CIS 13:2009

GUIDELINES ON HANDLING, TRANSPORTATION, STACKING AND INSTALLATION OF STRUCTURAL STEEL

Descriptors: handling, transportation, stacking, installation, structural steel, steel erector, still rigger, travelling anchorage, safety

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LEMBAGA PEMBANGUNAN INDUSTRI PEMBINAAN MALAYSIA
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Committee representation

This Construction Industry Standard (CIS) was managed and developed by the Construction Industry Development Board Malaysia with the assistance of the Technical Committee on Development of Standard for Industrialised Building System (IBS). Which comprises representatives from the following organizations:-

Association of Consulting Engineers Malaysia
Construction Industry Development Board Malaysia
Hume Industries (M) Berhad
The Institution of Engineers, Malaysia
Jabatan Kerja Raya Malaysia
Master Builders Association of Malaysia
MTD ACPI Engineering Berhad
Pertubuhan Akitek Malaysia
Setia Precast Sdn. Bhd.
UAC Steel System Sdn. Bhd.
Universiti Teknologi Malaysia
Foreword

This Construction Industry Standard (CIS) was developed as guidelines on handling, transportation, stacking and installation of structural steel with the assistance of the Construction Industry Development Board, Malaysia (CIDB) which acted as the moderator and facilitator for the technical committee throughout the development process of this standard.

This CIS is based on existing Malaysian manufacturer's method of statement with the main objective is to establish a detail and systematic framework for ensuring structural steel supplied to the project sites are handled orderly.

The use of this guideline is voluntary and compliance with this document does not in itself confer immunity from legal obligations.
Guidelines on Handling, Transportation, Stacking and Installation of Structural Steel

Section 1: General

1.1 Introduction

This standard may be cited as the approved standard for the safe erection of structural steelwork.

Transportation of structural steel refers to the process of delivery of fabricated structural steel sections from the fabrication workshop or factory to the designated area or job safely.

Planning for the safe erection of structural steelwork should start at the design stage. Design engineers should take into account the need to ensure safe working conditions for those involved in the construction stage.

Accidents in the erection of structural steelwork on site are not restricted to falls. Other accidents occur because of structural instability during erection, and while handling, lifting and transporting material. Failure to plan and design for safety at the earliest stages can encourage or lead to unsafe practices on site and to structural instability during erection or dismantling.

1.2 Purpose

The purposes of this standard are:

To provide practical guidance for the safe and efficient erection of structural steelwork in low-rise and multi-storey buildings or structures.

To define procedures for proper handling, storage and protection requirements of materials, products and works to prevent damage, deterioration or loss.

To define procedures for delivery of fabricated steel sections from fabrication workshop or factory to paint shop or hot dipped galvanizing factory for further treatments.

To define procedures for delivery of painted or hot dipped galvanized steel sections from paint shop or from hot dipped galvanizing factory to job site or temporary storage area for installation.

To define procedures for delivery of painted or hot dipped galvanized steel sections from paint shop or from hot dipped galvanizing factory to local port for export purposes.

1.3 Scope

The standard describes the design, planning, preparation and work practice requirements for the safe erection of structural steelwork. The structural steel components covered in this standard include the erection of:

a) Columns;
b) Beams;
c) Rafters;
d) Purlins;
e) Girts;
f) Bridging and fly bracing beams;
g) Other related steelwork.

This procedure applies to all project works sites.
1.4 Definitions

In this approved standard:

"Construction Manager" means the party responsible for managing and coordinating the work.

"Contractors" includes subcontractors.

"Design engineer" means the engineer responsible for the structural design.

"Low rise building or structure" means a single storey structure which may include a mezzanine floor over any part of its floor area and which is intended for industrial, commercial, recreational or community use.

"Multi-storey building or structure" means a structure which consists of two or more floors or levels and which is intended for industrial, commercial, recreational or community use.

"Other work" means operations, which generally include procedures such as welding, drilling, bolting, painting, and other tasks of a similar nature.

"Main contractor" means the contractor responsible for the construction of the building or structure.

"Material Controller" means responsible person from the contractors.

"Static line" means a line extending between two or more anchorages which has been designed to sustain the mass of workers who may be connected to the static line through travelling anchorages.

"Steel erector" means the party responsible for the erection of structural steelwork.

"Steel fabricator" means the party responsible for the fabrication of the steelwork.

"Steel rigger" means,

a) a person who holds a certificate of competency as a rigger from the CIDB or equivalent interstate authority, and who has at least 12 months experience working with the erection of structural steel;

or

b) a person with at least 12 months experience in the erection of structural steel who has worked consistently at heights over 4 metres during this period, and who can demonstrate a thorough knowledge of steel erection and connection procedures;

"Supervising engineer" means the engineer responsible for supervision of construction.

"Travelling anchorage" (for the purpose of this standard) means a fitting which may travel along a static line and to which a safety line and harness may be attached.
1.5 Statutory Regulations:

1. The Immigration Act, The Immigration Regulation The Passport Act (Manpower Recruitment)
2. Machineries & Factories Act 1967 (General Work Site Safety)
3. Machineries & Factories Act 1967 (Housekeeping)
5. Machineries & Factories Act 514 1994 (General Work Site Safety)

Section 2: Handling, Storage & Preservation of Structural Steel

2.1 Responsibility

The Material Controller is responsible for the proper handling and protection of raw materials / works at all stages.

The Material Controller is responsible to ensure that materials / products are stored in such a way that they do not suffer contamination, damage, deterioration or loss.

The Material Controller shall be responsible for proper protection of the completed project / works to ensure conformance to customer and / or in-house requirements.

