Solution - Design Example V4

Dead load, $G_k$ = 127,5 kN/m
Imposed load, $Q_k$ = 15,0 kN/m

Design load = $1,35 \times G_k + 1,5 \times Q_k$ (conservatively treating $Q_k$ as a single variable load)

Design dead load = $\gamma_f \times G_k = 1,35 \times 127,5 = 172,1$
Design imposed load = $\gamma_f \times Q_k = 1,5 \times 15 = 22,5$
Total = 194,6 kN/m

Enhanced restraint at top and bottom of wall:

Effective height, $h_{ef}$ = 2500 x 0,75 = 1875 mm
Effective thickness, $t_{ef}$ = actual thickness = $t$ = 140 mm
Slenderness ratio, $h_{ef}/t_{ef}$ = 1875 / 140 = 13,4

Hence eccentricity of design vertical load, $e_i = (M_{id} / N_{id}) + e_{he} \pm e_{init} \geq 0,05t$

Therefore $e_i = 0 + 0 + 4,2 = 4,2$ mm (i.e. 0,03t)

where $M_{id}/N_{id} = 0$ (no applied eccentricity at wall head)

$e_{he} = 0$ (horizontal loads effect)

$e_{init} = h_{ef}/450 = (2500 \times 0,75) / 450 = 4,17$ mm

$e_i$ is 0,05 t at top and bottom of the wall which are the minimum eccentricity design values to be used

Therefore $\phi_i = 1 - 2(e_i / t) = 1 - 2(0,05t / t) = 0,9$

And eccentricity of design vertical load, $e_m = (M_{md} / N_{md}) + e_{hm} \pm e_{init} \geq 0,05t$

Therefore $e_{mk} = e_m + e_k = 0 + 0 + 4,2 = 4,2$ mm (i.e. 0,03t)

where $M_{md}/N_{md} = 0$ (point of contraflexure of double curvature strut)
\[
\begin{align*}
e_{hm} &= 0 \text{ (horizontal loads effect)} \\
e_{\text{init}} &= h_{ef}/450 = (2500 \times 0.75) / 450 = 4.17 \text{ mm} \\
e_k &= 0 \text{ (creep effect)}
\end{align*}
\]

\(e_{mk}\) is 0.05 \(t\) at mid-height of the wall which is the minimum eccentricity design value to be used.

Hence for \(E = 1000f_k\) Part 1.1 Annex G equations or Figure G1 gives:

\[\Phi_m = 0.78\] governs design.

Assuming category II masonry units and class 2 execution control, \(\gamma_m = 3.0\)

Design resistance per unit length \(N_{Rd} = \Phi_t f_d\)

Where \(f_d = f_k/\gamma_m\)

Therefore \(f_k = N_{Rd} \gamma_m/\Phi_{\text{min}} t\)

\[f_k = 194.6 \times 3.0 / 0.78 \times 140 = 5.35 \text{ N/mm}^2\]

Required block masonry unit must have an \(f_k\) value \(\geq 5.35 \text{ N/mm}^2\)

**Group 1 Concrete Masonry Unit:**

\[f_k = Kf_{b}^{\alpha}f_{m}^{\beta}\]

Therefore \(5.35 = 0.75 \times f_{b}^{0.7} \times f_{m}^{0.3}\)

\[f_{b}^{0.7} = 4.71\]

\[f_{b} = 0.7 \times \sqrt{4.71} = 9.15 \text{ N/mm}^2\]

**Group 2 Concrete Masonry Unit:**

\[f_k = Kf_{b}^{\alpha}f_{m}^{\beta}\]

Therefore \(5.35 = 0.70 \times f_{b}^{0.7} \times f_{m}^{0.3}\)

\[f_{b}^{0.7} = 5.04\]

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Normalised compressive strength, \( f_b = \text{compressive strength} \times \delta \times \text{conditioning factor} \)

Using a 190 mm high by 140 mm wide masonry unit, \( \delta \), the shape factor from BS EN 772-1, Table A.1 is 1,24 for the air dry condition compressive testing regime

Therefore masonry unit compressive strength required \( = \frac{10,08}{(1,24 \times 1,0)} \)
\[ = 8,1 \text{ N/mm}^2 \]

Use a Group 1 or Group 2 concrete block masonry unit with a compressive strength (non-normalised) of say 10.4 N/mm\(^2\) minimum, (represents a normalised compressive strength of 12,9 N/mm\(^2\) minimum when masonry unit is conditioned for testing air dry).