



BCSA Code of Practice for Metal Decking and Stud Welding

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SUMMARY

This document is a code of practice for Decking Contractors and Steelwork Contractors responsible for the fixing of metal decking and for site welding of studs to steel-framed buildings. It also provides guidance to Clients, Planning Supervisors, Principal Contractors and Designers. It describes the management procedures and methods to be adopted and is intended to serve as a standard reference when drafting site- and project-specific method statements.

The aim of this best practice guide is to improve health and safety on sites where metal decking and associated components are being installed. The guide aims to ensure that a consistent approach is taken to health and safety by those either planning for, in control of, or undertaking metal decking installation. It sets out to provide clear, unambiguous and practical information about the systems of work to be employed on site together with the required site safety attendances.

The document is intended to aid compliance with the *Health and Safety at Work etc Act*, and with the relevant specific requirements of applicable regulations and approved codes of practice issued by the Health & Safety Executive.

Throughout the document the obligations are stated as those of the Decking Contractor. In practice, the Decking Contractor will generally be appointed as a specialist subcontractor to a Steelwork Contractor. Then some obligations defined in the code of practice will inevitably be discharged by the Steelwork Contractor or jointly – particularly those concerning the relationship with the Principal Contractor. Overall it is for both the Steelwork Contractor and the Decking Contractor to ensure that the code of practice is being followed properly by agreeing the allocation of responsibilities in advance.

ENDORSEMENT

The Health & Safety Executive welcomes this BCSA Code of Practice Erection of Metal Decking and Stud Welding and considers it as an important document in supporting the effective management of health and safety risk. It is a clear example of industry "self regulation", as the direct involvement of experienced and professional practitioners ensures that such guidance will be both relevant and authoritative.

The British Constructional Steelwork Association understands the importance of self regulation and over the years has been proactive and not simply reactive in reducing risks and accidents. The HSE welcomes working in partnership with BCSA because its positive approach has enabled steelwork erection to be undertaken both imaginatively and with increased safety.



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1 INTRODUCTION

1.1 SAFETY OBJECTIVES

The aim of this code is to improve safety on sites where metal decking and associated components are being fixed.

Every year many workers are injured or killed on construction sites. Many of the fatalities are the result of falls from height. As the installation of metal decking involves work at height it is inevitably hazardous, and without proper management it could be highly risky. Metal decking undertaken with proper management by competent Decking Contractors employing trained operatives has an excellent safety record.

1.2 COMPETENCE AND SUPERVISION

The single most important step that contributes towards safe practice is to ensure that competent persons are mobilised. This is because such persons will observe the following precautions concerning the work in general and tasks in particular:

PRECAUTIONS

- Do not commence work until it is clear what needs to be done.**
- Do not undertake work outside the limits of your competence.**
- Do not undertake tasks without the necessary tools and equipment.**
- Be clear about the arrangements for supervision in terms of the chain of command.**
- Do not deviate from what has been planned without checking with those in the chain of command.**
- Ensure that the area around the worksite is kept clear of hazards.**
- Watch out for hazardous activities being undertaken by other operatives, including others in your own gang.**
- Ensure that others not involved in the task do not encroach into an exclusion zone around the worksite.**

Selection of a competent Decking Contractor is a necessary precondition towards ensuring that competent persons are mobilised to undertake the work on site – whether these be employed by the Decking Contractor directly or by a specialist fixing subcontractor. The Decking Contractor must observe the following preconditions:

PRECONDITIONS

- Ensure that the scope of work is within the limits of competence of the firm.**
- Develop suitable method statements for the work in general and for specific tasks as necessary.**
- Agree the chain of command for site work with the Principal Contractor and the Steelwork Contractor.**
- Provide appropriate supervision to manage the work on site.**
- Provide the necessary resources of manpower, plant and equipment.**
- Agree how exclusion zones should be operated to keep others away from hazards arising from decking operations.**

Work should be supervised by persons who are suitably trained and experienced in the type of work being undertaken and their authority should be made known to all concerned, possibly by means of an organisation chart. The arrangements for supervision of work on site can vary as follows:

- The Decking Contractor must identify a manager in overall charge of the work being undertaken, and the personnel and resources mobilised. Often this person, such as a contracts manager, will be in charge of work on more than one site and will thus not be on site continuously.
- Individuals sent to site to work alone must be assessed as capable of self-supervision, and they must report regularly to the Principal Contractor's site manager.
- When work is in gangs, each gang requires a chargehand to be identified.
- A site foreman, often being the most senior chargehand, would often be in continuous charge of day-to-day site operations on smaller sites.
- If several gangs are working on site simultaneously with more than one foreman, it may be necessary for the Decking Contractor to maintain the continuous on-site presence of an overall site supervisor.

At all times whilst construction activity is taking place, it must be made clear to both the site operatives and to the Principal Contractor's management who is in direct supervisory control of those activities. The identity of the responsible construction supervisor may change over the period of a contract.

1.3 TRAINING AND QUALIFICATIONS

The Decking Contractor should be satisfied that those employed are fit enough to carry out the work required, have the necessary experience and have received the necessary training to carry out the work safely and without risk to health.

Experienced operatives may generally be assessed as being competent to undertake decking or stud welding based on their record of work. New entrants will require a more detailed record of training and assessment in a suitable National Vocational Qualification at Level 2 as a minimum. All persons employed on site need to produce evidence of having passed an appropriate Health & Safety Test. Advice on the specific NVQs and H&S Tests that are appropriate is available from the BCSA.

The Decking Contractor should ensure that training and qualifications meet that required by the Principal Contractor (eg those of the Major Contractors Group [MCG]). Minimum training and qualification requirements are as follows¹:

Managers and Supervisors	CSCS Manager or Supervisor Card
Deckers	Health & Safety awareness training Work at height awareness training Cartridge tools training Abrasive wheels certificate
Stud Welders	Health & Safety awareness training Stud welding training Fire safety training
Safety Net Riggers	Health & Safety awareness training Fall arrest safety equipment [FASET] training CPCS Card for operation of MEWP (or one issued by Certificate of Training Achievement [CTA] or International Powered Access Federation [IPAF])

1.4 BRIEFING AND INDUCTION

All operatives should be properly briefed about the tasks in hand using on-the-job instruction. Before beginning work on site, all operatives should attend a site induction which should include making operatives aware of special site restrictions or any specific hazards on site. Site inductions should be organised by the Decking Contractor in accordance with the Principal Contractor's arrangements for site inductions. Inductions should include a briefing conducted by the Decking Contractor based on the method statement for the work. Operatives should countersign a document that confirms that they have received and understood the site induction.

Operatives should continue to be briefed on the safe method of work to be employed on each particular job as the work progresses using regular toolbox talks that:

- Familiarise operatives with the development of the work in accordance with the method statement;
- Brief them on changes to methods and addendum method statements as necessary;
- Explain the content of any *Task Specific Method Statements*;
- Discuss other topics relevant to site conditions (eg developing weather conditions);
- Focus on problems identified from "walk round" risk assessments;
- Ensure that their equipment, training and certification are up-to-date.

1.5 PLANNING, PROGRAMMING AND COORDINATION

Safe working methods and practices on site require:

- Appreciation of the implications of design risk assessments;
- The preparation and use of detailed method statements;
- Thorough and active contract coordination both on and off site;
- The implementation and maintenance of effective communications;
- Realistic and effective methods of programming and progressing;
- The organisation of work, which takes into account adverse weather conditions;
- The provision of competent staff, as noted above;
- The provision of the necessary resources including protective equipment appropriate for the work.

Coordination and liaison should be planned before the job starts. Depending upon the size and complexity of the job, the Decking Contractor should identify a line manager responsible for construction and/or a manager with overall responsibility for the contract. The role of the person, or persons, responsible for coordination and liaison should be clearly defined and their authority made known to others involved.

Before implementing any procedures or changes in previously agreed procedures, the procedures must be verified as being safe by the person responsible for coordination.

The coordination necessary for safe construction includes ensuring:

- That liaison has taken place concerning:
 - Temporary works to prop the deck
 - Method of fixing metal decking into place
 - Sequence of work
 - Delivery, off loading and hoisting of metal decking bundles
 - Access to each working level
 - Perimeter edge protection
 - Method of fall prevention or arrest
 - Removal of waste
 - Power supply for stud welding
 - Interaction with following trades.
- The availability of the necessary information including sufficient detailed drawings available in time to allow effective forward planning for safe construction. This includes decking, trim and shear stud layout drawings including guidance notes.
- The manufacturer has adequate information and is manufacturing to specification and according to programme.
- That the supply of materials/components is according to the project specification. A copy of the project specification should be made available on site.
- That the correct components are delivered to site in the required order: if incorrect or insufficient or non-conforming components are delivered to site, the consequences should be reviewed and the effect on the construction sequence taken into account in any subsequent action.
- The availability of resources of manpower, plant and equipment.

Irrespective of the employment status of the site operatives, arrangements should be made to ensure that operatives know who to contact if the work cannot proceed as planned.

Construction progress should be recorded to help ensure that the correct components are available when required to enable the job to proceed according to the agreed sequence in the method statement. This may be by means of an easily read system of graphical representation to record progress. The system chosen should reflect the magnitude and type of job, and could be illustrated by bar charts, marked-up drawings or by more sophisticated computerised reviewing techniques.

