

# 7. Construction

## 7.1 Forward planning

The CDM 2007 regulations<sup>[33]</sup> are of particular importance during the construction phase of a project. Coordination between the designer and contractor will ensure that the construction work proceeds safely and with maximum efficiency.

Important mistakes to be avoided in the planning and execution of Slimdek projects:

- Design details that are impossible to install. Please refer to *Section 2, Figures 2.33 and 2.34* of this guide for examples of such design details (both of which have been derived from actual projects). Correct details are shown both in this book and are available on [www.corusconstruction.com](http://www.corusconstruction.com)
- Installation of handrails directly above edge beams. This frequent occurrence makes it very difficult to install the deck and edge trims safely. The handrails should cantilever outside the edge beams as provided by 'Easy Edge' and other proprietary systems.
- Incorrect placement of deck bundles. The correct placement positions are shown on the deck installation contractor's drawings. However, the crane operator is employed by the main contractor and sometimes places the deck bundles in the wrong place. It is essential for safe installation that the deck bundles are not only placed in the correct bay but also in the correct place in the bay. This ensures that the decking operatives can access the bundle from the safest place, reducing the need to access the beam flange.

Avoiding these errors (which are all outside of the control of the deck installation contractor) is the first step towards safe and efficient installation. Safe working is also promoted by eliminating difficult details which need to be assembled at height and speed of construction may sometimes be achieved by preparing elements for construction at ground level and lifting them into place in one piece.

Pre-assembly of ComFlor 225 decking is possible when sufficient space is available on site to enable decking bays to be assembled at ground level prior to lifting into place and a suitable crane is regularly available for lifting. Pre-assembly removes the need to pre-fix the end diaphragms and enables most of the work to be carried out without working at height. However, if this process is to be considered then early detailed discussions must be held between the principal steelwork and decking contractors, as pre-assembly requires a radical change to the planning, programming and construction process.

In most cases pre-assembly will not be possible and other measures should therefore be taken to reduce, as far as is reasonably practicable, the amount of work to be carried out at height. Work should be planned and programmed to allow the end diaphragms to be installed from Mobile Elevated Work Platforms (MEWPs) or mobile scaffold platforms wherever reasonably practicable.

Work should be planned so that no other trades or stored materials are permitted onto the deck and no other works are carried out immediately above or below the working area until it has been completed and handed over.

Safety netting is the preferred method of fall protection for the installation of deep decks as it provides passive and collective protection for operatives working above. Where safety nets are used they act as primary fall protection and there will be no requirement for the decking contractor to use additional measures such as running lines. The safety net system should be installed directly onto the bottom flange of the steelwork to which the decking is fixed minimising the height of any potential fall.

Consideration must be given to the sequence of installation of safety netting as the safety net anchors ('Grip' clamps or similar) will need to be installed in advance of the end diaphragms, as once the diaphragm is fitted the clamps cannot be installed. This method of work will require close cooperation and coordination between the deckers and the safety net riggers.

## 7.2 Steelwork erection

The erection of steelwork using ASB or RHSFB is similar in principle to other steel frames and should not cause any unusual difficulty. As with all steelwork erection, clear communication and allocation of responsibility is the key to speed and safety in erection. Designers and contractors should be aware of the guidance, recommendations and obligations contained in the following:

- The Construction (Design and Management) Regulations 2007 (CDM 2007)<sup>[33]</sup>
- British Constructional Steelwork Association (BCSA) publication: *Guide to the installation of deep decking*<sup>[48]</sup>
- British Constructional Steelwork Association (BCSA) Guidance Notes: *Safer Erection of Steel-Framed Buildings*<sup>[49]</sup>
- BS 5531: *Code of practice for safety in erecting structural frames*<sup>[15]</sup>
- Health & Safety Executive Approved Code of Practice (AcoP) in support of CDM 2007<sup>[50]</sup>

Designers are not legally required to keep records of the process through which they achieve a safe design, but it can be useful to record why certain key decisions are made. Brief records of the points considered, the conclusions reached and the basis for those conclusions can be very helpful when designs are passed from one designer to another. This will reduce the likelihood of important decisions being altered by those who may not fully understand the implications of doing so.

