / (f_u/(\beta_W \gamma_{M2})) \le 1.0$ (4.1)	0.09 < 1.00		verified	(0.09)

TRANSVERSAL WELDS OF STIFFENERS

Stiffener parallel to the web (along the extension of the column web)

$\sigma_\perp$ =	22.39	[MPa]	Normal stress in a weld	[4.5.3.(7)]
$\tau_\perp$ =	22.39	[MPa]	Perpendicular tangent stress	[4.5.3.(7)]
τ_{II} =	16.74	[MPa]	Parallel tangent stress	[4.5.3.(7)]
σ_z =	53.34	[MPa]	Total equivalent stress	[4.5.3.(7)]
β_W =	0.85		Resistance-dependent coefficient	[4.5.3.(7)]
$\max(\sigma_\perp, \tau_{II} \cdot \sqrt{3}, \sigma_z) / (f_u/(\beta_W \gamma_{M2})) \le 1.0$ (4.1)	0.16 < 1.00		verified	(0.16)

CONNECTION STIFFNESS

Bending moment $M_{j,Ed,y}$

b_{eff} =	115	[mm]	Effective width of the bearing pressure zone under the flange	[6.2.5.(3)]
l_{eff} =	216	[mm]	Effective length of the bearing pressure zone under the flange	[6.2.5.(3)]

$k_{13,y} = E_c \cdot \sqrt{b_{eff} \cdot l_{eff}}/(1.275 \cdot E)$

$k_{13,y}$ =	19	[mm]	Stiffness coeff. of compressed concrete	[Table 6.11]
l_{eff} =	194	[mm]	Effective length for a single bolt for mode 1	[6.2.6.5]
m =	31	[mm]	Distance of a bolt from the stiffening edge	[6.2.6.5]

$k_{15,y} = 0.425 \cdot l_{eff} \cdot t_p^3/(m^3)$

$k_{15,y}$ =	44	[mm]	Stiffness coeff. of the base plate subjected to tension	[Table 6.11]
L_b =	188	[mm]	Effective anchorage depth	[Table 6.11]

$k_{16,y} = 1.6 \cdot A_b/L_b$

$k_{16,y}$ =	2	[mm]	Stiffness coeff. of an anchor subjected to tension	[Table 6.11]
$\lambda_{0,y}$ =	0.63		Column slenderness	[5.2.2.5.(2)]
$S_{j,ini,y}$ =	25064.12	[kN*m]	Initial rotational stiffness	[Table 6.12]
$S_{j,rig,y}$ =	32458.35	[kN*m]	Stiffness of a rigid connection	[5.2.2.5]

$S_{j,ini,y} < S_{j,rig,y}$ SEMI-RIGID				[5.2.2.5.(2)]
Bending moment $M_{j,Ed,z}$				
$k_{13,z} = E_c*\sqrt{(A_{c,z})}/(1.275*E)$				
$k_{13,z}$ =	22	[mm]	Stiffness coeff. of compressed concrete	[Table 6.11]
l_{eff} =	194	[mm]	Effective length for a single bolt for mode 1	[6.2.6.5]
m =	31	[mm]	Distance of a bolt from the stiffening edge	[6.2.6.5]
$k_{15,z} = 0.425*l_{eff}*t_p^3/(m^3)$				
$k_{15,z}$ =	44	[mm]	Stiffness coeff. of the base plate subjected to tension	[Table 6.11]
L_b =	188	[mm]	Effective anchorage depth	[Table 6.11]
$k_{16,z} = 1.6*A_b/L_b$				
$k_{16,z}$ =	2	[mm]	Stiffness coeff. of an anchor subjected to tension	[Table 6.11]
$\lambda_{0,z}$ =	2.31		Column slenderness	[5.2.2.5.(2)]
$S_{j,ini,z}$ =	20268.82	[kN*m]	Initial rotational stiffness	[6.3.1.(4)]
$S_{j,rig,z}$ =	2399.22	[kN*m]	Stiffness of a rigid connection	[5.2.2.5]
$S_{j,ini,z} \geq S_{j,rig,z}$ RIGID				[5.2.2.5.(2)]

WEAKEST COMPONENT:

FOUNDATION - PULL-OUT OF AN ANCHOR BOLT FROM CONCRETE

REMARKS

Anchor curvature radius is too small. 40 [mm] < 54 [mm]
Segment L4 of the hook anchor is too short. 80 [mm] < 90 [mm]

Connection conforms to the code	Ratio	0.57