1.6 WEATHER CONDITIONS

As weather conditions can change from hour to hour, and as not all construction activities are similarly affected by weather changes, persons in charge of supervising work on site should regularly monitor weather conditions, and take appropriate decisions. Weather conditions that could have an adverse effect on decking work include:

- Wet or freezing conditions that militate against stud welding operations;
- High winds that may cause light components to blow about or suspended loads to swing;
- Frost, ice or snow that can result in slippery surfaces and endanger personal health.

On exposed sites it may be necessary to undertake a particular assessment of how wind might affect the proposed construction method in terms of access equipment and craneage. BCSA guidance on *Steel Erection in Windy Conditions* and any guidance given by the manufacture or supplier of the plant in use should be followed as relevant.

1.7 METHOD STATEMENTS

Employers must ensure, as far as is reasonably practicable, the provision of a safe system of work. The preparation of a method statement is an important part of planning for such a safe system of work. The extent of detail in a method statement will depend upon the size and/or complexity of the work. Simple jobs may only require a simple method statement and repetitive tasks may be covered by standard sheets. With this in mind, the BCSA has published a proforma suitable for use in preparing *Task Specific Method Statements*.

A method statement for decking operations should cover the following issues:

- Scope of work
- Company organisational structure for safety
- Programme, sequence and resource levels
- Risk assessments and controls identified as necessary
- Responsibility for attendances
- Delivery, off-loading and lifting arrangements
- Task specific method statements for decking, stud welding, netting etc
- Fall prevention arrangements and arrest systems
- Plant and equipment details
- Training details for site operatives
- Guidance for following trades including use of decked floors for storage of materials and other operations.

Note that in this document terms are used in the following way:

- **Decking operations:** Fixing of metal decking and the associated work of stud welding, netting etc.
- **Decking sheet:** Individual panels of decking.
- **Decking bundle:** Number of decking sheets secured together with metal bands (also called a "pack").
- **Edge trim:** Pressed steel formwork for restraint of wet concrete at slab edges.
- **Closure:** Pre-formed galvanized sheet steel to close gaps between sheets, also termed a "flashing". Note that profiled expanded polyethylene filler blocks or bungs are also sometimes used to prevent concrete loss through the ends of the decking profile.
- **Shear stud:** A site welded fastener that facilitates a composite connection between steelwork and concrete.
- **Cartridge tools:** Low velocity powder actuated fixing tools used to fix the decking and edge trims into place. Note that "shot firing" is the common term for how cartridge tools operate.
- **Exclusion zone:** The area immediately below the work area that other trades must be prevented from entering.
- **Multiple span:** Decking that spans over three or more supports.
- **Single span:** Decking that spans between only two supports.

1.8 REGULATIONS AND DOCUMENTATION

There are many regulations that affect construction work, and it is the responsibility of management to be both familiar with the regulatory requirements and to ensure that relevant requirements are observed. Generally, the most practical way of doing this is to follow the approved codes of practice and guidance notes that have been prepared for this purpose by the Health & Safety Executive [HSE]. The person named in the Company's H&S Policy as having primary responsibility for health and safety is responsible for ensuring that line managers have copies of the latest relevant HSE documents.

Where directly relevant, copies of useful documents (such as the HSE's Construction Information Sheets [CISs]) should be issued to those directly responsible for the supervision of site operations. Site supervisors can then use the codes and guidance issued to brief site operatives as necessary. Supervisors should not rely solely on issuing paperwork to those undertaking the actual work on site; instead key abstracts should be used to brief the site team.

The BCSA *Guidance Notes on the Safer Erection of Steel-Framed Buildings* incorporate many of the most important points flowing from the regulations. The Decking Contractor should ensure that those with overall responsibility for construction associated with steel-framed buildings are familiar with this document, and with the SCI publication *Good practice in composite floor construction* which provides valuable technical information describing installation practice.

Currently the regulations of most importance to decking work are:

- *Construction (Design and Management) Regulations* [CDM Regs]
- *Construction (Head Protection) Regulations*
- *Construction (Health, Safety and Welfare) Regulations* [CHSW Regs]
- *Control of Substances Hazardous to Health Regulations* [COSHH Regs]

- *Electricity at Work Regulations*
- *Health and Safety (First Aid) Regulations*
- *Health and Safety at Work, etc Act* [HSW Act]
- *Highly Flammable Liquids and Liquefied Petroleum Gases Regulations*
- *Lifting Operations and Lifting Equipment Regulations* [LOLER]
- *Management of Health and Safety at Work Regulations* [MHSW Regs]
- *Manual Handling Operations Regulations*
- *Noise at Work Regulations*
- *Personal Protective Equipment at Work Regulations* [PPE Regs]
- *Provision and Use of Work Equipment Regulations* [PUWER]
- *Reporting of Injuries, Diseases and Dangerous Occurrences Regulations* [RIDDOR]
- *Workplace (Health, Safety and Welfare) Regulations*

New Work at Height Regulations are in the course of preparation.

1.9 RISK ASSESSMENT

Employers must identify and assess hazards and risks that apply to their undertakings, and state the measures to be taken to eliminate, reduce or control those hazards. Such assessments should be in writing. The following steps should be followed:

- Operations or tasks that are or could be performed on site should be identified. Hazards that might arise from those activities are then listed. As these steps are generally common to operations on most construction sites irrespective of size and complexity, generic lists of activities and hazards may be prepared.
- The risk assessment then consists of evaluating the extent or degree of risk that could arise from each hazard. The ability to avoid, reduce or control risks arising from these hazards can be taken into account in order to reduce risks arising to an acceptable level, provided that the controls etc are managed. For instance, the risk of laceration from sharp edged metal decking components can be managed by the supply and enforced use of suitable gloves as personal protection equipment appropriate to the job in hand.
- Importantly, there is always the possibility that each new project may give rise to new hazards as each project is different. For this reason, the generic risk assessments associated with generic methods should always be reviewed alongside the implications of the site-specific method statement. If the design of the structure gives rise to special hazards, these should be identified in a design risk assessment issued as part of the *Pre-Tender Health & Safety Plan* and carried forward for action in the *Construction Health & Safety Plan*. The opportunity should be taken to consider whether some risks could be avoided by re-design.
- During the progress of the work on site situations may arise that require a review of methods and/or a re-assessment of risks. There may be the necessity to alter the sequence of work, to undertake variations to the work content, or a "walk round" the site may identify unanticipated or poorly controlled hazards. In all these circumstances, the BCSA's *Task Specific Method Statement* provides a proforma for additional hazard identification and risk assessment associated with specific situations.

2 DESIGN ISSUES

2.1 GENERAL

Metal decking has two principal functions:

- During concreting, it supports the weight of the wet concrete and reinforcement together with that of the concreting operatives and plant.
- In service, it acts compositely with the concrete to support the loads of the floor. Composite action is obtained by shear bond and mechanical interlock between the concrete and decking, achieved by the embossments rolled into the decking.

Decking profiles are produced by a number of manufacturers within the UK and fall into three distinct categories:

Re-entrant Profile

Generally 600mm cover width

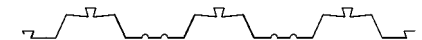
eg R51¹, Holorib², Multideck 50³, CF51⁴



Trapezoidal Profile

Generally 900 to 1000mm cover width

eg TR60/80¹ Ribdeck E60/AL/80², Multideck 60/80³, CF70⁴



Slimfloor Deep Deck Profile

Generally 600mm cover width

eg Ribdeck 210², SD225⁴



NOTES:

1 Structural Metal Decks Limited

2 Richard Lees Steel Decking Limited

3 Kingspan Metl-Con Limited

4 Corus Panels and Profiles Limited

Each profile has different characteristics, span widths and method of installation. This should be remembered during the early planning stages of a project to ensure the successful integration of the decking package within the overall project plan. Designers, Principal Contractors and Steelwork Contractors are therefore encouraged to engage Decking Contractors early to ensure that their advice and assistance can be taken into consideration during the planning and programming stage of the contract.

2.2 TEMPORARY WORKS

Decking is usually designed to span up to 3.00m unpropped for profiles up to 60mm deep, and 4.5m for profiles 80mm deep. This will however depend on the decking profile used, the depth of concrete, and whether the decking is multiple or single spanning. The limitations of the chosen decking profile should be checked with the decking manufacturer at an early stage, so that any potential propping can be planned in advance. The Designer should check whether beam deflections during construction and the method of slab levelling would lead to significant additional concrete loads (due to concrete ponding) that have not been allowed for in the design (supporting structure and/or decking).

Where decking spans perpendicular to the edge beam, the unpropped cantilever should be no more than 600mm or $\frac{1}{4}$ of the back span (whichever is the lesser dimension), depending on the depth of slab and type of decking used. Where the decking runs parallel to the edge beam and the edge trim and decking cantilevers past the toe of the beam flange, it may be necessary to provide additional support to the outstand. This will generally occur where the slab edge projection is greater than 200mm (dependent on the specific detail) and should be provided by the Steelwork Contractor.



In general terms, traditional "shallow" decks spanning greater than 4.00m between supports will require the propping system to be in place, levelled and suitably braced prior to the start of decking. This will reduce deck deflection from sheeting self weight, which may be difficult to level out if props are installed after decking installation. It will also minimise the risk of deck collapse under construction superimposed loads (decking gangs, reinforcement installation teams and/or storage loads) prior to concreting. SD225 decking will generally require pre-propping on spans in excess of 7.5m. Pre-propping of the decking can have sequence and programming implications. It may also preclude the use of safety netting and, therefore, needs to be considered from an early stage.

