Design Team:
Example Structural Calculations
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**Revisions:**


**Introduction:**

The following calculations are to size structural members for the new rear extension at [address].

Calculations are prepared in accordance with the following Standards:

- Weight of building materials: BS 648
- Loading: BS 6399, BS-EN 1991
- Structural concrete: BS 8110
- Structural steel: BS 5950, BS-EN 1993
- Structural timber: BS 5268, BS-EN 1995

**Loading Data:**

**Timber Pitched Roof:**

Dead Load

- Tiles: 0.75 kNm\(^2\)
- Battens: 0.05 kNm\(^2\)
- Felt: 0.05 kNm\(^2\)
- Rafters: 0.20 kNm\(^2\)
- Ceiling/Services: 0.15 kNm\(^2\)

Total: 1.20 kNm\(^2\) (on slope)

\[1.20 \text{ kNm}^2 / \cos(20) = 1.28 \text{ kNm}^2\] (on plane)

Imposed Load: 0.60 kNm\(^2\)

**Timber Floor:**

Dead Load

- Boarding: 0.15 kNm\(^2\)
- Joists: 0.20 kNm\(^2\)
- Ceiling/Services: 0.15 kNm\(^2\)

Total: 0.50 kNm\(^2\)

Imposed Load: 1.50 kNm\(^2\)

**Brickwork:**

Dead Load \[\gamma_{\text{brick}} = 18 \text{ kNm}^{-3}\]
Timber Stud Wall:

Dead Load

- Stud wall 1.00 kNm\(^2\)

Wind load on walls:

Imposed Load 0.70 kNm\(^2\)

Fire resistance:

Fire resistance period R = 30 min

Exposure to fire Exposed on more than one side

Soil bearing capacity: P = 91kPa

Note:

Calculations to be checked by local Authority before work commences. Client to ensure all of contractors’ works on site to comply with and meet Approval of the relevant British Standards and the Local Authority including Building Control and Planning Departments. Maximum liability for these works is equal to the fee being paid.

Dimensions: Note that all dimensions shown on the drawings are indicative and should be checked prior to start of the works on site. It is the responsibility of the client to notify the Designer of any discrepancies. The same applies to the alignment of walls and general layouts. All existing foundations and lintels to be exposed to verify suitability and to be checked for adequacy and/or replaced or surrounded in 150mm concrete cover if necessary. Prior to commencement a trial hole and/or soil report/investigation and an inspection of any trees in the areas may be required.

Structural Calculations Loadings: We do not have access to any plans of building as they were originally constructed. Consequently structural calculations are based upon assumptions. The client should be aware that the calculations have limitations based upon the information forthcoming. We are not privy to the original construction details of the building from the time of its construction. All Steel Beams to have minimum of 1/2hr Fire Resistance via ‘Nullifire’ Paint or 19mm Gyproc Plank tied with 1.6mm wire binding @ 100mm c/c and finished in Carlite Bonding 16mm thick. The dimensions of all steel sections required should be measured on site by the client (or their representative contractor or steelwork fabricator). Where the wall above is wider than the steel (supporting it) below there is the need to weld a 12mm thick plate to the top flange/s of the steels to ensure that the wall/steel interface are the identical width. All below ground steelwork must be concrete encased with minimum 100mm thickness.
**TIMBER RAFTER 'T-1'**

**TIMBER RAFTER DESIGN (BS5268-2:2002)**

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**Rafter details**
- Breadth of timber sections: \( b = 47 \text{ mm} \)
- Depth of timber sections: \( h = 150 \text{ mm} \)
- Rafter spacing: \( s = 400 \text{ mm} \)
- Rafter span: Single span
- Clear length of span on slope: \( L_{cl} = 2554 \text{ mm} \)
- Rafter slope: \( \alpha = 20.0 \text{ deg} \)
- Timber strength class: C24

**Section properties**
- Cross sectional area of rafter: \( A = 7050 \text{ mm}^2 \)
- Section modulus: \( Z = 176250 \text{ mm}^3 \)
- Radius of gyration: \( r = 43 \text{ mm} \)
- Second moment of area: \( I = 13218750 \text{ mm}^4 \)

**Loading details**
- Rafter self weight: \( F_j = 0.02 \text{ kN/m} \)
- Dead load on slope: \( F_d = 1.20 \text{ kN/m}^2 \)
- Imposed snow load on plan: \( F_u = 0.75 \text{ kN/m}^2 \)
- Imposed point load: \( F_p = 0.90 \text{ kN} \)

**Modification factors**
- Section depth factor: \( K_7 = 1.08 \)
- Load sharing factor: \( K_8 = 1.10 \)

**Consider long term load condition**
- Load duration factor: \( K_3 = 1.00 \)
- Total UDL perp. to rafter: \( F = 0.474 \text{ kN/m} \)
- Notional bearing length: \( L_b = 5 \text{ mm} \)
- Effective span: \( L_{eff} = 2559 \text{ mm} \)

**Check bending stress**
- Permissible bending stress: \( \sigma_{\text{m, adm}} = 8.904 \text{ N/mm}^2 \)
- Applied bending stress: \( \sigma_{\text{m, max}} = 2.200 \text{ N/mm}^2 \)

**PASS - Applied bending stress within permissible limits**

**Check compressive stress parallel to grain**
- Permissible comp. stress: \( \sigma_{c, \text{ adm}} = 5.848 \text{ N/mm}^2 \)
- Applied compressive stress: \( \sigma_{c, \text{ max}} = 0.330 \text{ N/mm}^2 \)

**PASS - Applied compressive stress within permissible limits**

**Check combined bending and compressive stress parallel to grain**
- Combined loading check: \( 0.308 < 1 \)

**PASS - Combined compressive and bending stresses are within permissible limits**

**Check shear stress**
- Permissible shear stress: \( \tau_{\text{adm}} = 0.781 \text{ N/mm}^2 \)
- Applied shear stress: \( \tau_{\text{max}} = 0.129 \text{ N/mm}^2 \)

**PASS - Applied shear stress within permissible limits**
Check deflection
Permissible deflection $\delta_{adm} = 7.677$ mm Total deflection $\delta_{max} = 1.951$ mm

PASS - Total deflection within permissible limits

Consider medium term load condition
Load duration factor $K_3 = 1.25$
Notional bearing length $L_b = 8$ mm
Effective span $L_{eff} = 2562$ mm
Total UDL perp. to rafter $F = 0.739$ kN/m

Check bending stress
Permissible bending stress $\sigma_{m, adm} = 11.130$ N/mm$^2$
Applied bending stress $\sigma_{m, max} = 3.438$ N/mm$^2$

PASS - Applied bending stress within permissible limits

Check compressive stress parallel to grain
Permissible comp. stress $\sigma_{c, adm} = 6.978$ N/mm$^2$
Applied compressive stress $\sigma_{c, max} = 0.515$ N/mm$^2$

PASS - Applied compressive stress within permissible limits

Check combined bending and compressive stress parallel to grain
Combined loading check $0.390 < 1$

PASS - Combined compressive and bending stresses are within permissible limits

Check shear stress
Permissible shear stress $\tau_{adm} = 0.976$ N/mm$^2$
Applied shear stress $\tau_{max} = 0.201$ N/mm$^2$

PASS - Applied shear stress within permissible limits

Check deflection
Permissible deflection $\delta_{adm} = 7.685$ mm Total deflection $\delta_{max} = 3.054$ mm

PASS - Total deflection within permissible limits

Consider short term load condition
Load duration factor $K_3 = 1.50$
Notional bearing length $L_b = 8$ mm
Effective span $L_{eff} = 2562$ mm
Total UDL perp. to rafter $F = 0.474$ kN/m

Check bending stress
Permissible bending stress $\sigma_{m, adm} = 13.355$ N/mm$^2$
Applied bending stress $\sigma_{m, max} = 5.280$ N/mm$^2$

PASS - Applied bending stress within permissible limits

Check compressive stress parallel to grain
Permissible comp. stress $\sigma_{c, adm} = 7.965$ N/mm$^2$
Applied compressive stress $\sigma_{c, max} = 0.374$ N/mm$^2$

PASS - Applied compressive stress within permissible limits

Check combined bending and compressive stress parallel to grain
Combined loading check $0.449 < 1$

PASS - Combined compressive and bending stresses are within permissible limits

Check shear stress
Permissible shear stress $\tau_{adm} = 1.172$ N/mm$^2$
Applied shear stress $\tau_{max} = 0.309$ N/mm$^2$

PASS - Applied shear stress within permissible limits

Check deflection
Permissible deflection $\delta_{adm} = 7.687$ mm Total deflection $\delta_{max} = 4.174$ mm

PASS - Total deflection within permissible limits
STEEL BEAM 'SB-1'

Loading

Dead load:

Pitched roof: \( g_1 = 1.28 \text{kN/m}^2 \times 2.60 \text{m} = 3.33 \text{kN/m} \)

Imposed load:

Pitched roof: \( q_1 = 0.60 \text{kN/m}^2 \times 2.60 \text{m} = 1.56 \text{kN/m} \)

STEEL BEAM ANALYSIS & DESIGN (BS5950)

In accordance with BS5950-1:2000 incorporating Corrigendum No.1

TEDDS calculation version 3.0.05

Support conditions

Support A  Vertically restrained  Rotationally free
Support B  Vertically restrained  Rotationally free

Applied loading

Beam loads  Dead self weight of beam × 1
            Dead full UDL 3.33 kN/m
            Imposed full UDL 1.56 kN/m
Load combinations

Load combination 1
Support A
Span 1
Support B

Analysis results

Maximum moment
M_{\text{max}} = 15.9 \text{kNm}  
M_{\text{min}} = 0 \text{kNm}

Maximum shear
V_{\text{max}} = 15.5 \text{kN}  
V_{\text{min}} = -15.5 \text{kN}

Deflection
\delta_{\text{max}} = 5.3 \text{mm}  
\delta_{\text{min}} = 0 \text{mm}

Maximum reaction at support A
R_{A,\text{max}} = 15.5 \text{kN}  
R_{A,\text{min}} = 15.5 \text{kN}

Unfactored dead load reaction at support A
R_{A,\text{Dead}} = 7.4 \text{kN}

Unfactored imposed load reaction at support A
R_{A,\text{Imposed}} = 3.2 \text{kN}

Maximum reaction at support B
R_{B,\text{max}} = 15.5 \text{kN}  
R_{B,\text{min}} = 15.5 \text{kN}

Unfactored dead load reaction at support B
R_{B,\text{Dead}} = 7.4 \text{kN}

Unfactored imposed load reaction at support B
R_{B,\text{Imposed}} = 3.2 \text{kN}

Section details

Section type
UC 152x152x30 (BS4-1)
Steel grade
S275

Classification of cross sections - Section 3.5
Tensile strain coefficient \( \varepsilon = 1.00 \)
Section classification Plastic

Shear capacity - Section 4.2.3
Design shear force \( F_v = 15.5 \text{kN} \)
Design shear resistance \( P_v = 169 \text{kN} \)
\text{PASS - Design shear resistance exceeds design shear force}

Moment capacity - Section 4.2.5
Design bending moment \( M = 15.9 \text{kNm} \)
Moment capacity low shear \( M_c = 68.1 \text{kNm} \)

Buckling resistance moment - Section 4.3.6.4
Buckling resistance moment \( M_b = 41.4 \text{kNm} \)
\[ M_b / m_{LT} = 41.4 \text{kNm} \]
\text{PASS - Buckling resistance moment exceeds design bending moment}
Check vertical deflection - Section 2.5.2
Consider deflection due to dead and imposed loads

Limiting deflection $\delta_{\text{lim}} = 11.389$ mm
Maximum deflection $\delta = 5.323$ mm

PASS - Maximum deflection does not exceed deflection limit
**STEEL BEAM 'SB-2'**

**Loading**

Dead load:

Reaction from SB-1: \( g_1 = 7.40 \text{ kN} / 1.80 \text{ m} = 4.11 \text{ kN/m} \)

Imposed load:

Reaction from SB-1: \( q_1 = 3.20 \text{ kN} / 1.80 \text{ m} = 1.78 \text{ kN/m} \)

**STEEL MASONRY SUPPORT**

In accordance with BS5950-1:2000 incorporating Corrigendum No.1

Steel member details

- **Torsion beam**: UB 203x133x30
- **Masonry support plate**: User
- **Steel grade of support plate**: S275
- **Design strength of support plate**: \( p_{ysb} = 275 \text{ N/mm}^2 \)
- **Modulus of elasticity**: \( E = 205000 \text{ N/mm}^2 \)
- **Constant**: \( \varepsilon = \sqrt{(275 \text{ N/mm}^2 / p_{ysb})} = 1.000 \)
- **Length of plate beyond beam**: \( l_h = 140 \text{ mm} \)
- **Total length of plate**: \( l_{plate} = 280 \text{ mm} \)
- **Thickness of plate**: \( t_{sb} = 10 \text{ mm} \)
- **Width of main beam**: \( B_{mb} = 134 \text{ mm} \)
- **Area of plate**: \( A_{sbu} = t_{sb} \times l_{plate} = 2800.0 \text{ mm}^2 \)
- **Distance from weld position to CoG**: \( c_yysb = l_h / 2 - (l_{plate} - l_h) / 2 = 0 \text{ mm} \)
**Supported materials detail**

- Density of masonry on main beam: \( \rho_{m,mb} = 18.0 \text{ kN/m}^3 \)
- Width of masonry on main beam: \( b_{mb} = 100 \text{ mm} \)
- Height of masonry on main beam: \( h_{mb} = 900 \text{ mm} \)
- Eccentricity of main beam material: \( c_{mb} = 39 \text{ mm} \)
- Add dead force main beam (not from masonry): \( P_{Qaddmb} = 4.1 \text{ kN/m} \)
- Add live force main beam (not from masonry): \( P_{Qaddmb} = 1.8 \text{ kN/m} \)
- Density of masonry on support beam: \( \rho_{m,sb} = 18.0 \text{ kN/m}^3 \)
- Width of masonry on support beam: \( b_{sb} = 100 \text{ mm} \)
- Height of masonry on support beam: \( h_{sb} = 900 \text{ mm} \)
- Add dead force support beam (not from masonry): \( P_{Qaddsb} = 0.0 \text{ kN/m} \)
- Add live force support beam (not from masonry): \( P_{Qaddsb} = 0.0 \text{ kN/m} \)

**Geometry**

- Cavity width: \( c = 90 \text{ mm} \)
- Supported width of masonry: \( d_{in} = h_{b} + c_{mb} - c = 89 \text{ mm} \)

**Biaxial stress effects in the plate (SCI-P-110)**

- Maximum overall bending moment: \( M_x = 29.1 \text{ kNm} \)
- Dist to NA combined section (CoG torsion beam): \( y_{c,all} = (D_{mb} + t_{mb}) \times A_{mbu} / (2 \times (A_{mb} + A_{mbu})) = 46 \text{ mm} \)
- Second moment of area of combined section: \( I_{xx,all} = (I_{xx} + A_{mb} \times y_{c,all}^2) + A_{sb} \times (D_{mb} / 2 + t_{mb} / 2 - y_{c,all})^2 = 4794 \text{ cm}^4 \)
- Elastic section modulus of combined section: \( Z_{xx,all} = I_{xx,all} / (D_{mb} / 2 + t_{mb} - y_{c,all}) = 709.66 \text{ cm}^3 \)
- Section modulus of plate: \( Z_{xx,plate} = 1 \times t_{mb}^2 / (6 \times 1) = 16.67 \text{ cm}^3/m \)
- Eccentricity of support beam masonry: \( e_1 = 100 \text{ mm} \)
- Force of masonry on support plate: \( P_l = (b_{mb} \times h_{mb} \times \rho_{m,mb} + P_{Qaddsb} \times \gamma_G + P_{Qaddsb} \times \gamma_Q) = 2.3 \text{ kN/m} \)
- Moment capacity of plate: \( M_{c,plate} = P_l \times c_1 = 0.2 \text{ kNm/m} \)
- \( M_c = 1.2 \times Z_{xx,plate} \times p_{sb} = 5.5 \text{ kNm/m} \)

