

# Formwork

Code of Practice 2016

OIR Disclosure Log

This Queensland code of practice was been approved by the Minister for Employment and Industrial Relations, Minister for Racing and Minister for Multicultural Affairs under section 274 of the *Work Health and Safety Act 2011* and commenced on 31 March 2016.

This code was varied by the Minister for Education and Industrial Relations on 1 July 2018.

OIR Disclosure Log

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# Foreword

This *Formwork Code of Practice 2016* is an approved code of practice under section 274 of the *Work Health and Safety Act 2011* (the WHS Act).

An approved code of practice is a practical guide to achieving the standards of health, safety and welfare required under the WHS Act and the *Work Health and Safety Regulation 2011* (the WHS Regulation).

From 1 July 2018, duty holders will be required to comply with either an approved code of practice under the WHS Act or follow another method, such as a technical or industry standard, if it provides an equivalent or higher standard of work health and safety to the standard required in the code.

A code of practice applies to anyone who has a duty of care in the circumstances described in the code. In most cases, following an approved code of practice would achieve compliance with the health and safety duties in the WHS Act, in relation to the subject matter of the code. Like regulations, codes of practice deal with particular issues and do not cover all hazards or risks which may arise. The health and safety duties require duty holders to consider all risks associated with work, not only those for which regulations and codes of practice exist.

Codes of practice are admissible in court proceedings under the WHS Act and WHS Regulation. Courts may regard a code of practice as evidence of what is known about a hazard, risk or control and may rely on the code in determining what is reasonably practicable in the circumstances to which the code relates.

An inspector may refer to an approved code of practice when issuing an improvement or prohibition notice. This may include issuing an improvement notice for failure to comply with a code of practice where equivalent or higher standards of work health and safety have not been demonstrated.

## Scope and application

This code provides practical guidance to persons conducting a business or undertaking on how to comply with their health and safety duties when carrying out construction work involving formwork including high risk construction work.

### How is the code organised

In providing guidance, the word 'should' is used in this code to indicate a recommended course of action, while 'may' is used to indicate an optional course of action.

This code also includes various references to provisions of the WHS Act and WHS Regulation which set out the legal requirements. These references are not exhaustive. The words 'must', 'requires' or 'mandatory' indicate that a legal requirement exists and must be complied with.

# 1 Introduction

## 1.1 What is formwork?

Formwork is a temporary structure that supports part or the whole of a permanent structure until it is self-supporting. Individual components of formwork, for example frames, are plant. Once assembled the components form the temporary structure. Some formwork systems are designed to remain with the permanent structure.

Generally work carried out to design, construct, erect, alter, maintain, dismantle or remove formwork will be defined as construction work.

**Formwork** means the surface used to contain and shape wet concrete until it is self-supporting. This includes the forms on or within which the concrete is poured and the frames and bracing which provide stability. Although commonly referred to as part of the formwork assembly, the joists, bearers, bracing, foundations and footings are technically referred to as falsework.

For the purpose of this code, the term 'formwork' will be used to describe both formwork and falsework.

### What is construction work?

**WHS Regulation section 289:** Construction work means any work carried out in connection with the construction, alteration, conversion, fitting-out, commissioning, renovation, repair, maintenance, refurbishment, demolition, decommissioning or dismantling of a structure.

Construction work includes:

- installation or testing carried out in connection with an activity referred to in the definition
- the removal from the workplace of any product or waste resulting from demolition
- the prefabrication or testing of elements at a place specifically established for the construction work, for use in construction work
- the assembly of prefabricated elements to form a structure, or the disassembly of prefabricated elements forming part of a structure
- the installation, testing or maintenance of an essential service for a structure
- work connected with an excavation
- work connected with any preparatory work or site preparation including landscaping as part of site preparation carried out in connection with an activity referred to in the definition above, and
- an activity referred to in the definition carried out on, under or near water including work on buoys and obstructions to navigation.

In addition, formwork may include construction work that is defined as high risk construction work in the WHS Regulation for which a safe work method statement (SWMS) must be prepared before the work starts (see section 3.3 for more information on SWMS requirements).

## 1.2 Who has health and safety duties in relation to formwork activities?

**A person conducting a business or undertaking (PCBU)** has the primary duty to ensure, so far as is reasonably practicable, workers and other people are not exposed to health and safety risks arising from the business or undertaking.

This duty requires the person to manage risks by eliminating health and safety risks so far as is reasonably practicable, and if it is not reasonably practicable to eliminate the risks, by minimising those risks so far as is reasonably practicable. It also includes ensuring, so far as is reasonably practicable the:

- design, provision and maintenance of safe formwork plant and structures
- safe erection, alteration, dismantling and use of formwork, and
- safe use, handling, storage and transport of formwork plant.

The WHS Regulation include specific duties for a person conducting a business or undertaking with management or control of a construction workplace, plant, powered mobile plant and plant that lifts or suspends loads.

**Designers, manufacturers, suppliers and importers** of plant or structures, including temporary structures, must ensure, so far as is reasonably practicable, the plant or structure is without risks to health and safety. This duty includes providing information to manufacturers so that plant can be manufactured and erected to the design specifications. Designers must give the person who commissioned the design of the temporary structure a written safety report.

**People installing, constructing or commissioning** plant or structures must ensure, so far as is reasonably practicable, all workplace activity relating to the plant or structure including its installation, use, decommissioning or dismantling is without risks to health or safety.

**Officers**, such as company directors, have a duty to exercise due diligence to ensure the business or undertaking complies with the WHS Act and WHS Regulation. This includes taking reasonable steps to ensure the business or undertaking has and uses appropriate resources and processes to eliminate or minimise risks from the formwork activity.

**Workers and other people at the workplace** must take reasonable care for their own health and safety, co-operate with reasonable policies, procedures and instructions and not adversely affect other people's health and safety.

### 1.3 What is involved in managing risks associated with formwork activities?

**WHS Regulation section 297:** A person conducting a business or undertaking must manage risks associated with carrying out construction work.

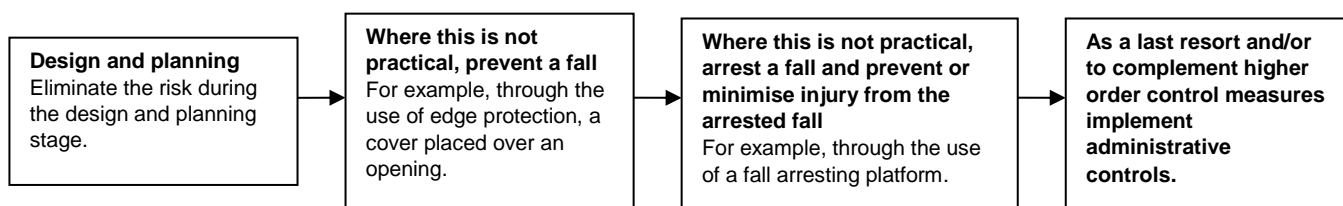
**WHS Regulation section 34-38:** To manage risk, a person conducting a business or undertaking must:

- identify reasonably foreseeable hazards that could give rise to risks to health and safety
- eliminate risks to health and safety so far as is reasonably practicable
- if it is not reasonably practicable to eliminate risks to health and safety—minimise those risks so far as is reasonably practicable by implementing risk control measures according to the hierarchy of control in WHS regulation 36
- ensure the control measure is, and is maintained so that it remains, effective, and
- review and as necessary revise control measures implemented to maintain, so far as is reasonably practicable, a work environment that is without risks to health or safety.

To properly manage risks, a person must:

- identify hazards – find out what caused the harm
- assess risks that may result because of the hazards – understand the nature of the harm that could be caused by the hazard, how serious the harm could be and the likelihood of it happening
- decide on control measures to prevent, or minimise the level of, the risks and implement control measures, and
- monitor and review the effectiveness of the measures.

Control measures to manage the risk of falls (see WHS Regulation sections 78 and 79) must be implemented in an order of priority and implemented before work commences. The following example illustrates the order of priority where there is a risk a person could fall.



Guidance on the general risk management process is in the *How to manage work health and safety risks Code of Practice*.

Hazards associated with work involving the erection, alteration and/or dismantling of formwork include:

- formwork collapse (before, during and after placement of concrete)
- falls from heights – see the *Managing the risk of falls at workplaces Code of Practice*.
- slips and trips
- falling objects
- noise – see the *Managing noise and preventing hearing loss at work Code of Practice*.
- dust
- manual tasks – see the *Hazardous manual tasks Code of Practice*.

### Consulting workers

**WHS Act section 47(1):** The person conducting a business or undertaking must, so far as is reasonably practicable, consult with workers who carry out work for the business or undertaking who are, or are likely to be, directly affected by a matter relating to work health or safety.

**WHS Act section 48(2):** If the workers are represented by a health and safety representative, the consultation must involve that representative.

Consultation involves sharing of information, giving workers a reasonable opportunity to express views and taking those views into account before making decisions on health and safety matters.

Consultation with workers and their health and safety representatives is required at each step of the risk management process. In many cases decisions about construction work and projects are made before engaging workers so it may not always be possible to consult with workers in these early stages. However it is important to consult with workers as formwork activities progress. By drawing on the experience, knowledge and ideas of your workers you are more likely to identify hazards and choose effective control measures.

You should encourage your workers to report hazards and health and safety problems immediately so the risks can be managed before an incident occurs and you must consult your workers when proposing any changes to the work that may affect their health and safety.

### Consulting, cooperating and coordinating activities with other duty holders

**WHS Act section 46:** If more than one person has a duty in relation to the same matter, each person with the duty must, so far as is reasonably practicable, consult, cooperate and coordinate activities with all other persons who have a duty in relation to the same matter.

Sometimes you may share responsibility for a health and safety matter with other business operators who are involved in the same activities or who share the same workplace. In these situations, you must exchange information to find out who is doing what and work together in a cooperative and coordinated way so that all risks are eliminated or minimised as far as reasonably practicable.

Further guidance on consultation is in the *Work health and safety consultation, co-operation and co-ordination Code of Practice*.

## 1.4 Information, training, instruction and supervision

**WHS Act section 19(3)(f):** A person conducting a business or undertaking must ensure, so far as is reasonably practicable, the provision of any information, training, instruction or supervision that is necessary to protect all persons from risks to their health and safety arising from work carried out as part of the conduct of the business or undertaking.

**WHS Regulation section 39(2) and (3):** A person conducting a business or undertaking must ensure that information, training and instruction provided to a worker is suitable and adequate having regard to:

- the nature of the work carried out by the worker



- the nature of the risks associated with the work at the time of the information, training and instruction, and
- the control measures implemented.

The person must ensure, so far as is reasonably practicable, that the information, training and instruction provided under this regulation is provided in a way that is readily understandable by any person to whom it is provided.

**WHS Regulation section 317(1):** A person conducting a business or undertaking must not direct or allow a worker to carry out construction work unless the worker has successfully completed general construction induction training and if the worker completed the training more than 2 years previously—the worker has carried out construction work in the preceding 2 years.

All persons who may be exposed to work health and safety risks resulting from formwork construction must be provided with information and training that is specific to the formwork system that is being used.

Such training and information should include details of:

- the formwork system, tasks, activities and components
- the way the manufacturer or designer of the formwork system intended the system to be erected, installed, used, moved, altered or dismantled
- specific training and information required to undertake or participate in specific tasks or activities
- control measures to minimise exposure to the risks, correct use of controls, and how to ensure they are kept in full working order
- safe working procedures, including the use of mechanical aids and devices, where appropriate
- how to use and maintain equipment, including any specific conditions and prohibitions on the use of equipment. Reference must be made to operator's manuals
- any special safety information needed such as safety precautions for working under certain conditions
- personal protective equipment required, including instruction in fitting, use, cleaning, maintaining and storing this equipment
- details of how accidents have occurred in the past involving the same work process(es).

Persons involved in formwork activities must also be provided with more general work health and safety information and training including:

- the effects of noise on their hearing and health
- Queensland's work health and safety legislation, including relevant parts of this code of practice
- the workplace's health and safety policies, and relevant procedures and safe work method statements
- the risk management process
- inspection and maintenance programs in place at the workplace
- how to access information such as manufacturer's instructions about hazards
- emergency procedures, including persons with specific emergency roles and responsibilities.

### **Training for persons involved in erection of modular formwork systems**

Persons involved in the erection of modular formwork systems should be trained in the safe erection and dismantling of the system as well as inspection criteria for materials as an example, defects which would preclude the use of the materials. The modular system designer should provide written instructions on the erection and dismantling of the system and these instructions should at least provide equivalent levels of safety for a person as those detailed in this code. Training by representatives of the modular formwork system supplier is encouraged.

### **Training for persons working on jump forms, slip forms, self-climbing and crane lifted vertical formwork**

In view of the specialised work systems and unique hazards that exist on jump forms and slip forms, specific training should be provided for persons intending to work on the forms.

Training should include, but not be limited to:

- The maximum loadings that can be applied to the various areas on the form. This would include information about areas where materials can be stored.
- Restricted access areas and procedures for installation and removal of edge protection.
- Climbing or jumping procedures for those involved in these operations.
- Emergency evacuation procedures for those required to work on the form.
- Firefighting procedures to be used in emergency situations prior to firefighting personnel arriving at the scene.
- Any other special work procedures that specifically apply to working on the form. As examples, time limits for working in cells where these apply or safe undertaking of manual tasks.

## 2 Design

Eliminating hazards at the design or planning stage is often easier and more cost effective to achieve than making changes later when hazards become real risks in the workplace. Safe design means the integration of control measures early in the design process to eliminate or, if this is not reasonable practicable, minimise risks to health and safety throughout the life of the structure being designed.

**WHS Act section 22:** A person (the designer) who conducts a business or undertaking that designs plant or a structure that is to be used, or could reasonably be expected to be used, as, or at, a workplace must ensure, so far as is reasonably practicable, that the plant or structure is designed to be without risks to the health and safety of persons who:

- use the plant or structure at a workplace for a purpose for which it was designed
- store the plant
- construct the structure
- carry out any reasonably foreseeable activity at a workplace in relation to the manufacture, assembly or use of the plant or structure for a purpose for which it was designed, or the proper storage, decommissioning, dismantling or disposal of the plant or structure, or
- are at or in the vicinity of a workplace and who are exposed to the plant or structure at the workplace or whose health or safety may be affected by one of the above uses or activities.

The designer must:

- carry out, or arrange the carrying out of, any calculations, analysis, testing or examination that may be necessary to ensure, so far as is reasonably practicable, that the plant or structure is designed to be without risks to the health and safety of persons
- give adequate information to each person who is provided with the design for the purpose of giving effect to it, and
- on request, so far as is reasonably practicable, give current relevant information to a person using the plant or structure for a purpose for which it was designed or when carrying out a reasonably foreseeable activity using the plant.

**WHS Regulation section 294:** A person who conducts a business or undertaking that commissions construction work (the client) in relation to a structure must, so far as is reasonably practicable, consult with the designer of the whole or any part of the structure about how to ensure that risks to health and safety arising from the design during construction are eliminated or minimised so far as is reasonably practicable.

Consultation must include giving the designer any information that the person who commissions the construction work has in relation to the hazards and risks at the workplace where the construction work is to be carried out.

Consultation should include the following:

- preparation of a project brief by the person commissioning the construction work that outlines the safety requirements and objectives for the project and provides the designer with all available site information that may affect health and safety (e.g. proximity to underground or overhead services — especially electric lines)

- the designer should ask the person commissioning the construction about safety issues such as the types of activities and tasks likely or intended to be carried out in the structure.

A safety report specifying the hazards relating to the design of a structure must be prepared by the designer for designs that have unusual or atypical features but not for common designs where the risks are already known. For example, a design specifying an unusual structure for a specific application may introduce unique hazards requiring specific risk controls. The written safety report should include information about:

- any hazardous materials or structural features and the designer's assessment of the risk of injury or illness to construction workers arising from those hazards,
- the action the designer has taken to control risks (e.g. changes to the design),
- how to use a component or component system safely,
- formwork methods
- the health and safety risk control measures to be used.

Where there is a principal contractor, the person conducting a business or undertaking who commissioned the construction must give a copy of the designer's safety report to the principal contractor.