When temporary propping is put in after decking installation, it is the responsibility of the contractor installing the propping system to ensure that the props are set in accordance with the temporary works designer's requirements. Excessive deflection of the decking (and supporting beams) may lead to "ponding" of the concrete and, therefore, an increase in the self weight of the slab. Where the additional weight of ponded concrete is not catered for in the design of the decking and supporting structure, the decking and propping requirements should be chosen to minimise ponding. The bearers of any propping system need to be continuous and extend to the full width of the bay. Isolated props should not be used, and all props should be suitably braced to prevent dislodgement during reinforcement installation and subsequent concreting operations. It is good practice to ensure that a final check of the propping system is made prior to pouring the concrete.



3 MANUFACTURE AND DELIVERY

3.1 MANUFACTURE

Decking sheets, edge trims and shear studs are all manufactured off site to design requirements. Decking is manufactured to contract specific lengths, square cut to minimise site cutting. Edge trims are manufactured in 3.00m lengths with gauges from 1.00 to 2.00 mm. The width of the edge trim needs to be sized to suit the planned edge position of the slab; its height to suit the nominal concrete depth.

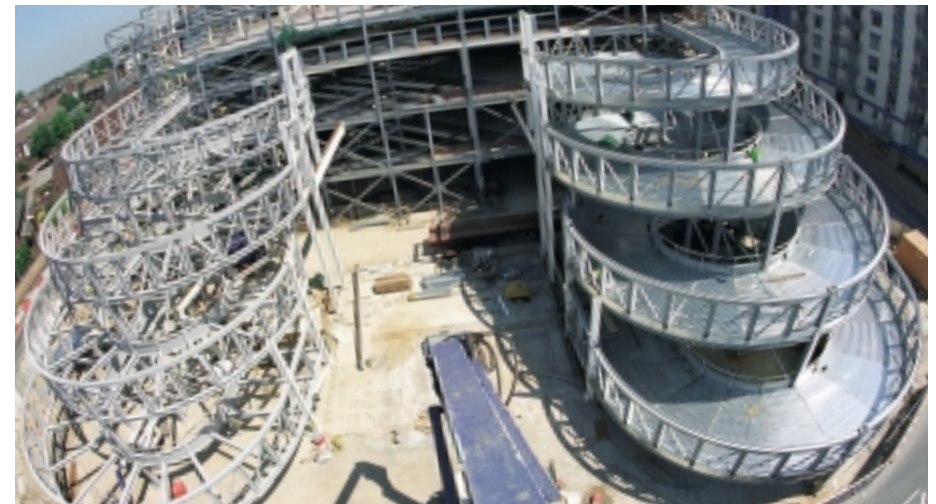
3.2 DELIVERY TO SITE

Decking sheets are delivered in bundles up to approximately 24 sheets secured with metal banding. The maximum bundle weight will be 2.00 tonnes although weights of 1.20 tonnes are more usual. A label will be attached to each bundle, identifying the bundle reference. This should then be cross-referenced with marked-up drawings supplied by the Decking Contractor to ensure that the bundles are loaded out to the correct level. Edge trims are delivered to site in bundles for individual floors or phases.

Shear studs are generally be delivered to site in barrels of 700. If static/mains power is not being used, a mobile generator will be delivered to site and will need to be off-loaded into position.

3.3 ACCESS FOR DELIVERY

Access onto the site needs to be provided by the Principal Contractor from the public highway. Decking and edge trims are usually delivered on 20 tonne capacity articulated vehicles with trailers up to 12.30m long. Suitable hard standing needs to be provided by the Principal Contractor for delivery vehicles at the point of unloading.



4 SITE ARRANGEMENTS

4.1 RELATIONSHIP WITH PRINCIPAL CONTRACTOR

4.1.1 Principal Contractor’s responsibility

The Decking Contractor will generally be engaged by either the Steelwork Contractor or by the Principal Contractor. Regardless of the contractual arrangement it is important that all parties agree the responsibility for each of the attendances relevant to the decking operations.

4.1.2 Site visit

A supervisor from the Decking Contractor will generally visit site prior to commencement to verify specific requirements and safety attendances to ensure that site activities can proceed. Considerations will include:

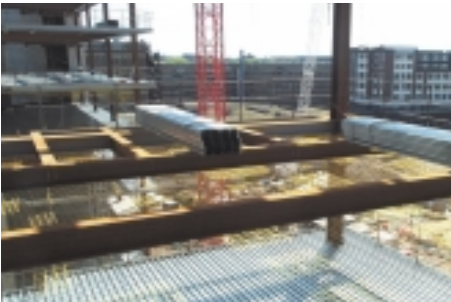
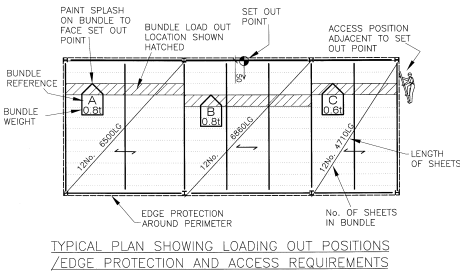
- Offloading and hoisting to level
- Safe method of work to be used on site
- Access to the working level
- Perimeter edge protection
- Method of fall arrest
- Provision of power
- Method of power supply for stud welding (if required)
- Removal of waste
- Protection of the public
- Provision of welfare facilities.

4.1.3 Off-loading and hoisting

The Steelwork Contractor will generally undertake the off-loading and positioning of the decking bundles to the correct level and area on the structure. This is safest and most cost-effective method of positioning the bundles, as the steel erectors have craneage, lift supervisors and powered mobile access on site.

If the decking delivery and steel erection programmes are coordinated, the bundles can be delivered and lifted onto the structure as it is erected. This will avoid site storage and the hazards relating to passing decking bundles through several floors of steelwork.

The Decking Contractor will provide loading out drawings indicating the required positions for individual bundles, the direction of span and orientation of the bundle. The illustration shows an example of a typical decking layout drawing.



The Decking Contractor will usually ensure that the manufacture of the decking is coordinated in separate bundles for each bay of steelwork. Each decking bundle should be loaded out onto the bay where it is to be installed; this greatly reduces the risks associated with working at height and the amount of manual handling required.

Adjacent bundles should be positioned on the steel frame with all the interlocking side laps on the same side. This enables the decking to be laid progressively without the need to turn the sheets. To assist with this, the decking bundles will usually come with a paint stripe down a common side.

When lifting the decking bundles, chains with a suitable lifting capacity need to be used. Care needs to be taken to position the chains correctly to avoid excessive pressure across the sheets. The use of nylon webbing slings is not recommended.

Edge trims need to be hoisted to level by crane or other mechanical plant and placed on top of one of the decking bundles, or if necessary stored directly on the steel frame. It is not permissible to load out the trim sections by hand, because of the risks associated with manual handling.

Shear studs should also be hoisted to level by crane to avoid unnecessary manual handling. Barrels must be lifted using only tested and certificated barrel lifts, pallet forks or stillages.

4.1.4 Provision of 110V power

Where possible, the Principal Contractor should provide a temporary static/mains electrical supply for hand tools. Where this is not possible, portable generators may be used, but consideration should be given to the problems of security, refuelling, noise and fumes.

4.2 SITE SAFETY REQUIREMENTS

4.2.1 Exclusion zones

The area immediately below the working level at which the erection of safety netting, decking or stud welding is progressing should be zoned off using bunting tape and signs to demark it as an exclusion zone so that other trades are kept clear of the overhead works.

It is not allowable for steel erection or roofing works to be undertaken in the zone immediately above the work area where decking operations are taking place.

4.2.2 Housekeeping and waste

Early consideration needs to be given to the removal of waste particularly on multi-storey construction where there is no available tower crane. Decking and edge trim offcuts are intrinsically sharp so it is particularly important to ensure that the waste can be safely removed from the building.

Suitable certificated lifting skips or skips with lifting cradles provide the safest means of clearing waste from each level, however provision needs to be made for lifting these skips to and from the working level.

The working areas should be cleared at the end of each shift to skips positioned at the working level whenever practical. Wherever possible other trades' materials should not be landed onto working areas as this often leads to trip hazards. Where materials such as mesh are landed to level it should be with the agreement of the Decking Contractor to enable the completion of the decking work to that location prior to the landing of materials.

4.2.3 Protection of the public

The Principal Contractor should consider the use of protective fans and hoardings to provide collective protection to the public etc when the building is located close to the perimeter of the site, or where work needs to continue at perimeters above site access routes.

4.2.4 Provision of welfare facilities

All site operatives are legally entitled to suitable and sufficient welfare facilities such as changing rooms, washing facilities and toilets. The Principal Contractor should provide these.

4.3 ACCIDENTS

4.3.1 Log/diary

In addition to any arrangements made by the Principal Contractor, the Decking Contractor should ensure that the person on site identified as being in direct control of decking operations maintains a record. It should record the significant events concerning:

- Time sheets for manpower on site.
- Toolbox briefings given.
- Handovers.
- Daywork.
- Liaison with the Principal Contractor or Steelwork Contractor and site instructions received.

Records should be summarised in the form of a short daily report for issue to the Decking Contractor's manager in charge.

4.3.2 Rescue and recovery

The Decking Contractor should review with the Principal Contractor what emergency rescue equipment should be available in case of accidents at heights.

