



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 those with responsibility as duty holders for the Construction (Design and Management) Regulations. 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 good 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 and 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 of the work commencing

ENDORSEMENT

The Health and Safety Executive welcomes this BCSA Code of Practice for Erection of Metal Decking and Stud Welding. Representatives of the industry have prepared this guidance, and HSE has had an opportunity to comment on the content.

HSE recognises that this guidance contains some advice that may go further than the minimum needed to comply with health and safety law. I commend the document to the industry as practical guidance on implementing reasonably practicable precautions and raising standards of health and safety in this industry.

Heather Bryant
HSE Chief Inspector of Construction



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1. Introduction

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, safety 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 or shot fixing" 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.

1.1 Safety Objectives

Every year many workers are injured or killed on construction sites. Many of the fatalities are the result of falls from height. The aim of this code of practice is to maintain the good safety record of the on site activities where metal decking and associated components are being fixed. The installation of metal decking involves work at height and without good management it could be deemed high risk. Metal decking undertaken with good 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/Studwelding 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/Studwelding Contractor directly or by a specialist fixing subcontractor. The Decking/Studwelding Contractor must observe the following preconditions:

Preconditions

- Ensure that the scope of work is within the limits of competence of the firm undertaking the work.
- Develop suitable method statements for the work in general and for specific tasks as necessary or the particular project.
- 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/Studwelding 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 supervisor to be identified.
- A site foreman, usually being the most senior supervisor, 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 supervisor, it may be necessary for the Decking/Studwelding 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/Studwelding 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.

Decking and stud welding operatives should hold CSCS Skills cards (Blue) for "Steel Decker" and "Stud Welder" Minimum training and qualification requirements are as follows:

Deckers

- Health & Safety awareness training.
- Work at height training.
- Cartridge tools training.
- Abrasive wheels certificate.
- Harness awareness training.
- Manual handling training.

Stud Welders

- Health & Safety awareness training.
- Stud welding training.
- Fire prevention safety training.

Safety Net Riggers

- CSCS Safety net rigger (Blue skills card). Trainees (red skills card).
- Health & Safety training.
- Fall arrest safety equipment [FASET] training.
- MEWP category 3a – scissors and/or 3b boom lifts Or CPCS (as applicable when using powered access).
- FASET Specialist riggers qualification (endorsed on CSCS riggers card for activities involving rope access, beam straddling and aiding techniques).

1.4 Briefing and Induction

All operatives should be properly briefed about the tasks in hand using on-the-job instruction prior to the works commencing. 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/Studwelding Contractor in accordance with the Principal Contractor's arrangements for site inductions. Inductions should include a briefing conducted by the Decking/Studwelding 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 for the decking work on the specific site.

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 (e.g. developing weather conditions);
- Focus on problems identified from "walk round" risk assessments;
- Ensure that their equipment, training and certification are up-to-date;
- Emergency arrangements and accident/incident reporting; including the rescue from a fall from height.
- Safe systems of work.

1.5 Planning, Programming and Coordination

Safe working methods and practices on site require:

- Appreciation and management of the hazards that could not be removed or reduced through the design process.
- 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;
- The provision of the necessary resources including personal 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/Studwelding Contractor should identify a manager responsible for construction and/or a manager with overall responsibility for the decking work. The role of the person, or persons, responsible for coordination and liaison should be clearly defined and their authority made known to others involved.

The coordination necessary for safe construction includes ensuring:

- That liaison has taken place concerning:
 - Access for delivery, offloading and hoisting of decking bundles and provision for associated equipment
 - Access to each working level
 - Perimeter/phased edge protection
 - Method of fall prevention or arrest
 - Sequence of work
 - Exclusion zones
 - Interaction with other trades
 - Temporary works to prop the deck and curing time before striking the propping
 - Method of fixing metal decking into place
 - Power supply for stud welding
 - Removal of waste
- The availability of the necessary information including sufficient detailed drawings in time to allow effective forward planning for safe construction. This includes decking, trim and shear stud layout drawings.
- 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 ordered in accordance with manufacturer's recommendations/specifications and delivered to site in the required order: if incorrect or insufficient or nonconforming components are delivered to site, the consequences should be reviewed and the effect on the construction sequence and any implication for safety taken into account in any subsequent action.
- The availability of all necessary resources i.e. manpower, plant and equipment, etc.

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 and deliveries should be monitored and 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.

Sketch showing two decks covering construction work area below giving a 'minimum horizontal separation from overhead work'.

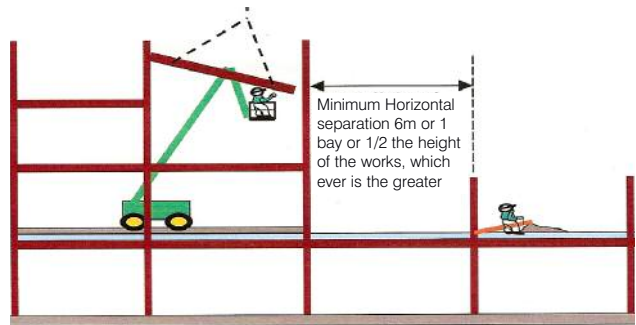


Diagram indicating minimum horizontal separation where overhead protection is not in place

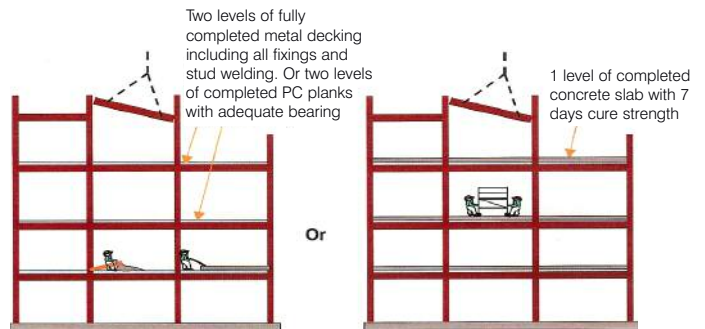


Diagram indicating minimum horizontal protection required

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 adversely affect stud welding operations;
- High winds that may cause light components to blow about, suspended loads to swing, un-banded sheets or scrap materials to be blown off the structure;
- 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.

For further information please refer to the 'BCSA Guide to Steel Erection in Windy Conditions (39/05)'.

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 task briefings. With this in mind, the BCSA has published a pro-forma suitable for use in preparing Task Specific Method Statements.