### Plant design registration

Structural components, including formwork frames, specifically intended to support formwork do not require design registration. However, if traditional prefabricated scaffolding is used as part of the supporting structure, these components require design registration. The person with management or control of design registrable plant must ensure the design registration number is kept where it is readily accessible. If you are hiring prefabricated scaffolding, the supplier must provide the design registration number, usually on the supply docket or agreement.

## 2.1 Safe design of buildings in relation to formwork

Safe design means the integration of control measures early in the design process to eliminate or, if this is not reasonably practicable, minimise risks to health and safety throughout the life of the structure being designed.

Safe design must be factored in during the design phase and should begin at the concept development phase of a structure when making decisions about:

- the design and its intended purpose
- possible methods of construction, maintenance, operation, demolition or dismantling and disposal;
- materials to be used
- what legislation, codes of practice and standards need to be considered and complied with.

### 2.1.1 Build-ability

Designers, including engineers and architects, must consider the 'build-ability' of a structure or building and produce a design that eliminates or minimises the risk of injury during construction.

The design of the final concrete structure can have a major effect on the ease of formwork construction, and consequently, on the safety of persons during construction. Generally, the more basic and simple the final concrete structure, the safer it is to erect.

Some of the measures that should be considered by the designer of the building or structure to minimise exposure to risk of injury during the construction of formwork include:

- Reducing variations in the floor depth so that it has one consistent depth.
- Reducing the number of columns required and where columns exist, design the columns so capitals or dropdowns don't exist.
- Reducing cantilevered floor sections.
- Consider alternative designs (e.g. prefabricated concrete elements-columns, beams and floor panels).
- Planning for manual tasks. Consideration must be given to the suitability of the design of different formwork systems that will reduce manual tasks risks, including:

- table forms
- systems with lighter weights of materials to be handled
- methods of formwork erection, alteration and dismantling
- improved access and egress for workers and movement of materials and equipment
- methods for moving large and heavy components, materials and equipment (i.e. making allowances for a crane and other mechanical lifting devices to be used).
- Planning for adequate access and sufficient workspace, for example designing cells that have adequate floor area and height to enable workers to carry out their work in a safe environment. Issues to consider include:
  - adequate ventilation
  - material access
  - allowance for access and egress systems,
  - adequate space to perform work safely.
- Allow sufficient clearance to adjacent structures and safe methods for moving large and heavy components, materials and equipment (i.e. making allowances for a crane and other mechanical lifting device to be used).

Further guidance on safe design is in the *Safe design of structures Code of Practice*.

### Changing floor levels

Formwork decks are rarely flat across the entire floor, generally due to deep beams or 'drop downs' (sometimes called 'capitals') around columns. Uneven floors introduce fall hazards. It is preferable that these hazards be eliminated at the design stage. These hazards are most effectively managed by ensuring that formwork supports and the deck are progressively constructed for the lower parts of the deck before work commences on the higher-level areas of the deck.

As illustrated in Diagram 1, decks of a consistent depth may result in savings in concrete and steel but will result in additional labour and material costs. Decks of a varying depth introduce a greater quantity of cantilevered beams and joists, which contribute to the risk of a person falling.

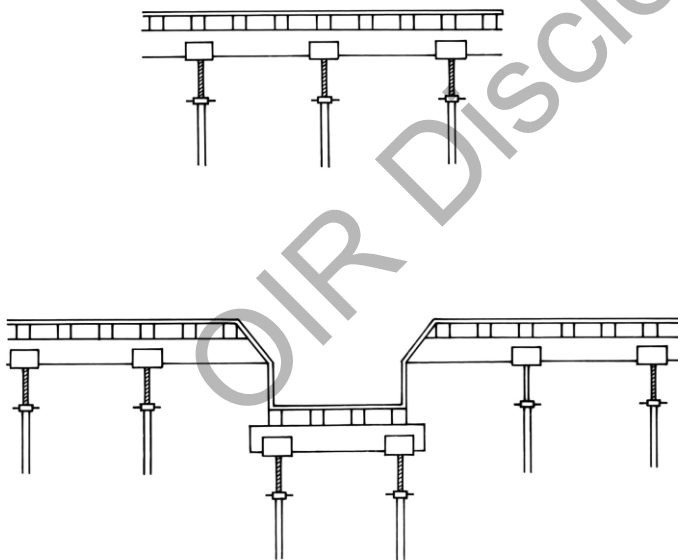


Diagram 1 - Flat floor and deep floor beams

### 2.1.2 Materials – traditional formwork

All materials and equipment used in formwork construction must be fit for the intended purpose and meet design specifications. Materials and equipment must be designed to conform to relevant Australian Standards. Where material is designed to an international or other standard, an engineer must certify that it conforms to the relevant Australian Standard. Materials and equipment must also be manufactured in accordance with a quality assurance system that ensures compliance with the design specification.

A suitable system must be implemented to ensure that only materials and components that comply with the specifications of the formwork design drawings and documentation are being used. Materials and components that are damaged, excessively worn or not fit for the intended use must not be used.

Evidence must be kept on site, which verifies that formply sheets conform to Australian Standards. Such evidence may include:

- a purchase order which details the specifications of the formply sheets ordered, or
- that the formply sheets be marked in accordance with Australian Standards (see *AS6669 Plywood – Formwork*).

For information regarding materials used in modular proprietary systems see section 2.2.2 – Modular proprietary system design.

### **Importers of material**

Importers have a duty to ensure, so far as is reasonably practicable, plant (e.g. prefabricated formwork) is without risks to health and safety. This includes, eliminating or minimising risks to health and safety regarding the plant being supplied, where the manufacturer has not already done so.

Importers should confirm they are being provided with safe plant. For example, they must inspect and test the supplied plant and inspect or get third party verification of the manufacturing process. The level of inspection and testing done by an importer should be based on what is necessary to be confident that the product is safe.

When dealing with a new manufacturer or one whose products have been previously identified as non-compliant, the inspection and testing of the supplied plant may initially need to be more extensive.

Any imported plant must be inspected having regard to information provided by the manufacturer. If this information requires the plant to be tested then the importer must undertake this testing.

## **2.2 Formwork systems**

The design of all formwork systems, both traditional and modular, must satisfy:

- *AS3610 - Formwork for concrete*
- *AS3600 - Concrete structures*.

### **2.2.1 Safe formwork design and certification**

An 'engineer' (as defined in Appendix 1), such as a suitably qualified civil engineer experienced in structural design, is responsible for overseeing the safe design and certification of the complete formwork structure. This includes design of the formwork support structure, the formwork deck and connection details, and certification that the formwork drawings and other formwork documentation have been completed. Sample engineer's certification letters are provided at Appendix 2. The project engineer is responsible for providing project documentation (as detailed in section 2.2.3 of this code) to assist with the design of the formwork.

While this code requires that overseeing the safe design and certification of formwork systems may only be performed by an engineer, it is recognised that some design work may be performed by appropriate personnel such as a 'competent person' experienced in formwork design and documentation. Design documentation may only be prepared by a competent person in the circumstances listed in Table 1 if the competent person is using brochures, charts, tables and information which has previously been verified for compliance with *AS3610 - Formwork for concrete* by a suitably qualified engineer. 'Competent person' is defined in the dictionary at Appendix 1.

<b>Formwork design and certification</b>	
<b>Vertical formwork (columns and walls)</b>	
Less than 2.4m high	Competent person
2.4 to 3.5m high	Engineer
More than 3.5m high (single arrangement)	Engineer
More than 3.5m high (repetitive arrangement)	Engineer
Single-sided less than 2.4m	Competent person
Single-sided more than 2.4m	Engineer
Self-climbing or crane assisted formwork systems	Engineer
<b>Soffit formwork</b>	
Less than 3m high and less than 250mm thick	Competent person
More than 3m high <b>or</b> more than 25 mm thick	Engineer
Infill slabs less than 4.5m high, 20m <sup>2</sup> and 300mm thick	Competent person
Stair and landing formwork more than 3m high <b>or</b> more than 200mm thick	Engineer
Multistorey formwork and backpropping	Engineer

Note: the height specified in Table 1 is the height measured from the floor/ground immediately below.

When specifying the design of the formwork system, an engineer or competent person (as per Table 1) must allow for all loads that can be expected to be applied during construction, including loads applied by:

- the formwork deck, supporting members and formwork frames
- any false decks that may be provided
- concrete pouring techniques (i.e. kibble or pump)
- the concrete pour which includes both the weight of the concrete and dynamic factors applied. The concrete pour rate and pour sequence must be specified.
- workers on the formwork deck and false decks
- stacked materials
- crane lifted materials on both the complete and incomplete formwork deck
- wind to the system as detailed in *AS1170.2 Structural design actions - Wind actions*. An allowance for wind loading is particularly important for vertical forms.
- environmental loads including forces due to water flowing around the formwork. Rain and run off can have a detrimental effect if not considered by a designer.

### Wind loading

An engineer must consider wind loadings on formwork, particularly for external walls, columns, free-standing shutters, blade walls and any platforms which may be subject to uplift.

Vertical elements must be fully braced prior to and during stripping, and until such time as the construction will provide adequate support and/or protection against wind loading.

Wind loading will vary depending on:

- the size of form
- the nature of the form
- wind speed
- wind resistance (e.g. screens)
- wind direction.

Shade cloth used on screens, signage and outside screens will increase the effective wind loading of an open structure.

The geographical location of the construction site will also have a bearing on the severity of wind on the structure. Wind generally has less effect in built up or hilly areas. *AS1170.2 Structural design actions - Wind actions* specifies four different terrain categories that must be taken into consideration by an engineer as well as basic wind speeds for different zones in Australia. There are three regions for Queensland:

- **Region A (normal)** – most of Queensland excluding coastal areas (includes Toowoomba and Mt Isa).
- **Region B (intermediate)** Queensland coastal areas south of Bundaberg and a narrow band behind region C (includes Brisbane and all of Gold Coast and Sunshine Coast).
- **Region C (tropical cyclones)** all coastal areas north of, and including, Bundaberg. Region C has the greatest wind speeds.

There are a number of other factors that need to be considered by an engineer when calculating wind pressure on wall and column forms and the resultant number of braces and size of anchorage point required. The number of braces for securing a column or wall form is not to be considered to be necessarily in direct proportion to wind speed. Wind pressure will vary as a function of the square of the wind speed. A small increase in wind speed produces a much larger increase in pressure and a much larger increase in the number of braces or size of brace anchors required.

### 2.2.2 Modular proprietary system design

A number of formwork support systems are designed as modular systems that are intended to be erected in specific configurations as prescribed by the designer and manufacturer. While modular systems require engineer design certification, this certification can be done once and used as evidence of design compliance provided:

- the design certification is carried out by an engineer
- the design certification is in the form of a signed compliance statement (in accordance with *AS3610 Formwork for concrete*)
- the compliance statement clearly identifies the modular formwork system and cross references the method in which the modular system must be erected.

The design certification can be provided as part of the brochure or erection instructions prepared by the manufacturer of the system.

The design certification only applies when the modular system is erected in accordance with the manufacturer's documented instructions. Specific engineering certification must be provided for the modular system if:

- there is any variation from the manufacturer's erection instructions  
or
- the modular system is used in conjunction with a traditional formwork support system or any other type of modular system.

Timber used with modular proprietary systems may comply with the relevant standard where the system is manufactured provided:

- The standard is specifically for formwork applications
- The timber is designed and manufactured for outdoor use
- The timber is marked in accordance with the design standard
- The standard makes reference to a quality assurance standard that the timber is to comply with.

### 2.2.3 Documentation

#### Project documentation

Project documentation must include the following information:

- minimum stripping times and stripping procedures and requirements for health and safety
- any limitations on the magnitude and location of stacked materials and minimum strength of concrete to be achieved prior to materials being stacked
- requirements for the minimum number of levels of supports relative to the type of formwork, timing and sequence of its use, the anticipated time between construction of subsequent floors and the expected ambient temperature for multistorey structures
- limitations on the use of the permanent structure for the restraint of formwork
- details of and information on the effect of post-tensioning procedures on the formwork and any special procedures to be adopted in the stripping of formwork
- location of any mandatory joints and any special procedures for locating other joints

- sequence of placement of concrete
- requirements for propping of any composite construction
- details of the cambering of any slabs or beams
- design loads for the permanent structure
- details of any inserts, water stops, specially formed shapes or penetrations to be constructed, the location and details of which are critical to the serviceability of the permanent structure
- any known information about the foundation which is relevant to the design of the footings for the formwork assembly
- information about any permanent formwork systems, together with any limitations on deflections and any special requirements for their erection and concreting
- information on any architectural or structural component details to be cast into the structural concrete
- details of fall and edge protection, that is, perimeter scaffolding
- details of back propping that may be required and minimum time intervals between concrete pours.

### **Formwork drawings**

Formwork drawings must explain:

- plans, elevations and sections to show the general arrangement of the formwork and to identify and locate all members and components including bracing
- wall and column form details
- the maximum point loadings to be applied
- the component types and spacings
- the maximum jack extensions
- the bearer and joist timber type, the dimensions and spacings
- the prop sizes and maximum extensions
- the methods for tying the structure together and spacing between ties (if required)
- the formply size.

Where eccentric loading is to be applied to U-heads (i.e. single bearers are positioned to one side of the U-head), the formwork drawings must state that this is permitted.

### **Other formwork documentation**

The following information must also be provided in the formwork documentation:

- details sufficient to fully describe important or unusual features of the design
- reference to documentation for proprietary items
- safe work method statements for the erection and stripping of the formwork assembly
- the areas of the forms designed to carry stacked loads
- acceptance criteria for single use formwork
- requirements of the project documentation relating to formwork
- method of provision for field adjustment of the forms prior to and during concrete placement
- where required, location of weep holes, vibrator holes, clean-out holes and inspection openings
- sequence of concrete placement, including direction of intended pour on raking or sloping surfaces (e.g. car park ramps and minimum elapsed time between adjacent placements)
- wrecking strips and other details relating to stripping of the forms
- design assumptions, including those related to strength, stability and stiffness
- footing design assumptions, such as foundation material description, safe bearing value, limitations on settlement during erection of formwork, placement of concrete and dismantling of formwork. Reference to information sources such as geotechnical reports must also be included
- preparation of the foundation, such as filling, compaction and drainage
- footing details, such as type and size of footings, level of soffit, concrete strength, reinforcement, specification and details of site filling or compaction, and precautions against washouts
- engineer certification of non-proprietary equipment
- vertical pour rates, and
- methods of securing single or multiple props.



## 2.2.4 Design variations

All variations from the design of a formwork system must be checked by an engineer and:

- certified in writing by the engineer as being acceptable (that is, complying with *AS3610 Formwork for concrete*), if the engineer can verify this is the case
- altered in accordance with the written directions of an engineer in order to comply with AS3610, within a time frame specified by the engineer.

Potential variations include:

- structural design change (i.e. a thicker floor slab).
- a reduced number of formwork frames under the formwork deck
- different types of braces or props to the ones indicated on the formwork drawing
- different types and/or quantities of ties on the formwork structure
- increased spans on members supporting the formwork deck
- variations in the back-propping system specified by an engineer
- connections between traditional formwork and modular formwork.

## 2.2.5 On site coordination and verification

The following documentation must be available for inspection on site:

- Certification of maximum loads from stacked materials that the formwork assembly can withstand.
- Specifications for the concrete and when formwork can be removed.
- Back propping details (plans and elevations including tying in).
- Drawings for the formwork design. The drawings must be signed by an engineer or be accompanied by a certification letter that lists the drawing numbers and drawing revision numbers.

### Verification of the structure with the design

Verification that the formwork structure complies with the design of the formwork system must be documented and provided. A construction check list (as illustrated at Appendix 3) can be used to assist in this process. Relying solely upon such a checklist will not be sufficient to verify compliance with relevant Australian Standards. The verification and documentation that a design has been complied with may be delegated to a 'competent person' (see Appendix 1) on site. Table 2 provides a list of circumstances where a competent person may perform an inspection.