2.2 Procedure

2.2.1 Handling

The Material Controller shall ensure the following, where applicable, in handling materials of raw steel and fabricated steel:

a) Proper lifting equipment shall be used to transport the materials
b) Materials shall be given proper packing, where applicable, before stacking them for handling by cranes and forklifts
c) Identification marks shall be made on these materials, if required
d) Lifting belts / slings shall be checked for damage before lifting heavy materials
e) Hooking point shall be checked to prevent slippage
f) When using lifting belts over painted areas, care shall be taken not to damage the painted surface
g) Cranes shall not lift weights that are beyond the capacity of the lifting belts / wire ropes
h) Materials shall not be stacked too high to avoid falling off
i) Painted materials shall not be shifted during rain to avoid slipping off
j) Inspected materials for dispatch shall not be mixed with other materials
k) During handling, great care shall be taken to avoid damage
l) A signaler, rigger and lifting supervisor shall be provided for all lifting operations

All other materials / products shall be handled appropriately with the use of correct handling equipment to avoid accidental damage or deterioration.
2.2.2 Protection & Preservation

All raw materials, fabricated items and completed works shall be appropriately protected or preserved from damage and deterioration until used or handed over. Applicable Malaysian safety requirements related to protection and preservation shall be observed at all times. Additional protection and preservation measures arising from or required to meet contractual requirements shall be observed.

Section 3: Transportation of Structural Steel

3.1 Common fabricated structural steel section

1. Fabricated structural steel sections can be of any shapes or size however must be of transportable size.

2. Single profile / piece / section with or without welded plate connection / attachment in different lengths.

3. Built-up girder section of any shapes or sizes in different lengths.

4. Built-up trusses of any sizes and lengths.

5. Completed or semi-completed of structural component such as bridges, ducts, stacks, drums and tower crane components etc.

3.2 Guidelines for transportation

To ensure transportability and safety during delivery, the following shall be considered:

a) Specific design requirement such as the stability of an over size or unusually shaped structural steel component during transportation.

b) Local traffic regulations governing maximum weight, length, width and height of the laden vehicle.

c) Providing all weather access for the delivery vehicle to and around the job site.

d) Small size structural steel sections should be packed or bundled together for transportation.

e) Smaller steel component should be packed on wooded pallets for easy handling and safe transportation without worried of falling off the vehicle.

f) Transportation of structural steel sections should utilize trailer with doors (cargo trailer) for safety reason unless or otherwise oversize.

g) To avoid mixing of small structural steel sections with heavy structural steel section in planning for transportation.
3.3 Loading and Unloading

Heavy structural steel sections should be loaded in such way that identification marks or numbers are visible during unloading.

Lifting points on heavy structural steel section should be checked to ensure they are correctly oriented or installed in according to the lifting planning and compatible with the lifting system used.

Lifting points should be coloured in yellow for clear identification during loading and unloading process.

Vehicles used to transport heavy and over size structural steel sections should be loaded such that the centre of the gravity of the load is as low possible. Placement of the steel sections should evenly spread the load along the vehicle’s centre line.

Particular care must be taken during loading and unloading of heavy structural steel section onto and from the vehicle to ensure that the vehicles remain stable at all stages.

Where unloading cannot take place on a firm level surface, heavy structural steel section must be individually restrained and the loading configuration must be checked to ensure that removing individual section does not result in the instability of the vehicle.

Restraints must not be removed until the crane takes initial weight of the steel section.

3.4 Secure and Restraint

Securing and restraint of loaded structural steel sections on vehicles is important especially for those over length or size sections and circular type of steel sections in preventing accidents and injuries.

The transporter must ensure that any load is safe and securely restrained.

This means that the structural steel sections:

a) Must be restrained by an appropriate method and

b) Must not be placed in a way that makes the vehicle unsafe and unstable

The adequacy of a particular method of restraint will depend on the type of structural steel sections being transported and the type of vehicle being used.

When transporting heavy structural steel sections, the transporter must ensure that suitable vehicles is used to transport structural steel sections of different types or shapes and sizes and that they are properly secured. A vehicle must not be moved without the load being secured in the appropriate manner.

Restraint equipment and anchor point must be strong enough to hold the weight of structural steel being transported. The equipment must be inspected before use to ensure it is serviceable.

Shortly after commencing the journey, the driver must stop to check the load again for possible movement or settlement to anchorage and restraints. If movement or settlement is spotted, the load must be re-secured and constrained before continue the journey.
3.5 Temporary Support

Temporary supports for over size structural steel sections or frames during transportation must be designed to withstand loads and extra forces during loading, transportation and unloading.

All temporary supporting structures or frame shall be properly secured to the main steel structures and if possible should be welded.

If timbers are used as temporary support for over size or odd shapes structural steel sections, the transporter has to ensure the timbers are properly secured without risk of falling off the vehicle.

3.6 Protection for Coated Structural Steel Section

Point of contact between steel section, supports, and restraints must be provided with protective material to prevent damage to the protective coating either of painting or hot dipped galvanized.

For the same purpose, corner protectors must be used under all restraints. Materials such as timber, rubber pads and rags should be used to protect the protective coating.

Structural steel sections must be stacked in such way that each section can support the load from above. The supporting point must be directly above each other unless otherwise specifically designed.

The stacked height of structural steel section must be limited to ensure that the bearers and lowest section can support the load from above and that stack remain stable during transportation.

3.7 Delivery and Transportation

Before the shop drawings are prepared, structural steel element sizes and transportability should be reviewed to confirm that the proposed elements are able to be transported to the building site and erected.

