**GENERAL**

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

**GEOMETRY**

**BARS**

<table>
<thead>
<tr>
<th>Bar no.</th>
<th>Chord</th>
<th>Diagonal 1</th>
<th>Diagonal 2</th>
<th>Post</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>HEA 240</td>
<td>SHS 120x4</td>
<td>SHS 120x4</td>
<td>SHS 120x4</td>
</tr>
<tr>
<td>349</td>
<td>230</td>
<td>120</td>
<td>120</td>
<td>120 mm</td>
</tr>
<tr>
<td>Chord</td>
<td>Diagonal 1</td>
<td>Diagonal 2</td>
<td>Post</td>
<td></td>
</tr>
<tr>
<td>-------</td>
<td>-----------</td>
<td>-----------</td>
<td>------</td>
<td></td>
</tr>
<tr>
<td>$b_f$</td>
<td>240</td>
<td>120</td>
<td>120</td>
<td>120</td>
</tr>
<tr>
<td>$t_w$</td>
<td>8</td>
<td>4</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>$t_f$</td>
<td>12</td>
<td>4</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>$r$</td>
<td>21</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

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 $\theta$  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

$M_0 = (N_{02}-N_{01}) \cdot e_0$
\[ M_0 = 17.14 \text{ kN·m} \] Additional moment from eccentric connection of members
\[ \Sigma E_iJ_i = 2298436.82 \text{ kN·m} \] Overall connection stiffness
\[ \Delta M_{01} = 6.71 \text{ kN·m} \] Additional moment in the chord
\[ \Delta M_{02} = 6.71 \text{ kN·m} \] Additional moment in the chord
\[ \Delta M_i = 1.13 \text{ kN·m} \] Additional moment in the diagonal
\[ \Delta M_3 = 1.46 \text{ kN·m} \] Additional moment in the diagonal

\[ \gamma_{MS} = 1.00 \] Partial safety factor [Table 2.1]

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

**GEOMETRICAL PARAMETERS**

\[ \beta = 0.50 \] Coefficient taking account of geometry of connection bars \( \beta = (b_2 + h_2 + b_1 + h_1 + b_3 + h_3)/(6b_0) \) [1.5 (6)]
\[ \gamma = 10.00 \] Coefficient taking account of geometry of the chord \( \gamma = b_0/2t_0 \)

**TUBE BRACE FAILURE**

**DIAGONAL 2**
\[ \rho_{eff} = 134 \text{ [mm]} \] Effective width in the connection of the diagonal to the chord
\[ M_{2,Rd} = 15.91 \text{ [kN·m]} \] Bending resistance
\[ |M_2 + \Delta M_2| \leq M_{2,Rd} |0.77| < 15.91 \] verified

**DIAGONAL 1**
\[ \rho_{eff} = 134 \text{ [mm]} \] Effective width in the connection of the diagonal to the chord
\[ M_{1,Rd} = 15.91 \text{ [kN·m]} \] Bending resistance
\[ |M_1 + \Delta M_1| \leq M_{1,Rd} |0.54| < 15.91 \] verified

**POST**
\[ \rho_{eff} = 134 \text{ [mm]} \] Effective width in the connection of the post to the chord
\[ M_{3,Rd} = 15.91 \text{ [kN·m]} \] Bending resistance
\[ |M_3 + \Delta M_3| \leq M_{3,Rd} |0.58| < 15.91 \] verified

**CHORD SHEAR**

**DIAGONAL 2**
\[ A_v = 38.46 \text{ [cm}^2\text{]} \] Shear area of the chord
\[ N_{2,Rd} = 713.98 \text{ [kN]} \] Tension capacity
\[ |N_2| \leq N_{2,Rd} |163.78| < 713.98 \] verified