Table 2 Circumstances where a competent person may perform an inspection

	Inspection	
	Access for trades	Pre-pour
<b>Vertical formwork (columns and walls)</b>		
Less than 2.4 m high	Competent person	Competent person
2.4 to 3.5 m high	Competent person	Competent person
More than 3.5 m high (single arrangement)	Competent person	Engineer
More than 3.5 m high (repetitive arrangement)	Initial pre-pour inspection by engineer on first arrangement only and then competent person thereafter	
Single-sided less than 2.4 m	Competent person	Competent person
Single-sided more than 2.4 m	Competent person	Engineer
Self-climbing or crane assisted formwork systems	Initial pre-pour inspection by engineer and then competent person thereafter	
<b>Soffit formwork</b>		
Less than 3m high and less than 250mm thick	Competent person	Competent person
More than 3m high <b>or</b> more than 250mm thick	Competent person	Engineer
Infill slabs more than 4.5m high, 20m <sup>2</sup> and 300mm thick	Competent person	Engineer
Stair and landing formwork more than 3m high <b>or</b> more than 200mm thick	Initial pre-pour inspection by engineer and then competent person thereafter	
Multistorey formwork and backpropping	Competent person	Engineer

Note: the height specified in Table 2 is the height measured from the floor/ground immediately below.

A competent person, if not an engineer, must have appropriate training and knowledge to perform onsite inspections of the formwork system. This delegated person needs to be experienced in formwork construction and be competent in reading drawings and be able to certify that the formwork structure satisfies the details on the formwork drawings, specifications and any other formwork documentation.

Should the competent person on-site not be an engineer, the delegated person can only verify that the designer's specifications and drawings have been complied with. A competent person who is not an engineer must not authorise variations to the design. The delegated person may require corrections to the formwork system if some details do not pass as indicated on the construction checklist by providing written instructions on remedial action to be undertaken prior to the concrete pour.

If any items on the construction checklist are to be referred to an engineer, then the competent person must refer them to an engineer in writing. A competent person must ensure the remedial action has occurred prior to the concrete pour including any items referred to an engineer for certification and modified as instructed by an engineer.

A pre-pour inspection should focus on verifying that the design has been complied with and matters such as:

- correct spacing of frames, props and timbers
- correct joist and bearer sizes
- acceptable jack extensions
- quality of materials being used
- back propping
- adequate bracing to ensure stability.

An effective quality control system must be implemented for the construction of formwork. A pre-pour inspection is a check to assist in ensuring the specifications of the engineer have been complied with. A pre-pour inspection should be a part of any quality control system.

Sign-off by an engineer or competent person as specified in Table 2 is required following the final pre-pour inspection. A sample pre-pour structural certificate is provided at Appendix 4.

Appendix 5 illustrates some of the more common defects which are likely to occur in a formwork system. This list is intended to give guidance to a competent person and should not be considered to be exhaustive. In any individual case, some items will be less important than others and only a competent person with appropriate experience can assess their relative importance.

## 3 Coordination and administration

### 3.1 Work program

The risk to a person's health and safety must be considered when designing a work program for erecting, altering and/or dismantling formwork. Consideration must be given to:

- sequencing work to ensure sufficient time is allowed for each work activity
- coordinating trades to allow work to be completed free from obstruction
- allowing for the progressive clean-up of work areas to prevent rubbish becoming a trip hazard and allowing access for mechanical aids
- taking account of edge protection requirements and ensuring these are designed and constructed appropriately.

### 3.2 The work environment

**WHS Regulation section 40:** A person conducting a business or undertaking must ensure, so far as is reasonably practicable, that:

- the layout of the workplace allows, and is maintained to allow, persons to enter and exit the workplace and move within it safely, both under normal working conditions and in an emergency

- work areas have space for work to be carried out safely
- floors and other surfaces are designed, installed and maintained to allow work to be carried out safely
- lighting enables each worker to carry out work safely, persons to move around safely and safe evacuation in an emergency
- ventilation enables workers to carry out their work without risk to their health and safety
- workers exposed to extremes of heat or cold are able to carry out work without risk to their health and safety
- work in relation to or near essential services (such as gas, electricity, water, sewerage and telecommunications) do not affect the health and safety of persons at the workplace.

Formwork construction, because of its constantly changing work environment, restricted access through frames and formwork supports and a large volume of material and waste, requires ongoing monitoring of housekeeping practices.

### 3.2.1 Entry and exit

Clear access is important for the safe movement of materials, equipment and persons on site. Designated access ways must be provided. Persons must be instructed to use the access ways and keep them clear of any rubbish, plant or materials. In some situations, it may be necessary to use hazard taping or other visual methods to clearly show where access ways are located. This is particularly important where access is required through formwork frames.

Emergency access and egress must be considered and provided to all parts of the workplace where persons are required to work (refer to section 7.1 for slip form, jump form, self-climbing and crane lifted vertical access and egress requirements). Where the plant listed in column 1 of Table 3 is available onsite for emergencies, the corresponding mechanisms in column 2 should be provided as a dual emergency access and egress option. Two forms of emergency access and egress should be maintained at all times.

Table 3 Dual emergency access and egress solutions

	<b>Emergency access and egress solutions required</b>	<b>Additional emergency access and egress solutions required</b>
1	Man and material hoist	Stretcher stair and single scaffold stair
2	Crane only	Stretcher stair and single scaffold stair
3	Man and Material Hoist and crane	Stretcher stair and single scaffold stair
4	No crane or man and materials hoist	Two stretcher stairs are to be provided for emergency access

Further information regarding access and egress requirements is provided in section 4.5 (use stair tread systems and ladders).

### 3.2.2 Material storage

Materials must be stored so as to minimise manual tasks hazards, trip hazards and the potential for falling objects. Smaller components such as U-heads, couplers, base plates and 'Z-bars' should be contained in material boxes. Where practicable, frames and formply should be strapped until it is time to use them. Bearers and joists should also be strapped together in bundles or stacks. These bundles or stacks should be located back from the edge of the deck or openings to prevent materials or persons accessing the materials falling through or off the deck.

It is preferable to lay wall forms flat on the ground instead of leaning them against structures or other forms that are not purpose made "A" frames. Timbers, or another effective means, must be provided under the forms where slings are to be placed under the forms for crane lifting.

When not in use, wall forms may be stacked in or against purpose made “A” frames. This is preferable to leaning the forms against other structures. If this is not practical, wall forms must be stacked in such a way that they cannot move away or rotate from the surface they are placed against. An engineer must verify in writing that a surface to be used for the stacking of forms is capable of withstanding the impact of all imposed loads, including wind loading. The engineer also needs to consider both maximum and point distributed loads on the formwork deck and record this information in the formwork drawings.

Incorrect materials delivery and storage can create significant manual tasks. Safe work practices to minimise exposure to these risks include:

- ensuring the formwork materials are delivered as close as possible to the job
- designing and designating a small section of the formwork as a loading platform to load ply and other components
- ensuring mechanical aids are used to handle loads wherever possible
- storing loads on trolleys to minimise double handling or on raised platforms to minimise manual lifting from ground level
- having adequate storage space or lay down area to safely store materials and equipment and to minimise double handling.

### 3.2.3 Rubbish storage and removal

Rubbish storage and removal for formwork may include the provision of rubbish skips and wheel barrows that are moved as work progresses. However, rubbish skips should only be positioned where the supporting structure has adequate strength to support the total weight of the bin and likely contents.

### 3.2.4 Lighting

Sufficient access lighting and task lighting must be provided, whether it is from a natural or artificial source, to allow safe movement around the workplace and to allow workers to perform their job without having to adopt awkward postures or strain their eyes to see. Additionally, emergency lighting must be provided for the safe evacuation of people in the event of an emergency.

AS/NZS1680.1: 2006 – *Interior workplace lighting* and the *Managing the work environment and facilities Code of Practice* provide guidance on the recommended illumination levels for various types of tasks, activities or interiors.

## 3.3 Safe work method statements

**WHS Regulation section 299(1):** A person conducting a business or undertaking that includes the carrying out of high risk construction work must, before high risk construction work commences, ensure that a safe work method statement for the proposed work is prepared or has already been prepared by another person.

A safe work method statement (SWMS) must be prepared for high risk construction work before the work starts.

A range of activities defined as high risk construction work may be carried out including work:

- involving a risk of a person falling more than 2 metres
- carried out on a telecommunication tower
- involving demolition of an element of a structure that is load-bearing or otherwise related to the physical integrity of the structure
- involving or likely to involve the disturbance of asbestos
- involving structural alterations or repairs that require temporary support to prevent collapse
- carried out in or near a confined space
- carried out in or near –
  - a shaft or trench with an excavated depth greater than 1.5 metresor

- a tunnel
- involving the use of explosives
- carried out on or near pressurised gas distribution mains or piping
- carried out on or near chemical, fuel or refrigerant lines
- carried out on or near energised electrical installations or services
- carried out in an area that may have a contaminated or flammable atmosphere
- involving tilt-up or precast concrete
- carried out on, in or adjacent to a road, railway, shipping lane or other traffic corridor that is in use by traffic other than pedestrians
- carried out at a workplace in which there is movement of powered mobile plant
- carried out in an area in which there are artificial extremes of temperature
- carried out in or near water or other liquid that involves a risk of drowning
- involving diving work.

The SWMS must:

- identify the type of high risk construction work being done
- specify the health and safety hazards and risks arising from the work
- describe how the risks will be controlled
- describe how the control measures will be implemented, monitored and reviewed.

A SWMS must be developed in consultation with workers and their representatives who are carrying out the high risk work.

## 4 Work systems

### 4.1 Formwork erection – traditional systems

Formwork must be erected systematically and tied in and/or braced progressively to stabilise the structure. Where a person is to install joists from underneath, the vertical distance between the formwork deck and the false deck can be increased. This is illustrated in Diagram 2 below.

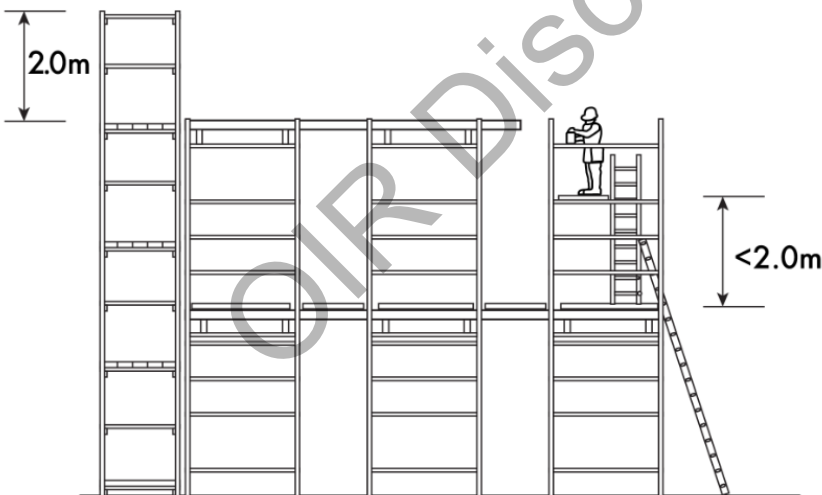


Diagram 2 - Worker erecting formwork on two planks

A person must be provided with a working platform of at least 450 mm wide (i.e. two planks). It is not acceptable for a person to stand on a single bearer or a single plank.

#### 4.1.1 Foundations

Formwork must be erected on a stable base to prevent the risk of collapse. Suspended slabs must be able to safely support loads that may be applied by the concrete pour, workers and crane lifted loads.

Base plates must be provided under props and standards on formwork frames unless the prop or standard has an integral foot or an engineer documents that a base plate is unnecessary. Sole boards designed to suit the ground conditions should also be used under props and standards on natural ground, unless an engineer states otherwise. Frames and props must be located on a firm base, which is ground that will not subside, fail or get washed away. The principal contractor is responsible for providing all information on ground conditions to the engineer.

#### 4.1.2 False deck

In situations where a deck is at a height that would require persons to stand at heights of two metres or more to install bearers and joists for the formwork deck, a “false” deck, which is a full deck the same area as the area being formed, should be provided (see Diagram 3). This deck should be provided both inside and between formwork frames and can typically consist of formply, scaffold planks or modular platform sections. When erecting backpropping frame towers over two metres high, a full deck of planks is to be provided within the tower. A protected access opening can be left in the deck to enable materials to be lifted up. The use of a captive platform system is preferable to lapped planks because a captive system cannot be accidentally dislodged. Lapped planks may only be used if secured against uplift and slipping. The false deck must be constructed such that no gap exceeds 225mm width and gaps may only exist where a vertical member of a frame passes through the deck.

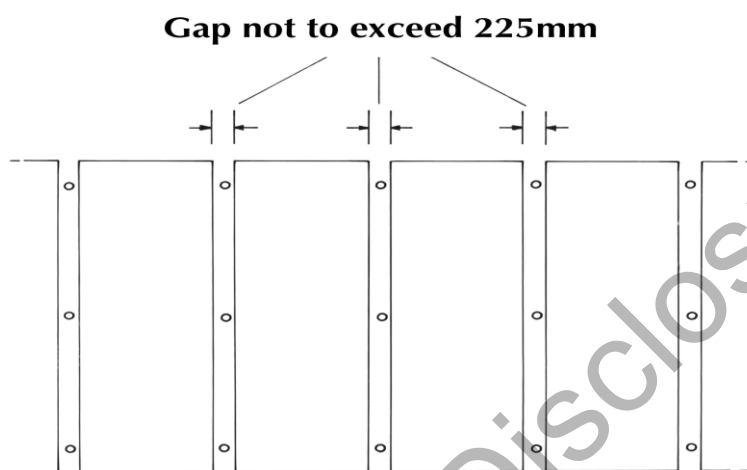


Diagram 3 – A false deck

The false deck must be designed and installed to have adequate strength to support persons required to stand on the deck and any materials or persons that could fall onto the deck or be placed on the deck. The deck must be able to withstand:

- a point load of 2kN distributed over an area of 100 x 100mm (2 kN is approximately equivalent to a mass of 200kg)
- a uniformly distributed load of 2kPa which is equivalent to a mass of 200kg per square metre.

When considering the design of the deck for the erecting, altering and/or dismantling of formwork the weight of the false deck, and live load should be applied to the formwork support structure.

The height between the false deck and the pouring deck must allow access for a person during stripping.

#### 4.1.3 Erecting frames

**WHS Regulation section 81:** A person must not carry out high risk work, including scaffolding work, unless the person holds a high risk work licence for that class of high risk work. For example, a person must hold a scaffolder’s licence if they are undertaking scaffolding work which involves erecting, altering or dismantling a temporary structure that is or has been erected to support a platform from which a person or thing may fall more than four metres.

Persons erecting formwork frames must be trained in their safe erection.

Formwork frames must be erected in a progressive manner to ensure both the installers safety and the stability of the overall structure. Braces must be attached to the frames as soon as practical.

The risk of a fall can exist on edges of formwork frames during their erection. In this situation, it is necessary to install edge protection on the frames as they are erected. Provided the side bracing (or other edge protection) is installed progressively and as soon as enough material has been raised up, additional control measures to prevent a fall occurring do not have to be provided. Many conventional formwork frames consist of diagonal braces that cross in the middle. While these braces are not considered to be suitable edge protection for a completed formwork deck, they may provide reasonable fall protection during frame erection. This is only the case where braces are installed in a progressive manner as soon as the braces are handed up to a person.

As the height of formwork frames increase, there is a greater need to provide lateral stability to the frames. All framing must be carried out so that it complies with on site design documentation and any manufacturers' requirements.

#### 4.1.4 Installing bearers

Bearers must be placed in position so that persons are located no more than two metres from the floor or from the fall arresting platform located immediately below them. For example, the bearer can be lifted up onto the top of the formwork frame with a person standing on a platform erected no more than two metres from the floor or false deck located immediately below them within the frame.

Bearers must be positioned such that they will not fall off the top of the frames. The usual method of ensuring this is by placing the bearers in U-heads on top of the frames and by ensuring cantilevers are minimised. Where only single bearers are placed in the U-head, the bearer must be placed centrally in the U-head unless an engineer states otherwise. Where the top of the supporting member consists of a flat plate, the bearer must be nailed or otherwise effectively secured to the plate. Flat plates may only be used where specified by an engineer.

#### 4.1.5 Fall protection from the formwork deck

**WHS Regulation section 78(1) and (2):** A person conducting a business or undertaking must manage risks to health and safety associated with a fall by a person from one level to another that is reasonably likely to cause injury to the person or any other person. This includes the risk of a fall:

- in or on an elevated workplace from which a person could fall
- in the vicinity of an opening through which a person could fall
- in the vicinity of an edge over which a person could fall on a surface through which a person could fall, or in any other place from which a person could fall.