The feasibility of utilizing / transporting a crane of the required type and capacity to lift the structural steel sections also need to be taken into account.

The fabricator must ensure that the structural steel sections are loaded in a sequence compatible with the required unloading and erection sequence on-site.

The transporter must ensure that the drivers have been briefed adequately in the safe transportation of heavy structural steel sections or over size steel structures with the particular attention given to

a) Power lines
b) Recognised truck routes for over size structural steel section
c) Round-about and reverse camber in the road
d) Bridges height
e) Road conditions

Delivery of structural steel materials or sections to the job site required cooperation and coordination between the fabricator, the transporter and the erector. Delivery planning shall be coordinated in such a way to minimize double handling, which could result in damages to the steel sections of the protective coating to the steel sections due to impact or scratches.
3.8 Relocation of Structural Steel Section

Temporary storage and relocation of structural steel should be minimised or avoided to prevent damage to the protective coating or steel section itself during handling.

Relocation of heavy structural steel section should refer to the section 3.2 for loading and unloading procedure and approved lifting procedure.

Section 4: Installation And Erection

4.1 Design and Planning Considerations

4.1.1 Design and Planning

In designing the structure and its component parts, the design engineers should consider the effect on safety of the work practices necessary to erect the structure as designed:

a) Site location
b) Access points
c) Structure location

The design engineer should also provide guidance to steel fabricators/erectors, so as to ensure safe erection practices, on matters including:

a) Joint positions (as they affect erection sequences)
b) Accessibility of connections
c) Erection cleats
d) Fixing for working platforms, hand rails, etc

4.1.2 Stability

Design safety implications should include; but are not limited to stability. Any special or unusual features of the structural design which may affect stability during erection should be highlighted by the design engineer.

In considering stability, all disturbing loads or forces likely to cause overturning, collapse or excessive movement, especially during erection, should be assessed in their realistic combinations and used to design suitable restraint systems.

The size and mass of individual members, in relation to crane size and site accessibility, should also be considered.

When anchor bolts are embedded in concrete to resist overturning of single columns or column assemblies during erection, a minimum strength of the concrete should be specified in order that the concrete may attain sufficient strength to retain the anchor bolts and safely restrain the column. The footing design should also be checked to ensure that it will itself be stable and retain its structural integrity during erection conditions, as well as provide the necessary stability to the steelwork.
4.1.3 **Work at Heights**

As far as practicable the design should minimise work at heights. For example, sections should be pre-assembled on the ground and guard railing installed to perimeter members prior to hoisting. Where work at heights is necessary, anchorage points for static lines or safety nets should be provided.

4.2 **Contractors**

4.2.1 **The Main Contractor**

The main contractor has the responsibility for providing and maintaining a work environment that is safe and without risks to health, in relation to matters over which the main contractor has control.

The contractor also has responsibilities as an employer under the Statutory Regulation, in relation to matters over which the contractor has control.

In the erection of structural steelwork, the main contractor should coordinate all contractors and other parties to ensure the programs for steel erection are integrated into the overall construction theme and safely carried out. The need for coordination is particularly important when there is more than one contractor.

4.2.2 **Accuracy of Work**

The main contractor (or, where there is no main contractor, the project manager) should ensure that the accuracy of each contractor's work is within the tolerance of the level or position nominated by the design engineer. When these are not specifically nominated, the tolerance nominated in appropriate standards or standards should apply. This will allow following trades or contractors to successfully complete their work within the level of accuracy demanded of them. Failure to ensure the accuracy of each contractor's work could lead to unsafe working conditions for those following and may even compromise the stability of the building or its component parts, especially during erection.

4.2.3 **Site Modification**

The main contractor should ensure that site modifications to the building layout or any other additions, modifications or remedial work on the structure considered necessary are not made without the prior approval of the design engineer.

4.2.4 **Site Conditions**

The main contractor should ensure that the steel erector and other contractors on site have sufficient space and clearance to allow safe access to the site and to safely maneuver to erect steelwork. Ground conditions should be maintained to remain sound, and sustain traffic and to allow plant and equipment to work and move about the site safely.

4.2.5 **Certification and Competency**

Main contractors should ensure that:

a) Workers engaged in the erection of steel are competent; and

b) Workers engaged in the operation of cranes are appropriately certified.

In the event of any uncertainty as to appropriate certification the main contractor should contact the relevant authorities (such as CIDB, DOSH, etc)
4.2.6 The Steel Fabricator

The steel fabricator bears the responsibility for the accurate detailing and fabrication of the steelwork to ensure components fit together correctly. During detailing, consideration should be given to the ease of making connections on site.

4.2.7 Co-ordination

Co-ordination between the steel fabricator and the steel erector is essential. To achieve this, a formal means of communication should be set up by the steel fabricator to monitor the site situation on a regular basis. This is most important when the steel fabricator and the steel erector are different.

4.2.8 Fabrication Sequence

Steel members should be delivered to the site in a sequence as required for each stage of erection.

4.2.9 The Steel Erector

The steel erector should submit a schedule and a method statement of erection to the main contractor.

4.2.10 Responsibility

The steel erector is responsible, under the main contractor, for ensuring the observance of all safety requirements by their employees. Individual employees are also required to take care of their own safety and for the health and safety of any other person who may be affected by the employee’s acts or omissions at the work place.

4.2.11 Staffing

The steel erector shall ensure that all employees working with steel are competent or in training under the supervision of a competent person (supervisor) and where required by regulation, are certified.

4.2.12 General Safety

Safety is an integral part of the erection process. Before commencing erection the steel erector should ensure that all necessary planning has been carried out and shall ensure safe working practices in the erection process.