4.3.3 First aid

The Principal Contractor should provide first aid cover for treating various types of on-site injuries. The site noticeboard and site induction should confirm the first aid arrangements including identification of the designated first-aiders and where the first aid facilities and resources are located.

The Decking Contractor has a special responsibility to ensure that specific situations that might possibly occur during decking operations are adequately covered by the Principal Contractor's arrangements. These include: trauma from falls in harnesses, lacerations from sharp edges and exposure of eyes to grinding dust.

4.3.4 Accident reporting

All accidents occurring on site must be reported to the Principal Contractor and be recorded in the site Accident Book.

It should be noted that:

- It is the responsibility of the employer of any injured person to report all major injuries, reportable diseases and dangerous occurrences (see RIDDOR for definitions) to the enforcing authority (usually the local HSE office) by the quickest means available (ie telephone). Generally the employer would be the Decking Contractor or their specialist fixing subcontractor.
- It is the responsibility of the employer of any injured person to report all injuries involving absence of more than three days to the enforcing authority within ten days.
- In such cases, a copy of the report should also be forwarded to the Principal Contractor.

4.3.5 Fire precautions

The Decking Contractor should ensure that:

- The relevant recommendations of HSE publication HSG 168 *Fire safety in construction work* are followed.
- A maximum of five litres petrol should be kept on site for refuelling. Further supplies should be stored in a suitable designated location.
- *Task Specific Method Statements* are developed for operations that could create fire hazards that include the consideration of whether a fire watcher needs to be appointed during these operations.

5 SITE PRACTICE

5.1 ACCESS AND WORKING PLACES

5.1.1 General

The Decking Contractor must ensure that method statements and their associated risk assessments address the need to provide safe access and working positions. This requires careful planning to ensure that the access provided is sufficient for the decking works.

Falls from height are the largest single cause of accidental death in the construction industry. They account for 50% of all deaths. Accidents involving falls can be prevented if an effective system of work is planned and adhered to. Some 90% of all metal decking installation is carried out at height and hence fall prevention and arrest should form a fundamental part of the planning and installation process. Therefore, the risk of falls must be assessed.

All access positions should be planned to ensure they correspond with the decking set out position at each level, thereby reducing the need for operatives to traverse steelwork. Planning will also ensure that the access point does not impede the positioning of the decking or the fall-arrest system used, and thus require altering later on.

Access is required to the working level and from there to the working positions from where the decking bundles will be split, positioned and secured. Provision is thus needed for:

- Safe access to the working level,
- Safe access at the working level,
- Safe working positions.

5.1.2 Access to the working level

There are six main methods of access to the working level:

- Permanent stair access,
- Temporary stair tower,
- Ladder tower,
- Ladders,
- Mechanical hoist,
- Tower scaffold.

Permanent or temporary stair access should be provided to the working level, wherever practicable. Ladders may provide suitable access but their use is not always appropriate. Factors to be considered include:

- The length of ladder required, very long ladders are heavy to handle and may bow during use. The maximum length of ladder must not exceed a vertical distance of 9m.
- The need to carry materials (small components such as edge trims, closures, tools) whereas both hands should be free when climbing a ladder.
- Ladders must extend 1m past the working level if other suitable handholds are not available. Ladders must be footed whilst being erected and tied prior to use.

5.1.3 Access at the working level

EDGE PROTECTION

Perimeter edge protection should be positioned to all perimeters, internal voids and phase edges to prevent falls from height. It must be in place before the decking installation begins on each floor or phase.

At design stage or early in the contract, consideration should be given to the possibility of the Steelwork Contractor pre-fixing handrails to beams at ground level prior to erection. This is recommended practice and reduces the need for scaffolders to work at height.

Wherever possible, hand railing should be positioned to the outside face of the columns/beams to preclude the need for operatives to lean through the hand railing to fix the edge trims. The installation of a toe board is not recommended as it often interferes with the placement of the decking sheets and edge trims, and involves additional risk to scaffolders installing it prior to the floor installation. The metal decking edge trims then form the temporary toe board until the floor is cast.

Proprietary systems are also available that are specially designed to provide access for fixing edge trims.

Where edge trims are not specified, edge protection requires consideration be given to the installation of a toe board as soon as practicable after the decking is installed, so that small objects can not be kicked along the troughs and out over the edge. The contractor responsible for the edge protection should provide this toe board.

VOIDS AND OPENINGS

Consideration should be given at the design stage to decking over small voids and openings. This prevents operatives, sparks, materials and fixings from falling, and reduces the amount of edge protection required. These openings can be boxed out during concrete placement to be cut out later when the opening is required.

Small voids may be boarded out following the installation of decking and trim, but before the removal of the fall arrest system.



5.2 FALL ARREST

5.2.1 Methods of fall arrest

In addition to the provision of perimeter edge protection at the working level, the working positions for decking operations require the provision of fall arrest systems. There are three principal systems for providing fall arrest that are used for decking installation:

- Safety netting – collective and passive fall arrest;
- Safety air mats/cushions – collective and passive fall arrest;
- Running lines and harnesses – personal and active fall arrest.

The choice of system will depend on a number of factors that are specific to individual projects. These will include type of structure (steel/masonry), storey heights, layout and access methods. However, fall arrest systems that provide collective and passive protection (eg nets or air mats/cushions) are preferable in principle, as they protect everyone working within their boundary and do not rely on individual personnel acting to ensure their own protection (eg clipping on harnesses). Whatever method is used requires careful planning and implementation.

On some contracts, two or more fall arrest methods may be used as dictated by individual circumstances.

5.2.2 Use of nets

GENERAL

Consideration needs to be given at the design stage to ensure that the proposed netting system can be planned, programmed and implemented on site.

The main issues to consider are:

- **The choice of supplier and rigger.** Fall arrest safety netting should be manufactured to BS EN 1263-1, and rigged in accordance with BS EN 1263-2.
- **The method of fixing the netting.** To fix the nets, proprietary fixing systems (eg "grippa" clamps) allow easy attachment of nets to steel beams. Where I-section beams are not used, or where suitable attachment points are not available (such as shelf angles to core walls), consideration should be given at the design stage to ensure the nets can be installed. Measures may include the provision of anchor points welded to the steelwork or the drilling of 22mm diameter holes for tie cords to pass through.
- **The method of access to rig the safety netting** (see below).
- **The sequence of steel erection/decking installation.** It is not practical to install netting to upper levels before lower levels and works should be programmed to progress sequentially up the building.
- **Effect on contract programmes.** The larger the decking/netting area available on each level, the less will be the overall disruption. Small phases (less than 500m²) on each level will increase disruption and extend the overall programmes, as a greater number of operatives and trades will be trying to operate in a confined area. This will also create a requirement for more phase edge protection.
- **Protection of phase edges.** Where possible, phase edges should be protected by scaffold edge protection. If edge protection is not installed, then decking should halt at least 2.0m back from the net edge. Temporary freestanding scaffold rails (or similar) should then be installed on the decking at least 2.0m back from this edge to demarcate safe working zones.
- **The height at which nets are to be installed.** Heights and tensions of the netting need to be considered against storey heights and the extensions that could be caused by falls of personnel into the net.
- **Pre-propped decking.** This will interfere with the netting once the decking is laid.
- **The risks involved.** The risk reduction provided by netting is balanced against the risks transferred to operatives erecting/dismantling the safety netting. Above first floor level, heights in excess of 5m will have increased risks which should be considered in the risk assessment by the Decking Contractor.

METHODS OF ACCESS TO RIG THE SAFETY NET SYSTEM

There are four main methods available for erecting safety netting:

- **Mobile elevating work platforms [MEWPs]**

- Require clear access at ground floor level.
- Provide good access to rig the nets to first floor levels.
- Not recommended for use up through the steelwork to higher levels, as they are often difficult to position, particularly once the decking bundles are loaded onto the frame.

- **Mobile access towers [MATs]**

- Provide access above the first floor, for floor heights not exceeding 4m.
- Above one lift become unstable when located on a metal-decked floor.
- Have implications for programme and handover requirements, as the studs cannot be welded until the MATs have been used to strike the nets from the floor above.
- Can be subject to overturning from lateral forces applied during the rigging operation.
- Risk increases near floor edges as consequence of fall heightened.



- **Ladders**

- Provide access to floor heights up to 5.0m.
- Must be footed at all times during use.
- Useful for floors with materials loaded-out and, or where other forms of access are restricted.
- Around perimeters above ground floor level, the net rigger should use individual fall arrest equipment attached to, say, beams when working aloft on ladders.
- Require closer supervision to ensure that riggers comply with their work procedures.
- Must be positioned and tied to cope with lateral forces applied during the rigging operation.

- **Roped access**

- Requires riggers to work at height for the full duration of their work.
- Can take longer to install the fall arrest system than to install the decking.
- Often a risk assessment will show an alternative system of work may be more suitable.

MAINTENANCE OF THE SAFETY NET SYSTEM

The inspection and maintenance of safety netting is a crucial part of the system. A comprehensive maintenance procedure should be adopted to ensure the nets are always fit for use. Safety net maintenance covers:

- **Installation maintenance**

Safety netting is generally installed immediately prior to the decking installation and is therefore usually only in place for a few days until the decking is complete. The net riggers must complete a safety handover certificate to confirm the netting has been correctly installed. A competent person should make a further check if the netting remains in place for more than seven days.

It is advisable for the decking foreman to have a working knowledge of safety net systems as this allows him to carry out a final visual inspection prior to commencing work.