**WHS Regulation section 306C and 306D:** A person conducting a business or undertaking who intends to do construction work where the risk of falling is at least two metres must, before work starts, use control measures to:

- prevent a person falling any distance, or
- if prevention is not practicable to arrest a person's fall to prevent or minimise the risk of death or injury.

A person conducting a business or undertaking who intends to do construction work where the risk of falling is at least two metres must, before work starts, use control measures to prevent a person falling any distance or arrest a person's fall.

During formwork construction the structure is constantly changing. Hence, continual modification of fall protection measures is also necessary. One of the biggest challenges is to provide adequate fall protection on the leading edge of the formwork deck. Where there is only one leading edge (i.e. the other edges are provided with two metre high edge protection), the provision of fall protection on the leading edge is relatively straightforward. However, where there are multiple leading edges and/or the deck is not at one consistent level the provision of fall protection can be very difficult to implement. Designers of buildings are therefore encouraged to design floor slabs that are one consistent thickness.

Control measures are required where a person could fall onto an object, such as frames, reinforcing steel or a rubbish skip.

### Edge protection on the formwork deck

**WHS Regulation section 306E:** Edge protection must be designed to withstand the downwards or outwards force of the impact of a fall against it of any person who may reasonably be expected to fall against it to ensure that the person does not fall from the surface from which work is to be done.

Where the design of the formwork is complex, it may be impractical to provide edge protection on leading edges because the profile of the deck is constantly changing and construction of leading edge protection would create more hazards than it would control. For example, the persons installing the edge protection could be exposed to risk when installing the edge protection. However, in some situations it may be necessary to provide perimeter edge protection on edges of the formwork deck. Examples where edge protection must be installed are:

- There is a change in deck height along the side of the deck being constructed (i.e. a drop down for a beam) and no joists and/or formply has been provided at this different height.
- If a leading edge is to be left unattended and access onto the deck by persons other than form workers is required (i.e. the formwork deck has not been barricaded off and provided with “keep out” signs).

The most effective means of providing edge protection on a completed formwork deck is by providing perimeter scaffolding or proprietary screen systems. Edge protection is erected prior to the formwork and prevents workers falling off the completed deck. The main advantage of these systems is that persons are not required to install edge protection on the perimeter of the formwork deck and are therefore not exposed to a risk of falling. The other advantage is that edge protection for persons installing the final perimeter formply sheets is already in place.

Where scaffolding over four metres in height is provided, any erection, dismantling or alteration of the scaffolding must only be undertaken by licensed scaffolders. Any scaffolding components must be replaced following removal. Gaps between a completed floor and scaffolding, that may exist after the formwork support system is removed, must be covered where there is a risk of a person or materials falling through the gap.

In some situations, it may be impractical to provide perimeter scaffolding. If this is the case, the work system used to install perimeter edge protection on the deck must ensure that a control measure is provided to ensure against the risk of a fall. The use of harness systems is discouraged, because it does not provide an adequate and practical control for the risk of a fall from height.

In some situations edge protection can be substituted with an alternative control measure provided this measure prevents a person falling from the edge. One alternative is the provision of a barricade 1.8 metres back from the edge with clearly visible “keep out” signs.

#### ***Unsuitability of harness system for formwork activity***

The use of:

- travel restraint harness systems to prevent a fall  
or
- fall arrest harness systems to arrest a fall when erecting, altering and/or dismantling formwork are not recommended because:

#### **Travel restraint harness systems**

Travel restraint systems, as a means to prevent a person falling, are impractical for formwork because:

- The contour of the leading edge is constantly changing so that the length of the travel restraint line needs to be continually adjusted
- Multiple lanyard anchorage points may be required
- The greater the number of workers building the formwork deck, the greater the likelihood of lines becoming tangled.

#### **Fall arrest systems**



- When erecting, altering and/or dismantling formwork there will be inadequate free fall distance underneath the working area and a person will strike the ground, a frame or other obstruction prior to the fall being arrested.
- A falling person can require in excess of 6 metres free fall distance for the fall to be safely arrested by a harness system. In some situations this distance can be substantially reduced by the use of shorter lanyards and/or higher anchorage points.
- The erection of formwork frames using fall arrest harnesses requires the user to regularly connect and reconnect to anchorage points. This requires use of a double lanyard.

#### 4.1.6 Laying formply on the deck

A formwork deck must be laid in a progressive way such that persons will be provided with a method of preventing them from falling below the deck. This control measure is particularly important in situations where a false deck has not been provided below the level of the deck to be laid.

Where a false deck has not been provided formply may only be spread on the joists provided where:

- Persons commence laying the formply sheets from the perimeter scaffolding or other edge protection that has been provided on the perimeter of the formwork.
- A minimum of four joists at 450mm centres (400mm gaps, totalling 1.8 metres) are located on bearers next to the person and in the other direction joists extend for at least 1.8 metres (see Diagram 4). Therefore, if a person falls they will fall onto the joists and should be prevented from falling further. (Note, in some situations, there may be a possibility of a person falling through the joists if the joists spread as the person's body makes contact. This is more likely to be a potential hazard when the person falls onto the joists such that the person's fall is in the same direction as the joists. Implementing controls to minimise sideways movement of joists will minimise this possibility).
- Persons lay the formply in front of their bodies so that if they stumble they are likely to fall on top of the sheets being laid.

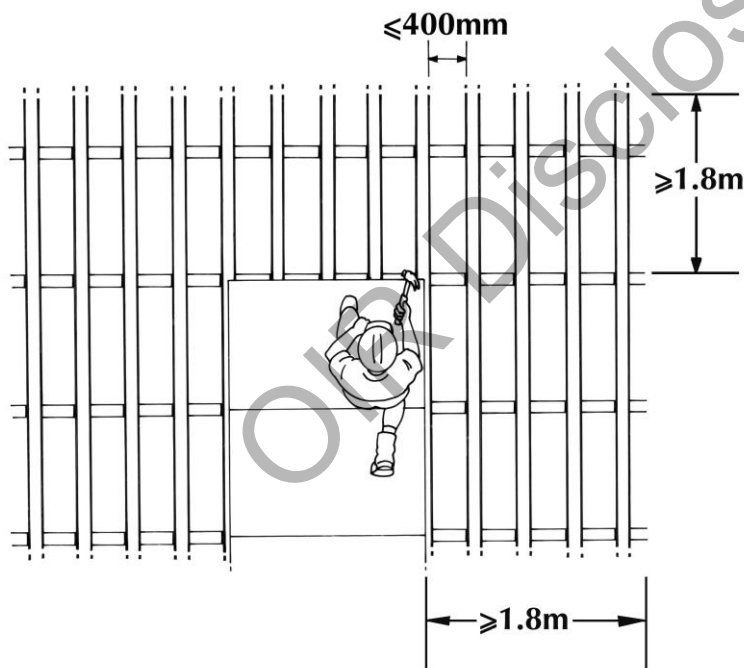


Diagram 4 – Maximum spacing of timbers around worker where false deck is over 2 metres below

#### Typical work system for a leading edge

The following work system may be used by persons to construct the formwork deck for typical or multi-level construction. The work system may be used irrespective of the distance to the false deck or floor below, but is specifically intended for situations where the vertical distance below the deck being constructed is greater than two metres.

- Place bearers on the U-heads of the formwork frames from the working platform provided immediately below. Secure bearers to prevent movement (i.e. by nailing to or wedging in the U-heads) before joists are placed on top. No eccentric (un-centred) loads should be applied to the U-heads.
- Place joists on the bearers in a progressive manner from the work platform located directly below the area to be worked on, and spaced at 450mm centres (maximum) or so that the gap between joists does not exceed 400mm.
- Cantilevered bearers and joists must be secured against uplift prior to persons being supported by them, if the cantilever distances exceed those specified in Table 4 (in section 4.1.7 of this code).
- Formply, or other deck material, must be laid out progressively. Wherever possible, the direction of the leading edge should be perpendicular to the joists (or parallel to the bearers).
- Formply should be placed on the joists with the installer located behind the sheet as it is positioned whilst standing on the previously laid sheet or provided work platform. In the event of a person tripping or stumbling they should fall on the sheet and not off the leading edge.
- Cover or protect all penetrations left behind the leading edge. Covers must be securely fixed and clearly signed to indicate they are protecting a penetration (see section 4.1.8).
- Nail or otherwise secure formply to the joists in accordance with the formwork design as soon as practical.
- Only persons involved in the construction of the formwork should be located in the formwork construction zone (see Diagram 7). Any person not involved in construction of the formwork deck and support structure should be excluded.
- The leading edge should be free of oil, sawdust and obstructions to reduce the likelihood of slips and trips, and fall prevention control measures should be provided for all leading edges, not just the direction formply is being laid.

#### 4.1.7 Cantilevers

Cantilevered bearers, joists and ply sheets can be hazardous when left unsecured. The weight of a person standing on the cantilever may make the timber see-saw and cause the person or material to fall. When designing the formwork system the use of cantilevers should be kept to a minimum. However, in some situations the use of cantilevered sections is unavoidable. Where this is the case, an engineer must consider the potential for persons and stored materials to cause cantilevers to pivot. Wherever the weight of a person will cause a cantilever to pivot, the cantilever must be positively secured such that this will not occur.

Table 4 provides guidance on the maximum permissible cantilever length without securing the back of the cantilever. The information is based on a person's weight of 120kg and includes a factor of two to allow for live loading when a person steps on to the cantilever:

*Table 4 - Maximum unsecured cantilevers for structural members*

<b>Member section size and material type</b>	<b>Total length of member</b>	<b>Maximum cantilever without securing</b>
150 x 100mm oregon bearer	5m	420mm
150 x 100mm oregon bearer	4m	270mm
150 x 100mm oregon bearer	3m	150mm
150 x 77mm LVL (laminated veneer lumber) bearer	5m	330mm
150 x 77mm LVL (laminated veneer lumber) bearer	4m	220mm
150 x 77mm LVL (laminated veneer lumber) bearer	3m	120mm

100 x 75 mm oregon joist	6m	310mm
100 x 75mm oregon joist	5m	220mm
100 x 75mm oregon joist	4m	140mm
100 x 75mm oregon joist	3m	80mm

Where self-weight of timber is inadequate to ensure the stability of the cantilever, all cantilevers should be secured in accordance with the designer's instructions. This may include nailing or another effective method such as bolting. Nailing should be carried out such that the nail will not pull out of the timber or shear off. Where skew nailing is used a minimum of two nails should be used and the nail should meet the designer's specifications.

Wherever practical, it is preferable to secure cantilevers such that the nail or bolt is loaded in pure shear (i.e. no pull-out load). The use of purpose designed brackets should also be considered.

Materials should not be stacked or stored on a cantilever section unless written certification is provided by an engineer.

#### 4.1.8 Penetrations

**WHS Regulation section 306F:** A fall protection cover used as a control measure must be able to withstand the impact of a fall onto it of any person who may reasonably be expected to fall onto it to ensure that the person does not fall and be securely fixed in place to prevent it being moved or removed accidentally.

Open penetrations, such as stairwells or penetrations to allow for services, create hazards for persons on the deck. A person may fall through a larger penetration, sustain injury by stepping into a smaller penetration or an object may fall through the opening onto persons below. Any penetration where there is a risk that a person or an object could fall through should be covered.

All penetrations on completed slabs should be provided with a cover mechanically fixed to the floor or otherwise effectively restrained so that it remains in position except for plumbing and inspection hole covers. Mechanical fixings for a penetration cover should be structurally adequate and require the use of a tool to be removed (e.g. an insert type anchor requiring a spanner or socket). Fixings must be placed an adequate distance from the cover edges to prevent the failure of the cover, its fixing or the supporting surface into which the fixings are placed (see Diagram 5).

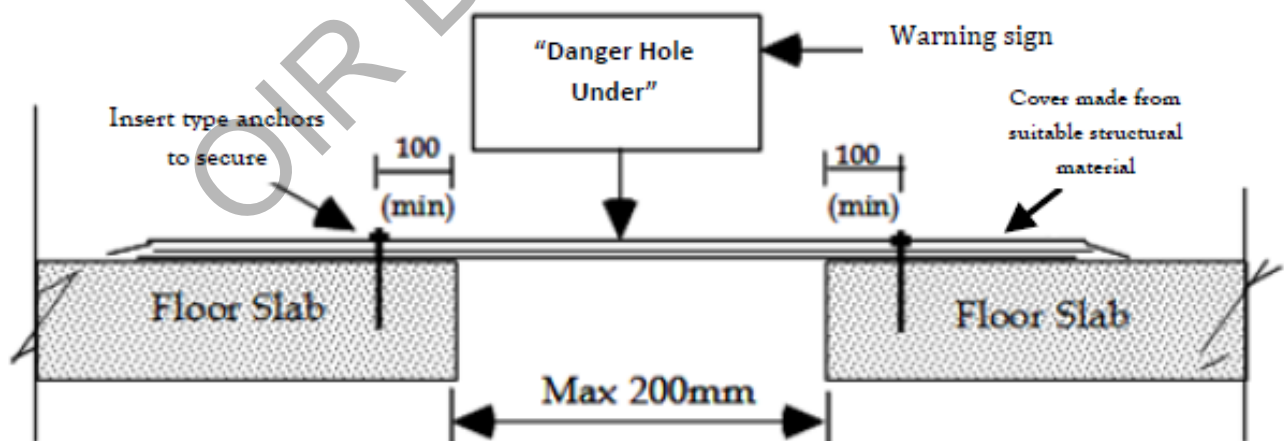


Diagram 5 – Example of a horizontal penetration cover

Open penetrations must be protected either with edge protection (e.g. handrails) or securely covered. Cast-in metal mesh should be used for small diameter penetrations. Vertical penetrations (e.g. lift doors) must be fully enclosed with mesh as a minimum standard. The mesh should have a small aperture (e.g. 50 x 50mm mesh size or smaller), and be made of material capable of withstanding the potential imposed load. Mesh provided over larger penetrations may require engineering certification to

ensure it can withstand potential loads, including those applied by people, equipment and material (see Diagram 6).

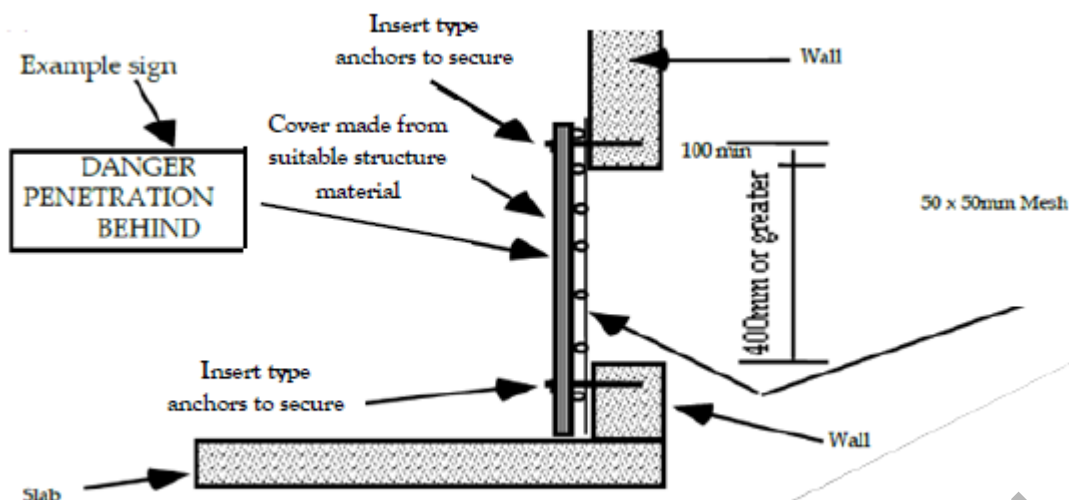


Diagram 6 – Example vertical penetration cover

Where holes are cut in the mesh for services to pass through, the hole should be cut to the profile of the service so that mesh remains in the penetration.

Ply covers on their own are not to be preferred because:

- the cover may be indistinguishable from other pieces of ply
- it may be difficult to determine if the ply is properly secured
- secured ply covers can be unsecured to gain access and not re-secured.

Where ply covers are used, they are to be a single piece of ply without multiple pieces and joins and the edge of the penetration should be bevelled to minimise any trip hazard. The ply cover should also be designed to safely withstand a point load of at least 2 kilonewtons (i.e. 200 kilograms). This is the same point load as required for heavy duty scaffolding – see *AS/NZS1576.1:2010 Scaffolding Part 1: General requirements* for further details.

