Solution – Design Example V3

Slenderness ratio:

Effective thickness of inner leaf, t_{ef} = $t_{ef} = \sqrt[3]{t_1^3 + t_2^3}$

= $t_{ef} = \sqrt[3]{(102,5^3 + 140^3)}$ = 156 mm

Effective height = 0,75 x 3000 = 2250 mm

$\frac{h_{ef}}{t_{ef}} = \frac{2250}{156} = 14,4$

Eccentricity of 1st floor loading, (10 kN/m) = t/6

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

Therefore e_i = 1,8 + 0 + 5,0 = 6,8 mm (i.e. 0,049t)

where M_{id}/N_{id} = *(10 x 140) / (130 x 6) = 1.80 mm*

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

$e_{init} = h_{ef}/450$ = *(3000 x 0,75) / 450 = 5,0 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 + 5,0 = 5,0 mm (i.e 0,036t)

where M_{md}/N_{md} = *0 (point of contraflexure of double curvature strut)*

e_{hm} = *0 (horizontal loads effect)*

$e_{init} = h_{ef}/450$ = *(3000 x 0,75) / 450 = 5,0 mm*

e_k = *0 (creep effect)*

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:

$\Phi_m = 0,76$

Design resistance per unit length $N_{Rd} = \Phi_{min}\ t\ f_d$

Where design strength, $f_d = \dfrac{f_k}{\gamma_m}$

$N_{Rd} = 0,76 \times 140 \times f_k / 2,3 = 130$ kN/m run

Hence f_k required = 2,81 N/mm^2

$f_k = K f_b^{\alpha} f_m^{\beta}$

Therefore $2,81 = 0,75 \times f_b^{0,7} \times 4^{0,3}$

$f_b^{0,7} = 2,472$ i.e. $f_{bmin} = {}^{0,7}\sqrt{(2,472)}$

$f_{bmin} = 3.64$ N/mm^2 min.

Normalised compressive strength, f_b = compressive strength x δ x conditioning factor

Using a 215mm high by 140mm wide masonry unit, δ, the shape factor from BS EN 772-1, Table A.1 is 1,30 for the air dry condition compressive testing regime

Therefore masonry unit compressive strength required = 3.64 / (1,30 x 1,0)

= 2.8 N/mm^2

Choose for convenience a concrete block masonry unit with a compressive strength (non-normalised) of 2.9 N/mm^2 , (represents a normalised compressive strength (f_b) of 3.77 N/mm^2 when masonry unit is conditioned for testing air dry).

Therefore actual f_k achieved = $f_k = K f_b^{\alpha} f_m^{\beta} = 0,75 \times 3.77^{0,7} \times 4^{0,3} = 2.88$ N/mm^2

$f_d = \dfrac{f_k}{\gamma_m}$

And actual wall vertical load capacity:

$N_{Rd} = 0,76 \times 140 \times 2.88 / 2,3 = 133$ kN/m run

Wall will carry a design vertical load of 133 kN/m run (> 130 kN/m applied)