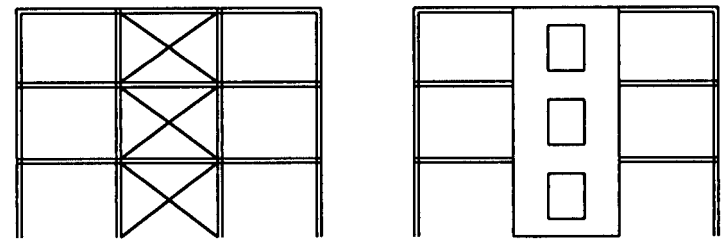
The bracing system is used to form a 'stiff box', to which the remaining structure can be attached. When the bracing comprises a component such as a concrete lift shaft, which is not complete at the time of erecting the first steel members, temporary steel bracing may be needed to allow steelwork erection to progress (see Section 4.2.4).

In an unbraced frame, horizontal loads are resisted by the bending stiffness of the frame members. These must therefore be joined together with rigid connections to provide continuity. Again, depending on the construction programme, temporary bracing may be needed to form a 'stiff box'.

Different ways of providing stability and resisting horizontal loads are shown schematically in Figure 3.1. Implications of the designer's choice at this stage are given below.



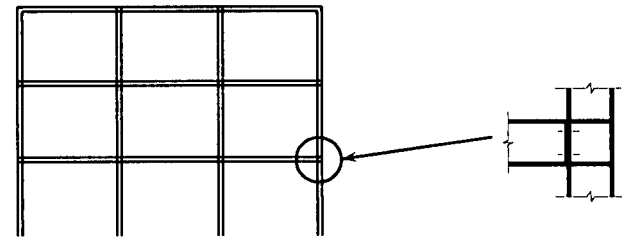


Figure 3.1 *Ways of providing stability and resisting horizontal loads; braced frames (with steel bracing or a shear wall), unbraced frame (relying on member and connection rigidity)*

Steel bracing

The advantage of adopting steel bracing members is that the steelwork package is self contained. The frame does not rely on any other elements (which may be the responsibility of another party) for stability. However, the inclusion of 'vertical' bracing members may be precluded by restrictions imposed by the client. Internal bracing members reduce the adaptability of the interior space (by preventing openings being made in certain locations), and bracing members around the perimeter of the frame may interfere with glazing requirements.

Other bracing

The use of stiff concrete or masonry elements enables some or all of the steel bracing members to be eliminated, but can lead to problems of responsibility; although the steelwork designer has the necessary load information, he may not want to design these secondary elements. Also, connections between steel and concrete or masonry elements may be difficult (see Section 6.2). Programming

must allow for the differences in speed of construction of steel and concrete or masonry elements. Temporary steel bracing is often required during construction as a result of connection or programme difficulties. Restrictions imposed by the client may prohibit the use of this type of frame (see above).

Rigid frame

Bracing is avoided when lateral loads are resisted by the frame members themselves. The members must be joined using rigid connections. The disadvantages of adopting a rigid frame are the complexity of the connections, and the need to complete these connections as erection progresses. The need for rigid connections can also result in relatively heavy columns, thereby increasing the frame cost.

Local bracing

As well as overall bracing to provide frame stability, local bracing may be used to provide member stability. This may be necessary at plastic hinge locations, or for compression members (see Figure 3.2).

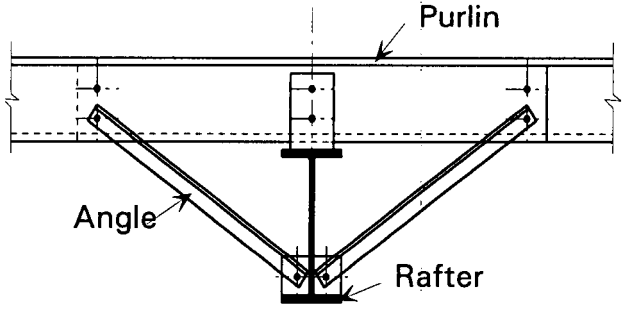


Figure 3.2 *Bracing to locally restrain a member in a portal frame*

Implications of the choice of frame type are summarised in the following 'Key Points'.

KEY POINTS - Frame types

Braced	Unbraced
• Restricts location of openings	• Client freedom
• Generally less expensive	• More expensive

3.3 Floor systems

For multi-storey commercial buildings, a range of steel and composite floor systems is available to the designer. The different systems are illustrated in Figure 3.3.