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

- Scope of work and list of relevant documentation including drawings
- Company organisational structure for safety
- Programme, sequence and resource levels
- Risk assessments and controls identified as necessary
- Responsibility for attendances (who should attend site and during what phase of the work)
- Delivery, offloading 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
- Identify any temporary works and supports and when and who can remove them
- Guidance for following trades including use of decked floors for storage of materials and other operations.

A Site Specific Risk Assessment should be carried out and included in the method statement to identify the hazards associated with the site e.g. public thoroughfare adjacent to the site, controls should be included in the assessment agreed with those in control of the site. The Site Safety Risk Assessment may have been carried out two weeks prior to the planned start date and should be reviewed, and if necessary revised/added to, by the site supervisor prior to works commencing and for the duration of the project.

1.8 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. Significant findings of 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 (see Section 6.1 PPE).

- 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 Task Specific Method Statement. If the design of the structure gives rise to special hazards that cannot be removed at the design stage, after reconsideration of the design then these should be identified as part of the Health & Safety Plan. The opportunity should be taken to consider whether some risks could be avoided by re-design. If the design gives rise to special hazards they should be identified in the pre-construction information so that a means of addressing them can be incorporated in the construction health and safety.
- 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.

Site Specific Risk Assessments (SSRA) should be carried out by site/contracts managers and should be reviewed by the site supervisor prior to works commencing to identify further hazards as the site may have changed since the SSRA was carried out by the contracts manager.

Generic risk assessments for repetitive tasks i.e. use of petrol driven saws etc should be read in conjunction with the site specific risk assessment and method statement.

1.9 Regulations and Guidance

The Site Safety Risk Assessment may have been carried out two weeks prior to the planned start date and should be reviewed, and if necessary revised/added to by the site supervisor prior to the work commencing and for the duration of the project. This may have implications for the Site Specific Method Statement which may have to be amended to accommodate the revised risk assessment. 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 and 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] and the Metal Cladding and Roofing Manufacturers Association Guides) 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 Guide to the Erection of Multi Storey Buildings (42/06)*' incorporates many of the most important points contained in the regulations. The Decking/Studwelding 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 '*Composite slabs and beams using steel decking: best practice for design and construction*' which provides valuable technical information describing installation practice.

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 on the floor. Composite action is obtained by shear bond from mechanical interlock between the concrete and decking, developed 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 e.g. R51, Holorib, Multideck 50-V2, ComFlor 51, Metfloor 55
- Trapezoidal Profile
Generally 600 to 1000mm cover width e.g. TR60/80 Ribdeck AL/E60/80, Multideck 60-V2/80-V2, ComFlor 46/60/80/100, Metfloor 60/80
- Deep Deck Profile
Generally 600mm cover width e.g. ComFlor 210/225, Multideck 146

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/Studwelding Contractor early to ensure that their advice and assistance can be taken into consideration during the planning and programming stage of the contract, i.e. the bottom sheet of a single span pack will need to be longer than the others for loading security.

2.2 Temporary Works

Decking is usually designed to span up to 3m un-propped 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 un-propped cantilever should be no more than 600mm or 25% 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 4m 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 imposed loads (decking gangs, reinforcement installation teams and/or storage loads) prior to concreting. Deep 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", concrete must not take place as the design has not catered for the additional weight of the slab. Where the additional weight of the pond of 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 the manufacturer's guides are referenced and a final check of the propping system is made prior to pouring the concrete. Many contractors find that using a 'Permit to Load' system overseen by a competent person helps to ensure the installation complies with the permanent and temporary works design before pouring the concrete.

The striking of the propping must also be agreed with the "Temporary Works Coordinator" to ensure sufficient strength has been achieved.

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 70mm 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 of 48 hours prior to placing of metal decking. This period may be longer if mortar retarders have been used or during cold weather. Fixings will be either by a 'hammer-screw', or by low-velocity cartridge tool masonry fixings.



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 3m lengths with gauges from 1 to 2mm. The width of the edge trim needs to be sized to suit the planned edge position of the slab and its height to suit the nominal concrete depth.

3.2 Access for Delivery

Access onto the site from the public highway needs to be provided by the Principal Contractor. Decking and edge trims are usually delivered on 20 tonne capacity articulated vehicles with trailers up to 12.3m long. Suitable hardstanding is needed for delivery vehicles at the point of unloading to be provided by the Principal Contractor.



3.3 Delivery To Site

Decking sheets are delivered in bundles up to approximately 18 sheets secured with metal banding. The maximum bundle weight will be 2 tonnes although weights of 1.2 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.

The Decking/Studwelding Contractor will provide loading out drawings indicating the required positions for individual bundles, the direction of span and orientation of the bundle.

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/Studwelding 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, it is recommended to use chains. These should be double wrapped around the decking bundle and be of a suitable lifting capacity. 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 as these can be easily damaged/cut by the sharp edges of the decking.

Edge trims need to be hoisted to level by crane or other mechanical plant and placed directly on the steel frame, or pre-laid on areas of deck suitably protected by hand rails.

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.

Shear studs are generally 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 offloaded into position.

4 Site Arrangements

4.1 Relationship with Principal Contractor

4.1.1 Principal Contractor's Responsibility

The Decking/Studwelding 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 roles and responsibilities for reporting and supervising during site operations.

4.1.2 Site Visit

A manager or supervisor from the Decking/Studwelding Contractor will generally visit site prior to commencement to verify specific requirements and the health and safety arrangements are adequate to ensure that site activities can proceed. Considerations will include:

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

4.1.3 Offloading and Hoisting

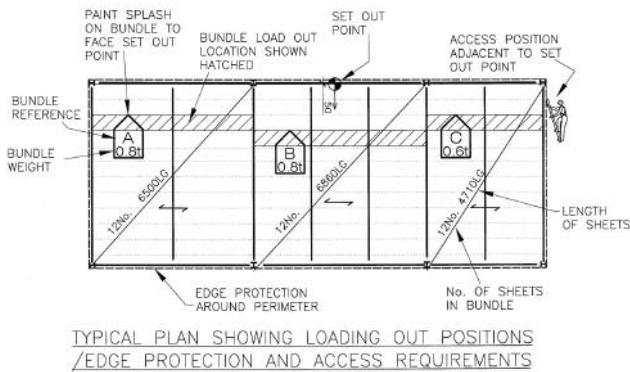
The Steelwork Contractor will generally undertake the offloading and positioning of the decking bundles to the correct level and area on the structure. This is safest and most cost-effective method of positioning the bundles, as the steel erectors have craneage, lift supervisors and powered mobile access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

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, refueling, 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.

