(b) Internal ties

Internal ties are designed to span both ways and should be anchored to perimeter ties or continue as wall or column ties. In order to simplify the specification of the relevant tie force it is convenient to introduce F_t' such that

$$F_t' = F_t[(G_k + Q_k)/7.5] \times L_a/5 \text{ (kN/m width)} \tag{9.3}$$

where (G_k+Q_k) is the sum of the average characteristic dead and imposed loads in kN/m^2 and L_a is the lesser of:

- the greatest distance in metres in the direction of the tie, between the centres of columns or other vertical loadbearing members, whether this distance is spanned by a single slab or by a system of beams and slabs, or
- 5×clear storey height h (Fig. 9.4).

The tie force in kN/m for internal ties is given as:

- *One-way slab* In direction of span—greater value of F_t or F_t'. Perpendicular to span—$F_{t.}$
- *Two-way slab* In both directions—greater value of F_t or F_t'.

Internal ties are placed in addition to peripheral ties and are spaced uniformly throughout the slab width or concentrated in beams with a 6 m maximum horizontal tie spacing. Within walls they are placed at a maximum of 0.5m above or below the slab and at a 6m maximum horizontal spacing.

(c) External wall or column ties

The tie force for both external columns and walls is taken as the lesser value of $2F_t$ or $(h/2.5)$ F_t where h is in metres. For columns the force is in kN whilst in walls it is kN/m length of loadbearing wall.

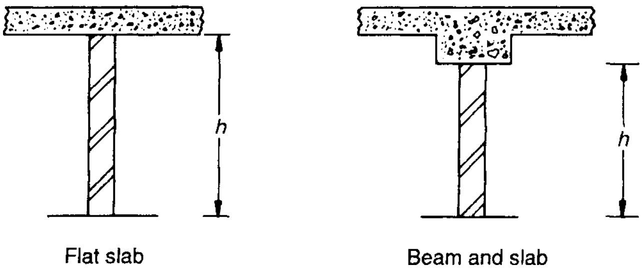

Fig. 9.4 Storey height.

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Corner columns should be tied in both directions and the ties may be provided partly or wholly by the same reinforcement as perimeter and internal ties.

Wall ties should be spaced uniformly or concentrated at centres not more than 5 m apart and not more than 2.5 m from the end of the wall. They may be provided partly or wholly by the same reinforcement as perimeter and internal ties.

The tie force may be based on shear strength or friction as an alternative to steel ties (see examples).

(d) Examples

Peripheral ties
For a five-storey building

$$\text{tie force}=20+(5\times4)=40\text{kN}$$

$$\text{tie area}=(40\times10^3)/250=160\text{mm}^2$$

Provide one 15mm bar within 1.2m of edge of floor.

Internal ties
Assume G_k=5kN/m^2, Q_k=1.5kN/m^2 and L_a=4m. Then

$$F_t=40\text{kN/m width}$$

$$F_t'=[40(5+1.5)\times4]/(7.5\times5)=35.5\text{kN/m width}$$

Therefore design for 40kN/m both ways unless steel already provided as normal slab reinforcement.

External wall ties
Assume clear storey height=3.0m. Tie force is lesser of

$$2F_t=80\text{kN/m length}$$

$$(h/2.5)\ F_t=(3.0/2.5)\times40=48\text{kN/m length (which governs)}$$

Shear strength is found using Clause 25 of BS 5628,

$$f_v=0.35+0.6g_A\ \text{(max. 1.75)}$$

or

$$f_v=0.15+0.6g_A\ \text{(max. 1.4)}$$

depending on mortar strength. From Clause 27.4 of BS 5628,

$$\gamma_{mv}=1.25$$

Assume mortar to be grade (i).

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