- **Safety net maintenance**

Safety nets should be fully examined by a competent person each time they are put into service. They should be laid out and fully checked for abrasion, wear and damage before they are sent out to site. Any damage should be tagged and the net quarantined for repair by a competent person authorised by the manufacturer.

Every safety net must have an identification label detailing the date of manufacture, class, net size and reference to the British Standard. They must also contain a unique serial number to ensure that the net can be traceable.

Each net will have three UV test meshes attached when new. One test mesh must be detached from the net each year and sent to the manufacturer for testing, to check that the safety net remains fit for purpose. The failure load of the mesh indicates the residual life of the net. If the chord fails below the manufacturer's threshold then the net needs to be destroyed. It is good practice to ensure that all inspections, repairs and UV tests are detailed in writing to show the full history of individual nets.

FALLS INTO THE NET

In the event that an operative falls from his working position into a safety net below, the net would be utilised as a 'rope ladder' to regain access to the working platform. As the safety net system is attached close to the working level any fall into the net is unlikely to result in severe injury. However in the unlikely event of a severe injury, movement of the casualty might be detrimental. The site emergency plan should be implemented, which may include calling the emergency services.

Following a fall into a safety net, the net must be immediately removed from service. The net must be quarantined for full examination by a competent person who decides if the nets needs to be repaired or destroyed.

5.2.3 Air mats and air cushions

Air mats/cushions are alternative forms of passive fall arrest. There is minimal risk to operatives installing this system. However the risks to operatives working above the air mat and falling onto it may be higher than with mats due to the potentially greater fall distance. Typical fall distances are 1.5m to 3.0m, dependent on storey heights.

If air mats are used on multi-storey constructions, consideration should be given to side protection at perimeters to prevent persons falling into the airmats and out over the hand railing. For this reason air mats are best suited to areas surrounded by block/brickwork within a structure.



5.2.4 Running lines and harnesses

Running lines, used in conjunction with harnesses, lanyards or inertia blocks can provide a safe method of work when installed and operated by trained and competent operatives. However this system has a number of disadvantages that need to be considered:

- A minimum clear vertical distance of about 5.6m (to be verified by calculation) is required from the line installation height to the floor below (distance is dependent on the type and length of lanyard used).
- Attachment points should be sufficiently high above the floor to maintain clearance in the event of a fall. A height of 1.50m is usually required; this can be difficult to achieve at levels where column splices occur as these often stand less than 1.50m above floor levels.
- Sufficient suitable attachment points are required that can sustain a fall load of 15kN.
- Safety whilst working at height depends on operatives clipping onto the running lines at all times.
- Where bundles are not loaded out strictly in accordance with decking drawings, it will be difficult for operatives to remain clipped on whilst laying the decking.
- An effective recovery procedure must be in place to ensure a fallen operative can be quickly rescued.
- The HSE has clearly indicated that it favours passive/collective systems.

As a result of these limitations, the use of running lines is usually limited to areas where nets cannot be erected, eg an area of decking on an upper floor that has an atrium on preceding floors, or where there is a significant risk transfer from decking operatives working at the leading edge to net riggers installing the nets.

A strict inspection and test regime is required for running lines, harnesses, webbing slings (used for attachment of running lines to columns etc) and lanyards.



5.3 HEALTH HAZARDS

5.3.1 Manual handling

Regulations place a legal responsibility on employers to ensure that manual handling operations are eliminated so far as reasonably practicable. If manual handling cannot be eliminated, an assessment is required of the risks created by that work, and of the steps that need to be taken to control exposure to the risks identified.

In general terms, the vast majority of manual handling can normally be eliminated from decking operations by ensuring that the decking bundles are loaded-out to the bay where they are to be fixed, and that the edge trims, shear studs and ancillary items are lifted to level by mechanical means, as discussed earlier in this document.

Designers and Decking Contractor should collaborate to limit the length of decking sheets to, say, 6.00m where possible, to reduce the effective weight of the individual sheets. However it should be noted that the weight of individual decking profiles varies, and is dependent on the size of the sheets, the profile, its width and gauge.

All decking operatives must be issued with and instructed to wear suitable gloves for handling decking and edge trims, as they have intrinsically sharp edges until they are fixed into position.

5.3.2 Noise

The Decking Contractors should try to minimise on-site noise by detailing the decking sheets to fit the structure without cutting wherever possible. However, some noise will always be generated on site during the decking and stud welding operations. The noise levels generated will vary from site to site. They can be affected a number of factors, including the proximity of adjacent buildings and the prevailing weather conditions. Typical noise levels associated with decking operations would be:

Laying out decking panels	up to 90dB(A)
Cutting of decking	up to 110dB(A)
Using cartridge tools	up to 115dB(A)
Shear stud installation (generator powered)	up to 90dB(A)
Shear stud installation (mains powered)	up to 70dB(A)
Testing shear studs	up to 100dB(A)

The noise produced can be potentially hazardous, and the cutting of the decking will usually produce the most noise nuisance as it can last for 30 seconds at a time and is intermittent throughout the day. The other activities are intermittent and for very short periods of time, in the case of cartridge tools for split seconds.

Regulations detail action levels at which employers must make adequate hearing protection available to employees (first action level) and when employers must make it compulsory for employees to wear the hearing protection (second action level). Most of the noise levels outlined above exceed the second action level and it should therefore be compulsory for the decking operatives to wear hearing protection during their work. If other trades are required to work in adjacent areas, particularly on confined sites, arrangements should be made through the Principal Contractor to ensure that they too are provided with suitable hearing protection.

Decking Contractors (and stud welding subcontractors) should ensure that all noisy equipment is regularly serviced, and that it is switched off when not in use.

5.3.3 Hand-arm vibration

Workers whose hands are regularly exposed to high levels of vibration may suffer from several kinds of injury to the hands and arms, including impaired blood circulation and damage to the nerves and muscles. Collectively the injury is known as 'Hand-Arm Vibration Syndrome' [HAVS]. The main symptoms of HAVS can include:

- Finger blanching (aka 'Vibration White Finger' [VWF])
- Carpel tunnel syndrome
- Permanent and painful numbness and tingling in the hands and arms
- Painful joints and muscle weakening
- Damage to bones in the hands and arms
- Loss of sensation and manual dexterity of the hands.

The effects of HAVS are cumulative, and, with the exception of mild cases of VWF, seem to be irreversible. Having cold and/or wet hands increases the likelihood of VWF attacks. Similarly, because smoking causes small blood vessels to constrict, it also may trigger VWF. HAVS is a notifiable disease.

The risk of contracting HAVS is dependent on both the magnitude and duration of exposure to hand-arm vibration. Therefore, it is important to minimise the exposure to vibrating equipment. Fortunately, decking work involves relatively little use of vibrating equipment. Nevertheless, some decking operations do require the use of power tools.

Decking Contractors should, where practical, detail decking to fit directly to the steel beams without requiring any on-site cutting. This can be achieved for all square-cut panel ends where they butt joint together by producing accurate decking layout drawings from the Designer's or Steelwork Contractor's general arrangement drawings.

Decking Contractors should ensure that all petrol driven disc cutters issued to site operatives are fitted with 'anti vibration' mountings to reduce the vibration transmitted from the equipment to the operator. All equipment should also be regularly maintained and the cutting blades should be checked and replaced, as a poorly maintained blade will increase vibration levels. Some tools carry 'traffic light' tags to indicate their 'safe trigger time'.

Cartridge tools should be regularly maintained and the operator should ensure that the power setting is appropriate for the underlying steel. If the power setting is too high, the fixings may be overdriven and the operator would be subject to unnecessarily high recoil from the tool itself.

It is important to ensure that, during cold spells, operatives using vibrating equipment keep their hands warm by wearing gloves. Operatives should also be instructed to rotate their work with others within the gang, as this will break up and limit overall exposure times for each discipline.

5.3.4 Hazardous substances

The use of hazardous substances are controlled by regulations to protect workers from the effects of exposure, whether immediate or delayed, to hazardous substances. The installation of metal decking systems is a relatively clean process in this respect; however there may be substances used that require assessment.

Assessments of substances that will or are likely to be hazardous should be made by the Decking Contractor and should be issued to the Principal Contractor together with suitable method of use and risk assessments prior to work commencing. Copies of the assessments must also be made available to the works supervisor and operatives undertaking the works, so they can ensure any control measures that may be required are implemented.



6 TOOLS AND EQUIPMENT

6.1 PERSONAL PROTECTIVE EQUIPMENT

It is not possible or practicable to eliminate all risks associated with decking installation, and therefore suitable Personal Protective Equipment [PPE] will be required. The type of PPE will depend on the risks involved and will be identified in the relevant risk assessments as required measures to reduce residual risks. Operatives issued with PPE must receive instruction on the use and maintenance of their PPE, which should be inspected regularly.

The following summarises decking related operations and indicates safety equipment required.

Work at height	Full body harness to BS EN 361 Lanyard to BS EN 355 (restraint or arrest as appropriate)
Handling decking and trim	Gloves to BS EN 388 Kevlar or similar cut resistance of 4+
Use of petrol cut-off saw	Goggles to BS EN 166 Mechanical Strength B, optical class 1 Ear defenders/plugs to BS EN 352
Use of cartridge tool	Goggles to BS EN 166 Mechanical Strength B, optical class 1 Ear defenders/plugs to BS EN 352
Stud welding	Goggles as above with dark lenses and face screen (not welding goggles)
Site operations generally	Hard hats to BS EN 397 Hi-visibility vest to BS EN 471 Gloves to BS EN 388 Kevlar or similar cut resistance of 4+ Safety footwear with steel toe caps to BS EN 344 and 345

The Decking Contractor should also ensure that clothing used does not have flaps that could get trapped and is suitable for the weather conditions. Warm, water-proof outer garments will generally be needed in winter. In sunny weather, shirts should be worn and sun-screen cream used to protect skin from UV radiation. Foul weather clothing should be issued and used when necessary.