Steel erection or roofing works must not be undertaken in the zone immediately above the work area where decking operations are taking place. Safe separation distance will be required (see diagram in Section 1.5)

4.2.2 Removal of Waste

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.

A skip should be available at, or adjacent to, the working level for the disposal of waste materials. Care should be taken to ensure that a skip is located securely over the structural steelwork and not loaded directly onto the decking as all deep decking is single span. If a skip is not available, the Decking/Studwelding 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 high rise buildings where windy conditions are expected it may be necessary for the Decking/Studwelding Contractor to temporarily cover or band down the scrap to prevent it from being blown away by the wind.

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 offcuts 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 kevlar anti-cut gloves must be worn at all times whilst handling decking or edge trims.

The working areas should be cleared at the end of each shift into 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 for the reinforced floor slab are landed to level, it should be with the agreement of the Decking/Studwelding 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, further information is available from HS(G) 151 "Protecting the public, your next move"

5 Site Practice

5.1 Access and Working Places

The Principal Contractor is responsible for the provision of safe means of access to and from the place of work. This may include designated pedestrian walkways to segregate plant and vehicle movement from access routes.

5.1.1 General

The Decking/Studwelding 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.

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 protection/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 to the working position,
- 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 (safety nets, small components such as edge trims, closures, tools) where 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. A gate for access should be installed at the landing point. More information is available from the HSE guidance - *Safe use of ladders and step ladders*.

5.1.3 Access at the Working Level

The access should be positioned adjacent to the first pack to enable the start point to be used to develop a safe working platform. It is important to ensure the loading diagram is followed when setting the pack and installing the access.

5.1.4 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 guardrails to beams at ground level prior to erection. This is recommended practice and reduces the need for scaffolders to work at height. Wherever possible, guardrails should be positioned to the outside face of the columns/beams to preclude the need for operatives to lean through the guardrails 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, however a maximum gap of 470mm must be maintained between the rails and from top of steel to the bottom of the first rail (bottom rail – this may require a third rail to be used). The metal decking edge trims then form the temporary toe board until the floor is cast.

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 cannot be kicked along the troughs and out over the edge. The contractor responsible for the edge protection should provide this toe board.

Proprietary edge protection systems that are specially designed for steel frame structures are also available. When considering the use of fully meshed barriers it is important to consider the position of the edge trim in relation to the location of the barrier to ensure the trim can be safely fitted.



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. Boards should be fixed down and marked e.g. 'hole below'

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 Protection

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 protection systems. There are three principal systems for providing fall protection that are used for decking installation in order of preference:

- 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 (e.g. 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 (e.g. 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.

When safety netting is in use, it provides the primary method of fall arrest, and there will be no requirement for the Decking/Studwelding 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 is supporting the decking, thus limiting the height of any potential fall to a minimum.

5.2.2 Use of Safety Nets

General

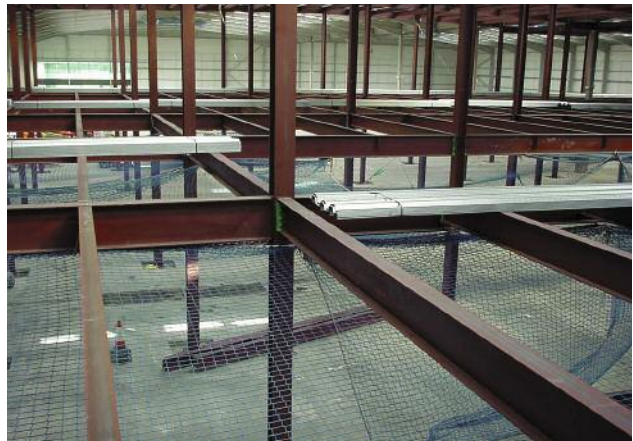
Safety nets are generally considered the best method of protection for operatives working at height installing metal decking as they provide both passive and collective protection, whilst limiting fall distances to the depth of the beams to which they are attached.

Consideration needs to be given at the design stage to ensure that the proposed netting system can be planned, programmed and installed 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 (e.g. "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 designed 22mm diameter holes during fabrication 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 programme – The larger the decking/netting area available on each level, the less the overall disruption will be. Small phases (less than 500mm²) on each level will increase disruption and extend the overall programme, as a greater number of operatives and trades will be trying to operate in one 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 2m back from the net edge. Temporary freestanding scaffold rails (or similar) should then be installed on the decking at least 2m back from this edge to demarcate safe working zones to prevent access to the leading edge.
- 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. The clearance distance of a net should be adequate to prevent a falling person striking the deck below or any other obstruction.



- 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. The following details explain the additional risks for consideration.

Methods of Access to Rig the Safety Net System

There are four main methods available for erecting safety netting:

Fall Arrest and Safety Equipment Training (FASET) recommended hierarchy for work at height:

There are four methods of access recommended for rigging and de-rigging safety nets which should be considered in the following order:

1. Rig/de-rig safety nets remotely – using remote attachment devices (maximum height 3.5m).
2. Rig/de-rig using powered access – MEWPs.
3. Rig/de-rig using ladders – recommended maximum height 4.5m.
4. Industrial climbing access techniques.

Remote attachment devices (heights up to 3.5m):

Allow rigging/de-rigging to be carried out remotely from the level below, and therefore do not expose riggers to any risks associated with working at height. The safety net border rope is usually placed into the beam attachment device and offered up into position via a pole, with the rigger standing on a floor below.

There are limitations that need to be considered with this method of installation, the principal ones being:

- Installation height; the higher the reach the more difficult it becomes to locate the device onto the bottom flange of the steelwork and the greater the lever arm created.
- Dependent on the steelwork arrangement and weather conditions, additional fixings such as rope ties are often required at the corners of the net to prevent movement during rigging. Installation of rope ties or similar will involve the rigger working at height to attach them, usually from a footed ladder; however this is for a short duration only, and the overall work at height is considerably reduced.
- Remote positioning devices can only be attached to "I" section beams. Other methods of attachment will be required to steel channels, angles or box sections etc.