**PASS - Design strength exceeds stress at heel**

- Longitudinal stress due to overall bending: \( \sigma_1 = M_x / Z_{xx,all} = 41.1 \text{ N/mm}^2 \)
- Constant relating to Von Mises curve: \( c_p = (4 \times p_{sb}^2 - 3 \times \sigma_1^2)^{0.5} = 545.4 \text{ N/mm}^2 \)
- Transverse bending stress ratio limit: \( \alpha_n = (c_p^2 - \sigma_1^2) / (2 \times c_p \times p_{sb}) = 0.986 \)
- Transverse bending stress ratio: \( \alpha_n = M_{c,plate} / M_c = 0.041 \)

**PASS - Transverse bending stress ratio less than allowable limit**

**Deflection at toe**

- Unfactored force on support angle: \( P_{1SLS} = b_{mb} \times h_{mb} \times \rho_{m,mb} + P_{Qaddsb} + P_{Qaddsb} = 1.6 \text{ kN/m} \)
- Distance from weld to load position: \( a_u = c_1 = 100 \text{ mm} \)
- Length of load resultant to edge of plate: \( b_u = l_b - c_1 = 40 \text{ mm} \)
- Dist from weld to load position as ratio of length: \( a_i = a_u / (a_u + b_u) = 0.714 \)
- Effective second moment of inertia: \( I_{eff,def} = t_{mb}^2 / 12 = 83333 \text{ mm}^4/m \)
- Deflection at toe: \( \delta = (a_i^2 \times (3 - a_i) / 6) \times (P_{1SLS} \times (a_u + b_u)) / (E5995 \times I_{eff,def}) = 0.05 \text{ mm} \)
- Deflection limit: \( \delta_{lim} = 1.99 \text{ mm} \)

**PASS - Deflection is within specified criteria**

**Weld details - assume a full length weld and that the plate acts as a propped cantilever with the prop at the weld position and the fixed end at the centre of the torsion beam**

- Leg length of weld: \( s_{weld} = 6 \text{ mm} \)
- Throat size of weld: \( a_{equ} = 1/\sqrt{2} \times s_{weld} = 4.2 \text{ mm} \)
- Shear force at weld position: \( R_A = P_l \times \max((1 + (3 \times c_1) / (2 \times b_{sb} / 2)), 1.4) = 7.3 \text{ kN/m} \)
Maximum possible force in plate

\[ R_p = (t_b + B_{mb}) \times t_s \times p_{ysb} = 753.2 \text{kN} \]

Longitudinal shear between beam and plate

\[ R_l = P_1 \times c_1 / (s_{weld} / 2 + t_s / 2) = 28.4 \text{kN/m} \]

Horizontal shear between beam and plate

\[ R_h = (R_s^2 + R_c^2 + R_y^2)^{0.5} = 0.369 \text{kN/mm} \]

Resultant weld force

\[ R_{weld} = 220.0 \text{N/mm}^2 \]

\[ p_{weld} = 0.933 \text{kN/mm} \]

\[ PASS - \text{Capacity of weld exceeds resultant force on weld} \]

Torsional loading ULS

\[ w_{1ULS} = (b_{hmb} \times b_{hmb} \times \rho_{m,sh} + P_{Gaddsb} \times \gamma_G + P_{Qaddsb} \times \gamma_Q) = 2.27 \text{kN/m} \]

\[ w_{2ULS} = (b_{hmb} \times b_{hmb} \times \rho_{m,sh} + P_{Gaddmb} \times \gamma_G + P_{Qaddmb} \times \gamma_Q) = 10.87 \text{kN/m} \]

\[ w_{3ULS} = A_{shb} \times \rho_{sh} \times \gamma_f = 0.31 \text{kN/m} \]

Torsional loading SLS

\[ w_{1SLS} = b_{hmb} \times b_{hmb} \times \rho_{m,sh} + P_{Gaddsb} + P_{Qaddsb} = 1.62 \text{kN/m} \]

\[ w_{2SLS} = b_{hmb} \times b_{hmb} \times \rho_{m,sh} + P_{Gaddmb} + P_{Qaddmb} = 7.51 \text{kN/m} \]

\[ w_{3SLS} = A_{shb} \times \rho_{sh} = 0.22 \text{kN/m} \]

Eccentricities

\[ c_{lmb} = 0 \text{mm} \]

\[ c_{1mb} = (B_{mb} + b_{hmb}) / 2 + c - c_{mb} = 168 \text{mm} \]

\[ c_{2mb} = (B_{mb} - b_{mmb}) / 2 - c_{mb} = -22 \text{mm} \]

\[ c_{lmb} = B_{mb} / 2 + c_{ysb} = 67 \text{mm} \]

Torsional effects

\[ T_{qULS} = abs(w_{1ULS} \times c_{1mb} + w_{2ULS} \times c_{2mb} + w_{3ULS} \times c_{lmb}) = 0.16 \text{kNm/m} \]

\[ T_d = T_{qULS} \times L = 0.66 \text{kNm} \]

\[ T_{qSLS} = abs(w_{1SLS} \times c_{1mb} + w_{2SLS} \times c_{2mb} + w_{3SLS} \times c_{lmb}) = 0.12 \text{kNm/m} \]

\[ T_d = T_{qSLS} \times L = 0.50 \text{kNm} \]

STEEL BEAM TORSION DESIGN

In accordance with BS5950-1:2000 incorporating Corrigendum No.1

Tedds calculation version 2.0.02

Section details

Section type UB 203x133x30
Steel grade S275
Design strength \[ p_{yw} = p_y = 275 \text{N/mm}^2 \]
Constant \[ \varepsilon = \sqrt(275 \text{N/mm}^2 / p_y) = 1.000 \]

Geometry - Beam unrestrained against lateral-torsional buckling

between supports.

Effective span \[ L = 4100 \text{mm} \]
Length of segment for LT buckling \[ L_{LT} = 4100 \text{mm} \]
Compression flanges laterally unrestrained
Partial torsional restraint against rotation about longitudinal axis provided by connection of bottom flange to supports
Effective length for LT buckling \[ L_{E,LT} = L_{LT} \times 1.0 + 2 \times D = 4514 \text{mm} \]

Loading - Torsional loading comprises only full-length uniformly distributed load(s)

Internal forces & moments on member under factored loading for uls design

Applied shear force \[ F_{vy} = 28.4 \text{kN} \]
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<tr>
<td>Maximum bending moment</td>
<td>$M_{LT} = M_x = 29.14 \text{ kNm}$</td>
</tr>
<tr>
<td>Applied torque</td>
<td>$T_0 = 0.66 \text{ kNm}$</td>
</tr>
<tr>
<td>Minor axis bending moment</td>
<td>$M_y = 0 \text{ kNm}$</td>
</tr>
<tr>
<td>Compression force</td>
<td>$F_c = 0 \text{ kN}$</td>
</tr>
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**Equivalent uniform moment factors**

EUM factor (Cl. 4.3.6.6 and T18) $m_{LT} = 1.000$  

**Torsional deflection parameters**

Beam is torsion fixed and warping free at each end. (as defined in SCI-P-057 section 2.1.6) - Appendix B case 4

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<tr>
<td>Dist along the beam for first derivative of twist</td>
<td>$z_1 = 0 \text{ mm}$</td>
</tr>
<tr>
<td>Dist along the beam for second derivative of twist</td>
<td>$z_2 = L / 2 = 2050 \text{ mm}$</td>
</tr>
<tr>
<td>First derivative of angle of twist</td>
<td>$\phi'_1 = T_q / (G \times J) \times a / L \times [L^2 / (2 \times a) \times (1 / L - 2 \times z_1 / L^2) + \sinh(z_1 / a) - \tanh(L / 2 \times a) \times \cosh(z_1 / a)] \times 1 \text{ rads} = 2.21 \times 10^{-2} \text{ rads/m}$</td>
</tr>
<tr>
<td>Third derivative of angle of twist</td>
<td>$\phi'''_1 = T_q / (G \times J) \times a / L \times [\sinh(z_1 / a) - \tanh(L / (2 \times a)) \times \cosh(z_1 / a)] \times 1 \text{ rads} = 1.99 \times 10^{-2} \text{ rads/m}$</td>
</tr>
<tr>
<td>Angle of twist</td>
<td>$\phi_1 = T_q / (G \times J) \times a / L \times [\sinh(z_1 / a) - \tanh(L / (2 \times a)) \times \cosh(z_1 / a)] \times 1 \text{ rads} = 0.028 \text{ rads}$</td>
</tr>
<tr>
<td>Second derivative of angle of twist</td>
<td>$\phi''_1 = T_q / (G \times J) \times a / L \times [\cosh(z_1 / a) - \tanh(L / (2 \times a)) \times \sinh(z_1 / a) - 1] \times 1 \text{ rads} = -1.52 \times 10^{-2} \text{ rads/m}$</td>
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**Design parameters**

<table>
<thead>
<tr>
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<tr>
<td>Total angle of twist</td>
<td>$\phi = \text{abs}(\phi_1) = 0.028 \text{ rads}$</td>
</tr>
<tr>
<td>First derivative of $\phi$</td>
<td>$\phi' = \text{abs}(\phi'_1) = 2.21 \times 10^{-2} \text{ rads/m}$</td>
</tr>
<tr>
<td>Second derivative of $\phi$</td>
<td>$\phi'' = \text{abs}(\phi''_1) = 1.52 \times 10^{-2} \text{ rads/m}^2$</td>
</tr>
<tr>
<td>Third derivative of $\phi$</td>
<td>$\phi'''' = \text{abs}(\phi''''_1) = 1.99 \times 10^{-2} \text{ rads/m}^3$</td>
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**Section classification**

<table>
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<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>$b / T = 7.0$</td>
<td></td>
</tr>
<tr>
<td>$d / t = 26.9$</td>
<td></td>
</tr>
<tr>
<td>$r_{1s} = \min(1.0, \max(-1.0, F_c / (d \times t \times p_{yw}))) = 0.000$</td>
<td></td>
</tr>
<tr>
<td>$r_{2s} = F_c / (A_y \times p_{yw}) = 0.000$</td>
<td></td>
</tr>
</tbody>
</table>

**Section classification is plastic**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shear capacity (parallel to y-axis)</td>
<td>$F_{vy} = 28.4 \text{ kN}$</td>
</tr>
<tr>
<td>Design shear force</td>
<td>$F_{vy} = 0.6 \times p_y \times A_{vy} = 218.4 \text{ kN}$</td>
</tr>
</tbody>
</table>

**Pass - Shear**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moment capacity (x-axis)</td>
<td>$M_x = 29.1 \text{ kNm}$</td>
</tr>
<tr>
<td>Design bending moment</td>
<td>$M_{exx} = p_y \times S_x = 86.5 \text{ kNm}$</td>
</tr>
<tr>
<td>Moment capacity</td>
<td>$M_{exx} = \min(p_y \times S_x, 1.2 \times p_y \times Z_x) = 86.5 \text{ kNm}$</td>
</tr>
</tbody>
</table>

**Pass - Moment capacity exceeds design bending moment**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lateral torsional buckling</td>
<td>$L_{LE,LT} = 4514 \text{ mm}$</td>
</tr>
<tr>
<td>Slenderness ratio</td>
<td>$\lambda = L_{LE,LT} / r_y = 142$</td>
</tr>
<tr>
<td>Buckling parameter</td>
<td>$u = 0.881$</td>
</tr>
<tr>
<td>Flange ratio</td>
<td>$\eta = 0.5$</td>
</tr>
<tr>
<td>Torsional index</td>
<td>$x = 21.5$</td>
</tr>
<tr>
<td>Slenderness factor</td>
<td>$v = 1 / \sqrt{1 + 0.05 \times (\lambda / x)^{0.25}} = 0.75$</td>
</tr>
</tbody>
</table>
Calc Date | Client | Job No. | Page No. | Revision
---|---|---|---|---
Calc By | Project | |

Ratio - cl 4.3.6.9 \[\beta_w = 1.0 = 1.000\]
Equivalent slenderness – cl 4.3.6.7 \[\lambda_{LT} = u \times v \times \lambda \times \sqrt{(\beta_w)} = 94\]
Limiting slenderness – Annex B2.2 \[\lambda_{L0} = 0.4 \times \sqrt{(\pi^2 \times E_{S5950} / p_y)} = 34\]
Euler stress \[p_e = \pi^2 \times E_{S5950} / \lambda_{LT}^2 = 230 \text{ N/mm}^2\]
Perry factor \[\eta_{LT} = \max(7.0 \times (\lambda_{LT} - \lambda_{L0}) / 1000, 0) = 0.42\]
Bending strength \[p_b = p_e \times p_y / (\phi_{LT} + (\eta_{LT} + 1) \times p_e) = 136 \text{ N/mm}^2\]
Buckling resistance moment \[M_b = p_b \times S_y = 42.8 \text{ kNm}\]
Max moment governing buckling resistance \[M_{LT} = 29.1 \text{ kNm}\]
Equiv uniform moment factor for LTB \[m_{LT} = 1.00\]

**Buckling under combined bending & torsion - SCI-P-057 section 2.3**

For simplicity, a conservative check is applied using the maximum stresses due to each of the separate load effects, even though these do not necessarily all occur at the same section along the member.

Span factor \[L / a = 4.22\]

Angle of twist \[\phi = 0.028 \text{ radians}\]

Second derivative of \(\phi\) \[\phi'' = 15.2 \times 10^{-3} \text{ radians/m}^2\]

Induced minor axis moment \[M_x = M_x \times \phi / 1 \text{ rad} = 0.80 \text{ kNm}\]

Normal stress at flange tip due to \(M_x\) \[\sigma_{bby} = M_x / Z_y = 14 \text{ N/mm}^2\]

Normal stress at flange tip due to warping \[\sigma_w = E_{S5950} \times W_{afl} \times \phi'' / 1 \text{ rad} = 21 \text{ N/mm}^2\]

Interaction index \[i_b = M_x \times m_{LT} / M_b + (\sigma_{bby} + \sigma_w) / p_y \times (1 + 0.5 \times M_x \times m_{LT} / M_b) = 0.85\]

**Pass - Combined bending and torsion check satisfied**

**Local capacity under combined bending & torsion**

For simplicity, a conservative check is applied using the maximum stresses due to each of the separate load effects, even though these do not necessarily all occur at the same section along the member.

Max. direct stress due to \(M_x\) \[\sigma_{ax} = M_x / Z_x = 104 \text{ N/mm}^2\]

Combined stress - eqn 2.22 \[\sigma_{ax} + \sigma_{hy} + \sigma_w = 139 \text{ N/mm}^2\]

Design strength \[p_y = 275 \text{ N/mm}^2\]

**Pass - Local capacity**

**Combined shear stresses - SCI-P-057 section 2.3**

For simplicity, a conservative check is applied using the maximum shear stresses due to each of the separate load effects, even though these do not necessarily all occur at the same section along the member.