6.2 WORK EQUIPMENT

6.2.1 General

Regulations place a legal responsibility on employers to ensure that any work equipment provided is suitable for the purpose for which it is provided, and is maintained in an efficient state. No piece of equipment should be permitted on site which does not satisfy this criteria and any appropriate regulation. The work equipment in common use for decking operations includes: disc cutters, cartridge tools, electric drills, stud welding equipment and petrol blowers.

6.2.2 Disc cutters

Disc cutters are the primary means of cutting the decking and edge trim. Petrol driven cut-off saws are generally used as they provide a reliable, fast and self-sufficient cutting method. Disc cutters fitted with abrasive wheels can be hazardous if used incorrectly. Decking Contractors should ensure that their operatives adhere to the correct procedures and training requirements at all times. Equipment manufacturers often offer free on-site training tailored to cover the specific tools and site conditions required.

A competent person should carry out maintenance of disc cutters, as 65% of the accidents involving abrasive wheels are a result of incorrect wheel selection. Key factors are:

- The blade must have label that indicates type of wheel and maximum rotation speed.
- The maximum rotation speed of tool must be below the maximum speed limit of the blade.
- The blade used must be suitable for the work, eg cutting, grinding, metal or stone.
- Blades must be dry, unwarped and free from defects and chips.
- Blades should be stored in an upright position in dry conditions.

Hazards associated with the use of disc cutting include:

- **Contact with blade.** If any part of the body comes in contact with the moving wheel, it will result in serious injury.
- **Bursting of blade.** This is usually caused by over-speeding of the abrasive wheel or by exerting excessive pressure. The correct wheel selection and mounting are essential. Grinding wheels must always be used for the removal of paint or primer from steelwork.
- **Fire hazard.** The use of disc cutters can create a fire hazard. The risk may arise from sparks produced during use and refuelling. Hot works permits are often required for cutting operations.
- **Noise.** Disc cutters may generate noise levels of 110 dB(A). Appropriate hearing protection must be worn.
- **Vibration.** Although modern tools are fitted with vibration dampers, the affect of vibration should still be assessed.



6.2.3 Cartridge tools

Cartridge tools can be used to secure decking to steel, concrete and masonry/brickwork. Only low velocity indirect-acting cartridge tools offer a reliable, fast, self-sufficient fixing method that can be used in all weather conditions.

Cartridge tools can be hazardous if used incorrectly. However, modern tools incorporate features that prevent accidental firing if the tool is dropped or if the tool is not pressed against the work surface with considerable force. Hence, cartridge tools have an excellent safety record, when used by trained and competent operatives.

Cartridges are available in various strengths, which are colour coded. The correct strength should be selected through trial fixing – fine adjustment can be made using the tool's regulator.

Operatives using cartridge tools must be trained and competent, at least 18 years of age, and have adequate colour vision. Equipment manufacturers often offer free on-site training tailored to cover the specific tools and relevant site conditions. Maintenance of cartridge tools should always be carried out by the manufacturer or authorised competent person.

Fixings and tools should be kept in a secure location on site both in between shifts and at break times. Quantities of fixings stored should be kept to a minimum, eg sufficient for no more than five days use.

Hazards using cartridge operated tools include:

- **Spalling of base material.** This can occur only when fixing to concrete and masonry where the base material can shatter and hit the user. The risk can be minimised by observing correct edge distances and fixing techniques.
- **Spent cartridges.** Spent cartridge strips must be removed from decked areas prior to handover. Empty strips can be deposited in site skips.
- **Noise.** The operator and others working close by must wear appropriate hearing protection.
- **Vibration.** The effect of vibration should be assessed.

6.2.4 Electric drills

Electric drills are required for the installation of self-drilling steel screws (TEK screws) to fix decking side laps and for installation of restraint straps to edge trims.

All portable electrical equipment used on construction sites must be 110 volt or lower. Drills, leads and splitter boxes must be subjected to portable appliance tests (PAT tested).

Site operatives should never tamper with electrical equipment or attempt to make repairs – even low voltage equipment can be dangerous. Electrical faults should be reported to the line supervisor, so that a competent person can be tasked to carry out the repairs.

6.2.5 Stud welding equipment

The stud welding gun locates the shear stud and controls the lift and plunge during the installation process. It is connected to a welding converter using a welding and control cable of maximum 80m length.

The welding converter is used to convert the input power supply into a weld current and to allow adjustment and control of the welding process. The welding converter is about 1m by 1m by 1m and weighs approximately half a tonne. The unit needs to be relocated and re-earthed as works progress so that the distance to the welding zone does not exceed 80m. The Designer should be consulted prior to positioning the converter on the steelwork or decking.

The power supply required for the converter can be provided using the following methods:

STATIC GENERATOR

The static generator is appropriate for larger, city centre sites where mains power is not available. The generator weighs approximately 5 tonnes and measures 3m long by 2m wide by 2m high. The unit will emit diesel fumes, so consideration should be given to its positioning on site as it should not be covered over as this would trap the fumes. It also needs regularly refuelling, so a bunded diesel bowser should be provided for storing fuel on site. The generator needs relocating as works progress so that the distance from the welding zone does not exceed 80m.

The Designer should be consulted prior to positioning the generator on the steelwork or decking.



MAINS SUPPLY

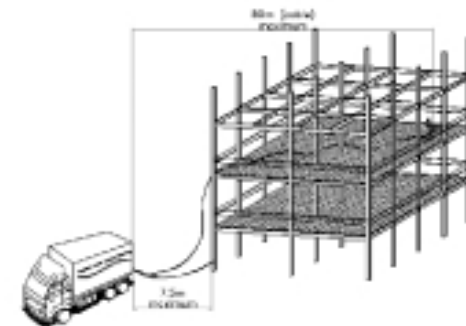
A mains power supply is the most environmentally friendly source of power and is suitable for large/high-rise sites where a dedicated 150 amp, 3-phase, 415-volt mains supply is available.

**MOBILE STUD WELDING RIG**

The mobile stud welding rig is appropriate for small or multiple visit contracts with good access. The diesel generating unit is housed in a 10 tonne rigid HGV, about 7m long 2.5m wide and 4.5m high. To obtain a suitable earth, access and hard standing is required for the rig to within 7.5m of the steel frame. The welding cables can run up to a maximum of 80m from the stud welding rig.

**6.2.6 Petrol blowers**

Petrol driven air blowers are used by stud welders to clear moisture from decking prior to commencing stud welding works. The provision of petrol on site requires a COSHH assessment. As with all specialist equipment, their safe use should be described in a *Task Specific Method Statement*.

**7 INSTALLATION OF METAL DECKING****7.1 GENERAL****7.1.1 Site set up**

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. The area immediately below the works should be zoned off using bunting tape and signs, to create an exclusion zone.

Wherever possible, the decking installation should be planned to commence from the corner of a building or phase, so that the number of leading edges is limited. The edge protection, access point and safety net system (if applicable) will have been installed prior to work commencing, thus effectively enclosing a 'safe area of work' for decking operatives to work within. Sheets should be secured against flying loose in windy conditions.

7.1.2 Fall arrest

When safety netting is in use, it provides the primary method of fall arrest, and there will be no requirement for the Decking Contractor to use additional measures such as running lines. The safety net fall arrest system should be installed directly onto the bottom flange of the steelwork that the decking is fixed onto, thus limiting the height of any potential fall to a minimum.

Even when safety netting is used, it is good practice for decking operatives to wear full body harnesses and lanyards for use where a residual risk of falls from height remains. These situations include installing cantilever perimeter edge trims where the decking operatives are required to lean through the edge protection and beyond the netting zone.

**7.1.3 Supporting structure**

The minimum bearing requirement for the decking is 50mm on steelwork, and 75mm on masonry or concrete supporting structures. When fixing to steel beams, a minimum fixing to edge distance of 20mm is recommended. This distance increases to 80mm for concrete and masonry supports for shot fired fixings and 50mm for drilled and plugged fixings.

The Principal Contractor should take care to ensure that brick or blocks used for the supporting structure do not contain frogs or holes, as these will have to be filled prior to decking installation to guarantee a good fix. Engineering bricks should also be avoided as their hardness tends to cause them to split when the fixings are driven in. Masonry or concrete structures need to be allowed to cure for a minimum 48 hours prior to placing of metal decking. This period may be longer if mortar retarders have been used or in cold weather. Fixings will be either by a 'hammer-screw', or by low-velocity cartridge tool masonry fixings.



7.1.4 Weather conditions

Decking bundles should not be opened if all the sheets in the bundle cannot be fixed or left in a safe condition at the end of the shift. During periods of freezing weather, heavy rain and/or high winds, the decking installation should not commence until the site foreman has inspected the working area and, using his experience, has assessed it fit to start work.