The designer should clearly state all design assumptions, including design loading considered and any allowances for temporary construction loads. It is particularly important that the designer identifies how the structural stability of the steel frame is to be achieved, and any assumptions made with regard to temporary stability during erection. It is helpful to the project if the designer identifies his recommended erection sequence.

The requirement for 'ledge angles' to be fitted in the appropriate places for side support is easier to address during the steelwork fabrication stage than on site. Some details also make it impossible to access with the low-velocity powder actuated fastener tools used to secure the edge of the sections. This is also a factor when hollow sections are positioned within the area to be concreted.

The steelwork contractor should prepare a detailed erection method statement. This should emphasise the sequence of erection and how stability is to be maintained throughout construction. The designer's assumptions and the steelwork contractor's erection method statement should be discussed with the principal contractor.

The designer and contractor should recognise that in a Slimdek system it is common for the beam to span in only one direction, with more flexible tie beams in the orthogonal direction. Therefore, there are limitations with regard to access onto tie beams. This will influence the erection method.

It is recommended that ASBs are hoisted into position using a 'Dawson Ratchet Release Beam Sling'. This lifting device avoids the need to access the sling after erection as the sling hooks are removed by remote operation. The usual range of access methods is available for the bolted end connections.

Every site is unique and poses individual challenges. Prior planning and individual attention is essential to overcoming these challenges and ensure the smooth running of any project.

### 7.3 Floor deck erection and fixing

All designers and installation contractors should be familiar with the *BCSA Guide to the Installation of Deep Decking*<sup>[48]</sup> available from The British Constructional Steelwork Association. The guidance in this manual is compatible with the BCSA publication and the joint MCRMA/SCI publication on *Composite Slabs and Beams using Steel Decking: Best Practice for Design and Construction* SCI-P-300<sup>[26]</sup>. As with the erection of the steel frame, clear communication and allocation of responsibilities is the key to the safe installation and subsequent use of the ComFlor 225 decking.

The designer should clearly state all relevant design assumptions including the span, the direction of span, the overall slab thickness, the design loading, the fire rating required and any constraints on deck erection which are perceived.

The decking contractor should normally prepare detailed decking drawings and an erection method statement which should identify methods of and restrictions to adjacent working. These should be discussed and agreed with the principal contractor. The structural engineer should also identify any temporary propping requirements, including prop locations and types, which should be shown on the decking drawings.

Decking installation will only commence once the end diaphragms and safety net fall arrest system are in place. As it is often not possible to straddle the steelwork once the end diaphragms are in place, decking operatives will usually stand on the top flange of the beam at either end of the first bundle of decking to cut open the steel banding and lift the first decking sheet out onto the steelwork and over the pre-fitted diaphragms. Decking sheets should always be positioned by a minimum of two operatives where sheets are longer than 6m, unless mechanical lifting systems are an option. Where practical, decking should be positioned by two operatives at each end of the sheet using an extended handlebar lifting device. Decking installation should always cease a minimum of two metres back from any unprotected edge, such as the end of a safety netted work zone.

#### 7.3.1 Delivery

The decking is delivered in bundles, sized to suit the project and placed by crane at the positions shown on the deck layout drawings. Each bundle normally contains sufficient deck pieces to cover one bay of the floor. The bottom sheet of each bundle is 200mm longer than those above to give sufficient bearing onto the top flange of the beams.

#### 7.3.2 Deck cut-outs

The decking elements are delivered to site cut to length with approximately 50mm x 240mm wide cut-outs in the crest at each end. These cut-outs are required in order to facilitate concreting around the steel section, see *Figure 7.4*. If sheets are cut to length on site, these cut-outs should be made on site.

### 7.3.3 Fasteners

Recommended fasteners for installation of the ComFlor 225 decking are given in *Table 7.1*.