Max shear stresses due to bending in web \[\tau_{bw} = F_{yy} \times Q_x / (I_x \times t) = 24 \text{ N/mm}^2\]

Max shear stresses due to bending in flange \[\tau_{bf} = F_{yy} \times Q_t / (I_x \times T) = 6 \text{ N/mm}^2\]

Max shear stresses due to torsion in web \[\tau_{ow} = \max(G \times t \times \phi' / 1 \text{ rad}) = 11 \text{ N/mm}^2\]

Max shear stresses due to torsion in flange \[\tau_{ot} = \max(G \times T \times \phi' / 1 \text{ rad}) = 17 \text{ N/mm}^2\]

Max shear stresses due to warping in flange \[\tau_{wt} = \max(-E_{S5950} \times S_{aw} \times \phi'' / 1 \text{ rad} / T) = 1 \text{ N/mm}^2\]

Amp shear stress torsion & warping in web \[\tau_{ovw} = \tau_{ow} \times (1 + 0.5 \times M_x \times m_{LT} / M_b) = 15 \text{ N/mm}^2\]

Amp shear stress torsion & warping in flange \[\tau_{ovt} = ((\tau_{ot} + \tau_{ovt}) \times (1 + 0.5 \times M_x \times m_{LT} / M_b) = 24 \text{ N/mm}^2\]

**Pass - Combined shear stresses**
**Deflection**

Maximum y-axis deflection

\[ \delta_{y,max} = 6.0 \text{ mm} \]

Deflection limit - cl. 2.5.2

\[ \delta_{lim} = \min(L/k, \delta_{lim, abs}) = 10.0 \text{ mm} \]

*Pass - Deflection within specified limit*
GROUND FLOOR STEEL FRAME

Loading

- **SB-3**

**Dead load:**

- Pitched roof: \( g_1 = 1.28 \text{ kN/m}^2 \times 2.60 \text{ m} = 3.33 \text{ kN/m} \)
- Timber floor: \( g_2 = 0.50 \text{ kN/m}^2 \times 1.40 \text{ m} \times 2 = 1.40 \text{ kN/m} \)
- Solid masonry wall: \( g_3 = 18 \text{ kN/m}^3 \times 0.25 \text{ m} \times 2.90 \text{ m} = 13.05 \text{ kN/m} \)
- Tiled stud wall *(possible loft)*: \( g_4 = 1.00 \text{ kN/m}^2 \times 2.60 \text{ m} = 2.60 \text{ kN/m} \)

\[ \text{Total Dead} = g_1 + g_2 + g_3 + g_4 = 20.38 \text{ kN/m} \]

**Imposed load:**

- Pitched roof: \( q_1 = 0.60 \text{ kN/m}^2 \times 2.60 \text{ m} = 1.56 \text{ kN/m} \)
- Timber floor: \( q_2 = 1.50 \text{ kN/m}^2 \times 1.40 \text{ m} \times 2 = 4.20 \text{ kN/m} \)

\[ \text{Total Imposed} = q_1 + q_2 = 5.76 \text{ kN/m} \]

- **SB-4**

**Dead load:**

- Solid masonry wall: \( g_1 = 18 \text{ kN/m}^3 \times 0.25 \text{ m} \times 2.90 \text{ m} = 13.05 \text{ kN/m} \)
- Tiled stud wall *(possible loft)*: \( g_2 = 1.00 \text{ kN/m}^2 \times 2.60 \text{ m} = 2.60 \text{ kN/m} \)
- Reaction from SB-1: \( g_3 = 7.40 \text{ kN} / 1.80 \text{ m} = 4.11 \text{ kN/m} \)

\[ \text{Total Dead} = g_1 + g_2 + g_3 = 19.76 \text{ kN/m} \]

**Imposed load:**

- Reaction from SB-1: \( q_1 = 3.20 \text{ kN} / 1.80 \text{ m} = 1.78 \text{ kN/m} \)

**Wind load:**

- \( w_1 = 0.70 \text{ kN/m}^2 \times 9.80 \text{ m}^2 = 6.86 \text{ kN} \)
### Members 1D

<table>
<thead>
<tr>
<th>Name</th>
<th>Cross-section</th>
<th>Material</th>
<th>Length [m]</th>
<th>Beg. node</th>
<th>End node</th>
</tr>
</thead>
<tbody>
<tr>
<td>SB-4</td>
<td>SB-4 - UC203/203/60</td>
<td>S 275</td>
<td>4.80</td>
<td>N1</td>
<td>N2</td>
</tr>
<tr>
<td>SB-3</td>
<td>SB-3 - UC203/203/46</td>
<td>S 275</td>
<td>1.70</td>
<td>N3</td>
<td>N4</td>
</tr>
<tr>
<td>C-1</td>
<td>C-1 - UC152/152/37</td>
<td>S 275</td>
<td>3.00</td>
<td>N5</td>
<td>N2</td>
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</tbody>
</table>

*Note: All lengths of steel members are for analysis purposes only, accurate lengths are to be measured on site prior to ordering steel members.*

### Nodal supports

<table>
<thead>
<tr>
<th>Name</th>
<th>Node</th>
<th>System</th>
<th>Type</th>
<th>X</th>
<th>Y</th>
<th>Z</th>
<th>Rx</th>
<th>Ry</th>
<th>Rz</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sn1</td>
<td>N4</td>
<td>GCS</td>
<td>Standard</td>
<td>Rigid</td>
<td>Rigid</td>
<td>Rigid</td>
<td>Free</td>
<td>Free</td>
<td>Free</td>
</tr>
<tr>
<td>Sn2</td>
<td>N1</td>
<td>GCS</td>
<td>Standard</td>
<td>Rigid</td>
<td>Free</td>
<td>Rigid</td>
<td>Free</td>
<td>Free</td>
<td>Free</td>
</tr>
<tr>
<td>Sn3</td>
<td>N5</td>
<td>GCS</td>
<td>Standard</td>
<td>Rigid</td>
<td>Rigid</td>
<td>Rigid</td>
<td>Free</td>
<td>Free</td>
<td>Free</td>
</tr>
</tbody>
</table>

### Load cases

<table>
<thead>
<tr>
<th>Name</th>
<th>Description Spec</th>
<th>Action type Load type</th>
<th>Load group</th>
<th>Direction</th>
</tr>
</thead>
<tbody>
<tr>
<td>LC1</td>
<td>Self Weight</td>
<td>Permanent</td>
<td>LG1</td>
<td>-Z</td>
</tr>
</tbody>
</table>

**Spec:** Self weight

<table>
<thead>
<tr>
<th>Name</th>
<th>Description Spec</th>
<th>Action type Load type</th>
<th>Load group</th>
</tr>
</thead>
<tbody>
<tr>
<td>LC2</td>
<td>Dead Load</td>
<td>Permanent</td>
<td>LG1</td>
</tr>
</tbody>
</table>

**Spec:** Standard

### Load cases

<table>
<thead>
<tr>
<th>Name</th>
<th>Description Spec</th>
<th>Action type Load type</th>
<th>Load group</th>
<th>Duration</th>
<th>Master load case</th>
</tr>
</thead>
<tbody>
<tr>
<td>LC3</td>
<td>Imposed Load</td>
<td>Variable</td>
<td>LG2</td>
<td>Medium</td>
<td>None</td>
</tr>
<tr>
<td>Name</td>
<td>Description</td>
<td>Action type</td>
<td>Load group</td>
<td>Duration</td>
<td>Master load case</td>
</tr>
<tr>
<td>------</td>
<td>-------------</td>
<td>-------------</td>
<td>------------</td>
<td>----------</td>
<td>------------------</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Standard</td>
<td>Static</td>
<td></td>
<td></td>
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</tr>
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</table>

<table>
<thead>
<tr>
<th>Name</th>
<th>Description</th>
<th>Action type</th>
<th>Load group</th>
<th>Duration</th>
<th>Master load case</th>
</tr>
</thead>
<tbody>
<tr>
<td>LC4</td>
<td>Wind</td>
<td>Variable</td>
<td>LG3</td>
<td>Medium</td>
<td>None</td>
</tr>
</tbody>
</table>

| LC4  | Standard    | Static      | LG3        | Medium   | None             |
Member loads

Line force

<table>
<thead>
<tr>
<th>Name</th>
<th>Member Load case</th>
<th>Type</th>
<th>Dir</th>
<th>Value - P₁ [kN/m]</th>
<th>Value - P₂ [kN/m]</th>
<th>Pos x₁</th>
<th>Coor</th>
<th>Orig</th>
<th>Ecc ey [m]</th>
<th>Ecc ez [m]</th>
</tr>
</thead>
<tbody>
<tr>
<td>LF1</td>
<td>SB-3</td>
<td>Force</td>
<td>Z</td>
<td>-20.38</td>
<td>0.00</td>
<td>0.00</td>
<td>Rela</td>
<td>From start</td>
<td>0.00</td>
<td></td>
</tr>
<tr>
<td></td>
<td>LC2 - Dead Load</td>
<td>GCS</td>
<td>Uniform</td>
<td>1.00</td>
<td>2.580</td>
<td>0.00</td>
<td>Length</td>
<td>From end</td>
<td>0.00</td>
<td></td>
</tr>
<tr>
<td>LF2</td>
<td>SB-4</td>
<td>Force</td>
<td>Z</td>
<td>-19.76</td>
<td>0.00</td>
<td>0.00</td>
<td>Abso</td>
<td>From end</td>
<td>0.00</td>
<td></td>
</tr>
<tr>
<td></td>
<td>LC2 - Dead Load</td>
<td>GCS</td>
<td>Uniform</td>
<td>1.00</td>
<td>2.580</td>
<td>0.00</td>
<td>Length</td>
<td>From end</td>
<td>0.00</td>
<td></td>
</tr>
<tr>
<td>LF3</td>
<td>SB-3</td>
<td>Force</td>
<td>Z</td>
<td>-5.76</td>
<td>0.00</td>
<td>0.00</td>
<td>Rela</td>
<td>From start</td>
<td>0.00</td>
<td></td>
</tr>
<tr>
<td></td>
<td>LC3 - Imposed Load</td>
<td>GCS</td>
<td>Uniform</td>
<td>1.00</td>
<td>2.580</td>
<td>0.00</td>
<td>Length</td>
<td>From end</td>
<td>0.00</td>
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</tr>
<tr>
<td>LF4</td>
<td>SB-4</td>
<td>Force</td>
<td>Z</td>
<td>-1.78</td>
<td>1.310</td>
<td>3.450</td>
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<td>From end</td>
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<tr>
<td></td>
<td>LC3 - Imposed Load</td>
<td>GCS</td>
<td>Uniform</td>
<td>1.00</td>
<td>2.580</td>
<td>0.00</td>
<td>Length</td>
<td>From end</td>
<td>0.00</td>
<td></td>
</tr>
</tbody>
</table>

Point force in node

<table>
<thead>
<tr>
<th>Name</th>
<th>Node</th>
<th>Load case</th>
<th>System</th>
<th>Dir</th>
<th>Type</th>
<th>Value - F [kN]</th>
</tr>
</thead>
<tbody>
<tr>
<td>F1</td>
<td>N2</td>
<td>LC4 - Wind</td>
<td>GCS</td>
<td>Y</td>
<td>Force</td>
<td>-6.86</td>
</tr>
</tbody>
</table>

Combinations

<table>
<thead>
<tr>
<th>Name</th>
<th>Description</th>
<th>Type</th>
<th>Load cases</th>
<th>Coeff. [-]</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO1</td>
<td>Strength</td>
<td>Envelope - ultimate</td>
<td>LC1 - Self Weight</td>
<td>1.40</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>LC2 - Dead Load</td>
<td>1.40</td>
</tr>
<tr>
<td>CO2</td>
<td>Strength</td>
<td>Envelope - ultimate</td>
<td>LC1 - Self Weight</td>
<td>1.20</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>LC2 - Dead Load</td>
<td>1.20</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>LC3 - Imposed Load</td>
<td>1.20</td>
</tr>
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<td></td>
<td></td>
<td></td>
<td>LC4 - Wind</td>
<td>1.20</td>
</tr>
<tr>
<td>CO3</td>
<td>Strength</td>
<td>Envelope - ultimate</td>
<td>LC1 - Self Weight</td>
<td>1.40</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>LC2 - Dead Load</td>
<td>1.40</td>
</tr>
<tr>
<td>Name</td>
<td>Description</td>
<td>Type</td>
<td>Load cases</td>
<td>Coeff. [-]</td>
</tr>
<tr>
<td>------</td>
<td>--------------</td>
<td>---------------------</td>
<td>-----------------------------</td>
<td>-----------</td>
</tr>
<tr>
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<td>Envelope - ultimate</td>
<td>LC3 - Imposed Load</td>
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<td>LC2 - Dead Load</td>
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<td>LC4 - Wind</td>
<td>1.40</td>
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<tr>
<td>CO5</td>
<td>Service</td>
<td>Envelope - ultimate</td>
<td>LC1 - Self Weight</td>
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<td>LC2 - Dead Load</td>
<td>1.00</td>
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<td>CO6</td>
<td>Service</td>
<td>Envelope - ultimate</td>
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<td></td>
<td></td>
<td>LC2 - Dead Load</td>
<td>1.00</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>LC3 - Imposed Load</td>
<td>1.00</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>LC4 - Wind</td>
<td>1.00</td>
</tr>
<tr>
<td>CO7</td>
<td>Service</td>
<td>Envelope - ultimate</td>
<td>LC1 - Self Weight</td>
<td>1.00</td>
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<tr>
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<td></td>
<td></td>
<td>LC2 - Dead Load</td>
<td>1.00</td>
</tr>
<tr>
<td></td>
<td></td>
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<td>LC4 - Wind</td>
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<td>CO8</td>
<td>Service</td>
<td>Envelope - ultimate</td>
<td>LC1 - Self Weight</td>
<td>1.00</td>
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<tr>
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<td></td>
<td></td>
<td>LC2 - Dead Load</td>
<td>1.00</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>LC3 - Imposed Load</td>
<td>1.00</td>
</tr>
</tbody>
</table>
**RESULTS - REACTIONS**

Reactions - Self weight + Dead load

Linear calculation
Combination: CO5
System: Global
Extreme: Member
Selection: All

Nodal reactions

<table>
<thead>
<tr>
<th>Name</th>
<th>Case</th>
<th>$R_x$ [kN]</th>
<th>$R_y$ [kN]</th>
<th>$R_z$ [kN]</th>
<th>$M_x$ [kNm]</th>
<th>$M_y$ [kNm]</th>
<th>$M_z$ [kNm]</th>
<th>$e_x$ [mm]</th>
<th>$e_y$ [mm]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sn1/N4</td>
<td>CO5/1</td>
<td>3.62</td>
<td>4.73</td>
<td>17.71</td>
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<td>0.00</td>
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</tr>
<tr>
<td>Sn2/N1</td>
<td>CO5/1</td>
<td>-3.62</td>
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Reactions - Imposed load
Linear calculation
Load case: LC3
System: Global
Extreme: Member
Selection: All

Nodal reactions

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Linear calculation
Load case: LC4
System: Global
Extreme: Member
Selection: All