**DIAGONAL 1**
\[ A_v = 38.46 \text{ [cm}^2\text{]} \] Shear area of the chord
\[ N_{1,Rd} = 713.98 \text{ [kN]} \] Compression capacity
\[ |N_1| \leq N_{1,Rd} |-189.82| < 713.98 \] verified
POST
\[ A_v = 38.46 \text{ [cm}^2\text{]} \] Shear area of the chord
\[ N_{3,Rd} = 551.14 \text{ [kN]} \] Tension capacity
\[
|N_3| \leq N_{3,Rd} \quad 11.16 \leq 551.14 \quad \text{verified} \quad (0.02)
\]

CHORD
\[ N_{0,Rd} = 0.00 \text{ [kN]} \] Chord resistance
\[
|N_0| \leq N_{0,Rd} \quad 588.30 \geq 0.00 \quad \text{verified} \quad (0.00)
\]

CHORD WEB YIELDING

DIAGONAL 2
\[ b_w = 320 \text{ [mm]} \] Effective width for the chord web
\[ M_{2,Rd} = 34.60 \text{ [kN}^\text{m}\text{]} \] Bending resistance
\[
|M_2 + \Delta M_2| \leq M_{2,Rd} \quad 0.77 \leq 34.60 \quad \text{verified} \quad (0.02)
\]

DIAGONAL 1
\[ b_w = 320 \text{ [mm]} \] Effective width for the chord web
\[ M_{1,Rd} = 34.60 \text{ [kN}^\text{m}\text{]} \] Bending resistance
\[
|M_1 + \Delta M_1| \leq M_{1,Rd} \quad 0.54 \leq 34.60 \quad \text{verified} \quad (0.02)
\]

POST
\[ b_w = 285 \text{ [mm]} \] Effective width for the chord web
\[ M_{3,Rd} = 30.77 \text{ [kN}^\text{m}\text{]} \] Bending resistance
\[
|M_3 + \Delta M_3| \leq M_{3,Rd} \quad 0.58 \leq 30.77 \quad \text{verified} \quad (0.02)
\]

VERIFICATION OF WELDS

DIAGONAL 2
\[ \beta_w = 0.83 \] Correlation coefficient
\[ \gamma_{M2} = 1.25 \] Partial safety factor

Longitudinal weld
\[ \sigma_L = 26.57 \text{ [MPa]} \] Normal stress in a weld
\[ \tau_L = 26.57 \text{ [MPa]} \] Perpendicular tangent stress
\[ \tau_b = 31.86 \text{ [MPa]} \] Tangent stress
\[
|\sigma_L| \leq 0.9f_u/\gamma_{M2} \quad 26.57 \leq 287.93 \quad \text{verified} \quad (0.09)
\]
\[
\sqrt{[\sigma_L^2 + 3(\tau_L^2 + \tau_b^2)]} \leq f_u/(\beta_w\gamma_{M2}) \quad 76.61 \leq 386.14 \quad \text{verified} \quad (0.20)
\]

Transverse inner weld
\[ \sigma_s = 30.12 \text{ [MPa]} \] Normal stress in a weld
\[ \tau_s = 6.20 \text{ [MPa]} \] Perpendicular tangent stress
\[ \tau_b = 0.00 \text{ [MPa]} \] Tangent stress
\[
|\sigma_s| \leq 0.9f_u/\gamma_{M2} \quad 30.12 \leq 287.93 \quad \text{verified} \quad (0.10)
\]
\[
\sqrt{[\sigma_s^2 + 3(\tau_s^2 + \tau_b^2)]} \leq f_u/(\beta_w\gamma_{M2}) \quad 31.98 \leq 386.14 \quad \text{verified} \quad (0.08)
\]

Transverse outer weld
\[ \sigma_1 = 8.89 \text{ [MPa]} \] Normal stress in a weld
\[ \tau_1 = 31.39 \text{ [MPa]} \] Perpendicular tangent stress
\[\sigma_t = 8.89 \text{ [MPa]} \text{ Normal stress in a weld} \]
\[\tau_\theta = 0.00 \text{ [MPa]} \text{ Tangent stress} \]
\[|\sigma_t| \leq 0.9 f_u/\gamma_{M2}\]
\[\sqrt{[\sigma_t^2 + 3(\tau_\theta^2 + \tau_{II}^2)]} \leq f_u/(\beta_w \gamma_{M2})\]
\[8.89 < 287.93 \text{ verified (0.03)}\]