### 7.3.4 Diaphragms

The diaphragms are fixed first, as shown in *Figure 7.1*. Diaphragms are manufactured from galvanised steel in the following sizes:

- without openings 1.6mm thick x 1800mm long
- with openings 2.0mm thick x 1800mm long

The diaphragms are fixed to the edges of the lower flanges of the beams on both sides (except for edge beam situations) using two fixings at pre-marked positions for each length. The 1800 length equates to three sections of ComFlor 225 decking. Each length should be positioned and abutted accurately so that the 600mm pitch of decking sections is located as shown on the layout drawings.

### 7.3.5 Very short lengths of deck

Where the beam spacing demands a length of deck of 1m or less, especially where the beams are not parallel, it is far more efficient to use a shallow composite floor deck. This eliminates the need for close spaced diaphragms and complicated cutting of very short pieces of ComFlor 225.

### 7.3.6 Decking to steelwork

Steelwork must be adequately restrained with support for the decking around columns and openings.

The individual deck sheets are then manually lowered onto the end diaphragms that provide both location and alignment. The nominal end bearing of the decking is 50mm, although this may reduce to an absolute minimum of 35mm on site, allowing for all constructional tolerances. When the sheets for the whole bay are in place, they are fixed through the trough of the profile to the beam lower flanges using steel/self-tapping screws or heavy duty shot-fired pins. Two main fixings per trough (one each side of the central dovetail) are required. The decking is then fixed to the top of the diaphragms using two self-drilling self-tapping screws. Side laps should be fixed at 500mm centres through the top flat of the dovetail using self-drilling fasteners.

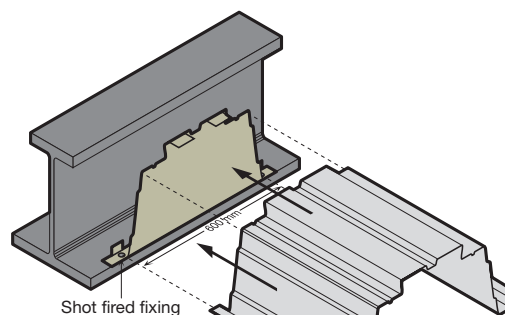
### 7.3.7 Edge and inside trim

A light steel edge trim is used for retention of the wet concrete and to form the vertical edges of the slab. Each length should be fixed to the perimeter beams with edge restraint straps fixed at 500mm centres. The decking installers should take care to ensure that the restraint straps are tight preventing the trim from bowing out during concrete placement. Edge trim positions are generally set out from the centre line of the supporting steelwork and should be fixed with a tolerance of +/- 10mm in accordance with the National Structural Steelwork Specification for Building Construction<sup>[51]</sup>. Edge trim should be set to the correct level taking account of beam and/or deck deflections at the deck floor perimeters. Internally

Z trim is used to close the decking where the 600mm profile of the deck does not align with the parallel supports and has to be cut longitudinally. Trims with butted joints should be propped where they are not adequately supported.

Generally, edge and Z trims are custom manufactured for each project from 2.0mm galvanised steel (up to 450mm deep) in 3m lengths. They should be fixed to the deck and/or support beams at approximate 500mm centres using fixings described in *Table 7.1*. The location of each type of fixing should be shown on the layout drawing.

Straps restraining deep edge trim are manufactured from 50mm x 1.25mm thick galvanised steel.



This diagram is for illustrative purposes only and does not show the recommended method of placement for the decking.

**Figure 7.1** Fixing of end diaphragms at ASB

### 7.3.8 Sealing joints

Normally, providing the decking installation has been carried out with reasonable accuracy, joints between decking and closures should be fairly tight fitting and do not require sealing. Small gaps tend to close and seal when the weight of concrete is applied, but some grout loss should be expected. In situations where larger gaps occur or where grout loss has to be minimised for visual reasons, a foam sealant can be used. It is easier to carry out this operation prior to fixing the reinforcement.