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**Reactions - Wind load**

Linear calculation  
Class: All ULS  
System: Global  
Extreme: Member  
Selection: All

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Reactions SLS
Linear calculation
Class: All SLS
System: Global
Extreme: Member
Selection: All

### Nodal reactions

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**RESULTS - 1D INTERNAL FORCES**

Linear calculation  
Class: All ULS  
Coordinate system: Principal  
Extreme 1D: Member  
Selection: All

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**Strength combinations - Moment envelope [kNm]**

![Diagram showing moment envelope]
Strength combinations - Shear envelope [kN]

Strength combinations - Axial force envelope [kN]
RESULTS - DEFORMATION

Relative deformation
Linear calculation, Extreme : Member, System : Principal
Selection : All
Class : All SLS

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Relative deformation; uz

![Diagram of deformation with labels -10.0 mm, -0.4 mm, and -2.0 mm]
STEEL MEMBER DESIGN & CHECK (BS-EN1993)

EC-EN 1993 Steel check ULS
Linear calculation
Class: All ULS
Coordinate system: Principal
Extreme 1D: Cross-section
Selection: All

EN 1993-1-1 Code Check
National annex: British BS-EN NA

Member SB-4 2.220 / 4.800 m UC203/203/60 S 275 All ULS 0.53 -

Combination key
All ULS / 1.20*LC1 + 1.20*LC2 + 1.20*LC3 + 1.20*LC4

Partial safety factors
γM0 for resistance of cross-sections 1.00
γM1 for resistance to instability 1.00
γM2 for resistance of net sections 1.10

Material
Yield strength f_y 275.0 MPa
Ultimate strength f_u 430.0 MPa
Fabrication Rolled

The critical check is on position 2.220 m

Internal forces Calculated Unit
N_x,Ed 0.00 kN
V_y,Ed 9.73 kN
V_z,Ed 28.76 kN
T_x,Ed 0.00 kNm
M_y,Ed 68.91 kNm
M_z,Ed 21.60 kNm

Classification for cross-section design
Classification according to EN 1993-1-1 article 5.5.2
Classification of Internal and Outstand parts according to EN 1993-1-1 Table 5.2 Sheet 1 & 2

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<tr>
<th>Id</th>
<th>Type</th>
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<th>t [mm]</th>
<th>σ1 [kN/m²]</th>
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Note: The Classification limits have been set according to Semi-Comp+. The cross-section is classified as Class 1

Bending moment check for M_y
According to EN 1993-1-1 article 6.2.5 and formula (6.12),(6.13)

| W_pl,y | 6.5608e-04 m³ |
| M_pl,y,Rd | 180.42 kNm |
| Unity check | 0.38 - |

Bending moment check for M_x
According to EN 1993-1-1 article 6.2.5 and formula (6.12),(6.13)

| W_pl,x | 3.0534e-04 m³ |
| M_pl,x,Rd | 83.97 kNm |
| Unity check | 0.26 - |
Shear check for $V_y$
According to EN 1993-1-1 article 6.2.6 and formula (6.17)

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Shear check for $V_z$
According to EN 1993-1-1 article 6.2.6 and formula (6.17)

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</table>

Combined bending, axial force and shear force check
According to EN 1993-1-1 article 6.2.9.1 and formula (6.41)

| $M_{pl,y,Rd}$ | 180.42 kNm |
| $\alpha$ | 2.00 |
| $M_{pl,z,Rd}$ | 83.97 kNm |
| $\beta$ | 1.00 |

Unity check (6.41) = 0.15 + 0.26 = 0.40 -

Note: Since the shear forces are less than half the plastic shear resistances their effect on the moment resistances is neglected.

The member satisfies the section check.

...::STABILITY CHECK::...

Classification for member buckling design
Decisive position for stability classification: 2.220 m
Classification according to EN 1993-1-1 article 5.5.2
Classification of Internal and Outstand parts according to EN 1993-1-1 Table 5.2 Sheet 1 & 2

<table>
<thead>
<tr>
<th>Id</th>
<th>Type</th>
<th>$c$ [mm]</th>
<th>$t$ [mm]</th>
<th>$\sigma_1$ [kN/m$^2$]</th>
<th>$\sigma_2$ [kN/m$^2$]</th>
<th>$\Psi$ [-]</th>
<th>$k_e$ [-]</th>
<th>$\alpha$ [-]</th>
<th>$c/t$ [-]</th>
<th>Class 1 Limit [-]</th>
<th>Class 2 Limit [-]</th>
<th>Class 3 Limit [-]</th>
<th>Class</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>SO</td>
<td>88.0</td>
<td>14.2</td>
<td>-1.255e+05</td>
<td>-2.176e+05</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>SO</td>
<td>88.0</td>
<td>14.2</td>
<td>-9.433e+04</td>
<td>-2.278e+03</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>I</td>
<td>160.8</td>
<td>9.4</td>
<td>-9.045e+04</td>
<td>9.045e+04</td>
<td>-1.00</td>
<td>0.50</td>
<td>17.11</td>
<td>66.56</td>
<td>76.73</td>
<td>114.63</td>
<td>114.63</td>
<td>1</td>
</tr>
<tr>
<td>5</td>
<td>SO</td>
<td>88.0</td>
<td>14.2</td>
<td>1.255e+05</td>
<td>2.176e+05</td>
<td>0.58</td>
<td>0.47</td>
<td>1.00</td>
<td>6.20</td>
<td>8.32</td>
<td>9.24</td>
<td>13.34</td>
<td>1</td>
</tr>
<tr>
<td>7</td>
<td>SO</td>
<td>88.0</td>
<td>14.2</td>
<td>9.433e+04</td>
<td>2.278e+03</td>
<td>0.02</td>
<td>1.59</td>
<td>1.00</td>
<td>6.20</td>
<td>8.32</td>
<td>9.24</td>
<td>24.46</td>
<td>1</td>
</tr>
</tbody>
</table>

Note: The Classification limits have been set according to Semi-Comp+. The cross-section is classified as Class 1

Lateral Torsional Buckling check
According to EN 1993-1-1 article 6.3.2.1 & 6.3.2.3 and formula (6.54)

| LTB parameters |                        |                        |                        |                        |
|----------------|------------------------|------------------------|------------------------|
| Method for LTB curve | Alternative case | Plastic section modulus $W_{pl,y}$ | 6.5608e-04 m$^3$ |
| Elastic critical moment $M_{cr}$ | 1785.11 kNm |
| Relative slenderness $\lambda_{rel,LT}$ | 0.32 |
| Limit slenderness $\lambda_{rel,LT,0}$ | 0.40 |

Note: The slenderness or bending moment is such that Lateral Torsional Buckling effects may be ignored according to EN 1993-1-1 article 6.3.2.2(4).

| LTB parameters |                        |                        |                        |                        |
|----------------|------------------------|------------------------|------------------------|
| LTB length $L$ | 2.220 m |
| Influence of load position | no influence |
| Correction factor $k$ | 1.00 |
| Correction factor $k_w$ | 1.00 |
| LTB moment factor $C_1$ | 1.74 |
| LTB moment factor $C_2$ | 0.01 |
### Mcr parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>LTB moment factor $C_1$</td>
<td>1.00</td>
</tr>
<tr>
<td>Shear center distance $d_z$</td>
<td>0.0 mm</td>
</tr>
<tr>
<td>Distance of load application $z_g$</td>
<td>0.0 mm</td>
</tr>
<tr>
<td>Mono-symmetry constant $B_3$</td>
<td>0.0 mm</td>
</tr>
<tr>
<td>Mono-symmetry constant $z_1$</td>
<td>0.0 mm</td>
</tr>
</tbody>
</table>

**Note:** C parameters are determined according to ECCS 119 2006 / Galea 2002.

### Bending and axial compression check

According to EN 1993-1-1 article 6.3.3 and formula (6.61),(6.62)

#### Bending and axial compression check parameters

<table>
<thead>
<tr>
<th>Interaction method</th>
<th>alternative method 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cross-section area $A$</td>
<td>7.6400e-03 m²</td>
</tr>
<tr>
<td>Plastic section modulus $W_{pl,y}$</td>
<td>6.5608e-04 m³</td>
</tr>
<tr>
<td>Plastic section modulus $W_{pl,z}$</td>
<td>3.0534e-04 m³</td>
</tr>
<tr>
<td>Design bending moment (maximum) $M_{y,Ed}$</td>
<td>68.91 kNm</td>
</tr>
<tr>
<td>Characteristic moment resistance $N_{Rk}$</td>
<td>2101.00 kN</td>
</tr>
<tr>
<td>Characteristic moment resistance $M_{y,Rk}$</td>
<td>180.42 kNm</td>
</tr>
<tr>
<td>Reduction factor $\chi_x$</td>
<td>1.00</td>
</tr>
<tr>
<td>Reduction factor $\chi_z$</td>
<td>1.00</td>
</tr>
<tr>
<td>Modified reduction factor $\chi_{T,mod}$</td>
<td>1.00</td>
</tr>
<tr>
<td>Interaction factor $k_{xy}$</td>
<td>1.00</td>
</tr>
<tr>
<td>Interaction factor $k_{xz}$</td>
<td>0.59</td>
</tr>
<tr>
<td>Interaction factor $k_{zy}$</td>
<td>0.58</td>
</tr>
<tr>
<td>Interaction factor $k_{zz}$</td>
<td>0.79</td>
</tr>
</tbody>
</table>

Maximum moment $M_{y,Ed}$ is derived from beam SB-4 position 2.220 m.

Maximum moment $M_{z,Ed}$ is derived from beam SB-4 position 2.220 m.

#### Interaction method 1 parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Critical Euler load $N_{cr,x}$</td>
<td>760.91 kN</td>
</tr>
<tr>
<td>Critical Euler load $N_{cr,z}$</td>
<td>12227.53 kN</td>
</tr>
<tr>
<td>Elastic critical load $N_{cr,T}$</td>
<td>11280.53 kN</td>
</tr>
<tr>
<td>Elastic section modulus $W_{el,y}$</td>
<td>5.8400e-04 m³</td>
</tr>
<tr>
<td>Elastic section modulus $W_{el,z}$</td>
<td>2.0100e-04 m³</td>
</tr>
<tr>
<td>Elastic section modulus $W_{pl,y}$</td>
<td>6.5608e-04 m³</td>
</tr>
<tr>
<td>Elastic section modulus $W_{pl,z}$</td>
<td>3.0534e-04 m³</td>
</tr>
<tr>
<td>Second moment of area $I_x$</td>
<td>6.1258e-05 m⁴</td>
</tr>
<tr>
<td>Second moment of area $I_y$</td>
<td>2.0646e-05 m⁴</td>
</tr>
<tr>
<td>Torsional constant $I_t$</td>
<td>4.7200e-07 m⁴</td>
</tr>
<tr>
<td>Method for equivalent moment factor $C_{my,0}$</td>
<td>Table A.2 Line 2 (General)</td>
</tr>
<tr>
<td>Design bending moment (maximum) $M_{y,Ed}$</td>
<td>68.91 kNm</td>
</tr>
<tr>
<td>Maximum relative deflection $\delta_x$</td>
<td>-12.0 mm</td>
</tr>
<tr>
<td>Equivalent moment factor $C_{my,0}$</td>
<td>1.00</td>
</tr>
<tr>
<td>Method for equivalent moment factor $C_{my,0}$</td>
<td>Table A.2 Line 1 (Linear)</td>
</tr>
<tr>
<td>Ratio of end moments $\mu_x$</td>
<td>0.00</td>
</tr>
<tr>
<td>Equivalent moment factor $C_{my,0}$</td>
<td>0.79</td>
</tr>
<tr>
<td>Factor $\mu_x$</td>
<td>1.00</td>
</tr>
<tr>
<td>Factor $\mu_z$</td>
<td>1.00</td>
</tr>
<tr>
<td>Factor $a_{LT}$</td>
<td>0.99</td>
</tr>
<tr>
<td>Critical moment for uniform bending $M_{cr,0}$</td>
<td>1024.70 kNm</td>
</tr>
<tr>
<td>Relative slenderness $\lambda_{rel,0}$</td>
<td>0.42</td>
</tr>
<tr>
<td>Limit relative slenderness $\lambda_{rel,0,lim}$</td>
<td>0.26</td>
</tr>
<tr>
<td>Equivalent moment factor $C_{my}$</td>
<td>1.00</td>
</tr>
<tr>
<td>Equivalent moment factor $C_{my,T}$</td>
<td>0.79</td>
</tr>
<tr>
<td>Equivalent moment factor $C_{my,T}$</td>
<td>1.00</td>
</tr>
<tr>
<td>Factor $b_{LT}$</td>
<td>0.01</td>
</tr>
<tr>
<td>Factor $c_{LT}$</td>
<td>0.13</td>
</tr>
</tbody>
</table>
### Interaction method 1 parameters

<table>
<thead>
<tr>
<th>Factor</th>
<th>LT</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>d</td>
<td></td>
<td>0.80</td>
</tr>
<tr>
<td>e</td>
<td></td>
<td>2.09</td>
</tr>
<tr>
<td>w_y</td>
<td></td>
<td>1.12</td>
</tr>
<tr>
<td>w_z</td>
<td></td>
<td>1.50</td>
</tr>
<tr>
<td>n_{el}</td>
<td></td>
<td>0.00</td>
</tr>
<tr>
<td>\lambda_{el,\text{max}}</td>
<td></td>
<td>1.66</td>
</tr>
<tr>
<td>C_{xy}</td>
<td></td>
<td>1.00</td>
</tr>
<tr>
<td>C_{xz}</td>
<td></td>
<td>0.93</td>
</tr>
<tr>
<td>C_{yyyy}</td>
<td></td>
<td>0.90</td>
</tr>
<tr>
<td>C_{zy}</td>
<td></td>
<td>1.00</td>
</tr>
</tbody>
</table>

Unity check (6.61) = 0.00 + 0.38 + 0.15 = 0.53
Unity check (6.62) = 0.00 + 0.22 + 0.20 = 0.42

### Shear Buckling check

According to EN 1993-1-5 article 5 & 7.1 and formula (5.10) & (7.1)

<table>
<thead>
<tr>
<th>Shear Buckling parameters</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parameter</td>
</tr>
<tr>
<td>Buckling field length a</td>
</tr>
<tr>
<td>Web</td>
</tr>
<tr>
<td>Web height h_w</td>
</tr>
<tr>
<td>Web thickness t</td>
</tr>
<tr>
<td>Material coefficient (\varepsilon)</td>
</tr>
<tr>
<td>Shear correction factor (\eta)</td>
</tr>
</tbody>
</table>

### Shear Buckling verification

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Web slenderness (h_w^4)</td>
<td>19.28</td>
</tr>
<tr>
<td>Web slenderness limit</td>
<td>66.56</td>
</tr>
</tbody>
</table>

Note: The web slenderness is such that Shear Buckling effects may be ignored according to EN 1993-1-5 article 5.1(2).

The member satisfies the stability check.

