Tandem lifting

Tandem lifting can be used if the weight or, more often, size of a load is such that it cannot be safely handled by a single crane. For example, if the truss shown in Figure 4.8 was sufficiently long that a single crane could not pick up the required attachment points, it would be necessary to perform a tandem lift using two cranes. More than two cranes may sometimes be required.

The whole operation must be carefully planned by the steelwork contractor, and carried out under proper supervision. It should not be assumed that the weight will be shared equally between the cranes, since manipulation of the load into position may alter the weight distribution. The cranes used must have similar characteristics, and the safe working load of each crane should normally be at least 25% in excess of the calculated shared load.

4.2.3 Pre-assembly on the ground

Pre-assembly on the ground may be adopted for the reasons already stated at the beginning of Section 4. However, before specifying the use of pre-assembled units, the designer should consider the following four factors. These factors affect the economy and practicality of using such a method:

- the weight of the sub-frame (including any lifting beams)
- the degree to which it is capable of being temporarily stiffened within weight constraints
- its bulk
- the need to use a crane to handle it.

When sub-frames are used, provision must be made to ensure that sufficient space is available on the ground. Pre-assembling may take place either in a suitable clear area, if the load can be moved easily, or behind the crane at the erection front. The most common components to be assembled on site are roof trusses and lattice girders.

4.2.4 Temporary bracing

When a 'stiff box' cannot be achieved early in the erection process by the provision of permanent frame members (see Section 3.2), temporary bracing is needed. A particular example is when the permanent bracing system relies on a component which is not in position during erection of the steel frame (for example a concrete shear wall).

The temporary works designer will need to consider the following points when designing the temporary bracing:

- the stiffnesses of the temporary bracing members, which may differ considerably from those of the permanent frame members. For example, wire ties have considerably less axial stiffness than rolled members, and whilst this is generally unimportant, situations can be envisaged where the frame movement permitted by flexible bracing would be unwelcome.
- load paths through permanent members which are used as part of the temporary bracing system. For example, a beam which has only been designed for bending and vertical shear in the final state may be subject to considerable axial load.
- the action of wind on the bare or partially clad steel frame. Very large horizontal loads can be developed in this state, although generally design to

resist wind loads on the final clad structure is more likely to govern the temporary bracing.

- the stage at which the temporary bracing can be removed (and who will be responsible for its removal).

It will generally be found that the strength of temporary bracing is likely to be more critical than its stiffness. Temporary bracing may also be used:

- to support unstable columns prior to erection of the beams
- to laterally restrain compression members before the floors or roof are in place
- to support continuous beams prior to the completion of splices
- when sliding or rotating supports are used.

KEY POINTS - Erection equipment and techniques

- Different types of crane are suited to different situations. The building design should consider the type of crane which can be used.
- The designer should be aware of the different lifting equipment and techniques which are available.
- Particular attention must be paid to temporary bracing design, to ensure that stability is maintained at all times.

4.3 Case study - Senator House

Senator House is a sophisticated eight storey office building which was built in London in 1990, comprising a 13400 m^2 main building and a 1200 m^2 annexe. In addition to the client's requirements for maximum lettable floor area and a minimum number of internal columns, the location placed an overall restriction on building height. The 3.55 m floor to floor spacing which was made possible by the framing system is extremely low compared with normal UK standards.

Management of the project had to cope with a complex interaction of several parties. Responsibilities for the tasks within the steelwork package are shown in Figure 4.9. Careful planning and good communications were two of the keys to success. The result was a lead-in time of only six weeks, and erection, including fixing of the steel decking, in 15 weeks.

The frame was split into 24 two-storey-high zones for erection. The size of each zone was chosen to represent 10 days work for a team of seven men. This gave the team a volume of work on a 'human scale', so they could focus their efforts more effectively. Figure 4.10 shows a plan of the building indicating the six principal zones (A to F), each of which contained four zones to achieve the full eight storey height. Although two tower cranes are indicated in this plan, generally only one was used at any one time for erection of the steelwork.