Seam stitching between decking panels is required to hold the lips of the decking together during concreting operations. Seam stitching should be carried out as soon as practical following the installation of the decking.

### 7.3.9 Working platform

The fixed deck is a safe and secure working platform for both the deck fixers and the following trades. The deck is capable of supporting foot traffic and loads from small tools carried onto the floor. Larger pieces of equipment, steelwork, bundles of mesh, etc. should be supported directly by the steel frame.

The main contractor completes the floor slab by fixing the reinforcement, provides any temporary propping and finally places the concrete.

Table 7.1 Schedule of decking fasteners

Location	No. of fixings	Type of Fastener		
		SFS Stadler	Hilti	ITW Construction Products
Diaphragm to Corus ASB or RHSFB flange plate	2	<b>Up to 9 mm flange thickness:</b> SFS self-drilling self-tapping SD12-5.5 x 36 mm screws.	Heavy duty shot-fired pins ref. Hilti ENP2 X-ENP-19 L 15	<b>Up to 9 mm flange thickness:</b> Heavy duty shot-fired pin ref. Spit SBR14FD or; self-drilling, self-tapping Buildex Teks Screw TL32.
ComFlor 225 decking rib to Corus ASB or RHSFB flange plate	2 each end			
Trims, closures and straps to Corus ASB, RHSFB or RHSFB flange plate	500mm centres			
Diaphragms, decking, trims, closures and straps to other carbon steel support beams.		<b>Up to 40 mm flange thickness:</b> SFS self-tapping TDC-T-6.3 x 25 mm fixed through a pre-drilled 5.9 mm diameter pilot hole.		<b>Up to 40 mm flange thickness:</b> Heavy duty shot-fired pin ref. Spit SBR14FD** or; self-drilling self-tapping Buildex Teks Screw T25B with pre-drilled 5.8 mm diameter pilot hole to both part and substrate.
ComFlor 225 decking crest to diaphragm	2 each end	SFS self-drilling self-tapping SD3-5.5 x 25 mm screws	N/A	Self-drilling self-tapping Buildex Teks Screw TC25
ComFlor 225 side laps (through top flat of dovetail)	500mm centres			
Trims, closures and straps to ComFlor 225 decking and to each other	500mm centres			

## Notes:

- Other fasteners of equivalent performance may be used.
- \*\* Site test for suitability recommended - contact manufacturer's technical support.

## 7.4 Reinforcement

The deck forms a part of the slab reinforcement, with the remainder being supplied by a bar in each trough of the decking and mesh placed near to the top of the slab. The deck reinforcement is fixed in accordance with the requirements of the deck designer. For low shear and up to 60 minutes fire resistance, spacers at an axis distance of 70mm from the base of the trough support individual straight bars. For high shear (spans greater than approx 6m) additional end anchorage in the form of L-bar or U-bar is required. The axis distance is increased to 90 and 120mm respectively for 90 and 120 minutes fire resistance. See *Table 2.3 for reinforcement requirements*.

Table 7.2 Minimum laps for mesh

Mesh type	Lap (mm)
A142	300
A193	400
A252	400

The top mesh is typically A142 to A252 mesh, with minimum cover as necessary for durability considerations – minimum laps are given in *Table 7.2*. At mesh overlaps, the support stools should be positioned more frequently.

There may be requirements for additional mesh or bar reinforcement adjacent to supports or edge beams for crack control or other purposes.

## 7.5 Propping

Where temporary supports are specified by the structural engineer it is important that:

- The props are of adequate strength and construction to carry the slab.
- Props will either be at half-span or one-third span position (or other specified by engineer).
- Bearers should be a minimum of 100mm wide.
- Propping should not be removed until the slab has reached at least 75% of its characteristic strength.

It is necessary to prop the ComFlor 225 decking where spans exceed the limit of the bending resistance of the decking in the construction stage (typically beam-beam centres of 6m).