### EN 1993-1-1 Code Check

National annex: British BS-EN NA

<table>
<thead>
<tr>
<th>Member</th>
<th>0.000 / 1.700 m</th>
<th>UC203/203/46</th>
<th>S 275</th>
<th>All ULS</th>
<th>0.34</th>
</tr>
</thead>
</table>

### Combination key

All ULS / 1.20*LC1 + 1.20*LC2 + 1.20*LC3 + 1.20*LC4

### Partial safety factors

<table>
<thead>
<tr>
<th>Factor</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>for resistance of cross-sections</td>
<td>1.00</td>
</tr>
<tr>
<td>for resistance to instability</td>
<td>1.00</td>
</tr>
<tr>
<td>for resistance of net sections</td>
<td>1.10</td>
</tr>
</tbody>
</table>

### Material

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yield strength (f_y)</td>
<td>275.0 MPa</td>
</tr>
<tr>
<td>Ultimate strength (f_u)</td>
<td>430.0 MPa</td>
</tr>
<tr>
<td>Fabrication</td>
<td>Rolled</td>
</tr>
</tbody>
</table>

### Internal forces

<table>
<thead>
<tr>
<th>Force</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>(N_{Ed})</td>
<td>9.73</td>
<td>kN</td>
</tr>
<tr>
<td>(V_{y,Ed})</td>
<td>-12.70</td>
<td>kN</td>
</tr>
<tr>
<td>(V_{z,Ed})</td>
<td>27.12</td>
<td>kN</td>
</tr>
<tr>
<td>(T_{Ed})</td>
<td>0.00</td>
<td>kNm</td>
</tr>
<tr>
<td>(M_{y,Ed})</td>
<td>0.00</td>
<td>kNm</td>
</tr>
<tr>
<td>(M_{z,Ed})</td>
<td>21.60</td>
<td>kNm</td>
</tr>
</tbody>
</table>

### Classification for cross-section design

Classification according to EN 1993-1-1 article 5.5.2
Classification of Internal and Outstand parts according to EN 1993-1-1 Table 5.2 Sheet 1 & 2
### Classification limits have been set according to Semi-Comp+.

The cross-section is classified as Class 1:

#### Tension check

According to EN 1993-1-1 article 6.2.3 and formula (6.5)

\[
A = 5.8700 \times 10^{-3} \text{ m}^2
\]

\[
N_{pl,Rd} = 1614.25 \text{ kN}
\]

\[
N_{u,Rd} = 2065.17 \text{ kN}
\]

Unity check: 0.01

#### Bending moment check for \(M_z\)

According to EN 1993-1-1 article 6.2.5 and formula (6.12),(6.13)

\[
W_{pl,z} = 2.3086 \times 10^{-4} \text{ m}^3
\]

\[
M_{pl,z,Rd} = 63.49 \text{ kNm}
\]

Unity check: 0.34

#### Shear check for \(V_y\)

According to EN 1993-1-1 article 6.2.6 and formula (6.17)

\[
\eta = 1.00
\]

\[
V_{pl,Rd} = 731.06 \text{ kN}
\]

Unity check: 0.02

#### Shear check for \(V_z\)

According to EN 1993-1-1 article 6.2.6 and formula (6.17)

\[
\eta = 1.00
\]

\[
V_{pl,z,Rd} = 269.02 \text{ kN}
\]

Unity check: 0.10

#### Combined bending, axial force and shear force check

According to EN 1993-1-1 article 6.2.9.1 and formula (6.31)

\[
M_{pl,z,Rd} = 63.49 \text{ kNm}
\]

Unity check: 0.34

**Note:** Since the shear forces are less than half the plastic shear resistances their effect on the moment resistances is neglected.

**Note:** Since the axial force satisfies criteria (6.35) of EN 1993-1-1 article 6.2.9.1(4) its effect on the moment resistance about the x-x axis is neglected.

The member satisfies the section check.

---

**...::STABILITY CHECK::...**

**Classification for member buckling design**

Decisive position for stability classification: 0.000 m

Classification according to EN 1993-1-1 article 5.5.2

Classification of Internal and Outstand parts according to EN 1993-1-1 Table 5.2 Sheet 1 & 2
Note: The Classification limits have been set according to Semi-Comp+.
The cross-section is classified as Class 1

Shear Buckling check
According to EN 1993-1-5 article 5 & 7.1 and formula (5.10) & (7.1)

<table>
<thead>
<tr>
<th>Shear Buckling parameters</th>
</tr>
</thead>
<tbody>
<tr>
<td>Buckling field length a</td>
</tr>
<tr>
<td>Web</td>
</tr>
<tr>
<td>Web height hw</td>
</tr>
<tr>
<td>Web thickness t</td>
</tr>
<tr>
<td>Material coefficient ε</td>
</tr>
<tr>
<td>Shear correction factor η</td>
</tr>
</tbody>
</table>

Shear Buckling verification
Web slenderness h_w/t 25.17
Web slenderness limit 66.56

Note: The web slenderness is such that Shear Buckling effects may be ignored according to EN 1993-1-5 article 5.1(2).
The member satisfies the stability check.

EN 1993-1-1 Code Check
National annex: British BS-EN NA

<table>
<thead>
<tr>
<th>Member</th>
<th>C-1</th>
<th>0.000 / 3.000 m</th>
<th>U/C152/152/37</th>
<th>S 275</th>
<th>All ULS</th>
<th>0.40</th>
</tr>
</thead>
</table>

Combination key
All ULS / 1.40*LC1 + 1.40*LC2 + 1.60*LC3

Partial safety factors
\( \mu_{M0} \) for resistance of cross-sections 1.00
\( \mu_{M1} \) for resistance to instability 1.00
\( \mu_{M2} \) for resistance of net sections 1.10

Material
Yield strength \( f_y \) 275.0 MPa
Ultimate strength \( f_u \) 430.0 MPa
Fabrication Rolled

Material classification

<table>
<thead>
<tr>
<th>Class</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>Limit</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \Psi )</td>
<td>( k_w )</td>
<td>( \alpha )</td>
<td>( c/t )</td>
<td></td>
</tr>
<tr>
<td>5.70</td>
<td>1.00</td>
<td>1.00</td>
<td>5.70</td>
<td>8.32</td>
</tr>
<tr>
<td>8.32</td>
<td>1.00</td>
<td>1.00</td>
<td>5.70</td>
<td>9.24</td>
</tr>
<tr>
<td>12.94</td>
<td></td>
<td></td>
<td></td>
<td>12.94</td>
</tr>
</tbody>
</table>

Classification for cross-section design
Classification according to EN 1993-1-1 article 5.5.2
Classification of Internal and Outstand parts according to EN 1993-1-1 Table 5.2 Sheet 1 & 2

<table>
<thead>
<tr>
<th>Id</th>
<th>Type</th>
<th>c [mm]</th>
<th>t [mm]</th>
<th>( \sigma_1 ) [kN/m^2]</th>
<th>( \sigma_2 ) [kN/m^2]</th>
<th>( \Psi ) [-]</th>
<th>( k_w ) [-]</th>
<th>( \alpha ) [-]</th>
<th>( c/t ) [-]</th>
<th>Class 1 Limit [kN]</th>
<th>Class 2 Limit [kN]</th>
<th>Class 3 Limit [kN]</th>
<th>Class</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>SO</td>
<td>65.6</td>
<td>11.5</td>
<td>1.670e+04</td>
<td>1.670e+04</td>
<td>1.00</td>
<td>0.43</td>
<td>1.00</td>
<td>5.70</td>
<td>8.32</td>
<td>9.24</td>
<td>12.94</td>
<td>1</td>
</tr>
<tr>
<td>3</td>
<td>SO</td>
<td>65.6</td>
<td>11.5</td>
<td>1.670e+04</td>
<td>1.670e+04</td>
<td>1.00</td>
<td>0.43</td>
<td>1.00</td>
<td>5.70</td>
<td>8.32</td>
<td>9.24</td>
<td>12.94</td>
<td>1</td>
</tr>
<tr>
<td>4</td>
<td>I</td>
<td>123.6</td>
<td>8.0</td>
<td>1.670e+04</td>
<td>1.670e+04</td>
<td>1.00</td>
<td>1.00</td>
<td>15.45</td>
<td>25.88</td>
<td>31.43</td>
<td>35.13</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>SO</td>
<td>65.6</td>
<td>11.5</td>
<td>1.670e+04</td>
<td>1.670e+04</td>
<td>1.00</td>
<td>0.43</td>
<td>1.00</td>
<td>5.70</td>
<td>8.32</td>
<td>9.24</td>
<td>12.94</td>
<td>1</td>
</tr>
<tr>
<td>7</td>
<td>SO</td>
<td>65.6</td>
<td>11.5</td>
<td>1.670e+04</td>
<td>1.670e+04</td>
<td>1.00</td>
<td>0.43</td>
<td>1.00</td>
<td>5.70</td>
<td>8.32</td>
<td>9.24</td>
<td>12.94</td>
<td>1</td>
</tr>
</tbody>
</table>

Note: The Classification limits have been set according to Semi-Comp+.
The cross-section is classified as Class 1
Compression check
According to EN 1993-1-1 article 6.2.4 and formula (6.9)

\[
\begin{align*}
A & = 4.7100 \times 10^{-3} \text{ m}^2 \\
N_{c,Rd} & = 1295.25 \text{ kN} \\
\text{Unity check} & = 0.06
\end{align*}
\]

Shear check for \( V_z \)
According to EN 1993-1-1 article 6.2.6 and formula (6.17)

\[
\begin{align*}
\Pi & = 1.00 \\
A_v & = 1.4256 \times 10^{-3} \text{ m}^2 \\
V_{pl,z,Rd} & = 226.34 \text{ kN} \\
\text{Unity check} & = 0.03
\end{align*}
\]

The member satisfies the section check.

---

**Classification for member buckling design**

Decision position for stability classification: 3.000 m

Classification according to EN 1993-1-1 article 5.5.2

Classification of Internal and Outstand parts according to EN 1993-1-1 Table 5.2 Sheet 1 & 2

<table>
<thead>
<tr>
<th>Id</th>
<th>Type</th>
<th>( c ) [mm]</th>
<th>( t ) [mm]</th>
<th>( \sigma_1 ) [kN/m²]</th>
<th>( \sigma_2 ) [kN/m²]</th>
<th>( \Psi ) [-]</th>
<th>( k_a ) [-]</th>
<th>( \alpha ) [-]</th>
<th>( c/t ) [-]</th>
<th>Class 1 Limit [-]</th>
<th>Class 2 Limit [-]</th>
<th>Class 3 Limit [-]</th>
<th>Class</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>SO</td>
<td>65.6</td>
<td>11.5</td>
<td>-6.225e+04</td>
<td>-6.225e+04</td>
<td></td>
<td></td>
<td></td>
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<td></td>
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</tr>
<tr>
<td>3</td>
<td>SO</td>
<td>65.6</td>
<td>11.5</td>
<td>-6.225e+04</td>
<td>-6.225e+04</td>
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<td></td>
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<td></td>
</tr>
<tr>
<td>4</td>
<td>I</td>
<td>123.6</td>
<td>8.0</td>
<td>-8.103e+04</td>
<td>-6.225e+04</td>
<td>-0.60</td>
<td>0.64</td>
<td>15.45</td>
<td>46.03</td>
<td>54.46</td>
<td>78.72</td>
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<td></td>
</tr>
<tr>
<td>5</td>
<td>SO</td>
<td>65.6</td>
<td>11.5</td>
<td>9.500e+04</td>
<td>9.500e+04</td>
<td>1.00</td>
<td>0.43</td>
<td>5.70</td>
<td>8.32</td>
<td>9.24</td>
<td>12.94</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>SO</td>
<td>65.6</td>
<td>11.5</td>
<td>9.500e+04</td>
<td>9.500e+04</td>
<td>1.00</td>
<td>0.43</td>
<td>5.70</td>
<td>8.32</td>
<td>9.24</td>
<td>12.94</td>
<td>1</td>
<td></td>
</tr>
</tbody>
</table>

**Note:** The Classification limits have been set according to Semi-Comp+.

The cross-section is classified as Class 1

**Flexural Buckling check**

According to EN 1993-1-1 article 6.3.1.1 and formula (6.46)

**Flexural Buckling verification**

Cross-section area \( A \) = 4.7100 \times 10^{-3} \text{ m}^2

Buckling resistance \( N_{b,Rd} \) = 603.86 \text{ kN}

Unity check = 0.13

**Torsional(-Flexural) Buckling check**

According to EN 1993-1-1 article 6.3.1.1 and formula (6.46)

**Note:** For this I-section the Torsional(-Flexural) buckling resistance is higher than the resistance for Flexural buckling. Therefore Torsional(-Flexural) buckling is not printed on the output.

**Bending and axial compression check**

According to EN 1993-1-1 article 6.3.3 and formula (6.61),(6.62)
### Bending and axial compression check parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interaction method</td>
<td>alternative method 1</td>
</tr>
<tr>
<td>Cross-section area A</td>
<td>4.7100e-03 m²</td>
</tr>
<tr>
<td>Plastic section modulus W_{pl,y}</td>
<td>3.0876e-04 m³</td>
</tr>
<tr>
<td>Design compression force N_{Ed}</td>
<td>78.67 kN</td>
</tr>
<tr>
<td>Design bending moment (maximum) M_{x,Ed}</td>
<td>23.13 kNm</td>
</tr>
<tr>
<td>Characteristic compression resistance N_{Rk}</td>
<td>1295.25 kN</td>
</tr>
<tr>
<td>Characteristic moment resistance M_{y,Rk}</td>
<td>84.91 kNm</td>
</tr>
<tr>
<td>Reduction factor ( \chi )</td>
<td>0.47</td>
</tr>
<tr>
<td>Reduction factor ( \chi_c )</td>
<td>0.60</td>
</tr>
<tr>
<td>Modified reduction factor ( \chi_{LT,mod} )</td>
<td>1.00</td>
</tr>
<tr>
<td>Interaction factor ( k_{yy} )</td>
<td>0.98</td>
</tr>
<tr>
<td>Interaction factor ( k_{zy} )</td>
<td>0.56</td>
</tr>
</tbody>
</table>

Maximum moment \( M_{y,Ed} \) is derived from beam C-1 position 3.000 m.
Maximum moment \( M_{z,Ed} \) is derived from beam C-1 position 0.000 m.