### Diagonal 1

\[\beta_w = 0.83 \text{ Correlation coefficient [Table 4.1]}\]
\[\gamma_{M2} = 1.25 \text{ Partial safety factor [Table 2.1]}\]

**Longitudinal weld**
\[\sigma_\| = -30.79 \text{ [MPa]} \text{ Normal stress in a weld} \]
\[\tau_\| = -30.79 \text{ [MPa]} \text{ Perpendicular tangent stress} \]
\[\tau_\theta = -36.93 \text{ [MPa]} \text{ Tangent stress} \]
\[|\sigma_\| \leq 0.9 f_u/\gamma_{M2}\]
\[\sqrt{[\sigma_\|^2 + 3(\tau_\|^2 + \tau_{II}^2)]} \leq f_u/(\beta_w \gamma_{M2})\]
\[|-30.79| < 287.93 \text{ verified (0.11)}\]

**Transverse inner weld**
\[\sigma_\| = -37.56 \text{ [MPa]} \text{ Normal stress in a weld} \]
\[\tau_\| = -12.79 \text{ [MPa]} \text{ Perpendicular tangent stress} \]
\[\tau_\theta = 0.00 \text{ [MPa]} \text{ Tangent stress} \]
\[|\sigma_\| \leq 0.9 f_u/\gamma_{M2}\]
\[\sqrt{[\sigma_\|^2 + 3(\tau_\|^2 + \tau_{II}^2)]} \leq f_u/(\beta_w \gamma_{M2})\]
\[|-37.56| < 287.93 \text{ verified (0.13)}\]

**Transverse outer weld**
\[\sigma_\| = -4.56 \text{ [MPa]} \text{ Normal stress in a weld} \]
\[\tau_\| = -33.67 \text{ [MPa]} \text{ Perpendicular tangent stress} \]
\[\tau_\theta = 0.00 \text{ [MPa]} \text{ Tangent stress} \]
\[|\sigma_\| \leq 0.9 f_u/\gamma_{M2}\]
\[\sqrt{[\sigma_\|^2 + 3(\tau_\|^2 + \tau_{II}^2)]} \leq f_u/(\beta_w \gamma_{M2})\]
\[|-4.56| < 287.93 \text{ verified (0.02)}\]

### Post

\[\beta_w = 0.83 \text{ Correlation coefficient [Table 4.1]}\]
\[\gamma_{M2} = 1.25 \text{ Partial safety factor [Table 2.1]}\]

**Longitudinal weld**
\[\sigma_\| = 3.56 \text{ [MPa]} \text{ Normal stress in a weld} \]
\[\tau_\| = 3.56 \text{ [MPa]} \text{ Perpendicular tangent stress} \]
\[\tau_\theta = 0.00 \text{ [MPa]} \text{ Tangent stress} \]
\[|\sigma_\| \leq 0.9 f_u/\gamma_{M2}\]
\[\sqrt{[\sigma_\|^2 + 3(\tau_\|^2 + \tau_{II}^2)]} \leq f_u/(\beta_w \gamma_{M2})\]
\[|3.56| < 287.93 \text{ verified (0.01)}\]

**Transverse inner weld**
\[\sigma_\| = -1.42 \text{ [MPa]} \text{ Normal stress in a weld} \]
\[\tau_\| = -1.42 \text{ [MPa]} \text{ Perpendicular tangent stress} \]
\[\tau_\theta = 0.00 \text{ [MPa]} \text{ Tangent stress} \]
\[|\sigma_\| \leq 0.9 f_u/\gamma_{M2}\]
\[\sqrt{[\sigma_\|^2 + 3(\tau_\|^2 + \tau_{II}^2)]} \leq f_u/(\beta_w \gamma_{M2})\]
\[|-1.42| < 287.93 \text{ verified (0.00)}\]

**Connection conforms to the code**

Ratio 0.27