4.3 Training and General Safety Consideration

4.3.1 Training

All persons working with steel shall be appropriately trained and competent to carry out the work, or be in training under the direct supervision of a competent person.

In addition, the Statutory Regulation requires that employers provide such information, instruction, training and supervision to all employees as necessary to ensure their health and safety.

Training needs can be split into induction and more specific task-related training and may be met by a mixture of on the job and off the job training. All information, instruction and training provided must be in a language and form, which employees will understand.

Competent personnel shall be assigned to carry out the training.
4.3.2 Induction Training

On joining a company a new employee’s previous safety training should be ascertained. Management should not assume that any employee has a particular skill or training without seeing some proof (e.g. Green Card) or demonstration. Induction training should explain such matters as the company’s safety policy/organisation, company safety rules, accident reporting requirements etc.

4.3.3 On the Job Training

Training and instruction will be necessary when employees first start on a project in order to cover the particular requirements of the site such as emergency procedures, any special hazards and the safety aspects of the proposed erection scheme. In general, training for people who will be carrying out steel erection should start at ground level. After basic skills have been acquired and when the trainees are proficient they may work at increasing heights.

4.3.4 Site Conditions

Weather

Adverse weather conditions can make steel erection hazardous and unsafe. Weather conditions which have an adverse effect on erection safety include:

a) Rain or dew;
b) Wind;
c) Heat;
d) Conditions which cause poor visibility such as fog, mist or glare.

Under such conditions, erection operations which become unsafe should be stopped, unless adequate measures are taken to ensure that the risk is no worse than under normal weather conditions.

If, under adverse weather conditions, the decision is made to stop work, measures should be taken to ensure the stability of the structure. Similarly, the stability of previously erected steelwork should be reassessed before work is restarted.

4.3.5 Access for Vehicles and Plant

The steel erector should check the site prior to steel being delivered to ensure that suitable, unobstructed safe access is available for delivery vehicles, cranes and other plant. Ground conditions on site should be checked to ensure that they are suitable for working and will safely support plant and equipment necessary for erection.

4.3.6 Powerlines

Special attention should be given to any overhead powerlines in the vicinity of the work site. Where the powerlines are near the crane operating area, the requirements of the relevant regulations shall be followed. In particular, no plant or equipment shall be used within 4.5 metres of a live electrical powerlines.
Where this minimum clearance cannot be maintained, steps shall be taken to have the electricity supply authority either:

a) Re-route the conductors, or  
b) Isolate the conductors, or  
c) Insulate the conductors, for the duration of the construction work.

4.3.7 Lighting

Adequate natural and/or other lighting shall be provided to all areas where work is to be carried out.

4.3.8 Equipment

Maintenance

Safety features built into tools and equipment are only as good as the safety practices of those using them. The employer shall ensure that regular inspection and maintenance is carried out to ensure that all tools and equipment, as well as plant and machinery, used in the erection of steelwork are always in good condition and safe to use. Each type of plant or equipment should be used as intended and within the limits of its rated capacity.

4.3.9 Safety Helmets

The wearing of a safety helmet is compulsory in areas designated as hard hat areas.

4.3.10 Footwear

Persons erecting steel should wear non-slip footwear. Rubber soled shoes can be a hazard where wet or slippery steelwork or surfaces are encountered. Consequently, work should not proceed during wet weather or until such surfaces are dry, unless some other safe method of erection is employed.

4.4 Working at Heights

4.4.1 Reduction of Work at Heights

Whenever possible the need to work at heights should be avoided, to minimise the risk of falls. Some alternative means of erection which may reduce the need to work at heights are:

a) Connecting as much steelwork as possible at ground level, from erected floor slabs or from decks in the structure. This should be planned and included in the erection scheme;  
b) Reducing the number of separate components lifted by connecting where practicable at ground level;  
c) Using a remote release lifting device on the lifting gear where possible. (See Figure 1);  
d) Inspecting and testing as much as possible at ground level.
4.4.2 Limitations on Work at Heights

Where work at heights is unavoidable, steel erectors shall ensure that employees have safe means of access to working positions. Steel erectors shall ensure that employees are suitably secured or otherwise protected against falling.

The method selected for the protection of employees will generally be determined by individual job factors including the nature of the work, the size of the job, equipment availability, interaction with other trades and the like. Methods of protection available include scaffolding, ladders, scissor hoists, personnel boxes, safety nets, cherry pickers and safety harnessees.

Traversing steel beams, rafters, or similar structural components should be avoided except where the worker is:

a) Working above scaffolding or similar structure, with a working platform not more than 4 metres below the worker; or
b) Wearing a safety harness securely attached to a static line as described in Sections 4.4.10; or
c) Walking immediately above a safety net; or
d) Straddling an I-section beam which is deep enough, within a range 200 to 700mm, to allow comfortable movement along the bottom flange and enable access to the working position. In such cases both hands must be free to grip the top flange.
4.4.3 Selection of Access to Working Places

The following sections outline ways in which safe access and protection from falls may be achieved while working at heights.

Annex B describes types of access to working places with conditions, comments and examples of their use.

The sequence of erection should be planned so that the permanent structure can be used as much as possible to provide safer access ways and working places, with little or no adaptation.

Access to working places should be restricted to persons actually engaged in work in that area.