### Interaction method 1 parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Critical Euler load N_{cr,y}</td>
<td>867.06 kN</td>
</tr>
<tr>
<td>Critical Euler load N_{cr,z}</td>
<td>1626.52 kN</td>
</tr>
<tr>
<td>Elastic critical load N_{el}</td>
<td>3985.33 kN</td>
</tr>
<tr>
<td>Plastic section modulus W_{pl,y}</td>
<td>3.0876e-04 m³</td>
</tr>
<tr>
<td>Elastic section modulus W_{el,y}</td>
<td>2.7300e-04 m³</td>
</tr>
<tr>
<td>Plastic section modulus W_{pl,z}</td>
<td>1.3958e-04 m³</td>
</tr>
<tr>
<td>Elastic section modulus W_{el,z}</td>
<td>9.1500e-05 m³</td>
</tr>
<tr>
<td>Second moment of area I_y</td>
<td>2.2109e-05 m⁴</td>
</tr>
<tr>
<td>Second moment of area I_z</td>
<td>7.0625e-06 m⁴</td>
</tr>
<tr>
<td>Torsional constant I_t</td>
<td>1.9200e-07 m⁴</td>
</tr>
<tr>
<td>Method for equivalent moment factor C_{my,0}</td>
<td>Table A.2 Line 1 (Linear)</td>
</tr>
<tr>
<td>Ratio of end moments ( \psi_e )</td>
<td>0.00</td>
</tr>
<tr>
<td>Equivalent moment factor C_{my,0}</td>
<td>0.78</td>
</tr>
<tr>
<td>Factor ( \mu_x )</td>
<td>0.95</td>
</tr>
<tr>
<td>Factor ( \mu_z )</td>
<td>0.98</td>
</tr>
<tr>
<td>Factor ( \epsilon_y )</td>
<td>5.07</td>
</tr>
<tr>
<td>Factor a_{LT}</td>
<td>0.99</td>
</tr>
<tr>
<td>Critical moment for uniform bending M_{cr,0}</td>
<td>200.36 kNm</td>
</tr>
<tr>
<td>Relative slenderness ( \lambda_{rel,0} )</td>
<td>0.65</td>
</tr>
<tr>
<td>Limit relative slenderness ( \lambda_{rel,0,lim} )</td>
<td>0.26</td>
</tr>
<tr>
<td>Equivalent moment factor C_{my}</td>
<td>0.93</td>
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<tr>
<td>Equivalent moment factor C_{mul,T}</td>
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<tr>
<td>Factor b_{LT}</td>
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<td>Factor d_{LT}</td>
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<td>Factor w_z</td>
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<td>Factor n_{el}</td>
<td>0.06</td>
</tr>
<tr>
<td>Maximum relative slenderness ( \lambda_{rel,max} )</td>
<td>1.22</td>
</tr>
<tr>
<td>Factor C_{yy}</td>
<td>0.99</td>
</tr>
<tr>
<td>Factor C_{zy}</td>
<td>0.94</td>
</tr>
</tbody>
</table>

Unity check (6.61) = 0.13 + 0.27 + 0.00 = 0.40 -
Unity check (6.62) = 0.10 + 0.15 + 0.00 = 0.25 -

### Shear Buckling check

According to EN 1993-1-5 article 5 & 7.1 and formula (5.10) & (7.1)

<table>
<thead>
<tr>
<th>Shear Buckling parameters</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Buckling field length a</td>
<td>3.000 m</td>
</tr>
<tr>
<td>Web</td>
<td>unstiffened</td>
</tr>
<tr>
<td>Web height ( h_w )</td>
<td>138.8 mm</td>
</tr>
<tr>
<td>Web thickness t</td>
<td>8.0 mm</td>
</tr>
<tr>
<td>Material coefficient ( \varepsilon )</td>
<td>0.92</td>
</tr>
<tr>
<td>Shear correction factor ( \eta )</td>
<td>1.00</td>
</tr>
</tbody>
</table>
Shear Buckling verification

Web slenderness $h/t = 17.35$
Web slenderness limit 66.56

Note: The web slenderness is such that Shear Buckling effects may be ignored according to EN 1993-1-5 article 5.1(2).

The member satisfies the stability check.

ULS Design check - Resultant utilisation

SLS Design check - Resultant utilisation

Relative deformation

Linear calculation, Extreme : Member, System : Principal
Selection : All
Class : All SLS
<table>
<thead>
<tr>
<th>Name</th>
<th>Type</th>
<th>Item material</th>
<th>h [mm]</th>
<th>b [mm]</th>
<th>t [mm]</th>
<th>s [mm]</th>
<th>r [mm]</th>
<th>Section</th>
</tr>
</thead>
<tbody>
<tr>
<td>SB-3</td>
<td>UC203/203/46</td>
<td>S 275</td>
<td>203.2</td>
<td>203.6</td>
<td>11.0</td>
<td>7.2</td>
<td>10.2</td>
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</tr>
<tr>
<td>SB-4</td>
<td>UC203/203/60</td>
<td>S 275</td>
<td>209.6</td>
<td>205.8</td>
<td>14.2</td>
<td>9.4</td>
<td>10.2</td>
<td><img src="SB4.png" alt="Image" /></td>
</tr>
<tr>
<td>C-1</td>
<td>UC152/152/37</td>
<td>S 275</td>
<td>161.8</td>
<td>154.4</td>
<td>11.5</td>
<td>8.0</td>
<td>7.6</td>
<td><img src="C1.png" alt="Image" /></td>
</tr>
</tbody>
</table>
**PAD FOOTING 1: COLUMN C-I**

**PAD FOOTING ANALYSIS AND DESIGN (BS8110-1:1997)**

---

**Pad footing details**

- Length of pad footing: \( L = 2400 \text{ mm} \)
- Width of pad footing: \( B = 1300 \text{ mm} \)
- Depth of pad footing: \( h = 500 \text{ mm} \)
- Depth of soil over pad footing: \( h_{soil} = 200 \text{ mm} \)
- Density of concrete: \( \rho_{concrete} = 23.6 \text{ kN/m}^3 \)

**Column details**

- Column base length: \( l_A = 350 \text{ mm} \)
- Column base width: \( b_A = 350 \text{ mm} \)
- Column eccentricity in x: \( e_{PyA} = 450 \text{ mm} \)
- Column eccentricity in y: \( e_{PxA} = 0 \text{ mm} \)

**Soil details**

- Depth of soil over pad footing: \( h_{soil} = 200 \text{ mm} \)
- Density of soil: \( \rho_{soil} = 20.0 \text{ kN/m}^3 \)

**Axial loading on column**

- Dead axial load: \( P_{GA} = 50.9 \text{ kN} \)
- Wind axial load: \( P_{WA} = 4.2 \text{ kN} \)
- Total axial load: \( P_A = 59.7 \text{ kN} \)
- Imposed axial load: \( P_{QA} = 4.6 \text{ kN} \)

**Foundation loads**

- Dead surcharge load: \( F_{Gsur} = 3000 \text{ kN/m}^2 \)
- Imposed surcharge load: \( F_{Qsur} = 2000 \text{ kN/m}^2 \)
- Pad footing self weight: \( F_{swt} = 11800 \text{ kN/m}^2 \)
- Soil self weight: \( F_{soil} = 4000 \text{ kN/m}^2 \)
- Total foundation load: \( F = 64.9 \text{ kN} \)

**Horizontal loading on pad footing**

- Dead load in x direction: \( H_{QxA} = 0.0 \text{ kN} \)
- Dead load in y direction: \( H_{QyA} = 4.7 \text{ kN} \)
- Imposed load in x direction: \( H_{QxA} = 0.0 \text{ kN} \)
- Imposed load in y direction: \( H_{QyA} = 0.0 \text{ kN} \)
- Wind load in x direction: \( H_{WxA} = 0.0 \text{ kN} \)
- Wind load in y direction: \( H_{WyA} = 6.9 \text{ kN} \)
- Total load in x direction: \( H_{xA} = 0.0 \text{ kN} \)
- Total load in y direction: \( H_{yA} = 11.6 \text{ kN} \)

**Check stability against sliding**

- Passive pressure coefficient: \( K_p = 2.464 \)
- Stability against sliding in y direction: \( H_{yres} = 65.0 \text{ kN} \)

**PASS - Resistance to sliding is greater than horizontal load in y direction**

**Check stability against overturning in y direction**

- Total overturning moment: \( M_{TOT} = 5795 \text{ kNm} \)
- Total restoring moment: \( M_{yres} = 48312 \text{ kNm} \)

**PASS - Restoring moment is greater than overturning moment in y direction**
Calculate pad base reaction

Total base reaction  \( T = 124.6 \) kN

Base reaction eccentricity in x  \( e_x = 0 \) mm

Base reaction eccentricity in y  \( e_y = 262 \) mm

*Base reaction acts outside of middle third of base*

Calculate pad base pressures

\[ q_1 = 0.000 \text{ kN/m}^2 \quad q_2 = 89.273 \text{ kN/m}^2 \quad q_3 = 0.000 \text{ kN/m}^2 \quad q_4 = 89.273 \text{ kN/m}^2 \]

Minimum base pressure  \( q_{\text{min}} = 0.000 \) kN/m²

Maximum base pressure  \( q_{\text{max}} = 89.273 \) kN/m²

*PASS - Maximum base pressure is less than allowable bearing pressure*

Partial safety factors for loads

Dead loads  \( \gamma_fG = 1.40 \)

Imposed loads  \( \gamma_fQ = 1.60 \)

Wind loads  \( \gamma_fW = 0.00 \)

Ultimate axial loading on column

Ultimate axial load on column  \( P_{\text{uA}} = 78.7 \) kN

Ultimate foundation loads

Ultimate foundation load  \( F_{\text{u}} = 92.1 \) kN

Ultimate horizontal loading on column

Ult. horizontal load in x dir  \( H_{\text{uxA}} = 0.0 \) kN

Ult. horizontal load in y dir  \( H_{\text{uyA}} = 6.6 \) kN

Ultimate moment on column

Ult. moment on column in x dir  \( M_{\text{uxA}} = 0.000 \) kNm

Ult. moment on column in y dir  \( M_{\text{uyA}} = 0.000 \) kNm

Ultimate pad base reaction

Ultimate base reaction  \( T_{\text{u}} = 170.8 \) kN

Ecc. of ult. base reaction in x  \( e_{\text{ru}} = 0 \) mm

Ecc. of ult. base reaction in y  \( e_{\text{ry}} = 227 \) mm

Calculate ultimate pad base pressures

\[ q_{\text{ru}} = 0.000 \text{ kN/m}^2 \quad q_{\text{ru}} = 112.070 \text{ kN/m}^2 \quad q_{\text{ru}} = 0.000 \text{ kN/m}^2 \quad q_{\text{ru}} = 112.070 \text{ kN/m}^2 \]

Minimum ult. base pressure  \( q_{\text{qru}} = 0.000 \) kN/m²

Maximum ult. base pressure  \( q_{\text{qru}} = 112.070 \) kN/m²

Library Item: Ultimate pressures summary

Ultimate moments

Ultimate moment in x dir  \( M_x = 24.818 \) kNm

Ultimate moment in y dir  \( M_y = 3.680 \) kNm

Material details

Char. strength of concrete  \( f_{c} = 30 \) N/mm²

Char. strength of reinf  \( f_y = 500 \) N/mm²

Char. strength of shear reinf  \( f_{yv} = 500 \) N/mm²

Nom. cover to reinforcement  \( c_{\text{nom}} = 30 \) mm
Moment design in x direction

Tens. reinforcement diameter \( \phi_{xB} = 12 \text{ mm} \)
Tens. reinforcement depth \( d_x = 464 \text{ mm} \)

Design formula for rectangular beams (cl 3.4.4.4)

\[ K_x = 0.003 \quad K_x' = 0.156 \]

\( K_x < K_x' \) compression reinforcement is not required

Tens. reinforcement required \( A_{x,req} = 129 \text{ mm}^2 \)
Tens. reinforcement provided \( 8 \text{ No. 12 dia. bars btm} \) \( A_{x,B_{prov}} = 905 \text{ mm}^2 \)

PASS - Tension reinforcement provided exceeds tension reinforcement required

Moment design in y direction

Tens. reinforcement diameter \( \phi_{yB} = 12 \text{ mm} \)
Tens. reinforcement depth \( d_y = 452 \text{ mm} \)

Design formula for rectangular beams (cl 3.4.4.4)

\[ K_y = 0.000 \quad K_y' = 0.156 \]

\( K_y < K_y' \) compression reinforcement is not required

Tens. reinforcement required \( A_{y,req} = 20 \text{ mm}^2 \)
Tens. reinforcement provided \( 15 \text{ No. 12 dia. bars btm} \) \( A_{y,B_{prov}} = 1696 \text{ mm}^2 \)

PASS - Tension reinforcement provided exceeds tension reinforcement required

Calculate ultimate shear force at d from right face of column

Ult. pressure for shear \( q_{su} = 56.035 \text{ kN/m}^2 \)
Area loaded for shear \( A_s = 0.653 \text{ m}^2 \)
Ult. shear force \( V_{su} = 17.306 \text{ kN} \)

Shear stresses at d from right face of column (cl 3.5.5.2)

Design shear stress \( \nu_{su} = 0.029 \text{ N/mm}^2 \)
Design concrete shear stress \( \nu_c = 0.347 \text{ N/mm}^2 \)
Allowable design shear stress \( \nu_{max} = 4.382 \text{ N/mm}^2 \)

PASS - \( \nu_{su} < \nu_c \) - No shear reinforcement required

Calculate ultimate punching shear force at face of column

Ult. press. for punching shear \( q_{puA} = 94.420 \text{ kN/m}^2 \)
Area loaded \( A_{PA} = 0.123 \text{ m}^2 \)
Length of shear perimeter \( u_{PA} = 1400 \text{ mm} \)
Eff. punching shear force \( V_{puA} = 70.728 \text{ kN} \)

Punching shear stresses at face of column (cl 3.7.7.2)

Design shear stress \( \nu_{puA} = 0.110 \text{ N/mm}^2 \)

PASS - Design shear stress is less than allowable design shear stress

Calculate ultimate punching shear force at perimeter of 1.5 d from face of column

Ult. press. for punching shear \( q_{puA1.5d} = 54.707 \text{ kN/m}^2 \)
Area loaded \( A_{PA1.5d} = 2.241 \text{ m}^2 \)
Length of shear perimeter \( u_{PA1.5d} = 2600 \text{ mm} \)
Eff. punching shear force \( V_{puA1.5d} = 22.230 \text{ kN} \)

Punching shear stresses at perimeter of 1.5 d from face of column (cl 3.7.7.2)

Design shear stress \( \nu_{puA1.5d} = 0.023 \text{ N/mm}^2 \)

PASS - \( V_{puA1.5d} < \nu_c \) - No shear reinforcement required
<table>
<thead>
<tr>
<th>Calc By</th>
<th>Project</th>
<th>Job No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cale Date</td>
<td>Client</td>
<td>Page No.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Revision</td>
</tr>
</tbody>
</table>

![Diagram of structural elements](image)

- 15 No. 12 dia. bars btm (175 c/c)
- 8 No. 12 dia. bars btm (175 c/c)

---

Shear at d from column face

- - - Punching shear perimeter at 1.5 × d from column face
## PADSTONE DESIGN SB-3

### MASONRY BEARING DESIGN TO BS5628-1:2005

#### Masonry details

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Masonry type</td>
<td>Clay or calcium silicate bricks</td>
</tr>
<tr>
<td>Compressive strength</td>
<td>$\sigma_{\text{unit}} = 5.0 \text{ N/mm}^2$</td>
</tr>
<tr>
<td>Mortar designation</td>
<td>iv</td>
</tr>
<tr>
<td>Mortar category</td>
<td>Category II</td>
</tr>
<tr>
<td>Construction control</td>
<td>Normal</td>
</tr>
<tr>
<td>Partial safety factor</td>
<td>$\gamma_m = 3.5$</td>
</tr>
<tr>
<td>Leaf thickness</td>
<td>$t = 215 \text{ mm}$</td>
</tr>
<tr>
<td>Wall height</td>
<td>$h = 2700 \text{ mm}$</td>
</tr>
</tbody>
</table>

#### Bearing details

- **Beam to span in plane of wall**
- **Spreader details**

#### Loading details

- **Concentrated dead load** $G_k = 18 \text{ kN}$
- **Design concentrated load** $F = 32.6 \text{ kN}$
- **Distributed dead load** $g_k = 20.4 \text{ kN/m}$
- **Design distributed load** $f = 37.7 \text{ kN/m}$

#### Masonry bearing type

- **Bearing type** Type 2
- **Bearing safety factor** $\gamma_{\text{bear}} = 1.50$