Where a ply cover is used in addition to cast-in mesh, it acts as a back-up system. Ply covers should be painted in a bright colour and be marked with the words “Danger Hole Under” or words to that effect. The cover should be firmly secured to the concrete and be designed for potential loads that may be applied.

Before stripping formwork, ensure the penetration that will be exposed as the formwork is stripped is covered and or protected prior to the commencement of the stripping operation.

Penetrations are also hazardous before the deck is laid. Joists placed up to the edge of the penetration should be secured so that the timbers cannot spread if a person falls on them.

#### 4.1.9 Working areas for steel fixers and others

Steel fixers, plumbers and electricians, often follow closely behind the formwork erection. Consultation between formworkers, the person conducting a business or undertaking and other trades should be undertaken to ensure a suitable hand over of completed elements of the formwork deck is provided. Following consultation, and access to the deck by required installers for water and power, trades that will be working on the deck and a delegated ‘competent person’ on site should signoff that the following has been completed:

- penetrations are covered
- handrails are installed
- water and power are installed
- there is a stair tread system provided for safe access and egress to the working deck.

The formwork zone must be sufficiently large to ensure that these other persons are clearly separated from formworkers. A ‘formwork only’ zone should be maintained behind the leading edge. This zone

should be clearly demarcated by signage and flagging. Diagram 5 illustrates the 'other work' zone, the formwork zone and the area retained as edge protection (four joists spaced 1800mm beyond the laid deck).

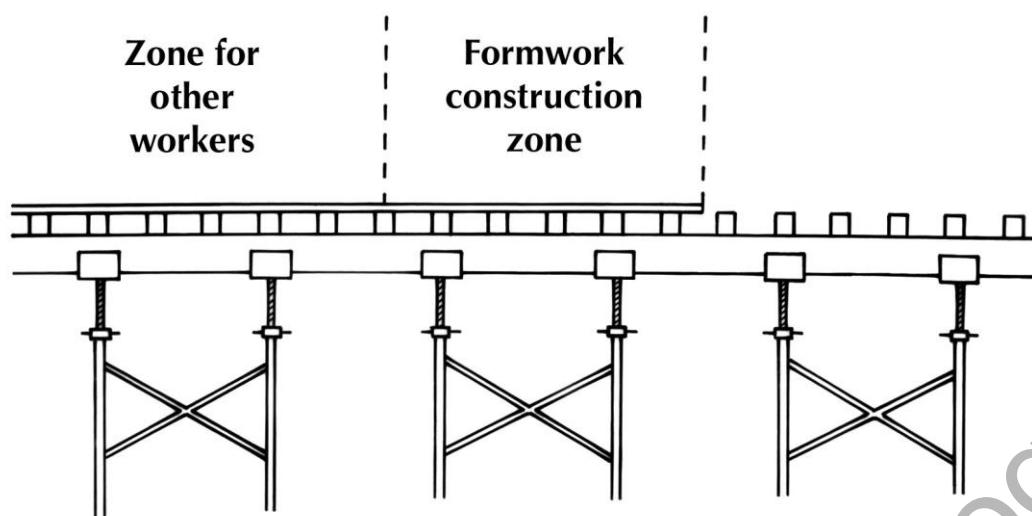


Diagram 7 – End view of deck showing working zones

## 4.2 Formwork erection – modular formwork systems

The basic principles discussed in section 4.1 on traditional systems should be applied to the erection of modular formwork systems. Although the erection technique and member dimensions may vary greatly between traditional systems and modular systems, the principles of maximum potential fall distance and gap width at the working level should be applied. The width of any gap on a working level is not to exceed 400mm unless a false deck has been provided within two metres of the working level. Working platforms used for modular systems should also have a minimum width of 450mm.

Modular and traditional formwork systems should be designed to comply with the loadings and general principles of *AS3610: Formwork for Concrete*.

Traditional formwork systems are sometimes used next to and connected to modular systems, particularly around unusually shaped areas. Where this is the case, the formwork drawings should show this and should be certified by an engineer. However, components from other types of formwork systems should not be used as an integral part of the modular formwork system unless the designer of the modular system states in writing that this is permitted.

Modular formwork systems are often lighter weight and require less physical effort than traditional systems because they are often constructed from aluminium instead of steel and they eliminate the need for tasks such as repetitive hammering. This reduces a person's exposure to the risk of injury resulting from undertaking manual tasks. However, because of their lighter weight, modular systems may be more susceptible to falling over during the erection of the system, due to factors such as wind loading. This will generally only be an issue prior to placement of the deck on the modular system. To effectively control this issue the formwork system should be progressively braced in accordance with the suppliers instructions during its erection.

## 4.3 Stripping formwork

Stripping formwork can be one of the most hazardous phases of concrete construction. While falling objects are the primary hazard, there may also be fall hazards as a result of floor collapse and manual tasks hazards from a person working in awkward postures, repetitive handling of materials and limited

task variety. As with formwork erection, the stripping operation must be carried out in an orderly, progressive manner.

### 4.3.1 Safe work method statement

A safe work method statement (SWMS) for the stripping operation should be prepared and provided to those who will be involved in this high risk activity. The SWMS should:

- identify the work that is high risk construction work
- state hazards relating to the high risk construction work and risks to health and safety associated with those hazards
- describe the measures to be implemented to control the risks
- describe how the control measures are to be implemented, monitored and reviewed; and include:
  - The number of persons in the stripping crew.
  - The sequence of stripping activities – this would need to detail how the frames and/or other supports should be removed (that is, how far U-heads are to be lowered).
  - Whether the support system is to be completely removed in a zone prior to removal of the formwork deck or whether the supports are to be lowered slightly but still remain under the formply while it is being removed.
  - When back-propping is required or only part of the support system is to be removed, how the structural members are to remain in place and/or the type and layout of members that will replace the formwork system.
  - Any other special requirements involved in the stripping and or building process (e.g. checking of back-propping after post-tensioning).

### 4.3.2 Certification prior to stripping

Prior to commencement of the stripping operation, a competent person, from the principal contractor (i.e. the project engineer), is to provide written certification that formwork can be removed. This certification should be based on an engineer's specifications for the building, the strength of the concrete mix and the time period that has elapsed since the pour. An engineer will also be required to have input into the stripping safe work method statement to ensure the concrete element will not fail and must have provided details on the structural engineering drawings as required by *AS3600 - Concrete structures*.

Documentation from the concrete supplier verifying the concrete specification should be available on request. A concrete sampling and testing procedure should be in place to verify concrete meets its design specification. Guidance on sampling and testing systems for concrete is provided in *AS1379 - Specification and supply of concrete*.

It is important to note that the compressive strength of laboratory cured test specimens may differ from the actual compressive strength due to factors such as temperature and humidity on site, poor curing techniques and the addition of water to the mix. Some builders may therefore choose to have test samples on site to give an indication of the variation between 'on site' tests and laboratory tests.

### 4.3.3 Exclusion zone

Only persons involved in the stripping operation should be permitted in the area to be stripped. Stripping areas should be cordoned off and signs should be displayed. The signs should require persons to keep out of the area (e.g. "Danger - Formwork stripping in progress – authorised persons only"). It is preferable to restrict access to the whole floor where soffit stripping is taking place and this should reduce the quantity of signage and barricades required. Where other trades are required to work on the same floor during stripping of walls, columns or small sections of soffit, the principal contractor or PCBU should ensure that stringent controls are applied that prevent other persons from entering the stripping area.

### 4.3.4 Drop stripping

'Drop stripping' is a term sometimes used to describe the method used when all of the formwork support system is removed and the formply is allowed to drop to the floor either by its own weight or by persons levering it off. In general, this method of stripping should not be used to strip formwork. It can be hazardous because the formply is likely to fall in an uncontrolled manner and can strike persons underneath.

However, in some situations, sheets can be dropped to the floor provided the following is ensured:

- The formwork support system (e.g. props or frame) is only removed from under the sheet to be dropped. Once the sheet is dropped the process progressively continues until all sheets are dropped.
- The person levering off the sheet is not at risk of being struck when the sheet falls to the floor, keeping in mind that sheets may fall at an angle due to their large surface area and effect of the air – for example, the person does not stand directly under the sheet but stands far enough away and uses a pinch-bar to lever the sheet off. It should be noted that this method can only be used on relatively low ceiling heights unless the person can be positioned on a working platform or elevating work platform. The advantage of using a platform is that the person will generally be able to get closer to the sheet to be removed without being at risk.
- The formwork system and sheets are not left in a haphazard manner on the floor but are placed in stacks and progressively removed from the floor area.

Formwork removal must be carried out in a systematic manner, such that the deck is progressively removed as the support system is gradually removed. One way to remove the formply is by partially lowering the support system and then dropping the segment of the deck (sheet) onto the support system. This is preferable from a manual tasks perspective also as it eliminates the need to lift sheets of ply from ground level.

## 4.4 Crane and load handling systems

### 4.4.1 Loading materials during formwork construction

Materials, including stacks of ply, forms, bearers and joists, are sometimes lifted onto a deck during formwork erection, and before the deck is signed over. Stacked materials create point loadings which the formwork structure may not be designed to bear. Materials should be stored only where and when the deck is able to bear the load.

Formwork is not suitable for any loading until it is fully secured, that is, the deck is in place with tie-ins and back-propping complete. In practice, some loading often occurs before the deck is completed, for example, unloading packs of ply and joists used to continue the deck.

To minimise the risk of collapse and other hazards:

- Formwork drawings should clearly identify the maximum (pre-pour) point loadings for the deck.
- Point loadings should not exceed the maximum weight specified by an engineer.
- Crane crews should be notified when an area of deck is ready to take a load, and where that load should be placed.
- Crane crews should not lift materials onto the deck until there is a designated lifting zone.
- Loads should only be placed in the area(s) designated as safe.
- Loads must not be placed on the formwork deck if the formwork documentation prohibits loadings.
- Delivery of materials to the site should be planned so that loads are not lifted onto unsecured decks.
- Prior to persons leaving the site, materials and equipment should be secured to prevent them being moved by wind.

### 4.4.2 Access for persons slinging loads

Safe access must be provided for persons slinging and un-slinging loads.

A dogger or other person working at two metres or more above the deck must be provided with adequate fall protection, unless the person is performing 'permitted work'.

Use of fall arrest systems for persons slinging formwork loads is usually impractical and is not recommended.

It may be more practical to fit platforms and edge protection to lift forms to protect persons when slinging the loads. The platforms must be at least 450mm wide. Persons required to access the

platforms from ladders should have a safe means of access provided between the ladder and platform. They should not climb over the top of the edge protection.

### 4.4.3 Lifting gear

Guidance on the use and inspection of chains, wire ropes and synthetic slings is provided in the following publications:

- *AS2759 – Steel wire rope - Use, operation and maintenance.*
- *AS3775.2 – Chain slings for lifting purposes – Grade T – Care and use.*
- *AS4497 – Roundslings – Synthetic fibre.*
- *AS1353.2 – Flat synthetic-webbing slings – Care and use.*

Non-positive lifting gear such as plate clamps and suction devices are not to be used.

Basic items that should be checked include:

- The lifting gear is tagged and all relevant information listed (e.g. relevant information for a chain sling is grade of chain, safe working load, manufacturer, chain size and Australian Standard marking).
- Lifting hooks are provided with operable safety latches.
- Shackles are prevented from unscrewing (e.g. mousing or similar).
- Lifting eyes and inserts are compatible and the same proprietary brand.
- Lifting slings are not damaged (e.g. excessive wear, damaged strands, cracks, deformation and/or severe corrosion).
- The sling is appropriate for loads being lifted, including adequate capacity and protection from sharp edges.

All lifting gear, including slings, hooks and material boxes, should be periodically inspected for damage and wear. The period between inspections shall depend on the severity of use. In the case of chain lifting slings and material boxes, a formal documented inspection should be completed at intervals not exceeding 12 months. Documented maintenance records for the lifting gear should be available on site.

### 4.4.4 Lifting formwork materials

Crane-lifted loads should be slung and secured so that the load (or any part of it) cannot fall, as follows:

- Tare mass of wall, lift or column forms should be provided on site with formwork documentation and made available for inspection by all interested parties.
- Safe working load mass should be clearly marked on bins.
- Lifting boxes should be appropriate for the material being lifted, and be engineer-designed and certified.
- Four chains (one in each corner) should be fitted to lift boxes.
- Specifically-designed lifting boxes should be used to lift smaller components (e.g. spigots, U-heads, base plates and couplers). Boxes should have enclosed sides or robust mesh (with openings less than the minimum size of materials being lifted).
- Lifting boxes should be inspected and maintained, and inspection records kept.
- Loads within lifting boxes should be secured against movement.
- Materials should not be stacked higher than the side of the box unless they are adequately secured, but at no time should the box become top heavy.
- Formwork frames should either be strapped together or lifting slings should be wrapped around the load.
- Loads of joists or bearers should be strapped together before lifting.
- Use tag lines as required to control loads and well as forms.
- Formply loads should be strapped together and lifted in a flat position.
- Ensure where possible all loads are supported with dunnage and the load is uniformly distributed over the supporting surface.



#### 4.4.5 Lifting lugs

Slings attached to lugs or holes cut into part of the load are often used to lift bins, and wall, lift or column forms (instead of wrapping the lifting slings around the load). Information verifying the structural adequacy of the lifting points should be available.

The certification should be provided by an engineer who should verify the:

- structural adequacy of the lifting lug
- means of attachment to the load (usually welded or bolted to the load).

### 4.5 Use of stair tread systems and ladders

Stair tread systems are to be used as the primary form of access and egress to and from a formwork zone unless it is not reasonably practicable to do so. Examples where it may not be reasonably practicable to use a stair tread system include:

- accessing column boxes up to 3.5 metres high (e.g. a platform ladder may be used for the purpose of tightening z bars, securing props, plumbing & checking inside box)
- accessing wall shutters to 3.5 metres high (e.g. a platform ladder may be used for the purpose of installing rebates and penetrations to the shutter, locating z bars, splicing timbers on shutters, securing props, plumbing and checking inside box)
- conventional core walls up to 3.5 metres (e.g. straight ladders may be used inside shafts for access, locating z bars, splicing shutters and working corners and tread scaffold stairs may be used for accessing pouring platforms at the top of cores)
- trenches/pits where a stair tread system would not fit within the space (e.g. a straight ladder may be used)
- core systems (e.g. a straight ladder can be used for access and working inside boxes and cells and tread stairs up to one metre wide can be used to access the system externally from the top of the system to the working soffit/slab below)
- safety screens (e.g. a straight ladder can be used to go platform to platform within screens and tread stairs up to one metre wide can be used when accessing floor to floor with a stairway on the outside or incorporated into the screens)
- drop panels/isolated beam to 4.5 metres high (e.g. formworkers could use a straight ladder for access). Where workers other than formworkers need access to drop panels/isolated beams there will need to be a stair tread system
- soffits (e.g. access to decks should be by tread stairs up to one metre wide or stretcher stairs one metre to 1.8 metre wide)
- high scaffolding support system (e.g. depending on the scaffold layout, access in scaffold should be by ladders for scaffolders and narrow tread stairs for formworkers getting up under the deck)
- initial entry to wall systems (e.g. may use a plywood stair tread system).

Adequate edge protection must be provided on the stair tread system and the area it provides access to in accordance with section 306E of the *Work Health and Safety Regulation 2011* and *AS/NZS 1576.1:2010 Scaffolding Part:1 General Requirements*.

Temporary timber or plywood framed steps, stairs, treads or ramps may be fabricated by competent tradespersons to gain access to vertical formwork systems and from scaffold platforms onto adjacent formwork decks. The maximum height of a timber stair, steps or ramp should not exceed 1.5 metres. The finished walking surface of the temporary timber or plywood framed steps/stairs/ramp is to be slip resistant and provide grip for inclined surfaces. Temporary stair and step fabrication information is available from *AS/NZS 1576.1:2010 Scaffolding Part:1 General Requirements*.

Stair tread systems are not required for isolated areas that are not integral to the main slab (i.e. drop panels and fire corridors).

Where single or extension ladders are used they must be secured, either:

- at the top to prevent it moving (e.g. tying the top of the ladder to a plate fixed to the top of a wall frame or clamping the top of the ladder to structural steel);  
or
- at or near the bottom to prevent it moving.

