elements must be such as to prevent sway. The possible effects of imperfections should be allowed for by assuming that the structure is inclined at an angle of $1/100\sqrt{h_{tot}})$ to the vertical where h_{tot} is the total height of the building. One designer must, unambiguously, be responsible for ensuring overall stability.

(b) Accidental damage

Buildings are required to be designed in such a way that there is a 'reasonable probability' that they will not collapse catastrophically under the effect of misuse or accident and that the extent of damage will not be disproportionate to the cause. This is to be achieved by considering the removal of essential loadbearing members or designing them to resist the effects of accidental actions. However, no specific rules relating to these requirements are given.

(c) Design of structural members

The design of members has to be such that no damage is caused to facings, finishes, etc., but it may be assumed that the serviceability limit state is satisfied if the ultimate limit state is verified. It is also required that the stability of the structure or of individual walls is ensured during construction.

Subject to detailed provisions relating to the type of construction, the design vertical load resistance per unit length, N_{Rd}, of an unreinforced masonry wall is calculated from the following expression:

$$N_{Rd} = \Phi_{i,m} t f_k / \gamma_m \quad (4.12)$$

where $\Phi_{i,m}$ is a capacity reduction factor allowing for the effects of slenderness and eccentricity (Φ_i applies to the top and bottom of the wall; Φ_m applies to the mid-height and is obtained from the graph shown in Fig. 4.6), t is the thickness of the wall, f_k is the characteristic compressive strength of the masonry and γ_m is the partial safety factor for the material.

The capacity reduction factor Φ_i is given by:

$$\Phi_i = 1 - 2e_i/t \quad (4.13)$$

where e_i is the eccentricity at the top or bottom of the wall calculated from

$$e_i = M_i/N_i + e_{hi} + e_a > 0.05t \quad (4.14)$$

where M_i and N_i are respectively the design bending moment and vertical load at the top or bottom of the wall and e_{hi} and e_a are

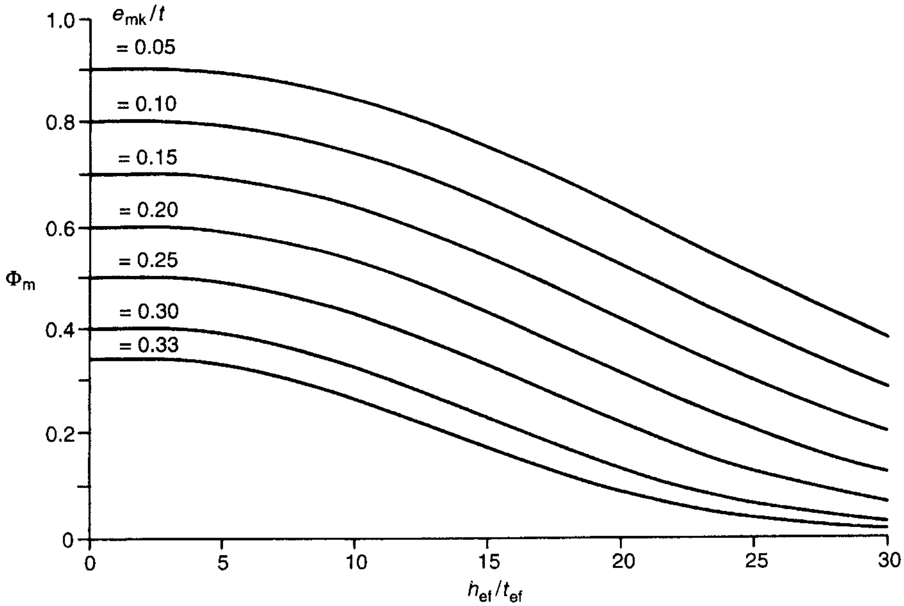

Fig. 4.6 Graph showing values of Φ_m against slenderness ratio for different eccentricities.

eccentricities resulting from lateral loads and construction inaccuracies, respectively. The recommended value of e_a for average level of construction is $h_{ef}/450$.

The basis of the capacity reduction factor is not stated but is known to derive from a complex theoretical solution originally developed for plain concrete sections (Kukulski and Lugez, 1966). The eccentricity at mid-height, e_{mk}, used in calculating Φ_m is given by

$$e_{mk} = e_m + e_k \geqslant 0.05\,t \tag{4.15}$$

where e_m, the structural eccentricity, is obtained from

$$e_m = M_m/N_m + e_{hm} \pm e_k \tag{4.16}$$

where M_m and N_m are respectively the greatest bending moments and vertical loads within the middle one-fifth of the height of the wall. The eccentricity e_k is an allowance for creep:

$$e_k = 0.002\,\Phi_{\infty}\,(h_{ef}/t_{ef})\,(te_m)^{1/2} \tag{4.17}$$

being a final creep coefficient (see Table 4.8) equal to zero for walls built of clay and natural stone units.