#### Check design bearing without a spreader

- **Design bearing stress** $f_{ca} = 0.979 \text{ N/mm}^2$
- **Allowable bearing stress** $f_{cp} = 0.943 \text{ N/mm}^2$

**FAIL - Design bearing stress exceeds allowable bearing stress, use a spreader**

#### Spreader details

- **Length of spreader** $l_s = 215 \text{ mm}$
Edge distance  $s_{edge} = 0 \text{ mm}$

**Spreader bearing type**

<table>
<thead>
<tr>
<th>Bearing type</th>
<th>Bearing safety factor $\gamma_{bear}$</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Type 3</strong></td>
<td>2.00</td>
</tr>
</tbody>
</table>

**Check design bearing with a spreader**

Loading acts eccentrically within middle third – triangular stress distribution

Design bearing stress $f_{ea} = 1.029 \text{ N/mm}^2$  
Allowable bearing stress $f_{tp} = 1.257 \text{ N/mm}^2$

**PASS - Allowable bearing stress exceeds design bearing stress**

**Check design bearing at 0.4 $\times$ h below the bearing level**

Design bearing stress $f_{ea} = 0.294 \text{ N/mm}^2$  
Allowable bearing stress $f_{tp} = 0.622 \text{ N/mm}^2$

**PASS - Allowable bearing stress at 0.4 $\times$ h below bearing level exceeds design bearing stress**
**PADSTONE DESIGN SB-4**

**MASONRY BEARING DESIGN TO BS5628-1:2005**

TEDDS calculation version 1.0.05

### Masonry details

**Autoclaved aerated concrete blocks**
- **Masonry type**: Autoclaved aerated concrete blocks
- **Compressive strength**: $p_{\text{unit}} = 7.3 \text{ N/mm}^2$
- **Least horiz dim of units**: $l_{\text{unit}} = 100 \text{ mm}$
- **Mortar designation**: iii
- **Height of units**: $h_{\text{unit}} = 215 \text{ mm}$
- **Masonry units**: Category II
- **Construction control**: Normal
- **Partial safety factor**: $\gamma_{\text{m}} = 3.5$
- **Characteristic strength**: $f_k = 6.4 \text{ N/mm}^2$
- **Leaf thickness**: $t = 100 \text{ mm}$
- **Effective wall thickness**: $t_{\text{ef}} = 100 \text{ mm}$
- **Wall height**: $h = 2700 \text{ mm}$
- **Effective height of wall**: $h_{\text{ef}} = 2500 \text{ mm}$

### Bearing details

- **Beam to span out of plane of wall**
- **Width of bearing**: $B = 203 \text{ mm}$
- **Length of bearing**: $l_b = 100 \text{ mm}$
- **Edge distance**: $x_{\text{edge}} = 1300 \text{ mm}$

### Loading details

- **Concentrated dead load**: $G_k = 22 \text{ kN}$
- **Concentrated imposed load**: $Q_k = 4 \text{ kN}$
- **Design concentrated load**: $F = 36.9 \text{ kN}$
- **Distributed dead load**: $g_\varepsilon = 5.0 \text{ kN/m}$
- **Distributed imposed load**: $q_\varepsilon = 2.0 \text{ kN/m}$

### Masonry bearing type

- **Bearing type**: Type 2
- **Bearing safety factor**: $\gamma_{\text{bear}} = 1.50$

### Check design bearing without a spreader

- **Design bearing stress**: $f_{ca} = 1.920 \text{ N/mm}^2$
- **Allowable bearing stress**: $f_{cp} = 2.743 \text{ N/mm}^2$

**PASS - Allowable bearing stress exceeds design bearing stress**

### Check design bearing at 0.4 $\times$ $h$ below the bearing level

- **Design bearing stress**: $f_{ca} = 0.258 \text{ N/mm}^2$
- **Allowable bearing stress**: $f_{cp} = 1.024 \text{ N/mm}^2$

**PASS - Allowable bearing stress at 0.4 $\times$ $h$ below bearing level exceeds design bearing stress**
FOUNDATIONS NEAR TREES (NHBC)

FOUNDATIONS NEAR TREES
In accordance with Appendix B of NHBC Part 4: Foundations - Chapter 4.2

Tedds calculation version 2.0.02

<table>
<thead>
<tr>
<th>Site Details</th>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td>Site location</td>
<td>London</td>
<td></td>
</tr>
<tr>
<td>Reduction depth due to climate variations - Fig. 13</td>
<td>$Z_c = 0.00\ m$</td>
<td></td>
</tr>
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</table>

<table>
<thead>
<tr>
<th>Soil Details</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Plasticity index from lab tests</td>
<td>$I_p = 40\ %$</td>
<td></td>
</tr>
<tr>
<td>Percentage of particles &lt; 425 $\mu$m</td>
<td>$p_{425} = 100\ %$</td>
<td></td>
</tr>
<tr>
<td>Modified plasticity index - cl. D5(b)</td>
<td>$I_p' = I_p \times p_{425} / 100\ % = 40\ %$</td>
<td></td>
</tr>
<tr>
<td>Volume change potential - Table 1</td>
<td>High</td>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Details for Tree - 1</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Species of tree</td>
<td>Broad leaf - Beech</td>
<td></td>
</tr>
<tr>
<td>Water demand of tree - Table 12</td>
<td>Moderate</td>
<td></td>
</tr>
<tr>
<td>Mature height of tree - Table 12</td>
<td>$H_{\text{m1}} = 20.00\ m$</td>
<td></td>
</tr>
<tr>
<td>Influence radius - Table 2</td>
<td>$r_{\text{inf1}} = 0.75 \times H_{\text{m1}} = 15.00\ m$</td>
<td></td>
</tr>
<tr>
<td>Measured height of tree</td>
<td>$H_{\text{mea1}} = 5.00\ m$</td>
<td></td>
</tr>
<tr>
<td>Distance from centre of tree to face of foundations</td>
<td>$D_1 = 3.20\ m$</td>
<td></td>
</tr>
<tr>
<td>Effective height of tree - Fig. 1</td>
<td>$H_{\text{eff1}} = 20.00\ m$</td>
<td></td>
</tr>
</tbody>
</table>

Minimum foundation depth - Table 5 | $Z_{\text{min}} = 1.00\ m$ |   |
Look up value for foundation depth - Chart 1 Soils with HIGH volume | change potential | $Z_{\text{LookUp1}} = 2.10\ m$ |   |
Required foundation depth | $Z_{\text{req1}} = Z_{\text{LookUp1}} - Z_c = 2.10\ m$ |   |

<table>
<thead>
<tr>
<th>Details for Tree - 2</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Species of tree</td>
<td>Broad leaf - Beech</td>
<td></td>
</tr>
<tr>
<td>Water demand of tree - Table 12</td>
<td>Moderate</td>
<td></td>
</tr>
</tbody>
</table>
Mature height of tree - Table 12
H_m2 = 20.00 m

Influence radius - Table 2
r_{inf2} = 0.75 \times H_m2 = 15.00 m

Measured height of tree
H_{me} = 5.00 m

Distance from centre of tree to face of foundations
D_2 = 6.00 m

Effective height of tree - Fig. 1
H_{e2} = 20.00 m

Minimum foundation depth - Table 5
Z_{min} = 1.00 m

Look up value for foundation depth - Chart 1 Soils with HIGH volume
change potential
Z_{LookUp2} = 1.84 m

Required foundation depth
Z_{req2} = Z_{LookUp2} - Z_{c} = 1.84 m

### Summary Table

<table>
<thead>
<tr>
<th>Tree</th>
<th>Name</th>
<th>Distance (m)</th>
<th>Measured Height (m)</th>
<th>Effective Height (m)</th>
<th>Tree to be removed</th>
<th>Required Foundation Depth (m)</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>Beech</td>
<td>3.2</td>
<td>5.0</td>
<td>20.0</td>
<td>No</td>
<td>2.10</td>
</tr>
<tr>
<td>2</td>
<td>Beech</td>
<td>6.0</td>
<td>5.0</td>
<td>20.0</td>
<td>No</td>
<td>1.84</td>
</tr>
</tbody>
</table>
300 MIN.
REFER TO FOUNDATION LAYOUT
LEAN MIX CONCRETE 1:8 CEMENT:COARSE AGGREGATE BY VOLUME. ALL TBC BETWEEN CLIENT, CONTRACTOR & B.C.O PRIOR TO WORKS COMMENCING
600/675mm WIDE MASS CONCRETE STRIP FOUNDATION TO NEW EXTENSION.

BRICKWORK IN 1:1:6 MORTAR.
7N BLOCKWORK IN 1:1:6 MORTAR.
DPC TBA BETWEEN CLIENT, CONTRACTOR & B.C.O PRIOR TO WORKS COMMENCING
GROUND FLOOR F.F.L.

USE OF INSULATION SUBJECT TO CLIENT FINISHES REQUIREMENTS. ALL TO BE AGREED BETWEEN CLIENT, CONTRACTOR & B.C.O PRIOR TO WORKS COMMENCING

NEW GROUND BEARING SLAB WITH TOP MESH (COVER 35mm MIN) TO BE AGREED BETWEEN CLIENT, CONTRACTOR AND BCO PRIOR TO SLAB WORKS COMMENCING

GROUND LEVEL (ASSUMED - TBC)

GROUND FLOOR F.F.L.
CONTRACTOR IS TO INSTALL ADEQUATE TEMPORARY SHEETING/WORKS TO KEEP SOIL STABLE DURING THE NEW EXCAVATION AND FOUNDATION WORKS

LEAN MIX CONCRETE 1:8 CEMENT:COARSE AGGREGATE BY VOLUME. ALL TBC BETWEEN CLIENT, CONTRACTOR & B.C.O PRIOR TO WORKS COMMENCING

COMPRESSIBLE MATERIAL (CLAYMASTER OR SIMILAR APPROVED)

600/675mm WIDE MASS CONCRETE STRIP FOUNDATION TO NEW EXTENSION.

PROJECT:
DRAWING:
CLIENT:
DATE:
SCALE 1:44-
DGR. No.: [REVISION] DATE:
USE OF INSULATION SUBJECT TO CLIENT FINISHES REQUIREMENTS. ALL TO BE AGREED BETWEEN CLIENT, CONTRACTOR & B.C.O PRIOR TO WORKS COMMENCING

NEW GROUND BEARING SLAB WITH TOP MESH (COVER 35mm MIN) TO BE AGREED BETWEEN CLIENT, CONTRACTOR AND BCO PRIOR TO SLAB WORKS COMMENCING

GROUND FLOOR F.F.L.

COMPRESSIBLE MATERIAL (CLAYMASTER OR SIMILAR APPROVED)

H12 ANCHOR L-BAR EMBEDDED 600mm MIN. TO STRIP FOUNDATION AND GROUND BEARING SLAB AT 400c/c

GROUND LEVEL (ASSUMED - TBC)

Lean Mix Concrete 1:8 Cement:Coarse Aggregate by Volume. All TBC between Client, Contractor & B.C.O prior to works commencing

600/675mm Wide Mass Concrete Strip Foundation to New Extension.

Contractor is to install adequate temporary sheeting/works to keep soil stable during the new excavation and foundation works

TYPICAL ECCENTRIC DEEP FOUNDATION DETAIL
STEEL POST CONNECTION DETAILS

TOP END PLATE
130x300x12DP
FULLY WELDED
TO STEEL POST

2x2No M16
BOLTS

STEEL POST

TOP END PLATE
130x300x12DP
FULLY WELDED
TO STEEL POST

2x2No M16
BOLTS

BASE END PLATE
350x350x15DP

2x2No M20
BOLTS

BASE END PLATE
350x350x15DP

2x2No M20
BOLTS

STRIP FOUNDATION

STRIP FOUNDATION

► ALL STRUCTURAL MEMBERS MUST BE SIZED ACCORDING TO THE STRUCTURAL CALCULATIONS

► STEEL BEAMS AND STEEL PLATE SHOULD BE WELDED WITH THE STEEL COLUMN BY
FULL PENETRATION 6mm WELD AROUND THE PERIMETER CONTACT
PROFILE, BASE PLATE AND STIFFENERS MUST BE WELDED AROUND THE PERIMETER OF CONTACT
THE WELDS WILL BE CONTINUOUS WITH FULL PENETRATION
ALL STRUCTURAL MEMBERS MUST BE SIZED IN ACCORDANCE WITH THE STRUCTURAL CALCULATIONS
STEEL BEAM SB-4 TO STEEL COLUMN C-1 CONNECTION DETAIL

ELEVATION 'A'

BEAM END PLATE 12.5mm THK TO BE WELDED TO SB-1 USING 6mm WELD

OVERLAP TO BE NOT LESS THAN 2xHEIGHT OR 1m, WHICHER IS GREATER.

BEAM END PLATE TO BE BOLTED TO C-1 USING 2x2No M16 BOLTS

ALL STRUCTURAL MEMBERS MUST BE-sized ACCORDING TO THE STRUCTURAL CALCULATIONS

STEEL BEAMS AND STEEL PLATE SHOULD BE WELDED WITH THE STEEL COLUMN BY FULL PENETRATION 6mm WELD AROUND THE PERIMETER CONTACT

STEPPED FOUNDATION DETAIL

OVERLAP TO BE NOT LESS THAN 2xHEIGHT OR 1m, WHICHER IS GREATER.

ALL STRUCTURAL MEMBERS MUST BE SIZED ACCORDING TO THE STRUCTURAL CALCULATIONS
10mm THICK MS PLATE FULLY WELDED TO UC AT 3/4 HEIGHT OR 600mm c/c VERTICALLY AND BOLTED TO WALL WITH 1No. M10 RESIN BOLT (WITH COUNTERSUNK HEAD) WITH 80mm EMBEDMENT INTO BRICKWORK VERTICALLY SLOTTED HOLES TO BE CUT INTO MS PLATE (25-30mm MAX) PLATES TO BE WELDED

UC COLUMN

3:1 S/C DRYPACK WELL RAMMED BETWEEN COLUMN & EXISTING WALL.