In choosing a particular method of access to a working place, consideration should be given to:

a) Ground conditions. A greater variety of access aids, for example scissor lifts, can be used if suitable hard standings or floor slabs are provided;

b) Any permanent access routes, such as stairways that could only be erected as construction progresses;

c) Permanent access floors, if these are erected as the structure progresses;

d) Height and accessibility of connections;

e) The number of times access is required, including any necessary supervision and inspection;

f) The type of activity, tools to be used, and how long the activity will take;

g) The type of labour required to undertake the work i.e.; certified steel riggers and their supervision, or other employees;

h) The availability of, and the clearances required for, any plant or equipment to be used;

i) The need to move access ways as the job progresses to form the shortest possible route;

j) Any abnormal site conditions (e.g.; unloading restrictions, limited hours of working, likely prevailing wind conditions).

4.4.4 Vertical Movement on Steelwork

Stairs, ladders or appropriate mechanical equipment such as personnel boxes, should normally be used for vertical movement above four metres. Proprietary equipment is available.

Riding of crane hooks or loads being hoisted is not permitted.
4.4.5 Horizontal Movement

Horizontal movement along beams may be required to reach a work area or to carry out the erection of building components. Such horizontal movement may be executed in any of the following ways:

Walking the top surface

Walking along the top surface of a beam by competent steel riggers is an acceptable means of horizontal movement providing the person can fall no more than four metres (See Figure 2). The beam should be fixed, be sufficiently stable to permit such walking along the top surface and have a minimum width of 130mm. The top surface of the beam should be free from shearbolts, cleats, and other obstructions. At a height above four metres, attachment by safety harness to a suitable anchorage should be used. For beams inclined at a slope greater than 15 degrees, an alternate method of movement should be used.

Beam straddling

Beam straddling is an acceptable means of horizontal movement to effect the erection of building components, provided it is carried out on an I-section beam (See Figure 3). The beam depth should be between 200mm and 700mm to allow the steel rigger to conveniently sit or stand astride the top flange with adequate hand and foot holds. Obstructions should not necessitate the steel rigger changing the basic position described and it should be noted that the presence of shearbolts, cleats, and other obstructions precludes safe passage.

Beam straddling includes sitting astride the top flange of the beam or walking on the bottom flange while straddling the top flange of the beam. For beams inclined at a slope greater than 30 degrees, an alternate method of movement should be used.

Walking the bottom flange

Walking or standing on the bottom flange means walking or standing wholly on one side of the beam or rafter and does not imply or include a straddling position. Walking the bottom flange of a beam or rafter is an acceptable means of horizontal movement (See Figure 4) provided that:

a) A secure handhold can be easily and conveniently reached by the steel rigger using both hands;

b) A secure foothold is available for both feet and can be used in conjunction with the handhold position without losing co-ordination; and

c) The top flange or surface does not reach higher than the steel rigger's chest.

For beams or rafters inclined at a slope greater than 30 degrees an alternate method of movement should be used.
Figure 2 Walking on the Top Surface of the Beam - below four metres only

Figure 3 Straddling the Beam

Figure 4 Walking the Bottom Flange
4.4.6 Ladders

To attain temporary access, ladders may be used for the purpose of connections and for short term operations such as the removal of lifting slings (See Figures 5 and 6).

![Figure 5 Ladders](image)

![Figure 6 Ladders](image)
Portable ladders shall be placed on a firm base. The slope of the ladder shall be about one (horizontally) to four (vertically).

Where the ladder is used for a short term work such as disengaging lifting slings, a second person should stand at the bottom of the ladder in such a way as to prevent slippage.

Where the work is of longer duration, the ladder should be secured at the top and the worker secured by means of a safety harness. Vertical ladders in excess of 9m in height should incorporate a fall arresting device, for instance, the rigid rail system. Attachment to a fall arrestor (See Figure 7) should occur from this height.

![Figure 7 Fall Arrester](image)

4.4.7 Work Platforms

There are different types of work platforms which may be used to attain access to steelwork. These are:

a) Temporary working platforms which can be fitted at ground level before erection. Design features of such platforms should include easy and safe dismantling for re-use at other locations;

b) Lightweight, fabricated, hanging working platforms (See Figure 8) which can be used in many locations if they are designed in such a way as to fit a variety of beam widths.
Elevating working platforms such as scissor lifts or cherry pickers which provide a safe working platform suitable for tasks such as bolting up, purlin bridging and installation of sag rods.

The surface of working platforms and gangways shall be free of protrusions or obstructions and shall be large enough and strong enough to carry the required loading of workers, tools and materials. Working platforms should be able to resist other likely induced forces such as impact and environmental conditions such as wind.

4.4.8 Personnel Boxes

Personnel boxes complying with the regulations can be used either to gain access onto the structure or as working platforms. When used for access, the box should where possible, be landed on a firm, level surface which is wide enough to fully support it. People should enter or leave the box one at a time and the alighting area should allow them to climb in and out of the box easily and safely. There should also be a safe means of access to the place of work from the box. When boxes are used as a working platform for making connections on an open framework, people should not attempt to leave the box at height unless a safety harness is used by each steel rigger to secure themselves to the box or structure.

4.4.9 Safety Nets

Safety nets may be a satisfactory alternative means of protection in the event of falling, while also allowing steel riggers maximum flexibility of movement.

In considering the use of safety nets as a fall protection measure, main contractors may take into account the usefulness of safety nets for the safety of persons in other occupations, for instance, roof plumbers.

Safety nets should be constructed in accordance with the Statutory Regulation. The use and maintenance of the nets should be in accordance with the Statutory Regulation.
4.4.10 Safety Harnesses and Anchorage Techniques

Safety harness equipment must fit correctly and be kept in good order. Safety harnesses, as opposed to belts, should be used because harnesses provide for better protection.