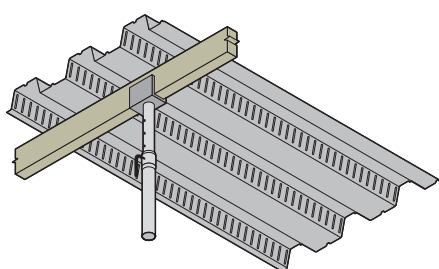
The decking should be propped by a continuous line of 'Acrow' or similar props with a timber spreader below the decking extending the full width of the bay and supporting each decking rib and Z trims if present, as illustrated in *Figure 7.2*. These requirements are presented in *Table 7.3* as a function of the slab depth (and hence weight). The width of the spreader should be at least 100mm to avoid local deformation of the decking. Spreaders should be of sufficient strength to span between props and support each rib.

For spans less than 7.5m, props may be positioned after the decking is placed. Props should be firmly wedged to level prior to concreting.

Props should be stable without relying on friction with the deck for lateral stability. The end props in a row should be self-supporting and braced to the internal props.

For spans greater than 7.5m, props should be in place prior to the decking being placed and should be adequately laterally restrained. Mobile towers may be used and the supporting floor must be checked for the applied concentrated construction loads.

For slabs subject to low construction loads, the props should not be removed until the concrete has achieved 75% of its specified strength (normally after seven days). The slab design should also be checked for cases of high construction loading (e.g., where palettes of bricks or plasterboard are stored on the slab). In this case and for cases where crack control is required, props should not be removed until the concrete has achieved its specified cube strength.



**Figure 7.2** Propping of slab during construction

It is not normally necessary to prop to more than one floor below the level concerned, because the imposed load resistance of the supporting slab should exceed the loading transferred through the props. However, the designer should ensure that the supporting slab has reached adequate strength at this stage. In cold weather, curing times may be extended.

### 7.5.1 Propping of partially encased ties

Where decking is unpropped, encased ties should normally be designed to support a 300mm width of slab in addition to the construction loads. Where cutting of the decking results in slab thickening over a width greater than 300mm, advice should be sought from the designer, or alternatively the tie member should be adequately propped.

Where decking is propped during construction, partially encased ties should normally be adequately propped.

### 7.5.2 Propping of beams

The structural engineer should specify requirements for the propping of beams. Propping will normally only be required for:

- long span ASBs (> 8m span)
- composite RHSFBs

Where propping is specified, the props used to support beams should be much more robust than those used to support decking. Generally, a 'Tri-shore' or braced propping system is required, which should have a load capacity of over 10 tonnes. These props should be placed at a maximum of 3m spacing along the beams. In this case, it will often be necessary to prop to two levels below the supported beam to avoid creep-induced deflections of the supporting beam.

## 7.6 Cladding attachments

Attachment to various forms of cladding may be considered in Slimdek construction:

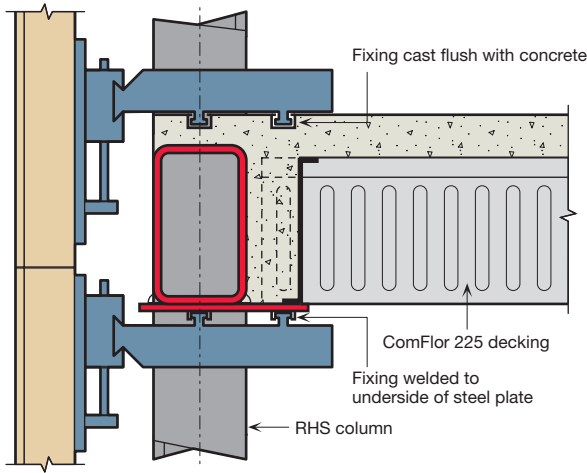
- Masonry
- Concrete panels
- Lightweight cladding
- Glazing

Special details have been developed for masonry cladding. Brackets can be welded to the side of RHSFBs or embedded in the concrete encasement to ASB sections.