7.2 DECKING INSTALLATION

7.2.1 Laying decking sheets

When commencing decking installation the operatives will use the access provided adjacent to the setout point. Decking operatives will usually straddle the steelwork at either end of the first bundle of decking and cut open the banding. The first decking sheet will then be either pushed out onto the steelwork or turned back, dependent on the decking profile used. This will then be used as a working platform from which to lay the remaining sheets in that bay. Decking sheets will be slid into position, lapped together, lined up then fixed into place using a cartridge operated fixing tool once the adjacent bay has been laid, and the troughs of the decking have been lined through.

Where full floors cannot be completed, for example where the building is split into different phases, consideration should be given to the provision of phase edge protection. Where steelwork has been erected, it is acceptable to extend a safety net fall arrest system out beyond the perimeter of the decking zone provided that it can extend a minimum of 2m and the fall height is less than 1m. As soon as the decking is laid, temporary barriers should be positioned 2m back from the decking edge to demarcate the safe working zone within which the stud welders could work. On multi-storey structures, Principal Contractors should be made aware of the 'pyramid effect' that occurs when using this method as the effective working area reduces on each floor. Where this occurs the use of temporary fixed phase edge protection should be considered.

On completion of an area or phase the fall arrest system will be removed once a check has been made to ensure all small openings and voids created in the floor have been adequately hand railed or boarded out.



7.2.2 Cutting decking sheets

Decking sheets should be detailed so that they are delivered to site at the correct length. In most instances, the only on-site cutting required should be where the decking sits on raking steels, where decking ribs sit over beams that require stud welding or where the decking requires cutting in around columns and other protrusions in the floor. On-site cutting will normally be carried out using petrol driven disc cutters. The use of electric angle grinders is not usually recommended except in areas of poor ventilation, because this equipment tends to be more awkward to operate and can take two or three times as long to make the cut. There is also little significant noise reduction from using such tools.



There may be occasions where on-site cutting of the metal decking sheets is required, for example following late design changes. It should be noted that an unpropped multiple span sheet cut into two single spans might not be capable of spanning the distance between supports, hence multiple spanning decking sheets should never be cut down to a single span without checking the design to ensure it is capable of spanning the distance. In general, any deviation from the approved decking layout drawings needs to be checked with the Steelwork Contractor.

7.2.3 Sealing and finishing off

The decking sheets will be detailed to butt together along the centre line of the supporting steelwork. Gaps up to 5mm at the butt joint are generally acceptable, as they are not sufficient to allow concrete aggregate to escape. The decking is not intended to provide a watertight seal and a degree of fines and water seepage should be expected from the panel ends and joints. The amount of seepage will depend on the profile and gauge of the decking, and the depth and mix of the concrete used. If necessary, the decking butt joints can be taped, however this practice tends to be an expensive and time-consuming process that yields little benefit, particularly during winter months. Gaps in excess of 5mm will generally be filled using expanding foam; the Decking Contractor should provide a COSHH assessment and suitable PPE, including gloves and protective clothing, to cater for the use of the foam.

Any gaps adjacent to the web of the columns should be filled using off-cuts of decking, closure or edge trim as appropriate. There may be a requirement for permanent support around column positions to support the ends of the decking sheets; this will depend on the configuration of the incoming beams and size of the columns. Support requirements will usually be shown on the Decking Contractor's layout drawings (see MCRMA Technical Paper No 13 for further details).



7.2.4 Seam stitching

Seam stitching between decking panels may be required to minimise concrete seepage; this will depend on the decking profile, length of span and construction loads expected. Seam stitching will not normally be required for re-entrant decking profiles with an interlocking side lap. Where stitching is required, it will generally be highlighted on the Decking Contractor's layout drawings, and will be undertaken on completion of the decking installation.

7.2.5 Removal of waste

A skip should be available, at or adjacent to the working level, for the disposal of waste materials. It is permissible for a skip to be placed on the decking providing care is taken to locate the skip over the supporting beam to avoid overloading. 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 trims.

7.2.6 Decking fixings

Fixings should be installed in accordance with the manufacturer's recommendations. These will include primary fixings at sheet ends, secondary fixings on intermediate beams and side lap stitching (if required).

Fixing of the decking and edge trim to the supporting steelwork will usually be carried out using low-velocity powder actuated cartridge tools, commonly known as 'shot firing'. This method provides a safe and economical method of fixing-down the decking. The operators must be fully trained and competent to use these tools.

Where the use of cartridge tools is not permitted, self-tapping screws are generally used to secure the decking. However, it should be noted that this method is time-consuming and would have an impact on the overall installation programme, particularly when fixing to steels with over 10mm deep top flanges, as these may need to be pre-drilled with a pilot hole to allow a successful fix. In addition, this methodology can lead to ergonomic difficulties, because the decking operatives would be bent over their work for much of the working day.

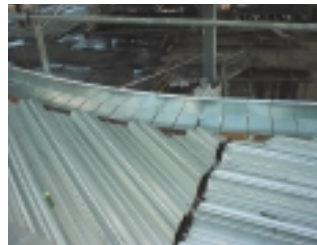
Other power tools are available, however the fixings used in these tools varies. Therefore, the Designer and Steelwork Contractor should always approve the use of such fixings.

7.2.7 Fixing edge trims

Edge trims are usually supplied in 3m lengths of 1mm or 2mm gauge pressed steel, which should be cut down on site to suit the steelwork configuration. Each length should be fixed to the perimeter beams with the edge restraint straps fixed at centres that are usually between 0.6m and 1m dependent on the slab depth and edge trim overhang. The deckers should take care to ensure that the restraint straps are tight, thus 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 ± 10 mm in accordance with the *National Structural Steelwork Specification for Building Construction*.

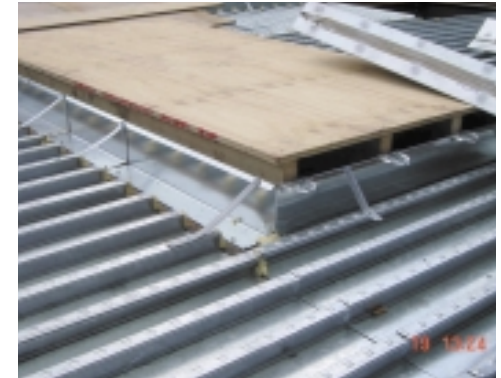
Should there be a particular requirement for setting edge trims from grid lines then consideration needs to be given to the protection of the floor edge until the trim can be installed, as the edge trim often acts as the toe board. The edge trim installation then becomes a second fix operation.

Where curved edges are required, it is normal practice for the deckers to lay out and fix the square ended decking panels. The site engineer or surveyor will then set marks on the decking which the deckers will use as a guide to form the curve. The edge trim will then be slotted to produce a faceted edge that can be bent to the radius required.



7.2.8 Forming holes and openings

Where trimmer steels are provided, the decking sheets will be cut to suit the size of the opening and the edge trim installed to the dimensions indicated on the Decking Contractor's drawings. Where there is no supporting steelwork, the voids will be decked over. The opening will then be formed by the concreting contractor who will box out the opening prior to pouring the concrete, so that when the slab has been cast, the decking can be cut out of the opening (see MCRMA Technical Paper No 13).



8 STUD WELDING

8.1 STUD WELDING PROCESS

"Thru-deck" stud welding involves welding the shear studs through the decking and onto the top flanges of the underlying beam, using a stud welding gun connected with welding cables to the welding power converter. This in turn is connected to a power source, which may be powered by mains supply or a mobile/static generator.

"Thru-deck" stud welding uses a drawn arc process. The stud produces a pilot arc for the main arc to pass, and this then causes the stud flux to melt along with the parent metal on the underlying beam. The duration of the arc and current applied are pre-set by the stud welding operatives on the welding converter, according to the size of stud being used and the conditions encountered on site. The stud is then automatically plunged into the pool of molten metal in the top flange and the timer automatically switches off the current.

A ceramic ferrule is used at the base of the stud, to act as a shutter to contain the weld. The ferrule also acts as a shield that prevents adjacent trades or members of the public viewing the weld arc. This removes the requirement for weld screens or similar protection.

The ferrule is then broken away from the base of the stud to allow a visual inspection of the weld. The ferrule segments will usually remain on the decking to form part of the concrete aggregate, provided they are not allowed to concentrate in one area. Should they require removing, the concreting contractor often removes together with other debris during/after the placement of the reinforcement.



8.2 STUD WELDING REQUIREMENTS

"Thru-deck" stud welding can be successfully achieved only when the upper flanges of the beams are unpainted and relatively clean. The upper surface of the steel should not have any weldable primer, galvanising, excessive rust, mill scale or dirt on it that could interfere with the welding operation. Stud welding cannot take place through reinforcing bar or mesh due to the risks of the welding equipment short-circuiting against the reinforcement.

A complete welding circuit needs to be created, so it is important to ensure that all the beams to be welded are interconnected and adequately bolted up. A continuous "earth loop" needs to be provided through the steel frame to within 7.5m of the welding converter. If the beams are not all interconnected, it may be possible to use earth extensions, which usually consist of welded steel sections connected to the steel frame and running to a distance of 7.5m of where the stud welding power plant is standing. This should be discussed with a decking/stud welding specialist at the design stage, to ensure that welding will be possible.

8.3 FIRE PRECAUTIONS AND PROTECTION

The stud welding process creates unavoidable molten weld spatter both above and below the area of welding. This should not cause unacceptable risks provided that suitable planning has taken place and control measures have been implemented.

