5.3.6.3 Eccentricity at the mid height of the wall

The eccentricity at the mid height of the wall e_{mk} used in design includes allowance for initial eccentricity e_{init}, eccentricity due to creep e_k, lateral load eccentricity e_{hm}, and load eccentricity e_m.

The UK National Annex[5] states that e_k may be ignored if the slenderness ratio of the wall is not greater than **27.** Thus, effectively there is never any need to allow for eccentricity due to creep in vertical load design.

The mid height eccentricity due to loads is given by:

$$e_{mk} = \frac{M_{md}}{N_{md}} + e_{hm} \pm e_{init}$$

Where: M_{md} is the design value of the greatest moment at mid height of the wall resulting from the moments at the top and bottom of the wall (see Figure 5.9), including any load applied eccentrically to the face of the wall (e.g. brackets)

N_{md} is the design value of the vertical load at the mid height of the wall, including any load applied eccentrically to the face of the wall (e.g. brackets).

e_{hm} need only be used in the appropriate load combination and its sign relative to the load eccentrically should be considered.

Again, e_{init} may be taken as $h_{ef}/450$.

Because eccentricity due to creep can be ignored, $e_{mk} = e_m$.

5.3.6.4 Simplified sub-frame analysis

Annex C to EC6 Part 1-1[1] gives a simplified method for obtaining the moments at the top and bottom of vertically loaded walls. This is based on a sub-frame analysis as shown in Figure 5.10. The ends of the members remote from the junction should be taken as fixed unless they are known to take no moment at all, when they may be taken to be hinged. The end moment at node 1, M_1 may be calculated from the equation below and the end moment at node 2, M_2 similarly but using $n_2E_2I_2/h_2$ instead of $n_1E_1I_1/h_1$ in the numerator.

$$M_1 = \frac{\frac{n_1E_1I_1}{h_1}}{\frac{n_1E_1I_1}{h_1} + \frac{n_2E_2I_2}{h_2} + \frac{n_3E_3I_3}{l_3} + \frac{n_4E_4I_4}{l_4}} \left[\frac{w_3l_3^2}{4(n_3-1)} - \frac{w_4l_4^2}{4(n_4-1)} \right]$$

Where: n_i is the stiffness factor of member i, where i = 1, 2, 3, or 4, and is taken as 4 for members fixed at both ends and otherwise 3

E_i is the modulus of elasticity of member i, where i = 1, 2, 3 or 4; (Note: It will normally be sufficient to take values of E_i as 1000 f_k for all masonry units)

I_i is the second moment of area of member i, where i = 1, 2, 3 or 4 (in case of a cavity wall in which only one leaf is loadbearing, I_i should be taken as that of the loadbearing leaf only)

5.3.8 Vertical load resistance of solid walls and columns

It should be noted that there are no separate provisions for columns in EC6 Part 1-1[1]. They are simply considered as short walls.

The design resistance of a single leaf wall per unit length is N_{Rd} given by:

$$N_{Rd} = \Phi \, t \, f_d$$

Where: Φ is a capacity reduction factor allowing for the effects of slenderness and eccentricity of loading

t is the thickness of the wall

f_d is the design compressive strength of the masonry.

When the cross-sectional area of the wall is less than 0.1m^2, f_d should be multiplied by:

$$(0.7 + 3A)$$

Where: A is the loadbearing horizontal gross cross-sectional area of the wall in square metres.

For a faced wall, the wall may be designed as a single leaf wall constructed entirely of the weaker unit with a longitudinal joint.

For a double-leaf wall, if the leaves are tied together adequately, the wall may be designed as a single leaf wall (assuming that both leaves are similarly loaded), or alternatively as a cavity wall.

Chases and recesses should be allowed for, see Section 6.4.

The slenderness reduction factor Φ is applied at the top or bottom of the wall Φ_i and at mid height of wall, Φ_m.

$$\Phi_i = 1 - 2\frac{e_i}{t}$$

Where: e_i is the eccentricity at the top or bottom of the wall, see Section 5.3.6.2

t is the thickness of the wall.

$$\Phi_m = A_1^{e-\frac{u^2}{2}}$$

Where: $A_1 = 1 - 2\frac{e_{mk}}{t}$

$$u = \frac{\lambda - 0.063}{0.73 - 1.17\frac{e_{mk}}{t}}$$

$$\lambda = \frac{h_{ef}}{t_{ef}}\sqrt{\frac{f_k}{E}}$$

As discussed in Section 5.3.6.3, e_{mk} is taken as equal to e_m where e_m is the eccentricity in the mid height of the wall.