Solution – Design Example V4

Dead load, G_k = 127,5 kN/m

Imposed load, Q_k = 15,0 kN/m

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

Design dead load = $\gamma_f G_k$ = 1,35 x 127,5 = 172,1

Design imposed load = $\gamma_f Q_k$ = 1,5 x 15 = 22,5

Total = 194,6 kN/m

Enhanced restraint at top and bottom of wall:

Effective height, hef = 2500 x 0,75 = 1875 mm

Effective thickness, tef = actual thickness = t = 140 mm

Slenderness ratio, hef/tef = 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 x 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)*

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

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

$\Phi_m = 0,78$ 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 fk = $N_{Rd}\ \gamma_m/\Phi_{min}\ t$

fk = 194,6 x 3,0 / 0,78 x 140 = 5,35 N/mm^2

Required block masonry unit must have an f_k value ≥ 5,35 N/mm^2

Group 1 Concrete Masonry Unit:

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

Therefore 5,35 = 0,75 x $f_b^{0,7}$ x $f_m^{0,3}$

$f_b^{0,7}$ = 4,71

$f_b = {}^{0,7}\sqrt{(4,71)}$ = 9.15 N/mm^2

Group 2 Concrete Masonry Unit:

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

Therefore 5,35 = 0,70 x $f_b^{0,7}$ x $f_m^{0,3}$

$f_b^{0,7}$ = 5,04

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$f_b = {}^{0,7}\sqrt{(5,04)} = 10,08 \text{ N/mm}^2$

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

Using a 190 mm high by 140 mm wide masonry unit, δ, 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 = 10,08 / (1,24 x 1,0)

= 8,1 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).

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