Other issues regarding the safe use of ladders include:

- At no time is material to be carried while using a ladder – three points of contact must be adhered to.
- A person's feet should not be higher than 900mm from the top of the ladder, and when using a platform ladder, a workers feet should not be more than two metres above the base of the ladder.
- Ladders should be set up on a firm, level surface. They should not be used on scaffolding or elevated work platforms to gain extra height.
- Ladders should not be handled or used if they may come into contact with electrical power lines. Metal or metal-reinforced ladders should not be used in the vicinity of live electrical equipment (timber ladders often have metal running along their length).
- Ladders must not be positioned above or adjacent to openings or edges where a potential fall could occur. Work platforms with edge protection should be provided in this instance.

Ladders can only be used if equipment can be operated with one hand. Activities requiring use of both hands must not be performed while standing on a ladder, for example:

- removing tie bar from wall and column forms during form stripping – this usually requires both hands and/or the use of a 'tie-bar puller'
- carrying timbers, formply, props or frames
- using power tools, such as circular saws.

Ladders used for access must extend at least one metre above the accessed surface. Ladders should not be used in access ways or where there is pedestrian traffic, vehicles or mobile plant.

AS1657 – (fixed platforms, walkways, stairways and ladders-design, construction and installation) must be complied with where fixed or permanent ladders are provided.

## 5 Falling objects

**WHS Regulation section 54:** A person conducting a business or undertaking at a workplace must manage risks to health and safety associated with an object falling on a person if the falling object is reasonably likely to injure the person.

**WHS Regulation section 315H:** A principal contractor must ensure that, before construction work starts, the adjoining area is closed under section 315M to the extent necessary to prevent objects falling, and perimeter containment screening complying with section 315I is erected along each part of the structure from which an object could fall.

Falling objects are significant hazards, creating risks to workers and others during formwork erection, alteration and stripping, when slipping and jumping forms, and whenever loads are lifted over work areas.

PCBUs have a duty to workers and other persons who could be injured or killed by any falling object during formwork activities.

The control measures that are implemented should firstly aim to prevent objects from falling, but equally prevent injury if an object has fallen. Small objects, such as bolts and concrete aggregate, falling from a height can cause serious injury.

### 5.1 Preventing objects from falling

Controls should be applied at the source to prevent objects from falling, that is, eliminate the risk. This is the most effective control to prevent injury or death caused by falling objects.

Good housekeeping practices are the most effective way of preventing small objects from falling. Ensure items are cleaned up and kept away from edges, voids and penetrations.

One control measure to prevent objects from falling is the use of perimeter containment screens. This Code recommends that perimeter containment screening be provided as a control measure for falling objects with equal regard for a person's safety and protection on site as well as for the protection of the public in adjoining areas.

### 5.1.1 Perimeter containment screening

**WHS Regulation section 315I:** If the perimeter containment screening is used to redirect a falling object onto a catch platform, each screen must be fitted vertically to the top of, or flush with, the outer edge of the catch platform to redirect a falling object that may reasonably be expected to hit the perimeter containment screening, onto the catch platform.

If the perimeter containment screening is not used to redirect a falling object onto a catch platform, each screen must be designed to prevent an object, that may reasonably be expected to hit the perimeter containment screening, from falling on persons from the level at which the work is to be done.

Each screen must be made of mesh or of timber, plywood or metal sheeting.

Each of the following gaps must be not over 25 mm:

- the gap, measured horizontally, between screens immediately beside each other or a screen and the framework supporting it;
- the gap, measured vertically, between a screen and another screen immediately above it or a screen and the framework supporting it.

The framework supporting a screen must be able to bear the load of the screen.

Containment sheeting is a protective structure fixed to the perimeter of a building, structure or working platform to prevent objects and people from falling. Containment sheeting should be used around the perimeter of a building or structure during construction, and especially during formwork erection or stripping. It is usually sheeted with: timber, plywood, metal or synthetic mesh or sheets.

Containment sheeting may be supported by the building, structure, or specially designed scaffolding. It must extend at least one metre above the working surface. When formwork is being erected or dismantled in the immediate vicinity of the screening, the screening should be captive to the building and extend at least 1 metre above the top of the completed floor slab. Examples of perimeter edge protection for falling objects include:

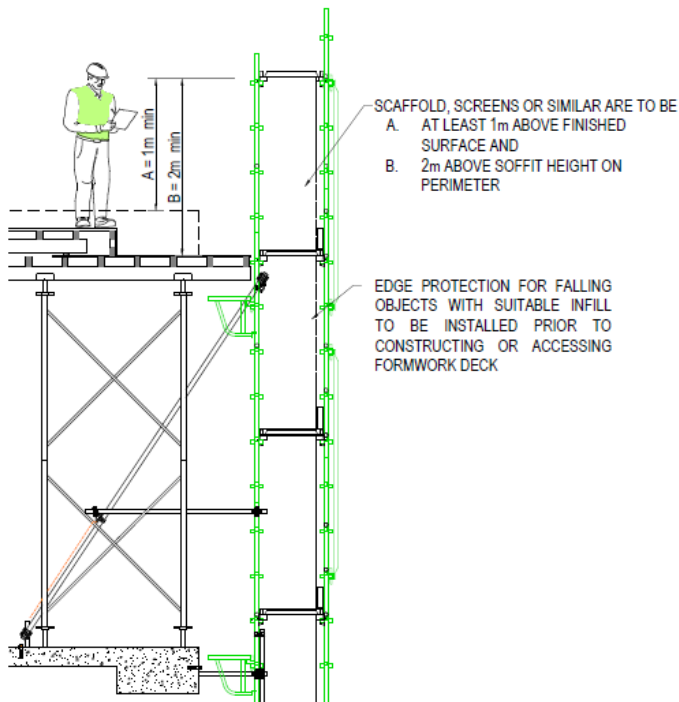


Diagram 8 - Typical single or multi-story construction

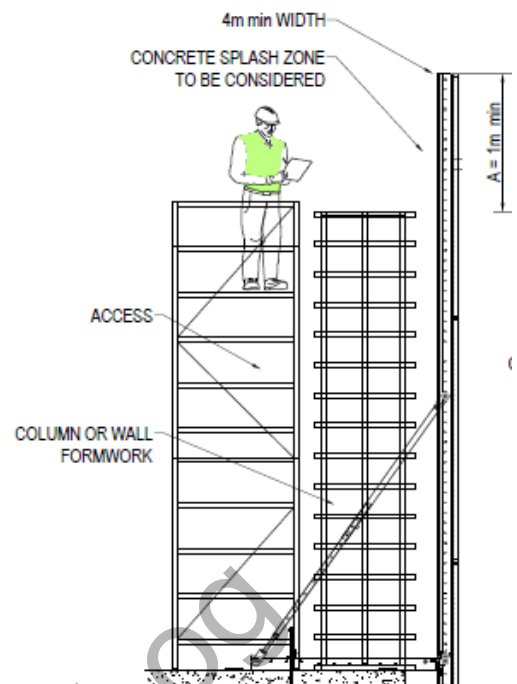


Diagram 9 - Typical single or multi-story construction

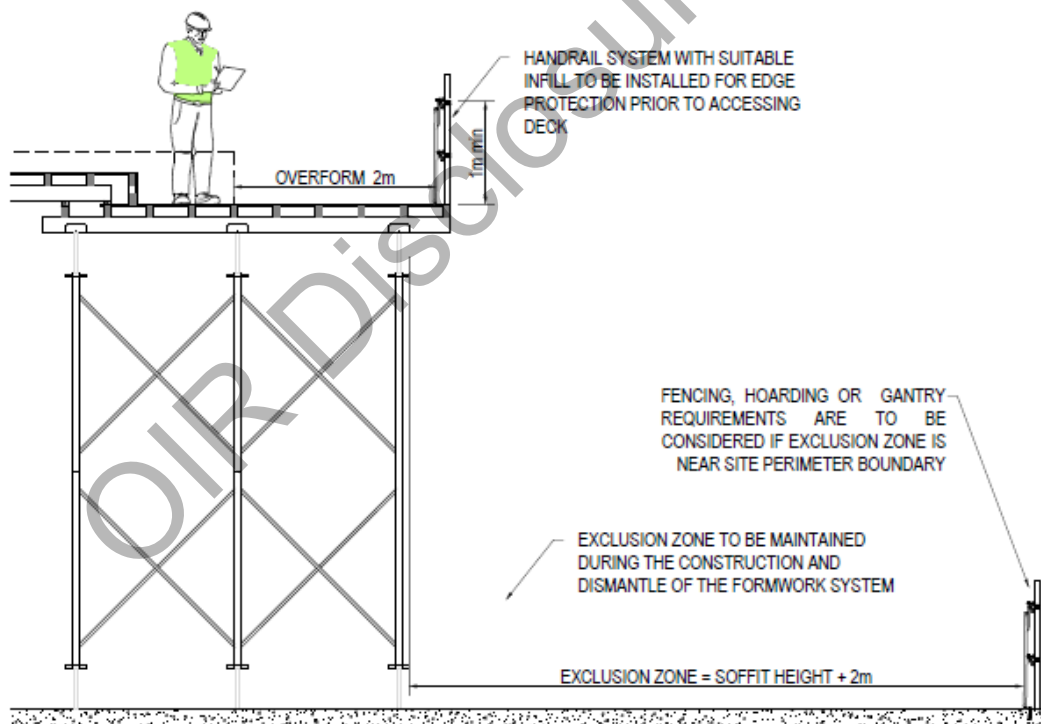


Diagram 10 - Typical single level construction

When selecting containment sheeting consideration must be given to:

- ability to support or contain imposed loads including building materials, equipment and waste materials
- ability to contain ejected objects
- pattern and frequency of fixing points
- degree of protection required from rain or washing down operations
- chemical reactivity

- flammability
- light transmission requirements (refer AS1680 for guidance)
- ventilation requirements (refer AS1668.2 for guidance)
- frequency of inspection
- wind loads on the supporting structure
- gaps created by a fixing method
- the ability for the containment sheeting to move within the supporting structure.

Perimeter containment screens used for formwork must be placed in position prior to formwork erection commencing and are not to be removed until all stripping is completed and all formwork materials are removed from the underside of the concrete as formed and/or removed from or stacked on the floor.

## 5.2 Building step-ins

Perimeter containment screens must extend above the formwork erection area so that materials cannot fall to the ground or other area where persons may be. Where the horizontal surface under construction steps in from the building perimeter, such as in the case of a plant room on a building roof, the perimeter screens must be erected to a height that will prevent any materials falling to the ground (see Diagram 9).

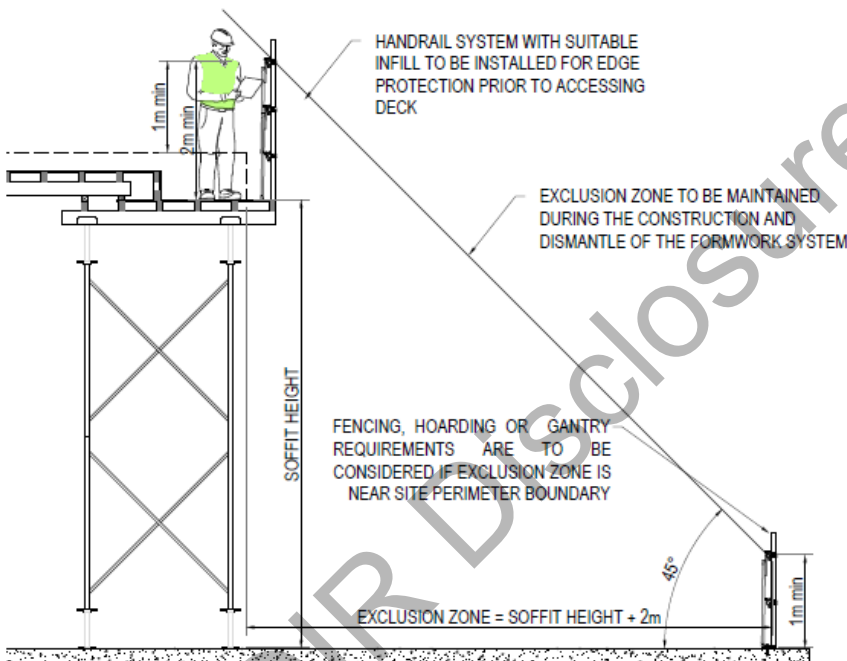


Diagram 11 - Typical set back or single construction

Persons not involved in formwork erection should not be located in the area of the building next to the step-in, unless controls have been implemented to prevent these persons being struck by falling objects.

## 5.3 Gaps

Gaps between perimeter screens and the formwork deck or floor should not be large enough to allow materials to fall below. This can be done by:

- fixed ply covers,
- or
- ply or rubber deflector shields that are connected to screens and the adjacent area cleaned up before they are moved.

Deflector shields deflect objects onto the deck, preventing objects from falling further down the gap. They should be attached to the screens by a system that will ensure the shields do not fall when the

screens are lifted and that is robust enough to withstand the environment. Deflector shields should be designed by an engineer and be adequate to resist impact loads likely to be applied (i.e. from bearers, formply props, etc.) Where chain is used to secure deflector shields, it should have a minimum link size of 5mm and be corrosion resistant. Light gauge domestic type chain is not suitable as it is easily damaged and will rust. Gaps on standard decks may have ply covers that are secured using nails, however fixings used on ply covers and deflector shields for jump forms, slip forms, self-climbing and crane lifted vertical formwork should only be bolted or screw connections – nails should not be used.

Covers should be designed for:

- potential loadings such as loads applied by workers
- the impact loadings of falling materials
- marking with their safe working load if they can be accessed as a platform.

## 5.4 Prior to lifting

Prior to lifting, the following should take place:

- formply, wall and column forms and other materials should have concrete removed to ensure it does not fall onto persons below
- an inspection carried out to ensure all loose materials and tools are removed from loads to be lifted.

Reference should also be made to section 4.4.4 of this code Lifting formwork materials.

# 6 Special requirements for wall and column forms

## 6.1 Bracing for wind loading

Wall and column forms should be designed to withstand wind loading prior to, during and after the concrete pour. The bracing and forms should not be removed from the cast element until it can safely withstand potential impact loads and wind loads.

Prior to commencing formwork stripping operations, a competent person (as described by this code) must verify that sufficient concrete strength has been achieved in accordance with the design documentation, and provide written certification that the formwork can be removed.

Lateral support can be provided to vertical elements in a variety of ways including horizontal and angled braces and structural connections to other parts of the building. A bracing element must be verified and signed off by an engineer. The bracing element must also be able to resist both tensile and compressive loads that may be applied by the wind. Anchors for braces should preferably be cast-in type anchors or 'through-bolts' that extend through both sides of the anchoring medium. Insert type anchors of the following types may be used provided they are installed in accordance with the manufacturer's instructions:

- Undercut type anchor that do not rely on friction to function.
- Expansion anchors of the high-load slip, torque controlled type. These anchors have a working load of at least 60 per cent of the first slip load and are generally suitable for structural tensile loads.
- Coil bolts.

The correct operation of insert type anchors is greatly dependant on their being installed in accordance with a manufacturer's specifications (e.g. drilling the correct size hole and applying the correct torque in concrete of adequate strength).

Insert type anchors are to be installed using a calibrated torque wrench or another reliable method that is specified by the anchor manufacturer. Written and signed records verifying the anchors have been installed in accordance with the manufacturer's instructions are to be available on site.

## 6.2 Access platforms

Suitable access for doggers, steel fixers and concreters should be provided and may include mobile scaffolding, purpose built work platforms or elevating work platforms. Edge protection should be provided on the access platforms. The access method should allow adequate room for a person and be positioned at a height and distance from the form so as to minimise movement and a person's exertion. Any concrete pouring system should permit adequate space for a person to stand with edge protection provided. All mobile work platforms should have their castors locked at all times except when moving the mobile platform. Platforms should also be designed to resist any side loading that may be applied during a concrete pour to ensure the platform does not overturn. Aluminium scaffolding may not have adequate self-weight to ensure this. The [Scaffolding Code of Practice](#) provides additional guidance on the design and use of scaffolding.

## 6.3 Lifting methods

Wall and column forms should be provided with lifting points that have been designed by an engineer. Documentation must be available that verifies this. Holes cut with oxy-acetylene torches are not permitted as they may damage the form, are inaccurate and may make it difficult to attach lifting gear. Where lifting lugs are attached to the form the weld size and length should be specified by an engineer and the manufacturer should ensure that the weld complies with the engineer's requirements (that is, is of the correct size and has adequate weld penetration).