The safety line of the harness should be attached to the structure or a static line or other fixing point, preferably above the working position to limit the height of any fall. Methods of attachment include:

a) Looping the safety line around a structural member and fastening the hook back onto the safety line. The use of such a “choke hitch” is dependent on the overall size of the frame member encompassed by the loop of the safety line or on the thickness of the extremities of the member which may be small enough to cut the safety line if a fall should occur. In such cases the safety line should be increased in thickness or be sleeved to prevent this cutting action;

b) Where frame members are too big to be choked around, a wire rope (minimum diameter 12.5mm) may be secured around the member (preferably at ground level prior to erection) and the safety line then attached to the wire rope itself;

c) Using proprietary girder grip devices. These may be:

- Attached around, or onto a structural member of a suitable size range (See Figure 9); or

![Figure 9 Steel Riggers Hook](image)

- Inserted into a suitable sized hole in the structural framework and locked to give a secure anchorage. This use is dependent on there being a spare, correctly sized hole, and it should therefore be included at the detailing stage. The frame material must also be suitable (see figure 10).

![Figure 10 Girder Grip Device](image)
Fall protection may also be achieved by the use of a parachute type, full body safety harness, attached at the top dorsal position by a safety line to a static line, through a suitable travelling anchorage, provided that:

a) the persons required to use the equipment are properly trained and supervised in its use;
b) persons using a safety harness are not working in isolation;
c) safety harnesses comply with the Statutory Regulation;
d) harnesses and other equipment are maintained in accordance with Statutory Regulation;
e) static lines and anchorages are designed for strength and movement restraint allowing for a minimum factor of safety of 6 with a minimum line diameter of 12.5mm;
f) the free fall limit for a person wearing a full body harness attached to a safety line behind the user’s head at the top of the back, does not exceed 1.8 metres, in accordance with Statutory Regulation;
g) safety lines have a minimum tensile strength of 22 kN;
h) there is a minimum of slack in the safety line, between the person and the attachment to the static line or other anchorage;
i) the anchorage used is as high as the equipment permits and the hazard of working above the point of anchorage is emphasised to workers;
j) the rescue and evacuation of a worker who is suspended in a full body harness occurs as soon as possible and in any event within twenty minutes of an arrested fall.

4.5 Erection of Steelwork

4.5.1 Erection Stability

Erection Method

The steel erector should carefully follow the method or sequence of erection shown on the erection drawings or described in the relevant contractual documents. Where no erection method is shown or described the steel erector should erect the building according to the method and sequence consistent with this standard. In the event of any uncertainty the steel erector should consult the design engineer.

The erection of any element or sub assembly should start only if all the necessary equipment and tackle is on site, to ensure that stability is maintained at all times. Sufficient provision and appropriate use of temporary guys should be made during all stages of erection to ensure the stability of all the parts of the structure as well as the structure as a whole. Added care should be taken to ensure that all temporary guys are appropriately attached and safely anchored.

The stability of a structure and the effectiveness of all temporary guys and supports should be checked at the end of each shift and re-assessed at the beginning of each shift before further erection work begins. Similarly, the stability of erected steelwork and temporary guys should be checked prior to work being stopped because of adverse weather and again when work restarts.
4.5.2 Bracing

Erection should start at a braced bay in order that a stable and self supporting portion of the structure can first be constructed, having the necessary internal or in-built restraints. Such a stable and self supporting braced bay can then be used to stabilise and support subsequently erected steelwork. Until the braced bay reaches the self supporting stage, some temporary support to the steelwork may be required. Generally this will be in the form of guys provided by the steel erector.

4.5.3 Column Stability

Where anchor bolts are embedded in concrete to resist overturning of freestanding, single columns or column assembly during erection, the main contractor should certify that the concrete has reached the appropriate strength before erecting the columns. If the concrete has not been appropriately cured, it cannot be relied on to have sufficient strength to retain the anchor bolts, nor to provide stability and support to the column.

In any case the steel erector should give consideration to the use of tightly fitted steel wedges driven under the edges of the column base plate to provide added stability, especially when less than four anchor bolts are being used to anchor the column.

All columns should be considered freestanding except where the design engineer requires that the column shall be guyed.

Once the column has been securely anchored and stabilised against overturning, the column lifting sling may be released by remote release shackle or by using a ladder leaning against the column, secured in accordance with Sections 4.4.6.

4.5.4 Site Modifications to Steelwork

Site modification or rectification of steelwork should only be made with the prior approval of the design engineer. Where such modifications or rectifications are being carried out, the steel erector should ensure the steelwork is safely and appropriately supported so as not to compromise the stability of the structure or any member of the structure.

Lifting Steelwork

The steel erector should assess the weight of all steelwork to be lifted and should ensure that sufficient craneage and slings of the appropriate type and capacity are being used. Cranes shall be operated within their safe working capacity. All cranes used for steel erection should be fitted with weight load indicators.

Before lifting any steelwork, the steel erector should ensure that the members are safely and suitably supported and that their ends are tied and held as necessary, to prevent uncontrolled movement of the steel while it is being transported or lifted into position. Particular care should be exercised with very long, slender or flexible members. In such cases, the use of spreader beams may be appropriate to ensure member stability during lifting and positioning.

Where connections are made at levels four metres or more above decked or ground level, the initial landing and bolting of the beam may be from:

a) A ladder, provided that the ladder is fixed to a column, adjacent secondary beam or core and the steel rigger is attached to a fixture on the column, core or ladder; (See Figures 11 and 12).

b) A personnel box suspended from a crane;
c) A purpose built platform supported from a column or adjacent member (See Figure 11);

d) Rungs welded to a column (See Figure 11). In this case the steel rigger is to be attached to the column by a safety harness, anchored above the work point to limit the distance of any fall;

e) A bosun's chair supported by an attachment at the top of a column with the steel rigger secured in the chair and tied off to the column at the work point (See Figure 12);

f) A trailing scaffold or a platform below a core slipform assembly;

g) A power operated mobile platform;

h) The final bolting may be made in any of the above ways, or by straddling the beam, provided that the steel rigger is attached by way of a safety line to the column, beam or wall at a point level with or above the highest point of working.

