6.4 Composite beams

It is possible to reduce the depth of the structural floor for a given span by utilising composite action between the concrete slab and steel beams. This can result in a saving of 30% to 50% in steel weight compared to a non-composite alternative. In addition to savings in the frame itself, secondary benefits of shallower floor construction include greater flexibility to route services under the structural floor. Various composite beam options, with a summary of their relative merits, are presented in Section 3.3.

Composite beams are normally, but not always, used in conjunction with composite slabs. The latter are generally formed using profiled steel decking and in-situ concrete. The use of lightweight concrete reduces the dead load of the slab. Lightweight concrete also undergoes less shrinkage and has a higher tensile strain capacity than normal weight concrete, so larger pours can be adopted. Alternatively, precast concrete units can be used to form the slab, as discussed separately in Section 6.5.

An alternative type of composite beam is one using a slim floor system. One current system uses a wide plate welded to the bottom flange of the steel beam to support deep decking or precast concrete units within the depth of the beam (see Figure 6.12). British Steel will also be launching a range of 'asymmetric' beams in May 1997. These will be rolled with differing flange widths. The advantages of a slim floor system are described in Section 6.5, with specific reference to the use of precast units.

The Sections that follow refer to the most typical type of composite beam, namely one which is used in conjunction with a composite slab, and therefore has steel decking present between the beam top flange and the concrete.

6.4.1 Erection

The main advantage of using steel decking at the erection stage is that the decking can be used as unpropped permanent formwork when the supporting beams are at not more than **3** m to **3.5** m centres. For greater spans, propping, or a deck with a 'deep' profile, is needed. The designer should adopt a framing plan to reflect the fact that the decking is only one way spanning (using a regular grid, with orthogonal beams where possible).

The sheets are laid out as erection progresses up the building. In this way the decking provides a working platform at each floor level, thereby eliminating the need for temporary platforms. It also serves as a crash deck to protect operatives working at lower levels from small objects, and it reduces the effective height at which erectors must work. A typical erection sequence for a multi-storey building is outlined in Section 4.1.4.

For speed of erection, the decking is normally secured to the beams using shot-fired pins. This positive attachment helps to maintain the stability of the steel frame during erection, and laterally restrain the top flanges of the beams during casting of the slab. At the ends of each sheet, the pins should be placed at 300 mm centres, but over intermediate beams the spacing can be increased to 600 mm. If the decking is required to act compositely with the beam, additional attachment is required. This is usually achieved by through-deck welding of the shear connectors (see below).

Sheets are lifted in bundles onto the frame using a crane, and are then light enough to be individually man-handled into position. This is not possible with precast planks. Sheets can be cut on site to fit details such as column locations. If the sheets are not supported by beams framing-in to the column then seating angles should be welded to the column sides to provide support.

> **KEY POINTS - Erection**
>
> Most composite beams are used in conjunction with composite slabs, the latter being based on profiled steel decking. Principal benefits during erection are that:
>
> - the decking is lightweight and therefore easy to place
> - the decking can serve as unpropped, permanent formwork
> - the decking provides a working platform.

6.4.2 Shear connectors

Welded shear studs (Figure 6.7) are normally used to develop composite action between a floor slab and supporting beams. The most commonly used studs have a shaft diameter of 19 mm, and are 100 mm long overall (although a range of sizes is available). The studs have a larger diameter head to achieve the necessary force transfer, and are attached using a special welding gun. For buildings, the designer should choose a uniform stud spacing for simplicity (unless there are heavy concentrated loads).

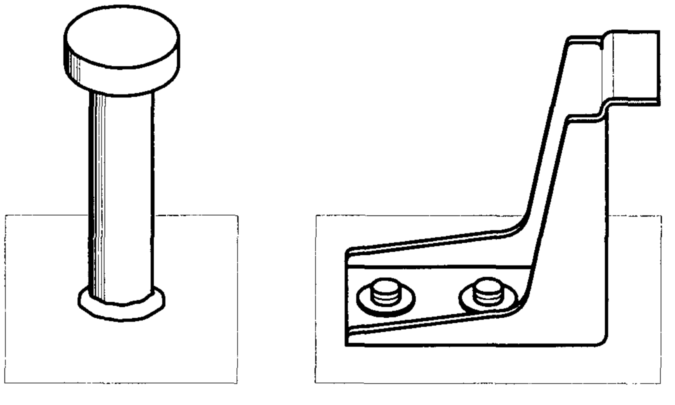

Figure 6.7 *Shear connectors (left) welded headed stud, (right) shot fired*

Normal UK site practice is to attach shear studs to the steel beam by through-deck welding; the stud is welded to the beam flange by burning through the decking during the welding process. The flange thickness should not be less than 8 mm (for 19 mm studs), unless a single row of studs is welded directly above the web. To achieve a good weld, the flange surface and decking must be free from paint, dirt and moisture. This may prove difficult in some situations. Through-deck welding ensures that the decking is well anchored to the beam, and can therefore be taken into account by the designer when he determines the required transverse slab reinforcement.