STEEL INDUSTRY GUIDANCE NOTES

Composite Construction

Composite construction is so common that it needs little introduction. Chosen for structural efficiency, cost-effectiveness, speed and safety, a composite floor is a hallmark of a modern multi-storey frame. This guidance note reminds designers of the issues of note.

Composite slabs

Slabs are formed from steel decking and a concrete topping. During concreting, the deck supports the weight of the wet concrete; in service composite action is obtained. Mesh is placed in the concrete to control cracking, occasionally with the dual role of enhancing the fire resistance of the slab.

Deck types

Three generic deck types are commonly available – re-entrant (dovetail), trapezoidal and so-called deep decking. Re-entrant and trapezoidal are both 'shallow' decking – typically between 45 and 90mm deep overall, and are used to span between 3 and 4.5m. Deep decking is suitable for spans up to around 9m, and is often used in shallow floor construction where steel members are incorporated in the floor depth.

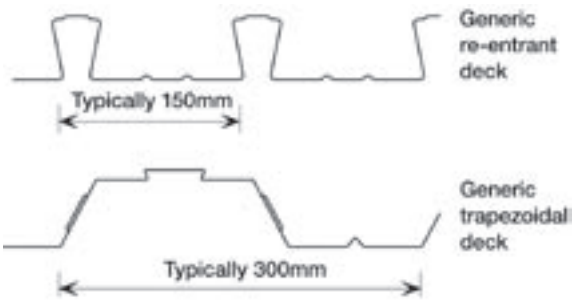

Figure 1: Typical deck profiles

Slab design

Software is often used to design composite slabs, or manufacturer's tables.

Composite slabs – what to watch

1. The fire design case is always important, and typically may mean increasing the chosen mesh size, or thickening the slab depth.
2. Designs may assume normal or lightweight concrete (NWC or LWC). Designers should check that LWC is readily available at the site location, or assume NWC
3. Deflections of the deck and supporting structure can lead to 'ponding', if the slab is poured to a specific level.
4. On steelwork, decking should have a minimum bearing length of 50mm, and the slab itself 75mm minimum.
5. Supporting members will be required around significant penetrations, and at columns, support cleats may be needed.
6. Significant openings in the slab are likely to need additional reinforcement.

Composite beams

Composite action increases the load carrying capacity and stiffness (i.e. reduces the deflections) by factors of around 2 and 3.5 respectively. The concrete forms the compression flange – the steel provides the tension component and shear connectors ensure that the section behaves compositely.

Usually, shear studs or proprietary shear cleats fixed using powder actuated fasteners are installed on site. Shear studs are attached by 'through-deck welding', which demands an unpainted top flange of the steelwork.

Note:

a) when using trapezoidal profiles for up to 90 minuets fire resistance, the voids between the steel and the underside of the decking do not need to be filled however the proposed fire protection thickness may need to be increased.

b) When using re-entrant profiles for up to 120minutes fire resistance, the voids do not need to be filled.

Beam design

Invariably, software is used to design composite beams, often as part of a design suite. Software for composite beam design is freely available from Corus (see further information)

BCSA corus SCI

Composite beams – what to watch

1. Lateral restraint to the beams in the temporary stage is achieved by adequate fixings and when the decking ribs are perpendicular to the beam.
2. Because the beam design is often governed by SLS criteria, the dynamic response of the floor plate should be checked
3. Service penetration or similar through the slab close to the beam will have a detrimental effect on beam performance – avoid if possible, but certainly account for in design
4. In trapezoidal decking, studs should be placed in the 'beneficial' position – which is at the side of the trough with the lowest bending moment (usually towards the beam end), or allowed for in design. See Figure 2.
5. If through-deck welding, the thickness of the top flange should be at least 40% of the stud diameter – i.e. minimum 7.6mm for a standard 19mm stud.
6. Shear studs should be checked in accordance with the National Structural Steelwork specification (NSSS)
7. The longitudinal shear resistance of the slab must be checked to ensure that the force from the shear connectors can be carried without splitting the concrete. Often, additional reinforcement is required. It is essential that this requirement be identified and suitable reinforcement be designed and detailed for installation on site.

Where next with composite construction?

Although composite construction is tried and tested, new possibilities are being explored that may be advantageous. These include:

Composite connections

In orthodox composite construction, the steel beam end connections are invariably assumed to be simple. It is relatively easy to design and detail beam-column connections with some moment capacity and stiffness, leading to reduced deflections and smaller beam sizes.

Fibre-reinforced concrete

The use of fibre-reinforced concrete can reduce or possibly eliminate the need for normal reinforcing mesh, potentially removing a site operation. The performance of fibre-reinforced slabs at normal temperatures and in the fire condition has been extensively tested. Manufacturers should be consulted for performance data, which depends on deck type, fibre type and fibre dosage in the concrete.

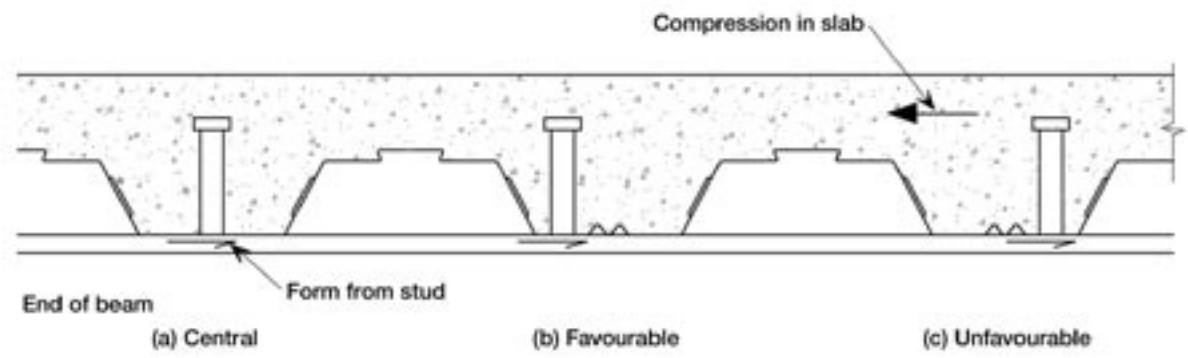

Figure 2: Stud welded in the 'beneficial' position.

Key Points

1. Design slab and beam with software – freely available from manufacturers
2. BDES is available from www.corusconstruction.co.uk
3. The requirement for transverse reinforcement is critical, and must always be checked
4. It is important that the latest design Standards are consulted for up-to-date information on stud resistances
5. Construction stage loading will be included in design tables and software. The deflection of supporting steelwork should be checked to avoid excessive ponding
6. Dynamic performance should be checked, though is unlikely to be critical in office or residential environments
7. When using trapezoidal profiles for up to 90 minuets fire resistance, the voids between the steel and the underside of the decking do not need to be filled however the proposed fire protection thickness may need to be increased
8. When using re-entrant profiles for up to 120 minutes fire resistance, the voids do not need to be filled.

Further sources of Information

1. **Composite slabs and beams: Best practice for design and construction. P300 from SCI and MCRMA**
2. **Design of Slimflor fabricated beams using deep composite decking. SCI**
3. **Corus Slimdek manual**