Figure 11 Connection of Beams 1
Rafters

For maximum safety and economy, a rafter spanning between adjacent columns should be erected in one length involving one crane and a single lift. However, where this is not practicable, the rafter will need to be erected in multiple lengths involving multiple lifts and at least two cranes. Only after a rafter has been securely fixed in position and stabilised as necessary (by means of either roof bracing, purlins, guys or other appropriate means), should support from the lifting crane be released and lifting slings removed.

Single Lift Erection

To erect a rafter in a single lift will generally require the rafter to be first bolted together on the ground at the ridge point or possibly at an intermediate point. The rafter may then be lifted into position and bolted to the portal columns and end-wall columns by steel riggers working from ladders leaning against the columns.

Multiple Lift Erection

Where the rafter cannot be erected in a single lift but needs to be jointed in the air, the rafter to column connections may be made by the steel rigger working from a ladder. The apex or intermediate rafter joints may be made by the steel rigger whilst either straddling the beam or standing on the bottom flange of the rafter wearing a suitably attached safety harness, or from a scissor lift, as appropriate for the circumstances.
Girts

Girts may be erected from a ladder. Individual girts should not be carried while climbing a ladder. Rather they should be lifted into position by means of a hand line, or with mechanical equipment when the girts are too heavy to safely lift by hand.

a) To aid the erection of girts a combined access lifting box may be used. With the latter the crane will need to be suitable for person-riding and the box designed for the intended loading. Clearly marked safe working loads should be displayed at each end, preferably in terms of the number of persons and the total weight of girts allowed, as well as the total safe working load in kilograms.

b) Girt bridging and any associated sag rods may be erected from a ladder. Bridging should not be carried up or down the ladder, rather it should be lifted from the ground by the steel rigger using a hand line.

Purlins

a) Where the conditions allow, panels of purlins with all bridging installed should be made up at ground level and a lifting frame used to raise and position each panel of purlins.

b) If it is not practicable to lift or install panels of purlins then a purlin bundle should be deposited at the base of the rafter slope. Individual purlins may then be carried into position from the purlin bundle. The steel rigger should wear a safety harness and safety line attached to a static line which should have been installed to the rafter while it is at ground level.

Other methods of protecting workers against serious injury from falling are described in Section 4.4 Working at Heights.

Where purlins cannot be erected directly from the rafter steelwork, alternate methods of safe erection will need to be developed involving the use of suitable and appropriate equipment and procedures such as the lifting frame.

Purlin Bridging

a) Purlin bridging may be erected from a scaffold plank spanning across the purlins. The scaffold plank should have a minimum length equal to at least three purlin spaces plus 600mm. It should also have attached some appropriate form of blocking piece or projection across the full width of the scaffold plank, to ensure that the scaffold plank can engage on any purlin in order to prevent the scaffold plank from sliding down the slope of the roof. The blocking piece or projection should be at least 100mm long when measured at right angles to the scaffold plank. While working from such a scaffold plank the steel rigger should ensure that the person is at all times wearing a safety harness attached by a safety line to the purlin.

b) Bridging may need to be raised from the ground by the steel rigger using a hand line. The steel rigger should never stand or walk on the scaffold plank spanning across the purlins but rather should work from a seated or lying position. Progressive movement up or down the roof may be made by sliding the scaffold plank across the purlins.

At no time should a steel rigger use the bridging for support or place any weight on bridging members.
4.5.5 Bracing

Fly Bracing

Column fly bracing may be erected from a ladder. Rafter fly bracing (see Annex A) may be installed by the steel rigger while straddling the rafter or standing on the bottom flange of the rafter.

Where rafter fly bracing cannot be erected directly from rafter steelwork, an alternate method of safe erection will need to be developed, generally in conjunction with the erection procedure for purlins.

Wall Bracing

Wall bracing may be erected from a ladder. Bracing members should be lifted by a crane. Where the weight of a bracing member is such that it can be safely lifted by hand, this may be done by the steel rigger while working from a ladder, using a hand line to lift the bracing member from the ground.

Roof Bracing

Roof bracing may be erected by a steel rigger straddling the rafter, or standing on the bottom flange of a rafter, which ever position is the more suitable and appropriate under the circumstances. Bracing members should be lifted by a crane.

Where the weight of a bracing member is such that it may be safely lifted by hand, this may be done by the steel rigger while working from the steelwork and using a hand line to lift the bracing from the ground. Bracing systems should be assembled on the ground where possible.

Beams

Beam connections should be made from a ladder or other steelwork. Where a continuous beam needs to be joined at an intermediate joint this may be done from the steelwork itself. Such connections are essentially identical to those in rafters and may be approached in a similar way.

Other Steelwork

All other steelwork not already covered should be erected in a manner consistent with the principles and methods of erection described in this standard for members performing essentially similar functions.

4.6 Personal Protective Methods

Only to be used when other methods do not give required protection.

Safety Harnesses

Examples : Making connections when other means of assuring a safe place is not practicable.

Some Conditions of Use: Means of anchorage must be provided; correct length of safety line to be used.

