$$\text{area/m} = 241.46 \times 10^3$$

$$\text{dead weight} = 2 \times 2.42 \times 3.6 + 2.42 \times 0.225 \times 3.6$$
$$= 17.42 + 1.96$$
$$= 19.38\,\text{kN}$$

$$\text{compressive stress at the base of the wall} = \frac{19.38 \times 10^3}{241.46 \times 10^3} = 0.08\,\text{N/mm}^2$$

The wall will be treated as a cantilever (safe assumption). Then BM at the base of the wall is 9.8kNm/m and

$$\text{stress due to wind loading} = \pm \frac{9.8 \times 10^6 \times 215}{6000 \times 10^6} = \pm 0.35\,\text{N/mm}^2$$

$$\text{combined stress} = 0.08 - 0.35 = -0.27\,\text{N/mm}^2$$

(about 10 times less than in previous case)

$$P_0 = \frac{0.27 \times 1000 \times 241.46 \times 10^3}{0.8 \times 10^3} = 81.8\,\text{kN}$$

$$\text{area of steel required} = \frac{81.8 \times 10^3}{0.7 \times f_y} = \frac{81.8 \times 10^3}{0.7 \times 1030} = 113.45\,\text{mm}^2$$

Provide one bar of 12 mm diameter.

11.3 BASIC THEORY

The design and analysis of prestressed flexural members is based on the elastic theory of simple bending. The criteria used in the design of such members are the permissible stresses at transfer and at service loads. However, a subsequent check is made to ensure that the member has an adequate margin of safety against the attainment of the ultimate limit state.

11.3.1 Stresses in service

Consider a simply supported prestressed brickwork beam shown in Fig. 11.5(a). The prestressing force P has been applied at an eccentricity of e. Owing to the application of prestress at a distance e, the section is subjected to an axial stress and a hogging moment; the stress distribution is shown in Fig. 11.5(b). As the prestress is applied, the beam will lift upwards and will be subjected to a sagging moment M_i due to its self-weight together with any dead weight acting on the beam at that time.

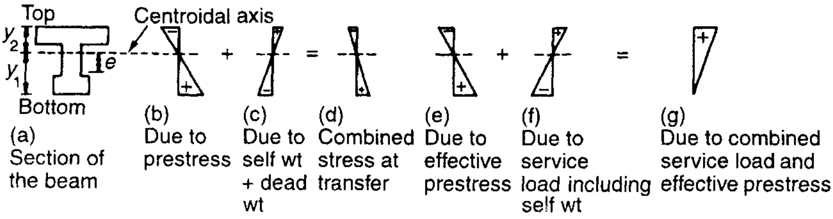

Fig. 11.5 Simply supported prestressed brickwork beam.

The stress due to the moment M_i is represented in Fig. 11.5(c) and the combined stress due to prestress and moment M_i is given in Fig. 11.5(d). At transfer, the tensile stress at the top and compressive stress at the bottom of the section should be less than or equal to the permissible stresses for the brickwork at the critical section. This can be represented in mathematical terms as in the following subsection.

11.3.2 Transfer (initial)

Stress at top

$$f_2 = \frac{P}{A} - \frac{Pey_2}{I} + \frac{M_i}{z_2} \geqslant f_{tt}$$

$$= \frac{P}{A} - \frac{Pe}{z_2} + \frac{M_i}{z_2} \geqslant f_{tt} \tag{11.1}$$

Stress at bottom

$$f_1 = \frac{P}{A} + \frac{Pey_1}{I} - \frac{M_i}{z_1} \leqslant f_{ct}$$

$$= \frac{P}{A} + \frac{Pe}{z_1} - \frac{M_i}{z_1} \leqslant f_{ct} \tag{11.2}$$

The effective stress distribution due to prestress is shown in Fig. 11.5(e); the stresses will reduce from those shown in (b), because of loss of prestress (to be discussed later in section 11.7). The stresses due to subsequent loading are shown in Fig. 11.5(g) and the resultant stress distribution in Fig. 11.5(h). The governing condition for the design will be that the compressive stress at the top and the tensile stress at the bottom should be less than or equal to the permissible compressive and tensile stresses of the masonry at the critical section (h).