For lightweight cladding and curtain walling, special adjustable brackets have been developed which can be attached to channels cast into the slab and attached to the bottom plate. A typical detail is shown in *Figure 7.3*.

**Table 7.3** Recommended maximum spacing of temporary props to slabs (in metres)

Concrete type	Slab depth			
	Up to 300	320	340	360
NWC	3.3	3.0	2.6	2.2
LWC	3.6	3.3	2.9	2.5



**Figure 7.3** Attachment for lightweight cladding to RHSFB

## 7.7 Concreting operation

### 7.7.1 Construction loads

The deck is designed in accordance with the requirements of BS EN 1994-1-1<sup>(1)</sup> for the dead load of the concrete and a construction stage imposed load. This imposed construction load is 1.5kN/m<sup>2</sup> over the centre 3m of the deck span and 0.75kN/m<sup>2</sup> for the remainder. This load is reduced to an average of 0.5kN/m<sup>2</sup> when considered over the supported area for design of the beams. These represent the load imposed by the operatives during placing of the concrete and allow for slight heaping of the concrete. If loads greater than these are expected, they must be taken into account in the design of the deck and supporting beams.

Similarly, high loads applied to the slab after construction should be checked carefully with respect to the design loads in normal conditions, as should punching shear due to point loads which may occur during construction.

### 7.7.2 Inspection

The decking should be checked prior to concrete placement to ensure it has been correctly fixed. Any damaged decking must be replaced. If the deck span requires propping, this should be in place and adequate. The deck and beam surfaces should be clean and free from dirt and grease that would affect the performance of the slab. Oil left from the roll-forming process will not affect the bond of the concrete to the galvanised steel or the performance of the slab.

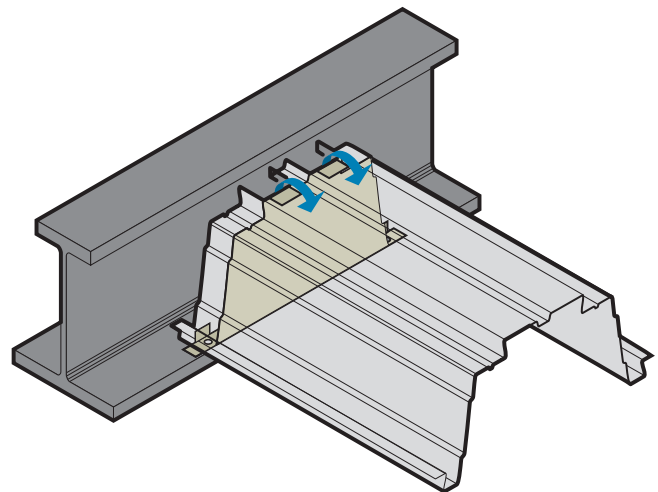
### 7.7.3 Placement

The normal practice for concreting a floor slab is either by pumping or by placement from a skip. Limitations on pour sizes need not be made because the decking acts as reinforcement and helps to distribute shrinkage stresses and early age thermal strains. C30 concrete is normally specified for normal and lightweight concrete in mild exposure conditions, see Table 2.1.

Lightweight aggregate is less than 12mm and should be used where the cover to the beam is less than 35mm, see Table 2.1. For other cases, either a 12mm lightweight aggregate or a 20mm normal weight aggregate may be used. Both lightweight and normal weight concrete are suitable for pumping.

Concrete placement by pump is the most popular method of construction. Flow rates of 0.5m<sup>3</sup> to 1m<sup>3</sup> per minute can be achieved. Long pump lines and greater pumping distances will slow the rates below these levels. Pumps are normally used for 'lifts' of up to 30m. Secondary pumps on intermediate levels may be necessary for higher lifts. The pump manufacturer or supplier should be consulted for further advice.

