**Fixed column base design**


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**GENERAL**

Connection no.: 2

Connection name: Fixed column base

**GEOMETRY**

**COLUMN**

- **Section:** SHSH 250x250x12.5
- **$L_c$** = 4.00 [m] Column length
- **$\alpha$** = 0.0 [Deg] Inclination angle
- **$h_c$** = 250 [mm] Height of column section
- **$b_c$** = 250 [mm] Width of column section
- **$t_{wc}$** = 13 [mm] Thickness of the web of column section
- **$t_{fc}$** = 13 [mm] Thickness of the flange of column section
- **$r_c$** = 13 [mm] Radius of column section fillet
- **$A_c$** = 11700 [mm$^2$] Cross-sectional area of a column
- **$I_{yc}$** = 109150000 [mm$^4$] Moment of inertia of the column section
- **Material:** S355
  - **$f_{yc}$** = 355.00 [MPa] Resistance
  - **$f_{uc}$** = 490.00 [MPa] Yield strength of a material

**COLUMN BASE**

- **$l_{pd}$** = 500 [mm] Length
- **$b_{pd}$** = 500 [mm] Width
- **$t_{pd}$** = 25 [mm] Thickness
- **Material:** S355
  - **$f_{ypd}$** = 355.00 [MPa] Resistance
  - **$f_{upd}$** = 490.00 [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
- **$d$** = 30 [mm] Bolt diameter
A_e = 561 [mm^2]  Effective section area of a bolt
A_v = 707 [mm^2]  Area of bolt section
n_H = 4  Number of bolt columns
n_V = 4  Number of bolt rows
Horizontal spacing e_H = 130;130 [mm]
Vertical spacing e_V = 130;130 [mm]

Anchor dimensions
L_1 = 50 [mm]
L_2 = 600 [mm]
L_3 = 50 [mm]

Anchor plate
l_p = 130 [mm]  Length
b_p = 130 [mm]  Width
t_p = 10 [mm]  Thickness
Material: S355
f_y = 355.00 [MPa]  Resistance

Washer
l_wd = 60 [mm]  Length
b_wd = 60 [mm]  Width
t_wd = 8 [mm]  Thickness

MATERIAL FACTORS
\( \gamma_{M0} = 1.00 \)  Partial safety factor
\( \gamma_{M2} = 1.25 \)  Partial safety factor
\( \gamma_C = 1.50 \)  Partial safety factor

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

Concrete
Class: C40
f_ck = 40.00 [MPa]  Characteristic resistance for compression

Grout layer
t_g = 25 [mm]  Thickness of leveling layer (grout)
f_ck,g = 40.00 [MPa]  Characteristic resistance for compression
C_f,d = 0.20  Coeff. of friction between the base plate and concrete

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

LOADS
Case: Manual calculations.
N_j,Ed = 1200.00 [kN]  Axial force
V_j,Ed,y = 550.00 [kN]  Shear force
V_j,Ed,z = 580.00 [kN]  Shear force

RESULTS

TENSION ZONE
STEEL FAILURE
A_b = 561 [mm^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)]
\( f_{L,Res,1} = \beta \cdot 0.9 \cdot f_{ub} \cdot A_b / M_2 \)
**Concrete Cone Failure**

- Effective anchorage depth: $b_{ef} = 270$ [mm] (CEB [9.2.4])
- Characteristic resistance of an anchor: $N_{RK0} = 210.44$ [kN] (CEB [9.2.4])
- Critical width of the concrete cone: $s_{cR} = 810$ [mm] (CEB [9.2.4])
- Critical edge distance: $c_{cr} = 405$ [mm] (CEB [9.2.4])
- Maximum area of concrete cone: $A_{cN} = 1440000$ [mm$^2$] (CEB [9.2.4])
- Actual area of concrete cone: $A_{cN} = 1080000$ [mm$^2$] (CEB [9.2.4])

**Resistances of Spread Footing in the Tension Zone**

- Resistance of a spread footing for axial tension: $N_{j,Rd} = 475.40$ [kN] (6.2.8.3)

**Connection Capacity Check**

- $N_{j,Ed} / N_{j,Rd} \leq 1.0$ (6.24)
  - $2.52 > 1.00$ not verified (2.52)