Powered access (MEWPs):

Where it is not reasonably practical to use remote positioning devices, powered access devices - mobile elevating work platforms (MEWPs) - should be considered. The safe use of MEWPs on site is dependent on various conditions; however the following can be used as guidance;

- Riggers must be suitably trained (IPAF/CPCS or equivalent), and experienced to use the type of machine chosen. Riggers must also wear suitable safety harnesses conforming to BS EN 361 and work restraint system to BS EN 354. When working aloft the lanyard must be attached to the designated anchorage point within the basket at all times.
- Ground conditions need to be suitable for MEWPs to be used, firm, level and free from obstructions.
- It is essential that the correct type of plant is specified for the intended work and the location is inspected for hazards, and an appropriate machine is chosen for the ground conditions on site, for example trenches should be adequately backfilled and other hazards such as manholes fenced off or adequately covered. The working area should be zoned off to restrict access for other trades during safety net rigging. The responsibility for undertaking this must be agreed prior to work commencing.

Additional care must be taken if MEWPs are used to manoeuvre up through several levels of steelwork to rig safety nets to upper levels first, as there is a risk of the operator becoming trapped and injured should the boom or basket strike the steelwork, especially during traversing. This risk increases with the number of levels the MEWP operates through and if materials such as floor decking bundles are loaded out onto the lower levels, as there will be reduced clearance

for the MEWP to manoeuvre. There is also a risk that materials could be dislodged by the boom or basket of the MEWP. The use of MEWPs is generally therefore restricted to two floors only (working through one floor only at a time). Rigging contractors and their clients should always discuss and agree the method and sequence of work in these circumstances at an early stage as, depending on site conditions, it may become more hazardous to use MEWPs than it is to use other forms of access such as footed ladders.

On multi-storey construction where the use of remote positioning devices is not suitable, early planning and programming may make it possible to sequence works on site so that floors can be concreted to allow small MEWPs or scissor lifts to be operated from the floor slab to reach higher levels (subject to suitable checks to ensure that the maximum axle loads imposed by the MEWP can be safely supported by the slab and supporting steelwork).

Use of ladders for rigging safety nets (heights up to 4.5m):

The use of ladders for rigging safety nets is justified where it is not reasonably practicable to rig nets remotely, or where the use of powered access is deemed to hold a higher level of risk. Ladders are also often used to tidy up and finish off the ends of the nets even where remote attachment devices are used, or where poor ground conditions prevent the use of MEWPs.

During ladder use the following steps shall be followed:

Ref: *Safe use of ladders and step ladders HSE.*

1. Train riggers in the correct use and inspection of ladders.
2. The ladder must be footed at all times during use and, where practical, wedged against the inside top flange of the steelwork at the top to prevent lateral movement.
3. Maintain three points of contact on the ladder at the work position. A safe system of work should be developed to ensure that contact with the ladder is maximised wherever possible. Additional measures may be necessary such as clipping onto the steelwork to maintain three points of contact.
4. Do not overload a ladder or overreach from it. Move it to suit each work position, so that the work position is directly in front of the rigger rather than stretching to either side. Keep both feet inside the stiles and on the same rung throughout the task.
5. Use a suitable ladder for the surface it will be used on. Manufacturers should indicate the type of surface it is intended for.
6. Place the ladder at the correct angle (1 unit out for every 4 units up). Where the work height is varied an extendable ladder may be more suitable than a fixed length ladder.
7. Around perimeters above ground floor level, the net rigger should use personal fall arrest equipment attached to, say, beams when working aloft on ladders.
8. The ladder must be positioned on firm level ground capable of supporting the ladder and user.

Note:

Fall Arrest and Safety Equipment Training and the Prefabricated Access Suppliers and Manufacturers Association do not recommend the use of scaffold towers or hop-ups for the rigging and de-rigging of safety nets under normal rigging conditions, due to the potential for the equipment to become unstable and overturn during use.

Industrial access techniques (roped access):

Industrial access work, often referred to as roped access, is generally considered for contracts where it is not reasonably practicable to use remote attachment devices or MEWPs, and where the working height exceeds 4.5m making the use of ladders unsuitable. The FASET specialist rigger training includes beam straddling and aiding.

Industrial access techniques require technicians to work at height for the full duration of the rigging. Rigging of nets in this manner is time-consuming, highly specialised and carries a degree of risk. Work must be carried out using operatives trained as FASET Specialist Rigger or Industrial Rope Access Trade Association (IRATA) trained operatives. Work must be carried out using operatives trained as FASET Specialist Rigger or IRATA trained operatives trained to rig nets.

During the planning stage particular attention must be paid to the access and egress to the workface including hauling nets and attachment devices to the required positions. Early planning is essential to ensure that the risks are reduced as far as is reasonably practicable. This may, for instance, include ensuring that nets are laced together where it would be problematic for riggers to access the steel at mid points and, where possible, ensuring that nets are attached in such a way that they can be released from above (providing a suitable attachment point exists).

For further information on safety net rigging techniques refer to the FASET website at www.faset.org.uk

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 Supervisor 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 tested to check that the safety net remains fit for purpose. If the test piece fails below the manufacturer's threshold then the net must be removed from service. All inspections, repairs and UV tests are detailed in writing to show the full history of individual nets.

Falls into the Net

FASET statistics highlight that in nearly all cases where falls have occurred the operative has been able to self rescue. In the event that an operative falls from his working position into a safety net below, the net should 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 occurring, 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 net is 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 nets due to the potentially greater fall distance. Typical fall distances are 1.5m to 3m, dependent on storey heights.

If air mats are used in multi-storey constructional steelwork, consideration should be given to side protection at perimeters to prevent persons falling onto the air mat and out over the handrailing. For this reason air mats are best suited to areas surrounded by block/brickwork within a structure.

5.2.4 Running Lines and Harnesses

The use of running lines, harnesses and lanyards or inertia blocks is usually limited to situations where it is not reasonably practical to use any of the passive fall arrest systems methods outlined above. 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 for running lines should be sufficiently high above the floor to maintain clearance in the event of a fall. A height of 1.5m is usually required; this can be difficult to achieve at levels where column splices occur as these often stand less than 1.5m above floor levels.
- Sufficient suitable attachment points are required that can sustain of 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.



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.