EXISTING BRICKWORK MADE GOOD USING 20N BRICKS IN 1:1:6 MORTAR FULLY BONDED TO EXISTING

CAVITY WALL TIED TO STEEL POST

► ALL STRUCTURAL MEMBERS MUST BE SIZED ACCORDING TO THE STRUCTURAL CALCULATIONS
► USE HALFEN BRICK TIE SYSTEM OR SIMILAR APPROVED
► HMS CHANNEL SHOULD BE WELDED WITH THE STEEP POST BY FULL PENETRATION WELD AROUND THE PERIMETER CONTACT.
STEEL BEAM SB-3 TO STEEL BEAM SB-4 CONNECTION DETAIL

ELEVATION 'A'

- 2x2No M16 BOLTS
- 5x150x47DP TIMBER PLATE BOLTED TO UC RIDGE BEAM USING M10 BOLTS AT 600c/c STAGGERED
- 1000LG TWISTED BAT M305 STABILITY STRAPS AT 1200c/c FULLY NAILED AND TEK-SCREWED TO RIDGE BEAM
- 150x47x150 C24 ROOF RAFTERS AT 400c/c

ELEVATION 'B'

- 3x2No M16 BOLTS
- UA 120/120/12

RIDGE BEAM DETAIL

- SB-1 UC 152/152/30 RIDGE BEAM
- TIMBER BLOCKING BOLTED TO WEB OF STEEL USING M10 BOLTS AT 600c/c
- RAFTERS NOTCHED AND FIXED TO RIDGE BEAM USING BAT AB604060 ANGLE BRACKETS FULLY NAILED

► ALL STRUCTURAL MEMBERS MUST BE SIZED ACCORDING TO THE STRUCTURAL CALCULATIONS

► ALL STRUCTURAL MEMBERS MUST BE SIZED ACCORDING TO THE STRUCTURAL CALCULATIONS
TYPICAL UC BEAM BOLTED TO PADSTONE DETIAL

UC 203/203/46 BEAM
END OF BEAM TO BE CONCRETED IN
MC PADSTONE

2No M10 RAG BOLTS
EXISTING WALL

TYPICAL UC/UB BEAM BOLTED TO PADSTONE DETIAL

UC 203/203/60 BEAM
END OF BEAM TO BE CONCRETED IN
MC PADSTONE

2No 100+1000 BAT M305 HOLDING DOWN STRAPS ON BOTH SIDES PLUGGED & SCREWED TO PADSTONE AND TO BLOCK WALL (MIN 6 SCREW)
EXTERNAL CAVITY WALL
HOLDING DOWN STRAP TO WALL PLATE DETAIL

100+1000 BAT M305 HOLDING DOWN STRAPS @1000c/c. NAILED TO PLATE AND PLUGGED & SCREWED TO BRICK WALL (MIN 4 SCREW)

75x100 C16 WALL PLATE BOLTED TO MASONRY WALL USING M16 ANCHORAGE CHEMICAL BOLTS AT 1000c/c

NEW CAVITY WALL

Timber Rafter

NOTE: PROVIDE SIMILAR DETAIL FOR THE FLAT ROOF

► ALL STRUCTURAL MEMBERS MUST BE SIZED ACCORDING TO THE STRUCTURAL CALCULATIONS
SECTION

1. Steel beam
2. Glucoroc F Firecase fixed together with Glucoroc F Firecase Screws or Glucoroc Staples & to FEA1 steel angles with Glucoroc F Firecase Screws at 150mm centres.
3. Gypframe FEA1 Steel Angle suitably fixed to beam flange at 600mm centres.
4. 60mm wide Glucoroc F Firecase backing strip at board joints.

STRUCTURAL ELEMENTS MUST BE SIZED ACCORDING TO THE STRUCTURAL CALCULATION

EXISTING DRAIN BRIDGING DETAIL

IF THIS DIMENSION IS LESS THAN 300mm THE CONTRACTOR IS TO OBTAIN FURTHER INSTRUCTIONS FROM STRUCTURAL ENGINEER BEFORE CONSTRUCTING FOUNDATION

EXISTING GROUND LEVEL

4No H16 BARS 1500lg MIN 50mm COVER

500mm WIDE MASS CONCRETE STRIP FOOTING TO NEW EXTENSION.

300mm EXPANDED POLYSTYRENE

MIN 300

MIN 300

MIN 300

MIN 300

150 MIN.

EXTG CLIENT'S WATER DRAIN

TOP OF M.C. STRIP FOOTING

MIN 1000
METHOD STATEMENT FOR STEEL BEAM INSTALLATION

1. Check the original construction techniques for correct type of temporary works.
2. Check condition of existing brickwork - break out and replace any badly damaged bricks, re-point mortar as required. Ensure any repairs to brickwork is checked and approved by BCO before works commence.
3. Support existing wall above intended beam by Needle Masonry Supports which are supported by Acrow props each 500mm. Install Acrow props support from interior or exterior (not from both side) on the existing (concrete or soil) ground, not on the joist floor. Under Acrow props use wooden or concrete base plate minimum 100x500x500mm.
4. Temporary support installation:
   a) Mark the wall in the correct position where the steel needles are to be inserted
   b) Scrape or grind out the mortar, or remove a brick prior to insertion of the needles in the identified position. Always ensure the underside of the brick to be supported is clean and will sit flat on the blade of the needles.
   c) Insert the blade into the mortar space or brick hole until the blade is at least at the same depth as the rear of the brick on the leaf of the wall is intended to be supported. Where possible the needles should be inserted until the tip of the web is nearly touching the wall.
   d) Ensuring the prop remains completely vertical and in plumb, tighten the collar of the prop until Strongboy and prop are fully engaged with the wall and do not move. Do not over tighten as that may cause the blade to bend or damage the brickwork. Hand tight is generally sufficient.
4. For point load use extra temporary support/s.
5. Make sure the wall is supported properly by temporary support.
6. Knock down wall carefully under temporary support.
7. Install beam from free side of the opening.
8. Make sure that existing wall is supported properly by new steel beam.
9. Remove temporary support.

METHOD STATEMENT FOR POURING STRIP FOUNDATION

1. The contractor to locate and protect any existing buried services.
2. Pouring and excavation sequences are to be not longer than shown on foundation drawing.
3. Pouring and excavation is to be carried out in order of shown sequences below starting with no. 1 only if new foundation is to be poured nearby existing neighbor's/adjoining foundation. This to be confirmed by the Building Control Officer on site.
4. Not less than 48 hours after casting blocks (1) excavate adjacent blocks.
5. Continue the above sequence until the perimeter foundation is casted.
6. Under no circumstances shall two simultaneous excavations be made on both sides of a length of wall.
7. Before casting concrete the underside of the already casted footing to be thoroughly cleaned to remove any soil adhering to the underside and then given a coat of rich cement grout to prime the surface.
8. No excavation to be left open for more than three hours before placing the concrete.
9. Not less than 48 hours after pouring the concrete the side sutter may be released.
10. The concrete is to be thoroughly vibrated with a mechanical poker to ensure maximum compaction.
11. If during excavation material is found to be significantly different from exposed in trial pits, the contractor shall inform the Engineer who may visit site to inspect the excavation.
12. Do not use concrete grade less than C20.

GENERIC POURING SCHEDULE

NEW FOUNDATION
FREQUENCY OF USE

1. **GENERAL NOTES:**
   - 1.1 THE STRUCTURAL WORK WITHIN THIS DOCUMENT IS TO BE READ IN CONJUNCTION WITH THE PROJECT INFORMATION. THE DRAWINGS AND SPECIFICATIONS FROM WHICH THE CONTRACTOR IS TO FRAME THEIR CONTRACT ENGINEERING AND WORKING DRAWINGS AND FOUNDATION DETAILS ARE SHOWN.
   - 1.2 THE DRAWINGS WITHIN THIS DOCUMENT ARE INDICATIVE ONLY. THEY ARE NOT TO BE USED IN CONJUNCTION WITH THE ARCHITECTURAL DRAWINGS FOR ALL PURPOSES. ALL DIMENSIONS SHOULD BE CHECKED ON SITE BY THE CONTRACTOR PRIOR TO CONSTRUCTION AND ORDERING OF MATERIALS.
   - 1.3 UNLESS OTHERWISE STATED ON THE DRAWINGS IN METRES FROM THE SITE DATUM.
   - 1.4 THE INFORMATION WITHIN THIS DOCUMENT CANNOT BE GUARANTEED AS COMPLETE. FIGURED DIMENSIONS MUST BE USED FOR SETTING OUT AND DETAILING.
   - 1.5 THE CONTRACTOR IS RESPONSIBLE FOR THE DESIGN OF ALL TEMPORARY WORKS, AND THE CONTRACTOR MUST NOTIFY THE STRUCTURAL ENGINEER OF THE INDICATION OF ALL TEMPORARY WORKS TO PROVIDE LATERAL AND DETAILING.
   - 1.6 THE CONTRACTOR (OR CLIENT) MUST NOTIFY THE STRUCTURAL ENGINEER OF ANY PROPOSAL THAT COULD AFFECT THE STRUCTURAL PROPORTIONS BEFORE WORK COMMENCES.
   - 1.7 THE CONTRACTOR SHALL AT THE OUTSET, ESTABLISH WITH THE LOCAL AUTHORITY THEIR REQUIREMENTS FOR INSPECTING THE WORKS, AND ADHERE TO THESE.
   - 1.8 ALL DIMENSIONS AND LEVELS SHOWN ON THE DRAWINGS ARE BASED ON SURVEY DATA AND THE CONTRACTOR IS TO SATISFY HIMSELF THAT DIMENSIONS, LEVELS, ETC. ARE CORRECT AND COMPLETE FOR FACILITATION OF THE CONTRACTOR PRIOR TO COMMENCING WORK.
   - 1.9 IF IN DOUBT ABOUT THE INFORMATION SHOWN ON THIS DRAWING OR ANY RELATED DRAWINGS - PLEASE ASK.
   - 1.10 CONTRACTORS ARE SOLELY RESPONSIBLE FOR THE DESIGN OF ALL TEMPORARY WORKS.
   - 1.11 ALL LINTELS TO HAVE A MINIMUM 100mm END BEARING INTO NEW EXISTING WALL.
   - 1.12 ALL EXISTING LINTELS ARE TO BE INSPECTED AND REPLACED IF THEY SHOW SIGNS OF DETERIORATION, CRACKING OR DISTRESS. THE MATERIAL NATURE OF THESE OPENINGS REQUIRED IN STUD WALL.
   - 1.13 Timber Notes:
     - 1.14 ALL TIMBER TO BE REGULARISED AND SUPPLIED AT A GRAIN PRESERVATIVE.
     - 1.15 WALLS BELOW GROUND LEVEL ARE TO BE BUILT UP IN TOB 115 MORTAR, WITH LEAN MAX CONCRETE FILL UP TO 100MM BELOW GROUND LEVEL.
     - 1.16 ANY EXCAVATIONS LIABLE TO REMAIN EXPOSED TO THE ELEMENTS IN EXCESS OF 24 HOURS PRIOR TO CONCRETING (OR LESS IN INCLEMENT WEATHER) ARE TO BE PROPOPPED AT 600mm CENTRES USING M12 GR. 4.6 BOLTS WITH 50mm GALVANIZED (140 MICRONS) OR CHEMICALLY CLEANED AND HOT DIPPED (85 MICRONS).
     - 1.17 ANY EXCAVATION OF THE FOUNDATION IN EARTH FOR THE INDICATIVE POSITIONS OF EXISTING BURIED SERVICES REFERENCE IS TO BE MADE TO THE ARCHITECTURAL DRAWINGS. THE DEPTH OF EXISTING SERVICES ARE TO BE CHECKED ON SITE BY THE CONTRACTOR PRIOR TO COMMENCING WORK.
     - 1.18 IN CASES WHERE EXISTING SERVICES ARE TO BE DEMOLISHED, DEMOLITION WORK MUST CEASE IMMEDIATELY AND THE CONTRACTOR IS TO OBTAIN FURTHER INSTRUCTIONS PRIOR TO COMMENCING WORK.
   - 1.19 ALL WORKS AND SITE PROCEDURES MUST BE IN KEEPING WITH THE LATEST VERSION OF THE CDM REGULATIONS AND THE LABOURER'S GUIDE TO THE CDM REGULATIONS.
   - 1.20 CONSTRUCTION OF THE SUPERSTRUCTURE AND FOUNDATIONS TO ENSURE THE SAFETY AND EFFECTIVE PERFORMANCE OF THE CONSTRUCTION. 'FLUID' IS TO BE PROVIDED WITH COPIES OF ALL WELD TEST RESULTS.
   - 1.21 LANDSCAPING WORKS TO BE SUBMITTED TO THE PRINCIPAL DESIGNER FOR COMMENT NOT LESS THAN 2 WEEKS PRIOR TO COMMENCING THE DEMOLITION WORKS.
   - 1.22 ALL WORKS AND SITE PROCEDURES MUST BE IN KEEPING WITH THE LATEST VERSION OF THE CDM REGULATIONS AND THE LABOURER'S GUIDE TO THE CDM REGULATIONS.

MASONRY NOTES:

1. **MASONRY NOTES:**
   - 1.1 ALL LINTELS ARE MASONRY STRAPS TO BE PROVIDED AT NOT LESS THAN 600MM CENTRES. MR lx 2100 AND MR lx 2505 PLUS ALL LATEST ALLOWANCES, INCLUDING PROJECT INFORMATION.
   - 1.2 BRICK AND BLOCK STRENGTHS SHOWN ARE MINIMUM REQUIRED AND SHOULD BE INCREASED AS NECESSARY.
   - 1.3 ALL EXISTING MINOR CRACKS TO BE REPAIRED USING 1:1:6 MORTAR.
   - 1.4 IF CRACKS WITH AN APERTURE GREATER THAN 2mm ARE UNCOVERED, THE CONTRACTOR IS TO FOLLOW THE SPECIFICATION (N.S.S.S.).
   - 1.5 WALLS BELOW GROUND LEVEL ARE TO BE IN-FILLED IN BONDED BRICK/BLOCK AS APPROPRIATE.
   - 1.6 UNLESS SHOWN OTHERWISE ON THE DRAWINGS.
   - 1.7墙下基础单独于200mm长的C16型钢梁。
   - 1.8 THE CONTRACTOR IS TO SUMMATE THE PRINCIPAL DESIGNER FOR COMMENT NOT LESS THAN 2 WEEKS PRIOR TO COMMENCING THE DEMOLITION WORKS.
   - 1.9 THE CONTRACTOR IS TO SUMMATE THE PRINCIPAL DESIGNER FOR COMMENT NOT LESS THAN 2 WEEKS PRIOR TO COMMENCING THE DEMOLITION WORKS.
1. The structural specification within this document is to be read in conjunction with all relevant architectural drawings, the standard notes that are contained on the drawings and any other relevant project information.

2. The drawings within this document are indicative only, and represent design intent only. No dimensions are to be scaled from drawings contained within this document. Refer to the Architectural drawings for all dimensions. All dimensions should be checked on site by the Contractor before fabricating or ordering of materials.

3. Unless noted otherwise, all dimensions are in millimetres and all levels are in metres from the site datum.

4. The information within this document cannot be guaranteed as dimensionally exact. Figured dimensions must be used for setting out and detailing.

5. The Contractor is responsible for the design of all temporary works, and is also responsible for the safe maintenance and stability of the existing building/s at all times.

6. All party wall awards are entirely the responsibility of the client.

7. The Contractor (or Client) must report any differences between the structural drawings and site conditions to the Structural Engineer.

8. The Contractor (or Client) must notify the Structural Engineer of any design changes that could affect the structural specification before work commences.

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**GENERAL NOTES:**

- **SB-1:** UC 203/152/30
  - Ridge beam
  - with bottom plate 280/10mm thk fully welded to UB using 6mm fillet weld. All to be galvanized.

- **SB-2:** UB 203/133/30
  - 47x150 [C24]
  - Timbers bolted together using M10 bolts at 500c/c max. (3no min.)

- **SB-3:** UC 203/203/46
  - MC PRECAST PADSTONE 100/330/215DP [C15]
  - SB-3 bearing to be 200mm min.
  - Wall condition to be checked by contractor before building works commence.

- **SB-4:** UC 203/203/60
  - MC PRECAST PADSTONE 100/330/215DP [C15]
  - SB-4 bearing to be 100mm min.

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**GROUND FLOOR PLAN**

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**STRUCTURE OVER**

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**NOTE:**

- All levels must be reviewed and confirmed between the architect, client, contractors and architect prior to works commencing.

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**LETTER OUT NOTE:**

- All settings & levels to be confirmed by the architect, client, contractor and architect prior to commencing fabrication.

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**NOTE:**

- Requirement for load bearing walls to be confirmed by contractor or beco on site.