3 DESIGNING FOR CONSTRUCTION

3.1 Design principles

Generally, the designer should adhere to the following four principles to facilitate construction:

- carry out a thorough design
- detail for repetition and standardisation
- detail for achievable tolerances
- specify suitable components.

These principles are taken from CIRIA guide **SP26([3]).** Their application to the design of steelwork is highlighted in the Sections that follow.

To assist the application of these four basic principles, examples of existing practice are often useful to both clients and designers. Examples help the assessment of possible alternatives. For clients, a portfolio of photographs and descriptions is useful. British Steel have built up a catalogue of case studies, and these are summarised in Appendix A. For structural designers, it is useful to have an indication of the weight of steel per unit area (or volume) that might be expected for the chosen framing plan. Appendix A also gives guidance on typical weights for various building forms.

3.1.I Thorough design

A thorough steelwork design should preferably be completed before commencing construction. Unfortunately, this rarely happens in practice for a variety of reasons, and the best a designer can do is often to try and minimise late changes. These are particularly expensive to accommodate if site modification is required.

A thorough design is one which includes consideration of how the frame could be erected. The designer has an obligation to consider erection under the CDM regulations (see Section 5) , and he must convey relevant information to the client. Information to be passed on to the site team must include:

- the method of erection the designer assumed
- requirements for temporary bracing or propping, and conditions for their removal
- features which would create a hazard during erection.

3.1.2 Repetition and standardisation

With increased automation in both design and fabrication processes there is an argument that repetition, which is a form of standardisation, is less important today than in the past. However, standard, and perhaps more importantly, simple details should be adopted wherever possible in order to reduce fabrication work and keep erection simple.

For example, increasing the serial size of a member to enable the adoption of a standard connection, with no need for stiffening or strengthening, is one way of simplification and is often of economic benefit. Simple standard solutions should be preferred, unless complex or unfamiliar forms of construction are necessary or appropriate for a specific situation (e.g. composite stub girders may be economical for relatively large spans in a highly serviced building with a restriction on inter-storey height, see Section 3.3).

3.1.3 Achievable tolerances

There are several reasons for specifying tolerances (see Section 8), and these may be split into two categories. The first is to ensure that the actual deviations or imperfections of the completed frame do not exceed those allowed for in the design. Secondly, frame members and other components should fit together correctly when they have been fabricated and erected within correctly specified tolerances. The latter requirement imposes more onerous tolerances, particularly at interfaces between different components such as steel and glazing. The designer should specify tolerances that will ensure that these requirements are satisfied. Appropriate values for most situations are given in the NSSS[6].

It is also essential that the designer specifies tolerances which can be achieved, recognising the limits of tolerances attainable in normal site construction. Problems of fit often occur at interfaces between different products, methods of construction, materials and methods of manufacture. These matters should be considered and allowed for by developing suitable jointing methods at the design stage.

The designer should also consider the consequences of assembly sequences; when pre-fabricated items are built in, differences between fine factory tolerances and those of site construction must be considered.

3.1.4 Suitable components

The designer should specify components which are suitable for the proposed application. Suitability will always mean being adequately robust, but other issues may also need to be considered. For example, the cold formed sheeting used to form composite slabs must be light enough to be manhandled into position, and strong enough to be walked on during erection. In addition to hindering construction, an unwise choice of component may result in increased maintenance costs, for example the cost of replacing an item with an inadequate design life.

3.2 Frame types

Basic design decisions taken at a very early stage can have significant implications on the ease of construction. The first choice is usually whether the frame will be braced or unbraced. The inclusion of bracing members may be precluded by criteria imposed by the client.

A braced frame includes members that provide positional restraint to other members, thus stabilising the frame, and that distribute horizontal loads to the supports (see Figure 3.1). The bracing system may comprise steel members, for example diagonals joining the frame nodes, acting in both horizontal and vertical planes. Alternatively, building components such as floors, shear walls, stair wells and lift shafts acting in isolation or together with steel members may be used. Such components may serve as bracing by acting as a diaphragm, but to achieve this, components must be adequately tied together; if floors are constructed using precast concrete units, transverse reinforcement suitably anchored into the units will be required.