cause reduction of stress in the tendon as the strain in the surrounding concrete or brickwork must be equal to the reduction of strain in the tendon.

In a pretensioned member, the force P_0 required in the tendon prior to elastic shortening can be calculated as explained below. Let us assume that P_0=force immediately before transfer, P_i= force in tendon after elastic shortening, E_m and E_s=Young's modulus of elasticity for masonry and steel, Ds_s=decrease of stress in tendon, f_m'=masonry compressive stress at tendon level after transfer, A=cross-sectional area of beam and A_{ps}=area of prestressing steel. Hence,

$$\frac{\Delta\sigma_s}{E_s}=\frac{f_m'}{E_m} \tag{11.25}$$

or

$$\Delta\sigma_s=\frac{E_s}{E_m}f_m' \qquad \frac{E_s}{E_m}=m \quad \text{(modular ratio)}$$

$$\Delta\sigma_s=mf_m'$$

From equilibrium

$$f_m'=\left(\frac{P_i}{A}+\frac{P_i e^2}{I}\right)=P_i\left(\frac{1}{A}+\frac{e^2}{I}\right) \tag{11.26}$$

where e is tendon eccentricity. Also,

$$\Delta\sigma_s=\frac{P_0-P_i}{A_{ps}} \tag{11.27}$$

From (11.25), (11.26) and (11.27)

$$\begin{aligned} P_0&=P_i\left[1+\left(\frac{1}{A}+\frac{e^2}{I}\right)mA_{ps}\right] \\ &=P_i\left[1+\left(\frac{1}{A}+\frac{e^2}{I}\right)\frac{E_s}{E_m}A_{ps}\right] \end{aligned} \tag{11.28}$$

In post-tensioning, the tendon is stretched against the masonry member itself. Thus the masonry is subjected to elastic deformation during the post-tensioning operation and the tendon is locked off when desired prestress or elongation of tendon has been achieved. Thus in a post-tensioned member with single tendon or multiple tendons, there will be no loss due to elastic shortening provided all of them are stretched simultaneously. If the tendons are stretched in a sequence, there will be loss of prestress in the tendon or tendons which were already stressed.

11.7.2 Loss due to friction

As the prestressing force is determined from the oil pressure in the jack, the actual force in the tendon will be reduced by friction in the jack. Data to allow for this may be obtained from the manufacturer of the particular jacking system in use.

During post-tensioning operations, there will be a further loss of prestress because of friction between the sides of the duct and the cable. The loss in the transmitted force increases as the distance increases from the jacking end and can be represented by:

$$P_x = P_0 e^{-kx}$$

where P_x=force at distance x from the stressing anchorage, k=coefficient depending on the type of duct, x=distance from the jack, P_0=force at the stressing anchorage and e=base of Napierian logarithms.

In masonry with a preformed cavity to accommodate straight tendons, the loss will be negligible as the tendons seldom touch the sides of the member.

11.7.3 Loss due to slip in anchorages

The anchorage fixtures are subjected to stress at transfer and will deform. As a result, the frictional wedges used to hold the cables slip a little distance which can vary from 0 to 5 mm. This causes a reduction in prestress which may be considerable in a short post-tensioned member. The loss cannot be predicted theoretically but can only be evaluated from the data obtained from the manufacturer of the anchorage system. However, in practice, this loss can be completely eliminated at the dead end by stressing the tendon and releasing the prestressing force without anchoring at the jacking end or can be compensated by overstressing. No loss of prestress occurs in a system which uses threaded bar and nuts for post-tensioning.

11.7.4 Relaxation loss

Relaxation loss can be defined as loss of stress at constant strain over a period of time. This loss in prestress depends upon the initial stress and the type of steel used. Normally, the test data for 1000 hours relaxation loss at an ambient temperature of 20°C will be available, for an initial load of 60%, 70% and 80% of the breaking load, from the manufacturers of the prestressing steel. Linear interpolation of this loss between 60% and 30% of breaking load is allowed, assuming that the loss reduces to zero at 30% of the breaking load. The value of the initial force is taken immediately after stressing in the case of pretensioning and at transfer