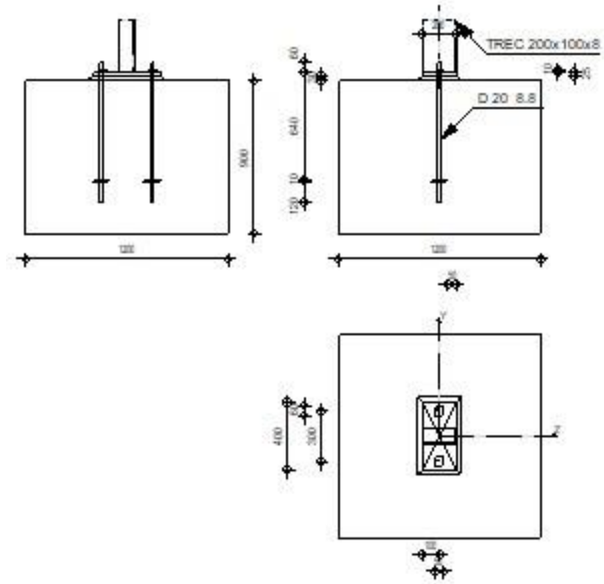
Robot Structural Analysis Professional 2024

Pinned column base design

Eurocode 3: EN 1993-1-8:2005/AC:2009 + CEB Design Guide: Design of fastenings in concrete

OK

Ratio **0,26**



GENERAL

Connection no.: 2
Connection name: Pinned column base

GEOMETRY

COLUMN

Section: TREC 200x100x8

L_c =	5,00	[m]	Column length
α =	0,00	[Deg]	Inclination angle
h_c =	200	[mm]	Height of column section
b_{fc} =	100	[mm]	Width of column section
t_{wc} =	8	[mm]	Thickness of the web of column section
t_{fc} =	8	[mm]	Thickness of the flange of column section
r_c =	0	[mm]	Radius of column section fillet
A_c =	43,46	[cm^2]	Cross-sectional area of a column
I_{yc} =	2113,00	[cm^4]	Moment of inertia of the column section

Material: S235

f_{yc} =	235,00	[MPa]	Resistance
f_{uc} =	360,00	[MPa]	Yield strength of a material

COLUMN BASE

l_{pd} =	200	[mm]	Length
b_{pd} =	400	[mm]	Width

l_{pd} =	200	[mm]	Length
t_{pd} =	25	[mm]	Thickness
Material:	S235		
f_{ypd} =	235,00	[MPa]	Resistance
f_{upd} =	360,00	[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} =	640,00	[MPa]	Yield strength of the anchor material
f_{ub} =	800,00	[MPa]	Tensile strength of the anchor material
d =	20	[mm]	Bolt diameter
A_s =	2,45	[cm^2]	Effective section area of a bolt
A_v =	3,14	[cm^2]	Area of bolt section
n =	2		Number of bolt rows
e_V =	300	[mm]	Vertical spacing

Anchor dimensions

L_1 =	60	[mm]
L_2 =	640	[mm]
L_3 =	120	[mm]

Anchor plate

l_p =	100	[mm]	Length
b_p =	100	[mm]	Width
t_p =	10	[mm]	Thickness
Material:	S235		
f_y =	235,00	[MPa]	Resistance

Washer

l_{wd} =	50	[mm]	Length
b_{wd} =	60	[mm]	Width
t_{wd} =	10	[mm]	Thickness

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 =	1200	[mm]	Spread footing length
B =	1200	[mm]	Spread footing width
H =	900	[mm]	Spread footing height

Concrete

Class	C20/25		
f_{ck} =	20,00	[MPa]	Characteristic resistance for compression

Grout layer

t_g =	30	[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 =	4	[mm]	Footing plate of the column base

LOADS

Case: Manual calculations.