Wall and column forms must only be lifted with a positive lifting system such as lifting lugs or by slinging the lifting slings around the form such that the form cannot slip out of the slings. Purpose designed lifting lugs are preferable to slinging the load because there is less risk of the load becoming inadvertently disconnected from the crane hook.

When lifting wall and column forms always make sure:

- there is an engineer's drawing or certification for lifting the form
- the lifting lug type, location and attachment are the same as specified on the drawing
- the types and spacing of members on the form are the same as those specified on the engineer's drawing
- the numbers, types and spacing of bolts and screws on the form are the same as those specified on the engineer's drawing
- the form is engineer certified for any side loading lifting (i.e. when flipping the form onto or when using multi-legged slings)
- any bracing on the form is the same as that specified on the engineer's drawing
- a competent person from the formwork contractor inspects the form every time it is lifted and verifies it is safe to lift.
- there is a documented system so the forms are inspected for damage or deterioration and remain safe.

It is important to:

- never lift a wall or column form unless the form complies with the engineer's drawing
- never lift a form that has lifting parts that are damaged or rotten
- never change the lifting points without engineer approval
- never drill extra holes in the lifting parts of the form
- never use bolts, screws or timbers different to those listed on the engineers drawing,
- never allow suction between two members.

# 7 Requirements for slip forms, jump forms, self-climbing and crane lifted vertical formwork

This section applies to slip forms, jump forms and crane lifted forms that incorporate working platforms and enclosed cells in which persons are required to work.

Slip forms and jump forms are the terms given to self-climbing formwork systems specifically intended to construct concrete walls and columns in high rise buildings and other concrete structures such as chimneys. In slip forms, the climbing is usually carried out continuously during the concrete pour. With jump forms, the climbing is done in steps, following the concrete pour. The term “climb form” is also used to describe a slip form or jump form. The power for the climbing operation can be provided in a variety of ways, but usually by means of hydraulic rams or electric motors connected to climbing feet or screw shafts.

Slip forms and jump forms usually consist of a number of decks and may also be fitted with trailing screens that are suspended from the form. As with perimeter screens, trailing screens may provide edge protection for persons, prevent materials from falling; provide support for work platforms or a combination of these uses. No two slip forms or jump forms will be identical because their design depends on the size and configuration of the structure under construction.

The work systems and layout of some crane-lifted forms may also be similar to those associated with slip forms and jump forms. This may be the case for crane-lifted forms provided for the inside of lift shafts. While most of the information in this section applies to slip forms and jump forms, some of the principles may also apply to crane-lifted forms.

When designing and operating these types of form, the following issues should be addressed:

- provision for safe access to all areas and work platforms
- control of risk associated with working at height
- provision of sufficient working space and head room
- specification of appropriate manual tasks methods for shutters and other components, e.g. the use of cranes to lift shutters and provision of safe access for persons attaching slings to shutters
- provision for retrieval of an injured or incapacitated person from any work area located within the structure.

It is acknowledged it may not be practicable to provide an access system and working environment on a jump form or slip form that are of the same standard as elsewhere. This is primarily due to structure characteristics and weight limitations. A designer must endeavour to minimise potential hazards.

## 7.1 Access and egress

Access to the form may be provided in a variety of ways including one or more of the following:

- personnel and material hoists on the building
- permanent stair systems in the building
- a trailing stair system suspended from the slip form or jump form
- an internal trailing ladder system.

A trailing access stair system should be the primary means of access over a ladder system because it is safer for persons to ascend and descend and emergency evacuation is generally safer on a stair system. Two forms of access and egress to the form should be maintained at all times. Where formwork systems are used on single cell cores, columns or isolated walls, a single stair tread system is acceptable provided the site crane or other alternative is available for emergency removal of workers. If the site crane, or another suitable alternative, is not available then no workers should access the system.

The access area between the trailing access system and the building should be clear of trip hazards and there should be no gaps between platforms exceeding 100mm wide.



A designer of formwork should ensure the trailing access system is designed for loads that could be applied in an emergency evacuation situation. Both the strength of the system itself, and the ability of the form to withstand applied loads from the access system, should be adequate. The trailing stair access system should be designed for a load of at least 2.5kPa unless the designer is able to justify a lesser load based on the anticipated number of persons on the form at any one time.

Where the designer of the formwork specifies a lesser live load than 2.5kPa, the following should be ensured:

- A sign stating the maximum load that can be applied to the stairs should be fixed to the stairs in a visible position.
- Written procedures are implemented to ensure the total acceptable number of persons on the form is not exceeded.

Ladders must be secured in place and be placed at an angle between 70 and 80 degrees to the horizontal, where this is practical.

Access openings for ladders on working decks should be provided with trapdoors that are closed except when being accessed. Trapdoors should be provided with a device so that they can be easily opened from above. This device should not pose a trip hazard for persons on the deck.

Access ways should be kept free of materials and rubbish to prevent objects falling to the level(s) below.

## 7.2 Working platforms and penetrations

The following points highlight specific issues that may apply:

- All penetrations should be covered by formply that is secured in position or should be provided with leading or perimeter edge protection.
- When placing steel or pouring concrete into a form, controls should be provided to prevent a person falling into or off the form. This becomes more of an issue when the width of the form is greater than 225mm prior to placement of reinforcing steel. A person working in proximity to projecting reinforcing steel or other objects must be protected from the risk of being impaled by these objects. Suitable controls may include edge protection on the internal side of the working platform or sheets of steel re-enforcement mesh temporarily placed on top of the form that is, the steel can be fed through the gaps in the mesh.
- All platforms that may be affected by uplift should be positively secured so that uplift cannot occur. Uplift can occur from wind loading or when a platform is out-of-level and unsecured. In the latter instance, the platform can see-saw when a load is applied to the end of the platform and then drop a person off the platform if one of the platforms supports moves. This may be the case where work platforms are supported by a trailing screen on one side and a parapet of the building on the other.
- Where individual cells of the form are climbed at different times, edge protection should be provided on each of the raised cells.

### 7.2.1 Trapdoors

Where penetrations exist, work procedures should be implemented to minimise the risk of workers and materials falling through the penetrations. This should include a process that helps workers to be aware of the location of trapdoors and covers. This will reduce the risk of workers tripping on penetration covers or inadvertently jumping on to a trapdoor without knowing they are doing so.

Trapdoors are to be constructed so that the trapdoor itself and its support will not fail. Trapdoors need to be able to support persons walking or standing on them. Persons should not jump onto trapdoors or penetration covers.

The following applies to trapdoors:

- The trapdoor itself should be constructed from a single piece of material.
- The material used to construct the trapdoor should be a structurally rated material. For example, if plywood is used to construct the trapdoor the plywood should be of a structural grade to an

appropriate design and manufacturing standard such as *AS/NZS2269 Plywood-Structural* or *AS6669 Plywood-Formwork*.

- The trapdoor should be designed and installed to be supported, when closed, around as much of its edge as practical. For example, support should be provided under all four edges of the trapdoor, except under the area of the trapdoor removed to allow the ladder to pass through the closed trapdoor.
- The support under the trapdoor should be by structural bearers and not strips of timber that have been screwed to the formwork deck.
- In order to allow the ladder to protrude through the deck, part of the trapdoor will need to have a section removed. This cut out should be as small as possible, while allowing a ladder angle of 4 to 1. The cut out should not be wider than the outside of the ladder stiles.
- Where a trapdoor is no longer in use it should be locked or fastened so that it cannot be easily opened.
- The hinges on the trapdoor are to be robust and remain serviceable for the life of the trapdoor.
- Trapdoors should be marked with the words 'Danger Hole Under' or, 'Danger Penetrations Below; or similar.

## 7.3 Trailing screens and platforms

Trailing screens can provide edge protection, a means of preventing falling objects and be designed to incorporate working platforms. Where platforms are provided these are usually for the purpose of patching the building or carrying out minor repairs, and for access for persons climbing the form. A designer of formwork will specifically need to address all issues for which the trailing screen system is designed. The following issues must be included in the design:

- A suitable design loading for any platforms on the trailing system. As a guide, platforms should be designed to support a minimum load of 2.5kPa. A designer may reduce this if the number of persons is strictly limited and controls are implemented on site to ensure this. If the design load is less than 2.5kPa, signs should be fixed to the platforms that state the maximum load permitted in kilograms. Persons on site should be made aware of the maximum loading that may be applied to the trailing platform and this should be stated in documentation kept on site.
- Adequate controls should be provided to control the risk of falling materials (see section 5 of this code for further guidance).
- All platforms should be secured to prevent uplift or any other movement.
- Safe working loads when the trailing screen is used as work platform.

Except where it is impractical to do otherwise, a person should not be located on trailing platforms while the platforms are crane lifted. If a person is located on a platform while it is being lifted by a crane, the following controls must be implemented:

- A person should be prevented from falling down any gap that may exist on the inside edge of the platform that is, between the platform and the wall being constructed. It is preferable to provide edge protection on the inside edge to ensure this. Fall arrest harnesses may be provided for workers as long as workers are trained in their safe use and a rescue procedure for retrieval of workers following a fall has been prepared.
- Persons on the platform hold at least a dogger or rigger licence class or a person with such a licence class is also located on the platform as it is lifted.
- A clear method of communication between the crane operator and the dogger responsible for directing the lift exists that is, a whistle or two way radios.
- Any crane making the lift complies with the requirements for cranes used to lift persons specified in *AS2550: Cranes, hoists and winches – safe use*.

## 7.4 Climbing the form

It is important to ensure the different parts of the form remain level during the climbing process. Climbing is usually carried out using a series of climbing devices set up to lift at the same time and at the same rate. If the lifting system is not properly synchronised the form may become wedged on the structure or structural members may be overloaded. There should therefore be a system to ensure that

the form does not go out-of-level during the climbing procedure. This system may be an automated system or may rely on operators stopping the climbing process. The following must be ensured:

- Only persons directly involved with the climbing process should be located on the form during the climbing process.
- Any potential nip or shear points where a person could be injured during the climb are identified and controlled.
- All obstructions on the form have been removed prior to the form being climbed. A 'sign-off' procedure for this should be provided. This includes the removal of 'Z-bars', ferrule bolts and other material that would snag on the structure if they were not removed.
- Services including electrical cable and water pipes have been designed so that they will not rupture or snag as the form is climbed.

When removing a form from a vertical element, the form must be effectively supported such that it never relies on suction for support. Serious incidents have occurred when it has been assumed that a form is supported from above when it is in fact relying on 'through bolts' through the wall for support. When the bolts have been removed the form has fallen, with the persons still standing on a platform attached to the form. This hazard can apply both to crane lifted forms and jump forms.

A checklist (as illustrated in Appendix 6) can be used to assist in this process.

## 7.5 Ventilation and amenities

Adequate ventilation and access to all cells in jump forms or slip forms should be provided where reasonably practicable. It is difficult for persons to spend extended periods in cells due to the heat and cramped working conditions. Allowance should be made for these issues and it may be necessary to specify maximum times for particular cells depending on temperature, humidity and cell size. These times should be developed as part of a safe work method statement following consultation between the workers and their PCBU.

Adequate ventilation and access should also be provided within cells and it may be necessary to provide ventilation fans or access ways in the cells.

Clean drinking water should be provided on the top level of the slip form and jump form. On larger slip forms and jump forms it may be necessary to provide clean drinking water on other levels. A chemical toilet should be provided on the top of the jump form when installation of a plumbed toilet is not practical.

## 7.6 Engineering issues

The design of jump forms and slip forms is more complex than the design of formwork systems for floors. Greater technical input from a designer is required including consideration of wind loading. For this reason, the slip form or jump form designer must be an engineer.

The jump form or slip form designer must be involved both in the initial design of the form and in addressing ongoing design issues that will occur during form erection and during the life of the building project. Many of the design problems associated with jump forms and slip forms will not become apparent until the job is progressing, and it is likely that alterations to the design of the form will be necessary. The designer must therefore inspect the form on site and work closely with persons involved in its operation, and the principal contractor, to determine if difficulties are being encountered.

Section 2 of this code discusses engineering issues. In addition, the following factors must be addressed by the designer of these types of formwork:

- Minimum concrete strength required prior to climbing.
- Allowance for all loads, including dynamic and wind loads that may be applied to the form. Loads applied by workers and concrete placing activities must also be allowed for. Allowance may also need to be made for impact loading when materials are lifted onto the deck of the form. The designer must consider the effects of eccentric loading on the form, both during climbing and at other times, and note the requirements in the operating procedures for the form.

- The maximum degree to which the form can be out-of-level during climbing, and the procedure required both to minimise the likelihood of this occurring and how to remedy the situation if the form becomes out-of-level.
- Consideration of rescue procedures that may affect the design of the form. The rescue procedure may require access to all levels of the form and cells, either through the provision of gates or removal of panels on the form.

## 7.7 Emergency issues

Fire extinguishers, hoses and other means of fire prevention and control must be provided on the jump form or slip form in accordance with relevant legislation.

Emergency procedures for the jump form or slip form must be developed, documented and implemented. Persons must be trained in these procedures and a list of persons who have received the training must be documented.

The emergency procedures must include, but not be limited to the following:

- the method of alert in the event of an emergency and the method of extracting persons from each location or cell that the persons have access to or could fall into
- when to evacuate persons from the form
- evacuation muster points both on and off the form
- training in the use of fire extinguishers
- identifying persons responsible for ensuring evacuation takes place
- rescue procedures in the event of severe medical conditions
- identifying persons responsible for rescuing workers, and
- rescue training for persons involved in rescuing others, where outside experts will not be responsible for performing the rescue.

Where the form can be accessed using cranes on site, a first aid box for emergency rescue of injured and incapacitated persons must be readily available and accessible at all times while work is being undertaken.

Response to emergency situations must be considered during formwork design stages and in an ongoing way during construction. Emergency situations requiring evacuation of an injured worker from a formwork 'cell' need to consider how to safely remove an immobilised or unconscious person. This may include creating emergency access holes and doorways through decks and screens. Procedures must identify how to access lift-voids and other areas, including cells within the core which may have limited access. In relation to emergency evacuation from vertically lifted systems two forms of access and egress should be provided as set out in Table 3 in section 3.2.1.

Emergency services contacts must be clearly identified and available. These must be nominated by all parties on site, including the principal contractor, sub-contractors and workers.

# Appendix 1: Dictionary

Bearer:	Primary horizontal support members for a formwork deck that are placed on top of formwork frames. Bearers are usually constructed from timber but are sometimes constructed from metal, such as in the case of some modular formwork systems.
Cell:	An area of a slip form, jump form or crane lifted form where a worker or workers are required to carry out work. The cell will at least be enclosed by all sides and a bottom surface.
Competent person:	<p>In relation to performing an inspection or other task for a control measure is a person who has acquired, through training, qualifications or experience knowledge and skills, including:</p> <ul style="list-style-type: none"><li>• sound knowledge of relevant Australian Standards, relevant codes of practice and other relevant legislation,</li><li>• ability to read and interpret drawings</li><li>• sound knowledge of, and competence in, the risk management process for the erecting, altering and dismantling of formwork, including:<ul style="list-style-type: none"><li>– hazard identification and risk assessment</li><li>– measures to control exposure to risks</li><li>– safe work practices and procedures</li><li>– how to plan and prepare formwork.</li></ul></li></ul>
Containment sheeting:	A protective structure fixed to the perimeter of the building, structure or working platform to contain objects and prevent them from falling.
Edge protection:	<p>A barrier to prevent a person falling erected along the edge of:</p> <ul style="list-style-type: none"><li>• A building or other structure.</li><li>• An opening in a surface of a building or other structure.</li><li>• A raised platform.</li></ul>
Engineer:	<p>In relation to the performance of a task, means a person who:</p> <ul style="list-style-type: none"><li>• is a registered professional engineer under the <i>Professional Engineers Act 2002</i></li><li>• is competent to perform the task.</li></ul>
False deck:	A deck provided to safely arrest a falling person and/or provided as a working platform (different to the 'pouring deck').
Form:	An object used in the casting of concrete walls or columns that has part of its surface in contact with the concrete during the concrete curing process.
Formwork frame:	A structural assembly, a number of which are used to support a formwork deck. Bearers are placed directly on these frames.
Horizontal member:	Any horizontal member of a formwork frame that is provided as stiffening for the frame and may also be used to support a working platform.
Intermediate platform:	A platform at least two planks wide, located less than 2 metres above a continuous deck.