The decking industry worked closely with the Health and Safety Executive, Health and Safety Laboratories, Clients and Trade Unions to investigate the health risks associated with metal decking installation. This culminated in the production of an HSE research report and Sector Information Guidance (SIG) for industry to use covering the following topics:

SIG.01 Manual Handling Survey – A summary of the results and conclusions

SIG.02 Off Site Cutting Procedures – A case study of the benefits

SIG.03 Material Loading Out and Guidelines for Principal/Sub-Contractors

SIG.04 Manual Handling – Advice to Structural Engineers – Guidance on designing out the risks

SIG.05 Manual Handling of Decking Sheets – Reducing the Risk – A toolbox talk for decking operatives on manual handling good practice when laying decking.

The guides can be downloaded from the following BCSA web site link: <http://www.steelconstruction.org/resources/health-and-safety/erection-guides.html>

The study concluded that in general terms decking operatives were at no greater risk of sustaining musculoskeletal related health problems than other industries that had undergone similar detailed studies.

Designers and Decking/Studwelding Contractors should collaborate to limit the length of decking sheets 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. Whilst decking sheet lengths could be significantly reduced through the use of single spanning deck sheets, it is recognised that single spans will in most cases require additional support which entails a degree of risk transfer to other trades. Historically single span sheets are also more susceptible to collapse should they be overloaded during concrete placement and, for these reasons, they are best avoided where possible.

The vast majority of manual handling can normally be eliminated from decking operations by ensuring that the decking bundles are loaded-out within 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.

All decking operatives must be issued with and instructed to wear suitable anti-cut 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/Studwelding 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/Studwelding Contractors (and stud welding subcontractors) should ensure that all noisy equipment is regularly serviced, and that it is switched off when not in use.

Computer aided design and revised methods of work have made it possible to accurately predict the locations where the decking would traditionally be cut on site i.e. along beams, around columns and other penetrations which extend through the floor level. This has enabled Decking Contractors to “off-site cut” decking sheets thus reducing the noise and waste generated on site through these activities. It should be noted however that these methods require greater input at the design and detailing stage, need significantly more time and resources as well as additional works at the rolling mills. Early discussions between the Principal Contractor, Steelwork Contractor and Decking/Studwelding Contractor is required at tender stage.

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])
- Carpal 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, are irreversible. Having cold and/or wet hands increases the likelihood of VWF. Similarly, because smoking causes small blood vessels to constrict, it also may trigger or increase the risk of VWF in users of vibrating equipment.

The risk of contracting HAVS is dependent on both the magnitude and duration of exposure to hand-arm vibration. HAVS is a notifiable disease.

Decking operatives are generally exposed to vibration levels up to or exceeding the Exposure Action Value (EAV 2.5m/s^2) but must not be exposed to vibration levels exceeding the Exposure Limit Value (ELV 5m/s^2)

The Control of Vibration at Work Regulations 2005 requires employers to:

- Assess the risk of exposure to vibration
- Decide if levels exceed the EAV. If levels do exceed the EAV
 - Immediately introduce adequate control measures to eliminate the risk and reduce exposure
 - Provide health surveillance to those exposed
 - Keep records of controls and health surveillance

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. Equipment should be regularly maintained and the cutting blades should be checked and replaced, as a poorly maintained blade will increase vibration levels. Some tools carry/use a 'traffic light' system or vibration information tags to indicate their 'safe trigger time' or points value, based on the HSE points system which is used to monitor exposure.

Direct fastening tools should be included in any vibration assessment and monitoring as the recoil from these tools has a similar effect to vibrating tools. Manufacturers of direct fastening tools will provide the data needed to make an assessment of the risks and exposure levels.

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 when possible, as this will break up and limit overall exposure times for each discipline.

Further information is available from HSE - publications INDG175 & INDG296

5.3.4 Hazardous Substances

The use of hazardous substances is 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/Studwelding 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)
- Safety helmets (hard hats) to BS EN 397
- Site operations generally 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
- Cold weather protection where necessary

The Decking/Studwelding Contractor should also ensure that clothing used does not have flaps that could get trapped and is suitable for the weather conditions. Warm, waterproof outer garments will generally be needed in winter. In sunny weather, hi-visibility vests will offer some protection and should be worn and operatives advised 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 efficient cutting method. Disc cutters fitted with abrasive wheels can be hazardous if used incorrectly. Decking Contractors should ensure that their operatives are appropriately trained and adhere to the correct procedures at all times. Equipment manufacturers often offer free on-site training tailored to cover the specific tools and site conditions.



Hazards associated with disc cutters:

- 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 refueling or from materials stored below. Hot works permits are often required for cutting operations.
- Noise – Disc cutters may generate noise levels in excess of 110 dB(A). Appropriate hearing protection must be worn.
- Vibration – Although modern tools are fitted with vibration dampers, the effect of vibration should still be assessed.

6.2.3 Cartridge Tools

Low velocity cartridge tools are generally used to secure decking to the base material (steel, concrete and masonry/brickwork).

The correct tool, cartridge and fixing to be used should be in accordance with the project specification, as well as the decking and cartridge/fixing manufacturer's recommendations.

Ensure the following is adhered to at all times to ensure safe use:

- Adequate information, instruction and training
- Competent and responsible users over the age of 18
- The correct type of tool, fixing and cartridge is selected
- Ensure compatibility with the base material
- Maintain the correct fixing and edge distances
- Ensure third parties are kept well away
- The provision and use of the appropriate PPE

Further information is available in BS 4078-1 - *Powder actuated fixing systems. Code of practice for safe use*

Hazards associated with cartridge tool use include:

- Through penetration - where the fixing goes through the material emerging in free flight on the other side, this is generally caused by
 - Cartridge being too powerful for the task
 - Missing the base material below the decking
- Ricochet – where the fixing is deflected after firing, usually towards the operator. Causes include
 - Firing into a previously attempted fixing
 - Fixing to particularly hard base materials such as hardened steel or welded areas.
 - Incorrect use of tool – not holding the tool square to the decking.
 - Fixing too near an edge
 - Hitting reinforcing bar or aggregate in concrete

- Spalling of the 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 and avoiding the use of engineering bricks, bricks with frogs or thin blocks on the top course of the supporting structure.
- Spent cartridges – Spent cartridge strips must be removed from decked areas prior to handover. Empty strips can be deposited in site skips, miss-fired cartridges must be removed from site and disposed of as hazardous waste.

Other hazards associated with the use of cartridges are identified in Section 5.3 Health Hazards.



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 subject to regular inspections and maintained in a good condition.

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 approximately 1m by 1m and weighs approximately 0.5 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 refueling, 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.