Any surfaces adjacent to or below the welding zone that are susceptible to damage need to be fully covered or protected before work begins. Weld spatter will fall from the underside of the welded beams, so it is important to ensure that flammable materials are not present below the work zone. It is particularly important to ensure that the Principal Contractor fully protects any flammable materials or surfaces susceptible to damage that cannot be removed.

The area immediately below the stud welding works should also be demarcated as an exclusion zone. The stud welding contractor should erect bunting and signage below to warn of the impending works overhead. The Principal Contractor should ensure that this area remains clear of personnel and plant during the stud welding works.

The Principal Contractor will usually require the issue of hot works permits before stud welding commences. Operatives should obtain hot works permit if necessary and carry out inspection of floor level immediately below that being welded.

The stud welding contractor should carry suitable fire retardant sheets for use when welding around the building perimeter in sensitive locations such as adjacent to public areas. These sheets should contain the majority of weld spatter to within the confines of the site, but will not contain all weld spatter. The sheets should be draped from the handrail down to the floor below and will be moved along continually to suit the progress of the stud welding. Welding at the perimeter should not be undertaken when the winds are considered sufficient to carry sparks beyond the length of sheets. In particularly sensitive areas the Principal Contractor should consider the use of protective fans at the perimeter of the building.

On multi-storey buildings or in city centre sites, the Principal Contractor should consider the use of protective fans to provide global protection to public areas or areas where other trades are required to work below. It is also very difficult to prevent weld spatter from falling down core voids and consideration should also be given to boarding these areas out at alternate floors.

8.4 PLANNING AND SEQUENCING WELDING

When planning the stud welding works, it is important to consider the method of work employed for the decking fall arrest system. If mobile access towers are used for safety net rigging then the stud welding works cannot progress until the safety nets have been stripped from the floor above the welding zone, as the studs prevent tower placement on that floor tight up to the perimeter beams. It is also important to ensure that the fall arrest system is removed from the floor below prior to welding commencement as the nets or airbags would be damaged by the weld spatter.

8.5 WELDING CONDITIONS

"Thru-deck" stud welding should not be carried out in inclement weather when water cannot be kept from laying on the deck or beams. It should also not be undertaken when the temperature is below freezing.

In open, well-ventilated sites there should be no risks from the inhalation of welding fumes as the fumes are quickly dispersed into the general atmosphere. In confined spaces or poorly ventilated areas such as within existing buildings or basements, inhalation of fumes can result in respiratory effects such as 'metal fume fever', and suitable protective measures may be required. These may include the use of local exhaust ventilation, air blowers or suitable respiratory protection for the stud welding operatives.

8.6 LIFTING SHEAR STUDS INTO POSITION

Wherever possible shear stud barrels should be craned to the appropriate levels to reduce the need for manual handling as a barrel of studs weights up to 200kg. Stud barrels can be lifted using proprietary pallet-lifting forks and safety net or a tested and certificated barrel lift. All lifting equipment must be regularly inspected in accordance with the relevant Regulations. If mechanical means are not available then the studs will generally be transferred to buckets of manageable size. The usual regulatory provisions associated with lifting operations and lifting equipment apply.

8.7 TESTING OF SHEAR STUDS

Prior to commencing stud welding, or after the welding equipment has been moved, changed, or not used for a period of time, a minimum of two test studs should be welded. These studs will then be bent to an angle of 30° from their original axis by placing a pipe over the stud and manually bending the stud in the direction of the span of the beam towards the nearest column. If failure occurs in the weld of either stud, the set up will adjusted and the tests repeated.

After welding, the ferrules need to be broken away from the base of the stud to allow a visual inspection of the weld. If the inspection reveals that the stud does not have a full 360° weld collar, it should be subjected to a bend test. The stud should be bent by placing a tube over the stud and manually bending it 15° from the vertical, towards the nearest end of the beam. If the weld does not fracture, the stud should be considered acceptable and left bent. Studs that fail this test must be replaced. It is not considered good practice to bend test the studs by using a hammer.

All welded studs should be subjected to a 'ring test'. The head of the stud should be tapped lightly with a hammer in the direction of the beam. A clear 'ring' sound would indicate an acceptable weld, whereas a dull sound would indicate a possible imperfect stud that should then be subjected to a bend test.



After the visual inspection, bend tests should be carried out to a minimum of 5% of the welded studs, or no less than two studs per beam. Any further studs indicating weld imperfections should also be bend tested, and if a failure is found the stud should be replaced and the studs on either side of the failed stud should then be tested.

8.8 SHOT FIRED CONNECTORS

Hilti shear connectors can provide an alternative method of shear restraint for beams that cannot be stud welded. These connectors are shot-fired into position rather than welded and can therefore be used where stud welding creates an unacceptable fire risk. Alternatively, they can be used where the requirement is outside the parameters of the stud welding plant or where the beam top flanges are galvanized or painted. The Designer should check the design, as each shear connector does not provide the same shear value as a welded stud. To cater for the lower shear capacity, it is common to replace each welded stud with two or three shear connectors.



9 COMPLETION

9.1 USE OF DECKING PRIOR TO CONCRETING

The loading of materials onto the decking prior to concreting should be avoided wherever possible. However it may sometimes be necessary for the decking to be loaded with, for example, steel components for later erection on a multi-storey building or bundles of reinforcing mesh.

Wherever this occurs, close liaison is required between all parties to ensure that the materials placed on the decking do not cause hazards for the decking or stud welding contractors that may still be working in adjacent zones. Materials should not be placed on the decking until the decking and stud welding works have been completed in that area.

When loading decking with other materials the following recommendations should be considered:

- Typical decking can support distributed loads of 3 to 4kN/m².
- Imposed loads should be placed over or close to supporting beams.
- The load should be distributed over a number of ribs, using timbers.
- Materials should never be loaded onto single span decking sheets.
- Materials should be landed so as not to cause impact loading.
- The decking should never be point-loaded.
- If any damage to the decking occurs, the whole sheet must be replaced.

9.2 TEMPORARY PROPPING

There may be a need for temporary props in small areas of a building even when the majority of the floor remains unpropped. These areas might include tower crane voids or areas adjacent to lift shafts/ stairwells where non-standard span lengths exist or single span sheets are required. It is, therefore, very important that the Principal Contractor asks the concreting contractor to carry out a thorough check of the Decking Contractor's and/or Designer's drawings to ensure that any necessary propping has been installed.

Normally props are placed at either mid-span if one row of props is required or at third points if two rows are required. The props will normally consist of a row of "Acrows" supporting timber bearers. The size of the timber bearer will depend on the span length and depth of the slab but will usually be in the region of 75mm to 100mm wide with depth to suit the construction loading and scaffold boards should not be used. The timber bearer needs to be continuous and to extend the full width of the bay. Props are normally positioned about 1m apart dependent upon the capacity of props and bearers, floor-to-floor height and slab weight. Props need to be levelled and suitably braced to ensure a safe working platform. Design of the propping system should be the responsibility of a suitably qualified person, such as the Designer or a temporary works coordinator.

Props may be supported off the floor below provided that the design capacity of that floor is not exceeded. If the lower floor capacity is insufficient then further back propping will be needed. Props should never be placed directly on the decking alone as it can result in damage. Props should not be removed until the floor has reached its specified design strength, which will usually take at least eight days. The Designer or temporary works coordinator should specify the length of time the props should remain in position. Removal of props prior to the end of the specified minimum period may severely reduce the load-carrying capacity of the composite slab.

9.3 CONSTRUCTION JOINTS

Any construction or "day" joints should always be formed as close as is possible to the deck support over which the panels are butt-jointed. If construction joints cannot be made at butt joints then the distance from the centres of the butt end support to the stop end should never exceed one-third of the span between the supports.

When concreting up to the perimeter of a phase, or adjacent to crane/lifting voids, it is important to ensure that the rebar does not project into the adjacent bays still to be decked. If the rebar does project, it will impede the safe placement of the decking and could obstruct the placement of shear studs at a later stage.

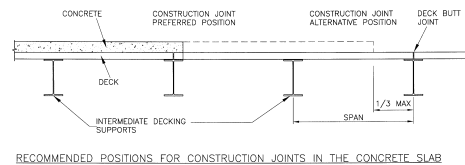
9.4 CONCRETE PLACEMENT

Concrete should be poured in a way that minimises the permanent deformation of the decking. The normal way for pouring concrete is by the use of concrete pumps which are less likely to cause deformation than delivery by skip. It is important to ensure that there are no more than four men present around the pipe outlet during pumping and that the concrete is not dropped from a height of more than 1m onto the decking. This should eliminate the potential for overloading of the decking.

Wet concrete should not be heaped significantly in any area during the laying sequence. It should be poured evenly over two spans towards the panel ends in the direction of the span of the decking and always from the overlapping sheet first as grout loss can occur if the concrete is spread from the under lapping sheet.

Where the concrete is being transferred into position using barrows or by lines of pipe for pumping, boards should be used to provide a load-spreading platform across the deck, thus reducing the risk of accidental damage to the profile.

For further information on loading of decking and general construction practice for the concreting operations refer to MCRMA Technical Paper No 13.



REFERENCES

Publications produced by the BCSA:

Guidance Notes on the Safer Erection of Steel-Framed Buildings

National Structural Steelwork Specification for Building Construction

Steel Erection in Windy Conditions

Task Specific Method Statement

Other publications:

MCRMA Technical Paper 13 / SCI P-300 *Composite slabs and beams using metal decking*

SCI P-090 *Good practice in composite floor construction*

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