Solution – Design Example V5

Loading to ground floor level:

	Dead		Imposed	
Roof:	6,0 x 0,5 x 3,8	= 11.4	6,0 x 0,5 x 0,75	= 2,25
3 floors:	6,0 x 0,5 x 4,0 x 3	= 36,0	6,0 x 0,5 x 3,5 x 3	= 31,50
4 storeys: of walling	2,9 x 2,5 x 4	= 29,0		= 0,0
Total		76,4 kN/m		33,75 kN/m

Design load = 1,35 G_k + 1,5 Q_k

= (1,35 x 76,4) + (1,5 x 33,75)

= 153,8 kN/m

Eccentricity of Load:

Building Research Digest No. 246 gives guidance on the assessment of eccentricity. For an end wall with a concrete floor supported over the whole wall leaf thickness the centre of action of the force should be taken as 1/6 of the wall thickness from the centreline. However, where the floor is of very short span or very stiff it may be reasonable to regard the load as axial without applied eccentricity.

If the span to wall thickness ratio less than 30 then consider the load acting axially

For this example $\frac{\text{span}}{\text{thickness}} = \frac{6000}{140} = 43$

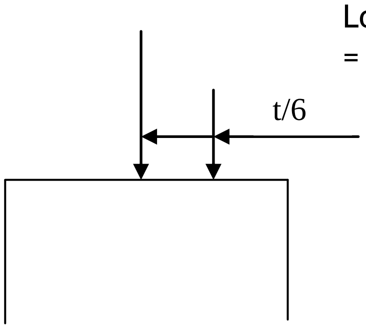
Therefore load from first floor acts at t/6 while the loads from the upper floors act axially.

Load from first intermediate floor = (1,35 x 12) + (1,5 x 10,5) = 31,95 kN/m run

Load of the bottom wall = 1,35 x 29/4 = 9,79 kN/m

Load from upper floors + roof
= (153,8 -31,95 -9,79)
= 112,06 kN/m

Load from first floor
= 31,95 kN/m



Effective thickness of wall, 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 of wall, h_{ef} = 0,75 x 2900 = 2175 mm

And hef/tef = (2175 / 156) = 13,94

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

Therefore e_i = 5,18 + 0 + 4,83 = 10,01 mm (i.e. 0,07t)

where M_{id}/N_{id} = (31,95 x 140) / (144,01 x 6) = 5,18 mm

e_{he} = 0 (horizontal loads effect)

$e_{init} = h_{ef}/450$ = (2900 x 0,75) / 450 = 4,83 mm

e_i is 0,07 t at top and bottom of the wall which are the minimum eccentricity design values to be used

Therefore $\phi_i = 1 - 2(e_i / t) = 1 - 2(0{,}07t / t) = 0{,}86$

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 + 4,83 = 4,83 mm (i.e 0,035t)

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

e_{hm} = 0 (horizontal loads effect)

e_{init} = $h_{ef}/450$ = (2900 x 0,75) / 450 = 4.83 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:

Φ_m = 0,77 governs design

Assuming category II masonry units and class 2 execution control, γ_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 = 153,8 x 3,0 / 0,77 x 140 = 4,28 N/mm^2

Required block masonry unit must have an f_k value ≥ 4,28 N/mm^2

Group 1 Solid Masonry Unit:

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

Therefore 4,28 = 0,75 x $f_b^{0,7}$ x $4^{0,3}$

$f_b^{0,7}$ = 3,76

f_b = $^{0,7}\sqrt{(3,76)}$ = 6,6 N/mm^2

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

Using a 190mm high by 140mm 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 = 6,6/ (1,24 x 1,0)

= 5,3 N/mm^2

Use a Group 1 concrete block masonry unit with a compressive strength (non-normalised) of say 7,3 N/mm^2 minimum, (represents a normalised compressive

strength of 9 N/mm^2 minimum when masonry unit is conditioned for testing air dry).

Note: The calculation for wall capacity will need to be repeated for full design dead and imposed loading coming from the first intermediate floor construction onto the wall head level combined with minimum design dead loading from the walling, floors and roof construction above this level. This will give a maximum wall head eccentricity load case, but with minimum vertical design loading. Usually this design case does not govern, but alternative load cases should be tested.