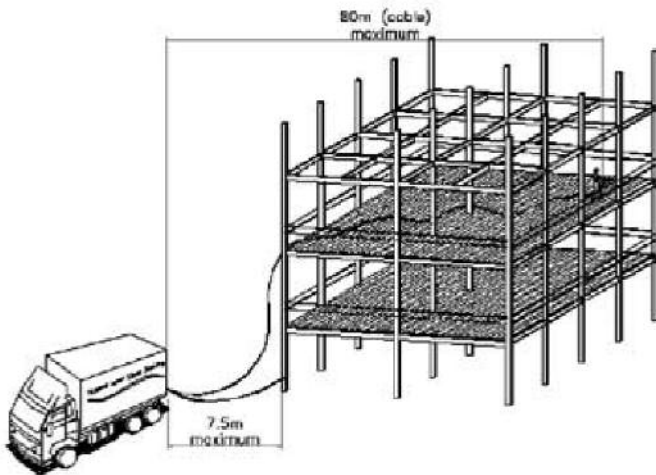
Mobile Stud Welding Rig

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 and DSEAR assessment and dispensation for petrol storage is attained. 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. All flammable materials must be removed from below the work area. 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.

7.2 Decking Installation

7.2.1 Installation of Shallow Decking Sheets

When commencing decking installation the operatives will use the access provided preferably adjacent to the setout point to reduce the need for traversing the steel. Decking operatives will 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.

Note:

Where safety netting is used along side perimeter edge protection, the nets will provide the primary method of fall protection and additional measures such as running lines will not be required. As decking operations require operatives to reach the ends of each sheet to ensure good manual handling practices, it is not practical to provide fall restraint systems or to avoid the straddling of steelwork altogether.

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 3m and the distance from the deck to the net is less than 1m (vertical) distance from the working level to the safety net attachment points. As soon as the decking is laid, temporary barriers should be positioned 2m back from the decking edge to provide a safe distance from the leading edge 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 handrailed or boarded out.



7.2.2 Installation of Deep Decking Sheets

Deep decking profiles differ from shallow decking as the decking fits onto end diaphragm plates which must be installed on the steelwork in advance of the deck, and the decking sheets are always of a single span configuration. The installation methods employed are therefore significantly different from those used during shallow deck installation.

End diaphragms installation:

End diaphragms are manufactured in 1800mm long sections consisting of three rib closures. These closures must be installed in advance of the decking to the lower flanges of the beams on both ends of the steelwork bay, and fixed into place using two fixings at pre-marked positions for each length. Each length must be fitted accurately so that the 600mm pitch of the decking section is located as shown on the decking layout drawings.

A risk assessment should be carried out by the Decking Contractor to determine the most suitable method for the installation of the diaphragms. It may be possible to install the diaphragms onto the steelwork in advance of its erection if sufficient space is available to lay out the beams. This method should be discussed with the Decking Contractor at an early stage as it will require additional setting out/dimensioning to be detailed on drawings for the deckers to work from.

For single-storey constructions with suitable access and ground conditions MEWPs should be considered for access to install the diaphragms. On larger multi-storey buildings it may be possible for the floors to be cast to allow small MEWPs to be utilised, however consideration will need to be given to how these machines will be lifted in and out of the floors, and Designers must check the floor slab to ensure it can take the imposed loads of the chosen machinery. For multiple floor construction where floors are not cast, the use of MEWPs will not usually form the most appropriate method of access as the use of MEWPs up through a number of levels of steelwork is not usually recommended. This is due to the increased risk of entrapment when traversing the machine along the beams on each occasion to fit the diaphragms, particularly as the decking bundles are preloaded onto the steel frame.

For upper floors on multi-storey buildings it may be appropriate to install the diaphragms one piece at a time in advance of the decking sheet as this will limit the requirement to traverse the steelwork, providing that safety nets have been installed as fall protection. It is not good practice to install all the diaphragms from the steelwork in advance of the decking as this increases the time operatives are on the steelwork.

Decking installation will only commence once the end diaphragms and safety net fall arrest system are in place. When commencing decking installation the operatives will use the access that should be provided adjacent to the set out point which will be denoted on the decking layout drawing. The first bundle of decking to be laid will have been loaded out so that it is immediately accessible from this location, thus reducing the need for operatives to traverse the steelwork. The bundle supporting longer sheet (bay length +250mm) will be the last to be installed and will be cut down to the required length prior to installation.

Decking operatives will usually stand on the top flange of the beam at either end of the first bundle of decking and will cut open the steel banding, as it is not possible to straddle the steelwork on most occasions once the end diaphragms are in place. The first decking sheet will then be lifted out onto the steelwork and placed over the pre-fitted end diaphragm by a minimum of two operatives, one at each end of the decking sheet. Once in place this sheet will then be used as a working platform from which to lay the remaining sheets. Decking operatives will then stand on the beam immediately adjacent to the end diaphragm that the sheet will be placed over whilst lowering the decking sheet into position. Decking sheets must always be manoeuvred into position by two operatives. Once the decking sheets have been laid and lapped together and temporarily fixed into place, the safety nets and clamps can be removed. The decking will then be fully fixed into place using a cartridge tool and two heavy duty nails per panel end.

On completion of the first bay of decking the second bundle of decking, sheets should be immediately accessible. This will allow the bundles banding to be removed whilst the decking operatives remain on the previously laid decking.

The installation process will then be repeated. When installing decking bundles running parallel to one another, one decking operative will be able to use the first bundle laid as a position of work for splitting and laying the adjacent bundle, the second operative will work as described for the first bundle.

Decking installation should always terminate a minimum of 3m back from any unprotected edge, such as the end of a safety netted work zone.

It is critical that the Decking Contractor's drawings are strictly followed during installation, particularly the set out of each bay, as the decking will have been detailed to take account of the services and/or openings that may be run through the underside of the decking trough, or be formed in the crest of the decking at a later date.

7.2.3 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 un-propped 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 without the need for supplementary temporary propping. In general, any deviation from the approved decking layout drawings needs to be checked with the Steelwork Contractor.



7.2.4 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 too small to allow concrete aggregate to escape. The decking is not intended to provide a watertight seal and a degree of fines and water seepage from the concrete 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.

Consideration should be given to the applied finish to the steelwork and how seepage of fines and grout can affect these. The use of vibrating concrete pokers will increase the potential for grout loss.

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 Metal Cladding and Roofing Manufacturers Association Technical Paper No 13 for further details).