Comments : The use of harnesses is preferred as this reduces injuries should a fall occur; harnesses which incorporate tool frogs (a loop fastened to a belt to hold a tool) and pouches are to be encouraged. Competent person to check and maintain.
Anchorage Methods to Structure

Example: To secure safety line of safety harness (a) in a free hole in structural steelwork, or (b) around a structural member.

Some Conditions of Use: Inspected before use and attached properly before being relxed upon.

Comments: Single hand only required for attachment; and extra hole may have to be planned and left open.

Static Lines

Examples: For the attachment of a safety harness via a safety line and travelling anchorage.

Some Conditions of Use: Effective anchorages required; whole system should be designed for loads which it is expected to take safely.

Comments: Use recommended only if direct fixing for safety line is not possible.

Safety Eyebolt

Examples: To secure safety line of safety harness in, for example, concrete or masonry. Security of eye bolt should be checked before use.
Annex A

View of Typical Building Showing Arrangement Of Components.
Annex B
Access and Working Places

a) Walkways and Stairways

Examples : General Access

Some Conditions of Use: Edge protection must be adequate; grating or flooring units must have flush finish and be securely fixed; they must be maintained in a fit condition and checked regularly.

Comments : All permanent walkways, ladders and steps should be erected as early as possible. Temporary guard rails should be used, if necessary, in order to advance the use of those means of access if the permanent rails are not available (fixings may need to be built in for temporary provisions).

b) Ladders

Examples : General access to height, sometimes in confined spaces.

Some Conditions of Use: Permanent fittings should be securely fixed before used.

(i) Vertical Ladders

Examples : Access to columns

Some Conditions of Use: Securely fixed along length; Capable of safe removal; At edge of structure or over 9m high a proprietary fall protection system on the ladder should be used.

Comments : Fix to column prior to erection preferably on faces within the building line. Ladders should be of good construction without defects; Spaces to be allowed for toes behind ladder.

(ii) Inclined Ladder

Examples : General access to heights for bolting up of joints.

Some Conditions of Use: Securely fixed and founded. A person at bottom to stabilise ladder is satisfactory. Slope to be 1 in 4.

c) Rungs Welded to Columns

Examples : Access to tops of steel columns (requires some other form of access to that point - such as a ladder); access for maintenance if rungs not removed on completion of erection.

Some Conditions of Use: Properly designed and fabricated; pitch (or spacing) of flats should be based on requirements for ladders. A proprietary fall protection system should be incorporated on columns in excess of 9m in height.
d) **Telescopic Boom Articulated Arms**

**Single Arm Scissor Lifts**

**Examples** : Access to, and making connections (particularly for short duration repetitive work, such as final bolt up). Inspection of completed or partially completed work.

**Some Conditions of Use:** Firm and level purchase, stable base; operators should be trained and competent to use the machine.

**Comments** : Erection should be planned so that, for instance, previously erected members will not hinder the operation; ground conditions for both use and access to the point of use should be satisfactory; gives increased speed of access.

e) **Personnel Boxes**

**Examples** : Access to, and making connections on an open structure (particularly beams to columns).

**Some Conditions of Use:** Cranes must be fitted with automatic return-to-neutral controls. Limitations on carrying material inside box; cranes must have power load lowering. Maximum load must be clearly indicated.

f) **Tower Scaffolds**

**Examples** : Making connections. Permanent and welded connections.

**Some Conditions of Use:** Firm foundation, sound, even surface; erected by qualified persons only; height to base width can be critical and should be checked for stability; safe means of access to working places.

**Comments** : Ready made, moveable access as well as a working place. Tower may need to be secured.

g) **Swing Stage**

**Examples** : Remedial work on completed structure.

**Some Conditions of Use:** Outriggers to be of adequate length and correctly counterweighted or securely fixed to the structure.

**Comments** : Maximum load clearly indicated. Fall arrest device, on secondary safety rope, to be provided.

h) **Bosun Chair and Safety Chair**

**Examples** : Making connections where access from above is required.

**Some Conditions of Use:** Only to be used if access from immediately below the connection is unreasonable.

**Comments** : If bosun chair is used, occupant must be secured to the suspension rope.
i) **Common or Proprietary Scaffolds**

Examples: Construction of ladder access towers; providing a working platform.

Some Conditions of Use: Properly constructed under the supervision of a competent person; inspected regularly by a competent person; should be capable of being dismantled safely.

Comments: Scaffold may be erected with work-piece to avoid constructing the working platform at height.

j) **Purpose Built Platform (e.g., fabricated)**

Examples: At connections where a large number of fasteners or welding is required.

Some Conditions of Use: Fabricated platforms need to be properly designed and constructed; must be capable of being removed safely. Method of connection to supporting member should not allow accidental release or removal.

Comments: Removable platforms can be lifted (empty) for reuse at a new location. Fixed platforms can be attached to work-piece (e.g., to top of column) prior to erection.

k) **Hung Scaffold**

Examples: Atrium faces, below core slipform assemblies.

Some Conditions of Use: Properly constructed with suspension; inspected regularly by competent person.

l) **Lightweight Staging**

Examples: General access; working place; more than one unit may be required to provide sufficient width for intended use.

Some Conditions of Use: Must be adequately supported; must not be able to move (or slide) inadvertently; edge protection should be provided; safety harnesses or belts may be required if working below guard rail.

Comments: Can provide ready-made decking which can be moved readily; width can be increased by providing extra units; requires fewer supports than scaffold boards. May need securing against movement.

m) **Scaffold Planks**

Examples: General access; working place; normally more than one plank will be required to provide sufficient width for intended use.

Some Conditions of Use: Must be sound boards used in accordance with regulations.

Comments: A regular check on condition is required. May need securing against movement.
Acknowledgement

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