$N_{j,Ed}$ =	-210,00	[kN]	Axial force
$V_{j,Ed,y}$ =	3,00	[kN]	Shear force
$V_{j,Ed,z}$ =	3,00	[kN]	Shear force

RESULTS

COMPRESSION ZONE

COMPRESSION OF CONCRETE

f_{cd} =	13,33	[MPa]	Design compressive resistance	EN 1992-1:[3.1.6.(1)]
f_j =	26,67	[MPa]	Design bearing resistance under the base plate	[6.2.5.(7)]

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

c =	43	[mm]	Additional width of the bearing pressure zone	[6.2.5.(4)]
b_{eff} =	51	[mm]	Effective width of the bearing pressure zone under the flange	[6.2.5.(3)]
l_{eff} =	186	[mm]	Effective length of the bearing pressure zone under the flange	[6.2.5.(3)]
A_{c0} =	94,42	[cm^2]	Area of the joint between the base plate and the foundation	EN 1992-1:[6.7.(3)]
A_{c1} =	849,80	[cm^2]	Maximum design area of load distribution	EN 1992-1:[6.7.(3)]

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

F_{rdu} =	377,69	[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} =	26,67	[MPa]	Design bearing resistance	[6.2.5.(7)]
$A_{c,n}$ =	371,39	[cm^2]	Bearing area for compression	[6.2.8.2.(1)]

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

$F_{c,Rd,n}$ =	990,38	[kN]	Bearing resistance of concrete for compression	[6.2.8.2.(1)]

RESISTANCES OF SPREAD FOOTING IN THE COMPRESSION ZONE

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

$N_{j,Rd}$ =	990,38	[kN]	Resistance of a spread footing for axial compression	[6.2.8.2.(1)]

CONNECTION CAPACITY CHECK

$N_{j,Ed} / N_{j,Rd} \le 1,0$ (6.24)	0,21 < 1,00	verified	(0,21)

SHEAR

BEARING PRESSURE OF AN ANCHOR BOLT ONTO THE BASE PLATE

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

$\alpha_{d,y}$ =	0,76	Coeff. taking account of the bolt position - in the direction of shear	[Table 3.4]
$\alpha_{b,y}$ =	0,76	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]

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

$F_{1,vb,Rd,y}$ =	272,73	[kN]	Resistance of an anchor bolt for bearing pressure onto the base plate	[6.2.2.(7)]

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

$\alpha_{d,z}$ =	1,52	Coeff. taking account of the bolt position - in the direction of shear	[Table 3.4]
$\alpha_{b,z}$ =	1,00	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]

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

$F_{1,vb,Rd,z}$ =	360,00	[kN]	Resistance of an anchor bolt for bearing pressure onto the base plate	[6.2.2.(7)]

SHEAR OF AN ANCHOR BOLT

α_b =	0,25		Coeff. for resistance calculation $F_{2,vb,Rd}$	[6.2.2.(7)]
A_{vb} =	3,14	[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)]

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

$F_{2,vb,Rd}$ =	49,86	[kN]	Shear resistance of a bolt - without lever arm	[6.2.2.(7)]
α_M =	2,00		Factor related to the fastening of an anchor in the foundation	CEB [9.3.2.2]
$M_{Rk,s}$ =	0,75	[kN*m]	Characteristic bending resistance of an anchor	CEB [9.3.2.2]
l_{sm} =	52	[mm]	Lever arm length	CEB [9.3.2.2]
γ_{Ms} =	1,20		Partial safety factor	CEB [3.2.3.2]

$F_{v,Rd,sm} = \alpha_M * M_{Rk,s} / (l_{sm} * \gamma_{Ms})$

$F_{v,Rd,sm}$ =	23,94	[kN]	Shear resistance of a bolt - with lever arm	CEB [9.3.1]

CONCRETE PRY-OUT FAILURE

$N_{Rk,c}$ =	260,61	[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]

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

$F_{v,Rd,cp}$ =	241,31	[kN]	Concrete resistance for pry-out failure	CEB [9.3.1]