The ends of the deep decking sheets are generally closed off by the end diaphragms. On completion of the decking it will be possible, when viewed from underneath, to see gaps between the crest of the decking and the end diaphragms.

Small gaps such as these will tend to close off when the weight of the concrete is applied. The deckers will seal off the larger gaps at the trough re-entrant and end diaphragm.

In other areas of the decking i.e. cuts around columns, gaps up to 5mm are generally acceptable, as they are too small to allow concrete aggregate to escape.



7.2.5 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 be highlighted on the Decking Contractor's layout drawings and will be undertaken on completion of the decking installation.

7.2.6 Decking Fixings

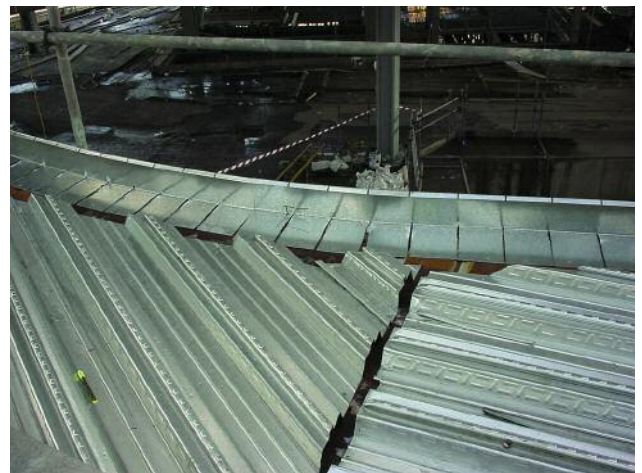
Fixings should be installed in accordance with the manufacturer's recommendations. These will include primary fixings at sheet ends, secondary fixings on intermediate beams and side lap stitching (if required). Fixing of the decking and edge trim to the supporting steelwork will usually be carried out using low velocity powder actuated cartridge tools, commonly known as "shot firing or shot fixing". 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, as some fixing screws need to be pre-drilled with a pilot hole to allow a successful fix. In addition, this method 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 0.6m 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 +/- 10mm 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, this must be carried out in a way that ensures the hole cannot be accidentally or easily exposed and a fall hazard created. 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 (refer to MCRMA Technical Paper No 13).

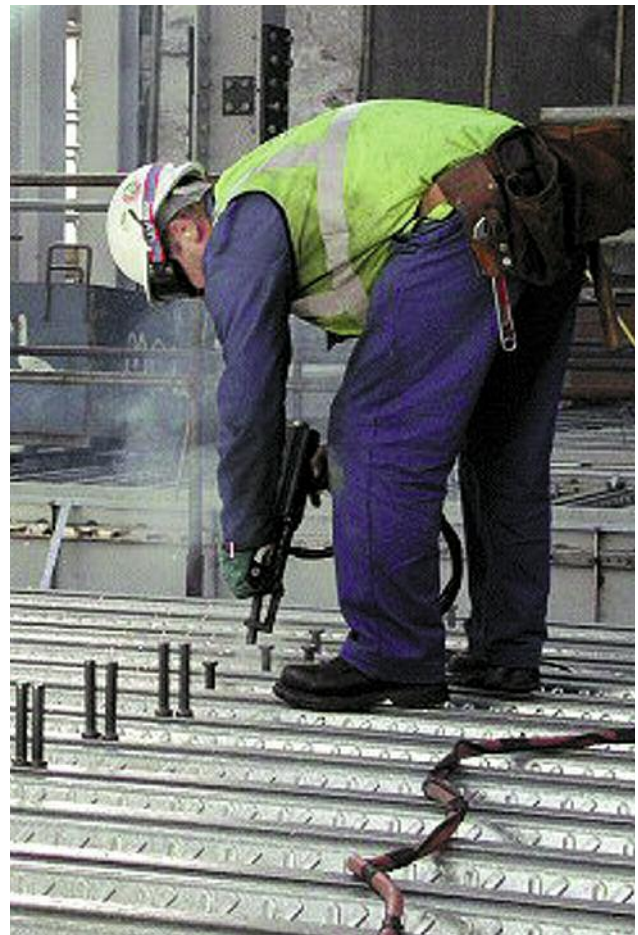


8 Stud Welding

8.1 Stud Welding Process

The drawn-arc stud welding process uses shear studs with a special shape with a flux pellet on the end. This flux initiates and improves starting and stabilising the welding arc. It also serves to deoxidise the molten metal for a sound, low-porosity weld zone to produce a full penetration weld.

The ceramic ferrule confines the weld arc and heat to a specific area of the base metal and holds the molten metal in place to provide the uniform weld collar. The term collar is used instead of fillet because the weld zone comprises a mixture of melted material from the stud end and expelled from the base plate material, rather than a weld made from a separate filler material that a fillet weld would comprise. The ferrule is broken away after the welded is complete to allow visual inspection of the weld collar.



8.2 Stud Welding Requirements

Through 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, galvanizing, 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 risk of the welding equipment short-circuiting against the reinforcement.

Welding should take place as soon as possible after the deck has been laid this will help prevent dirt, moisture, and other contaminants building up between the deck and top flange thus facilitating good weld quality.

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 molten weld spatter both above and below the area of welding. This should not present an unacceptable hazard 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 or combustible 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 Studwelding 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 Studwelding Contractor should check the area is clear before commencing work.

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 Studwelding 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 protecting these areas at alternate floors.

When netting fans are in use to provide protection against falling materials at the perimeter of the building, the contractor responsible for their positioning and relocation should liaise closely with the Decking/Studwelding Contractor to ensure that the location brackets and associated supporting tubes do not interfere with the location of the welders fire blankets. For this reason it is good practice to ensure the level to which the materials fan is attached has been fully studded prior to its erection.

8.4 Planning and Sequencing Welding

When planning the stud welding works, it is important to ensure that the fall protection system is removed from the floor below prior to welding commencement as the nets or airbags would be damaged by the weld spatter. Where possible the safety nets should be struck from the floor above that being welded to ensure that the nets do not snag on the studs when de-rigged from the floor above.

8.5 Welding Conditions

Through 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 weighs 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

Conditions related to the welding position

Through deck stud welding shall be carried out in the PA position (downhand) only.

Pre-production test for stud welding on site (for through deck stud welding)

This test shall be carried out for building constructions with principally static loads. This test is applicable to an individual site under prevailing conditions. If there are significant changes influencing the weld quality a new pre-production test is required.