The pipes used to carry the wet concrete are normally approximately 150mm diameter and are connected in segments. The pipes should be supported on timber blocks at intervals of 2m to 3m. The force exerted at bends may be significant, therefore, straight-line pumping is preferred. The outlet pipe should be moved frequently and carefully so that heaping of the concrete is minimised and excessive deflection prevented. Two operatives are often needed to shovel away excess concrete. Despite the fluidity of the mix, good vibration is important, particularly around the beam to ensure adequate compaction. The deck cut-outs and clearances to the top flange give adequate space for placement and observation of concrete filling around the steel section, as shown in Figure 7.4.



**Figure 7.4** ComFlor 225 decking showing cut-outs for placement of concrete

Using a skip from a crane to place concrete may be difficult because of obstruction from decking on levels above. However, it is sometimes necessary to use a skip and barrow method for small infill bays. Skips should have a controlled outlet and should not be discharged at more than 0.5m above the deck or barrow. Barrows should be placed on a 20mm thick plywood board placed on top of the ComFlor 225 decking or finished slab, in order to limit point and impact loads. Barrows should be run over scaffolding boards placed on the mesh, which should be supported locally to prevent it being depressed or displaced.

The concrete should be placed to a level dictated by deflection of the support beams. Therefore, the slab thickness at the centre of the deck span will be slightly greater than at the beams, which should be taken into account in design. If a level surface is required, beam deflection should be taken into account in setting the level of tamping rails positioned above the beams.

#### 7.7.4 Curing

Concrete gains strength relatively quickly and is able to resist damage due to low temperature, if kept above 5°C for at least three days after placement. Similarly, in warm or windy weather, it may be necessary to prevent excessive moisture loss by the use of wet hessian on the slab surface or similar procedure.

#### 7.7.5 Screed or raised floor

There is no structural requirement for a screed, although a levelling screed may be specified. Furthermore, the achievable quality of surface to the slab should be considered before specifying the floor finish. Power floating and power trowelling of the slab may be used to allow direct application of surface coverings but allowance for movement or deflection of the structural members should be made. If a raised floor is specified, a wood-floated surface finish is generally adequate. All standard raised floor systems are suitable for use with Slimdek.

### 7.8 Ceiling finishes

Slimdek accommodates a standard ceiling panel based on the 600mm grid. The ceiling manufacturer's guidance on support systems should be sought to ensure suitable construction details.

Exposed floor slabs can be used for advanced energy systems using fabric energy storage, see *Section 5.6*. A range of perforated ceilings is available that allows for air movement over the deck soffit and for heat exchange.

### 7.9 Refurbishment

The Slimdek system allows for extensive alteration to internal layout and servicing after construction. The clear space between the ribs and below the slab allows new service or partition layout. Small service ducts may be cut in the crest of the ComFlor 225 deck using appropriate concrete-coring equipment. Should large service duct openings be required in a refurbishment scheme, it is recommended that new steel trimming members be provided.

If service ducts are to be cut through the slab or beam after concreting, care should be taken to avoid loss of the shear bond between the steel and concrete by using a non-percussion drill.

Where flying shores retained facades require penetrations through the decking, special temporary/permanent trimming may be required to support the decking. The designer should make clear notes on the drawings so that the contractor and temporary works designers can carry out a design risk assessment.

### 7.10 Removal of waste

A skip should be available at or adjacent to the working level for the disposal of waste materials. Care should be taken to ensure that a skip is located securely over the structural steelwork and not loaded directly onto the decking as all ComFlor 225 is single span. If a skip is not available, the decking contractor will be required to gather the scrap together in one neat pile at each level for disposal by others once suitable means of removal are available. The skips should be arranged to arrive as soon as possible following the start of the decking work.

On single storey structures, a controlled drop may be permissible, subject to assessment of the risks and the inclusion of a suitable procedure in the method statement. It should be noted that off-cuts of decking and edge trims are extremely sharp and can be hazardous to move long distances. The distance to the skip should therefore be kept to a minimum. Scrap should never be carried down ladders or over long distances across the site. Protective gloves must be worn at all times whilst handling decking or edge trim.