CONCRETE EDGE FAILURE

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

$V_{Rk,c,y}^0$ =	227,13	[kN]	Characteristic resistance of an anchor
$\psi_{A,V,y}$ =	0,67		Factor related to anchor spacing and edge distance
$\psi_{h,V,y}$ =	1,00		Factor related to the foundation thickness
$\psi_{s,V,y}$ =	0,90		Factor related to the influence of edges parallel to the shear load direction
$\psi_{ec,V,y}$ =	1,00		Factor taking account a group effect when different shear loads are acting on the individual anchors in a grou
$\psi_{\alpha,V,y}$ =	1,00		Factor related to the angle at which the shear load is applied
$\psi_{ucr,V,y}$ =	1,00		Factor related to the type of edge reinforcement used
γ_{Mc} =	2,16		Partial safety factor

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

$F_{v,Rd,c,y}$ =	63,09	[kN]	Concrete resistance for edge failure	CEB [9.3.1]

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

$V_{Rk,c,z}^0$ =	227,13	[kN]	Characteristic resistance of an anchor
$\psi_{A,V,z}$ =	0,67		Factor related to anchor spacing and edge distance
$\psi_{h,V,z}$ =	1,00		Factor related to the foundation thickness
$\psi_{s,V,z}$ =	0,90		Factor related to the influence of edges parallel to the shear load direction
$\psi_{ec,V,z}$ =	1,00		Factor taking account a group effect when different shear loads are acting on the individual anchors in a grou
$\psi_{\alpha,V,z}$ =	1,00		Factor related to the angle at which the shear load is applied
$\psi_{ucr,V,z}$ =	1,00		Factor related to the type of edge reinforcement used
γ_{Mc} =	2,16		Partial safety factor

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

$F_{v,Rd,c,z}$ =	63,09	[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)]
$N_{c,Ed}$ =	210,00	[kN]	Compressive force	[6.2.2.(6)]

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

$F_{f,Rd}$ =	63,00	[kN]	Slip resistance	[6.2.2.(6)]

SHEAR CHECK

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

$V_{j,Rd,y}$ =	110,87	[kN]	Connection resistance for shear	CEB [9.3.1]

$V_{j,Ed,y} / V_{j,Rd,y} \leq 1,0$	0,03 < 1,00	verified	(0,03)

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

$V_{j,Rd,z}$ =	110,87	[kN]	Connection resistance for shear	CEB [9.3.1]

$V_{j,Ed,z} / V_{j,Rd,z} \le 1,0$	0,03 < 1,00	verified	(0,03)
$V_{j,Ed,y} / V_{j,Rd,y} + V_{j,Ed,z} / V_{j,Rd,z} \le 1,0$	0,05 < 1,00	verified	(0,05)

WELDS BETWEEN THE COLUMN AND THE BASE PLATE

$\sigma_{\perp}$ =	46,40	[MPa]	Normal stress in a weld	[4.5.3.(7)]
$\tau_{\perp}$ =	46,40	[MPa]	Perpendicular tangent stress	[4.5.3.(7)]
τ_{yII} =	3,75	[MPa]	Tangent stress parallel to $V_{j,Ed,y}$	[4.5.3.(7)]
τ_{zII} =	1,88	[MPa]	Tangent stress parallel to $V_{j,Ed,z}$	[4.5.3.(7)]
β_W =	0,80		Resistance-dependent coefficient	[4.5.3.(7)]

$\sigma_{\perp} / (0.9 * f_u/\gamma_{M2})) \le 1.0$ (4.1)	0,18 < 1,00	verified	(0,18)
$\sqrt{}(\sigma_{\perp}^2 + 3.0 (\tau_{yII}^2 + \tau_{\perp}^2)) / (f_u/(\beta_W * \gamma_{M2}))) \le 1.0$ (4.1)	0,26 < 1,00	verified	(0,26)
$\sqrt{}(\sigma_{\perp}^2 + 3.0 (\tau_{zII}^2 + \tau_{\perp}^2)) / (f_u/(\beta_W * \gamma_{M2}))) \le 1.0$ (4.1)	0,26 < 1,00	verified	(0,26)

WEAKEST COMPONENT:

WELDS JOINING THE COLUMN PIER WITH THE BASE PLATE

Connection conforms to the code	Ratio	0,26