Welding procedure specifications, pWPS and WPS, shall conform to the provisions ie:

- A minimum of 10 studs shall be welded.
- Visual examination on all studs.
- Bend test (30°) on all studs.

The welding parameters and set-up conditions on site shall be recorded in the WPQR or in a test report according to BS EN ISO 14555 Annex F. The influence of cable length, cable cross section, and environmental conditions shall be taken into account.

Welding and testing of the test pieces shall be witnessed by an examining body (see ISO 15607:2003, 3.9) or in accordance with national regulations.

Visual examination

For drawn arc stud welding with ceramic ferrule or shielding gas and short-cycle drawn arc stud welding, visual examination is used for assessing the following as appropriate for the application:

- a) The uniformity of the shape, the size and the colour of the surface of the weld collar (guidance values for drawn arc stud welding with ceramic ferrule are given in ISO 13918), and
- b) Location, length and angle of the stud after welding.

Ring test

The ring test serves as a production test for shear connectors principally subject to static loads in building constructions. The ring test is only permitted for studs welded under the qualification in accordance with BS EN ISO 14555 10.3.2.

The head of the shear connector is tapped with a hammer with a weight of 0.9kg to 2kg. The angle of swing shall be between 20° and 30° and shall be allowed to free fall.

Note: The execution and the assessment of the ring test needs sufficient experience.

Simplified production test

Simplified production tests shall be performed by the manufacturer before the start of each shift. They can also be requested after a certain number of welds, by the application standard rules or in the specification.

The purpose of the simplified production test is to check that the equipment is correctly set up, and that it is operating correctly. Three studs shall be welded. The simplified production tests comprise at least the following test and examination:

- a) Visual examination (all studs);
- b) Bend testing (all studs).

The examination and test are performed and evaluated in accordance with Clause 11 of EN ISO 14555

The results of the simplified production test shall be documented. The bent studs should remain in place.

Re-testing for production test or simplified production test

If one of the studs does not meet the requirements, two additional studs of the same type can be taken from the associated test piece. If this is not possible, similar studs shall be additionally welded.

Note: This necessitates that a sufficient quantity of replacement specimens be provided in a production test. If one of the additional studs does not satisfy the requirements, corrective action (see BS EN ISO 14555 14.7) shall be taken and the production test shall be repeated.

Production surveillance for drawn arc stud welding with ceramic ferrule with qualification according to BS EN ISO 14555 10.3.2

A bend test (15°) shall be performed on the greater of 5% or at least on two studs on each beam.

The following examinations and tests shall be performed on all studs:

- a) Visual examination according to BS EN ISO 14555 11.2;
- b) Ring test according to BS EN ISO 14555 11.8.

Production surveillance record

The manufacturer keeps a production surveillance record which contains the results of the production test, simplified production test and production surveillance. The manufacturer shall keep a different record for each stud welding process and the record shall be kept available with the results of all tests recorded. BS EN ISO 14555 Annex H is an example form and should be used, where appropriate.

Non-conformance and corrective actions

If there is an indication of non-conforming welding, e.g. porosity, collar not complete or unequal, unacceptable ring test or if the length of one stud is outside the specification, a bend test (15°) or tensile test (limited to the design strength) shall be performed on that stud. If the stud weld fails to satisfy the requirements in this test, three welds made before and, where appropriate, after the defective weld shall also be subjected to bend or tensile testing.

If one of these studs also fails to satisfy the requirements in the test, appropriate testing shall be carried out on all studs on the same work piece.

Corrective actions shall be taken for all non-conforming stud welds, either by removal of the defective stud where necessary and repeat stud welding, or by repair welding with a suitable welding process. In isolated cases, stud welding processes may be replaced by other suitable welding processes. Depending on the stud diameter, a fillet weld shall reach the calculated throat.

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.

Note: Sometimes defective studs do not need to be removed, but can be substituted by extra studs.



8.8 Shot Fired Connectors

Shot fired shear connectors can provide an alternative method of shear connection 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 resistance value as a welded stud. To cater for the lower shear capacity, it may be necessary if appropriate space is available 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/Studwelding 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 un-propped. 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 temporary props 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; 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.

There is guidance available for the propping of floors from the manufacturers and deck installers.

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.

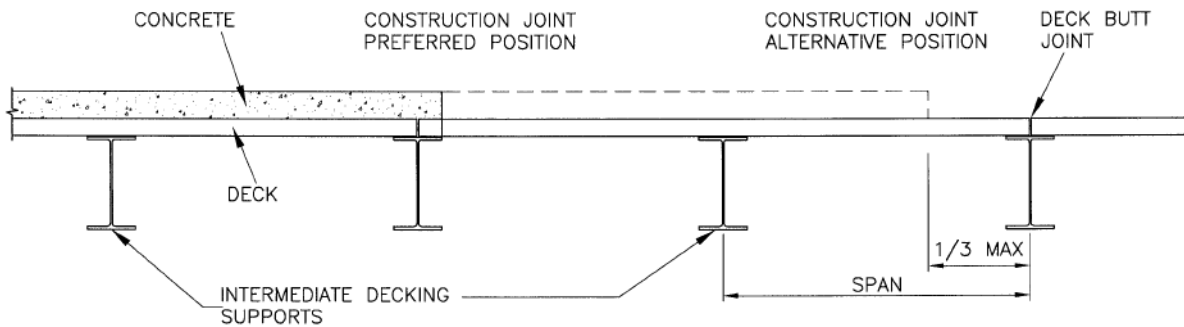
9.4 Concrete Placement

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 underlapping 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 and best practice guide No:4.



RECOMMENDED POSITIONS FOR CONSTRUCTION JOINTS IN THE CONCRETE SLAB

References

Publications produced by the BCSA:

National Structural Steelwork Specification for Building Construction

Task Specific Method Statement

Guide to Steel Erection in Windy Conditions (39/05)

Guide to the Erection of Multi Storey Buildings (42/06)

Currently the Regulations of most importance to decking work are:

- Construction (Design and Management) Regulations [CDM Regs]
- 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
- Work at Height Regulations.

Other publications:

Metal Cladding and Roofing Manufacturers Association Technical Paper 13 / SCI P-300 Composite slabs and beams using metal decking

SCI P-300 Concrete Society Good Concrete Guide 5 Composite concrete slabs on steel decking.

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BCSA Code of Practice for Metal Decking and Stud Welding

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