**Shear**

- Shear force $V_{j,Ed,y}$
  - $a_{dy} = 0.57$ Coeff. taking account of the bolt position - in the direction of shear (Table 3.4)
  - $a_{dy} = 0.57$ 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)
  - $F_{1,vb,Rd,y} = k_{1,y} \cdot v_{d,y} \cdot \frac{d^2 t_y}{2}$
  - $F_{1,vb,Rd,y} = 421.09$ [kN] Resistance of an anchor bolt for bearing pressure onto the base plate (6.2.2.7)
\[ a_{b_z} = 0.57 \] Coeff. taking account of the bolt position - in the direction of shear [Table 3.4]

\[ a_{d_z} = 0.57 \] 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]

\[ F_{1, vb, Rd, z} = k_{1_z} \cdot \frac{n_{b_z} \cdot \gamma_{up} \cdot d \cdot t_p}{\gamma_{M2}} \] [kN] Resistance of an anchor bolt for bearing pressure onto the base plate [6.2.2.(7)]

**SHEAR OF AN ANCHOR BOLT**

\[ a_d = 0.25 \] Coeff. for resistance calculation \( F_{2, vb, Rd} \) [6.2.2.(7)]

\[ A_{vb} = 707 \] [mm²] Area of bolt section [6.2.2.(7)]

\[ f_{ub} = 800.00 \] [MPa] Tensile strength of the anchor material [6.2.2.(7)]

\[ \gamma_{M2} = 1.25 \] Partial safety factor [6.2.2.(7)]

\[ F_{2, vb, Rd} = a_d \cdot f_{ub} \cdot A_{vb} / \gamma_{M2} \] [kN] Shear resistance of a bolt - without lever arm [6.2.2.(7)]

\[ F_{2, vb, Rd} = 112.19 \] [kN]

**SPLITTING RESISTANCE**

\[ C_{fr} = 0.20 \] Coeff. of friction between the base plate and concrete [6.2.2.(6)]

\[ N_{c, Ed} = 0.00 \] [kN] Compressive force [6.2.2.(6)]

\[ F_{fr, Rd} = C_{fr} \cdot N_{c, Ed} \] [kN] Slip resistance [6.2.2.(6)]

\[ F_{fr, Rd} = 0.00 \] [kN]

**SHEAR CHECK**

\[ V_{j, Rd, y} = n_b \cdot \min(F_{1, vb, Rd, y}, F_{2, vb, Rd}) + F_{fr, Rd} \] [kN] Connection resistance for shear CEB [9.3.1]

\[ V_{j, Rd, y} = 1346.31 \] [kN] verified (0.41)

\[ V_{j, Ed, y} / V_{j, Rd, y} \leq 1.0 \]

\[ V_{j, Rd, z} = n_b \cdot \min(F_{1, vb, Rd, z}, F_{2, vb, Rd}) + F_{fr, Rd} \] [kN] Connection resistance for shear CEB [9.3.1]

\[ V_{j, Rd, z} = 1346.31 \] [kN] verified (0.43)

\[ V_{j, Ed, z} / V_{j, Rd, z} \leq 1.0 \]

\[ V_{j, Ed, y} / V_{j, Rd, y} + V_{j, Ed, z} / V_{j, Rd, z} \leq 1.0 \]

**WELDS BETWEEN THE COLUMN AND THE BASE PLATE**

\[ \sigma_1 = 106.07 \] [MPa] Normal stress in a weld [4.5.3.(7)]

\[ \tau_1 = 106.07 \] [MPa] Perpendicular tangent stress [4.5.3.(7)]

\[ \tau_{yII} = 137.50 \] [MPa] Tangent stress parallel to \( V_{j, Ed, y} \) [4.5.3.(7)]

\[ \tau_{zII} = 145.00 \] [MPa] Tangent stress parallel to \( V_{j, Ed, z} \) [4.5.3.(7)]

\[ \beta_W = 0.90 \] Resistance-dependent coefficient [4.5.3.(7)]

\[ \sigma_1 / (0.9 \gamma_{M2}) \leq 1.0 \] (4.1) verified (0.30)

\[ \nu(\sigma_1^2 + 3.0 (\tau_{yII}^2 + \tau_{zII}^2)) / (f_t / (W \cdot \gamma_{M2})) \leq 1.0 \] (4.1) verified (0.73)

\[ \nu(\sigma_1^2 + 3.0 (\tau_{yII}^2 + \tau_{zII}^2)) / (f_t / (W \cdot \gamma_{M2})) \leq 1.0 \] (4.1) verified (0.75)

**WEAKEST COMPONENT:**

BASE PLATE - BENDING

**Connection does not conform to the code**

**Ratio** 2.52