Joist:	Secondary horizontal support members for the formwork deck that are placed on top of bearers, at right angles to the bearers. Joists are usually constructed from timber but are sometimes constructed from metal, such as in the case of some modular formwork systems.
Licence class:	A class of high risk work endorsed on a licence to perform a class of high risk work.
Modular formwork systems:	A formwork system that is specifically designed for formwork and consists of components that are not designed to be used with other systems.
Perimeter edge protection:	Edge protection that is provided on the perimeter of the formwork to be erected. (Note: Perimeter edge protection will prevent a fall off the outside perimeter of the formwork but will not prevent internal falls through the formwork).
Pouring deck:	A deck on which concrete is poured.
Prop:	A slender structural member placed in a vertical position between two horizontal surfaces and used to support the upper surface. The proprietary term "Acrow" is often used to describe the prop. The height of a prop is usually adjustable.
Vertical member:	A vertical structural member which may or may not form part of a frame, also known as standard, vertical tube.

OIR Disclosure Log

# Appendix 2: Sample engineer's certification letters

(A) Engineer's certification letter – no variation to design

.....  
.....  
.....  
.....

Dear Mr/Ms .....

Project .....

I certify that the formwork system detailed below has been designed in accordance with Australian Standards AS3610 – Formwork for concrete and AS3600 – Concrete structures and the project documentation including the structural engineering drawings and specification. The system is detailed on the drawings and documentation listed below.

Drawing number	Drawing name
Specifications	

Yours faithfully

Signature

Engineer's name

RPEQ No.

(B) Engineer's certification letter – variation to design

.....  
.....  
.....  
.....

Dear Mr/Ms .....

Project .....

I certify that the variations to the formwork system detailed below have been checked and satisfy the Australian Standards *AS3610 – Formwork for concrete* and *AS3600 Concrete structure* and the project documentation including the structural engineering drawings and specification.

Variation number	Details of variation of formwork system

Yours faithfully

Signature  
Engineer's Name

RPEQ No.

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# Appendix 3: Construction checklist

Note: '#' denotes an item that, if not passed by the competent person, must be referred to the engineer. All other items not passed by the competent person must be corrected on site and certified by the competent person when he/she is satisfied.

## Loads

- What are the stacked load limits at all stages?
- Are the stacked materials on spreaders?
- # Will the loads be exceeded by any construction procedure?

## Materials

- # Are the correct form materials being used?
- Is the formface appropriate to the finish required?

## Formwork frames

- # Are the formwork frames in the correct location and correct number?
- Are they to dimension and within tolerance?
- Are they accurate to line, level and plumb?

## Bracing/props

- # Are there different props or braces to the ones indicated on the formwork drawings?
- Are the props plumb?
- Are all loads centrally placed?
- Are supported elements wedged and nailed?
- Are props straight?
- Are base plates on adequate foundations?
- Is the bracing correct?
- Is the bracing firmly connected?

## Fixing

- Is the nailing/screwing adequate?
- # Are the ties the correct type?
- # Are they on the correct grid?
- Are all ties, clamps and bolts tight?
- Are wedges tight and nailed?
- # Are connections between traditional formwork and modular formwork correct?

## Back-propping

- # Is the back-propping system correct?
- # Are the number of floors required for back-propping correct?

## Cleanliness

- Are the formfaces cleaned?
- Is any damage correctly repaired?
- Is the correct release agent in use?
- Is it being correctly applied?
- Has all debris been removed from within the form?

## Water-tightness

- Are all joints properly sealed and cramped?
- Are the construction joints sealed?

### Concrete/concreting

- What is the maximum rate of placement permitted?
- Are the forms maintaining line, level, plumb, shape, etc. during concreting?

### Stripping

- What are the minimum stripping times?
- Has the project designer permitted modification of these?
- Do the procedures enable stripping without damage to form or concrete?
- Are the provisions consistent with the re-use times required?
- Has the crane the necessary slings, etc. to move the forms quickly?
- What curing methods must be used once the formwork is removed?
- Is the storage area for the formwork organised?

### Safety

- Are there adequate guardrails, handrails, walkways, signs, etc. in position?

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# Appendix 4: Sample structural (pre-pour) certificate

Engineer's/Competent person's name:..... Telephone.....

Address: .....

FAX:.....

Mobile: .....

Date: .....

Project: .....

Level:.....

Area:.....

This is to certify that the ..... Formwork for the above project has been inspected and is considered to have been erected in accordance with the formwork design documents and meets relevant Australian Standards including *AS3610 Formwork of concrete*.

The following items were included in the inspection:

ITEM	CONDITION	WORK REQ'D Yes/No??
Base plates	OK	No
Frame spacing	OK	No
Frame bracing	OK	No
Frame extensions	OK	No
Bearer size and spacing	OK	No
Joist size and spacing	OK	No
Prop spacing	OK	No
Prop bracing	OK	No
Eccentric loading	OK	No
Prop inclination	OK	No
Timber condition	OK	No
Steel condition	OK	No
Nails in plates as req'd	OK	No
Column framing	OK	No
Column bracing	OK	No
Plywood fixing	OK	No
Back propping	OK	No
Quality of materials	OK	No

If there is any additional work required before the pour takes place please detail what is required

\_\_\_\_\_

.....  
*Engineer's / Competent person's name*

.....  
*Signature*

# Appendix 5: Defects commonly found in formwork systems

## Sole plates

- (a) not levelled in or eccentrically placed
- (b) inadequate load-carrying capacity of the ground and uneven bedding
- (c) deterioration with time (e.g. due to weather conditions)
- (d) deterioration of load-carrying capacity of the ground, (e.g. washouts)
- (e) crushing due to inadequate load distribution from vertical and horizontal members.

## Horizontal supports

- (a) folding wedges cut to too coarse a taper, not properly cleated, cut from wet material
- (b) inadequate lateral and torsional bracing, (e.g. between telescopic centres, centres carrying heavy loads over long spans, steel props supporting heavy loads at, or near, maximum extension and between towers supporting independent spans)
- (c) horizontal members not centrally placed in forkheads
- (d) inadequate supports to cantilevers, (e.g. struts supporting deep beam sides on the outer face of the structure)
- (e) inadequate bearing areas to vertical supports and underside of principal members causing crushing
- (f) inadequate support to prevent overturning of deep principal members because stirrups or forkheads often omitted
- (g) bolted timber connections not staggered creating tendency to split out.

## Vertical supports

- (a) inadequate bracing during erection
- (b) support not plumb
- (c) inadequate lateral ties and/or vertical and plan bracing
- (d) no ties between standards at point of loading (most important where telescopic centres are being supported)
- (e) incorrect provision of props from floor to floor
- (f) lack of rigidity of screw connections due to over-extension or lack of bracing
- (g) adjustable steel props with nails, mild-steel bolts and reinforcing bars used in place of correct pins
- (h) omission of scaffold forkheads or supports, otherwise eccentrically loaded without allowance having been made for this condition
- (i) bearing plates distorted (top and bottom plates of steel props)
- (j) inadequate or discontinuous bracing to scaffold.

## General

- (a) excessive tolerances in construction
- (b) failure to check tightness of bolts, wedges, etc.
- (c) failure to control vertical rate of placement of concrete
- (d) failure to control placement of concrete, causing uneven loading of forms
- (e) inadequate allowance for uplift of concrete under inclined forms
- (f) inadequate allowance for the effects of vibration on joints
- (g) inadequate allowance for stresses induced by prestressing, temperature and moisture movements
- (h) no allowance for wind loading
- (i) no allowance for the effect of vibration on ties, struts, braces, and wedges
- (j) unrealistic assessment of stresses due to over-simplification of design assumptions
- (k) unequal load distribution between two or more members carrying a common load.

# Appendix 6: Perimeter screen handover checklist

<b>Project:</b>		<b>Date:</b>
<b>Scope:</b>	<b>Checklist for climbing screens</b>	
<b>Activity:</b>	<b>Climbing the perimeter safety screens</b>	

#	Description of activity	Screen Supervisor	Sign	Area Foreman	Sign
1	Pre-climb prep				
2	Actions during the climb				
3	Post climb actions				
4	Task completion checklist				
5					
6					
7					
				<b>Yes</b>	<b>No</b>
<b>Pre climb preparation of the screens</b>					
The screen supervisor and area foreman have checked that formwork is clear of screens.					
All platforms on the screens and building edges have been swept and cleaned at least 1 meter from the edge of the building line.					
The screen supervisor has briefed the screen crew, crane crew and other workers involved in the task. Two way radio communication is established between screen crew and spotter(s).					
The screen crew have verified that edge protection is in place at the building edge on all levels – including the level that is exposed after screen is climbed, and barricades and screen crew only signage is in place (exclusion zones) a minimum of at least 960mm barricade mesh.					
All flaps, needles, push pull props, tie down bolts are released from behind compliant edge protection or by a worker anchored in a safety harness. See SWEMS 0058 and SWEMS 0068 trailing screen procedures and SWEMS 0074 using a safety harness.					
All flaps, push pull props, infill's, are properly chained or secured to the screens					
Exposed back props closer than 2/3 the length of the prop from the exposed edge have been bolted to the concrete					
The screen supervisor has contacted and area foremen to confirm the screens are clear from the building and ready to jump.					
Ensure availability of the cane to lift and secure a series of screens in sequence before the crane is taken away for other lifts. Confirmation consultation with crane crew and builder before preparing to lift screens.					
Dogman to connect the chains to the identified lifting points on the screen. Chains to be connected where there the dogman can reach after lifting. Note: crane crew to be inducted into the lifting of the screen procedure.					
<b>Actions during the climbing of screens</b>					
All workers in the screen crew are watching for hang ups from <b>behind</b> compliant edge protection and must notify the Screen Supervisor of any problems					
If workers have to stand outside the edge protection to free hang ups they must be <b>anchored in a safety harness</b> - see SWEMS 0074					
<b>Post climbing actions</b>					
All needles / push pull props / connection Z-bars are fixed to concrete slab and all screens are secured to the building					
Platforms on all levels have flaps in place					
				<b>YES</b>	<b>NO</b>
Note: When the live deck is being laid it is the responsibility of the formworkers to re-fix					



# Managing the risk of falls at workplaces

## Code of Practice 2018

OIR Disclosure Log



This code is based on a national model code of practice developed by Safe Work Australia and approved by the Workplace Relations Ministers' Council on 10 August 2011 as part of the harmonisation of work health and safety laws.

This Queensland Code of Practice was made by the Minister for Education and Industrial Relations on 1 July 2018.

This code commences on 1 July 2018.



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# Foreword

This Code of Practice on how to manage the risk of falls in the workplace is an approved code of practice under section 274 of the *Work Health and Safety Act 2011* (the WHS Act).

An approved code of practice is a practical guide to achieving the standards of health, safety and welfare required under the WHS Act and the *Work Health and Safety Regulation 2011* (the WHS Regulation).

From 1 July 2018 duty holders are required to comply either with an approved code of practice under the WHS Act or follow another method, such as a technical or an industry standard, if it provides an equivalent or higher standard of work health and safety to the standard required in the code.

A code of practice applies to anyone who has a duty of care in the circumstances described in the code. In most cases, following an approved code of practice would achieve compliance with the health and safety duties in the WHS Act, in relation to the subject matter of the code. Like regulations, codes of practice deal with particular issues and do not cover all hazards or risks that may arise. The health and safety duties require duty holders to consider all risks associated with work, not only those for which regulations and codes of practice exist.

Codes of practice are admissible in court proceedings under the WHS Act and WHS Regulation. Courts may regard a code of practice as evidence of what is known about a hazard, risk or control and may rely on the code in determining what is reasonably practicable in the circumstances to which the code relates.

Compliance with the WHS Act and WHS Regulation may be achieved by following another method, such as a technical or an industry standard, if it provides an equivalent or higher standard of work health and safety than the code.

An inspector may refer to an approved code of practice when issuing an improvement or prohibition notice. This may include issuing an improvement notice for failure to comply with a code of practice where equivalent or higher standards of work health and safety have not been demonstrated.

This Code of Practice has been developed by Safe Work Australia as a model code of practice under the Council of Australian Governments' *Inter-Governmental Agreement for Regulatory and Operational Reform in Occupational Health and Safety* for adoption by the Commonwealth, state and territory governments.

## Scope and application

This code applies to all workplaces covered by the WHS Act and WHS Regulation where there is a risk of a fall by a person from one level to another that is reasonably likely to cause injury.

This code provides practical guidance to persons conducting a business or undertaking, including those persons who design, construct, import, supply or install plant or structures, on how to manage health and safety risks arising from falls. It includes information on a range of control measures to eliminate or minimise the risks.

## How to use this Code of Practice

In providing guidance, the word 'should' is used in this code to indicate a recommended course of action, while 'may' is used to indicate an optional course of action.

This code also includes various references to sections of the WHS Act and WHS Regulation which set out the legal requirements. These references are not exhaustive. The words 'must', 'requires' or 'mandatory' indicate that a legal requirement exists and must be complied with.

# 1. Introduction

Falls are a major cause of death and serious injury in Australian workplaces. Fall hazards are found in many workplaces where work is carried out at height, for example stacking shelves, working on a roof, unloading a large truck or accessing silos. Falls can also occur at ground level into holes, for example trenches or service pits.

## 1.1 Who has health and safety duties in relation to falls?

**A person conducting a business or undertaking (PCBU)** has the primary duty under the WHS Act to ensure, as far as reasonably practicable, that workers and other persons are not exposed to health and safety risks arising from the business or undertaking.

A person conducting a business or undertaking has more specific obligations under the WHS Regulation to manage the risk of a fall by a person from one level to another, including requirements to:

- ensure, so far as is reasonably practicable, that any work involving the risk of a fall is carried out on the ground or on a solid construction
- provide safe means of access to and exit from the workplace
- minimise the risk of falls so far as is reasonably practicable by providing a fall prevention device, work positioning system or a fall arrest system.

**Designers, manufacturers, suppliers, importers and installers** of plant or structures that could be used for work must ensure, so far as is reasonably practicable, that the plant or structure is without risks to health and safety. Designers of plant or structures have an important role in eliminating or minimising the risks of falls in the design stage (see Chapter 11 of this code).

**Officers**, such as company directors, have a duty to exercise due diligence to ensure that the business or undertaking complies with the WHS Act and WHS Regulation. This includes taking reasonable steps to ensure that the business or undertaking has and uses appropriate resources and processes to eliminate or minimise risks of falls from one level to another that are likely to cause injury.

**Workers** have a duty to take reasonable care for their own health and safety and that they do not adversely affect the health and safety of other persons. Workers must comply with any reasonable instruction given by the person conducting the business or undertaking.

## 1.2 The meaning of key terms

**Fall** means a fall by a person from one level to another.

**Risk of a fall** means a circumstance that exposes a worker while at work, or other person while at or in the vicinity of a workplace, to a risk of a fall that is reasonably likely to cause injury to the worker or other person. This includes circumstances in which the worker or other person is:

- in or on plant or a structure that is at an elevated level
- in or on plant that is being used to gain access to an elevated level
- in the vicinity of an opening through which a person could fall
- in the vicinity of an edge over which a person could fall
- on or in the vicinity of a surface through which a person could fall
- on or near the vicinity of a slippery, sloping or unstable surface.

**Risk control** means taking action to eliminate health and safety risks so far as is reasonably practicable, and if that is not possible, minimising the risks so far as is reasonably practicable. Eliminating a hazard will also eliminate any risks associated with that hazard.

**Competent person** means a person who has acquired through training, qualification or experience the knowledge and skills to carry out the task.

Further definitions relating to fall control measures are listed in *Appendix A*.

### 1.3 What is required to *manage the risk* of falls?

**WHS Regulation 34-38:** In order to manage risk under the WHS Regulation, a duty holder must:

- identify reasonably foreseeable hazards that could give rise to the risk
- eliminate the risk so far as is reasonably practicable
- if it is not reasonably practicable to eliminate the risk – minimise the risk so far as is reasonably practicable by implementing control measures in accordance with the hierarchy of control
- maintain the implemented control measure so that it remains effective
- review, and if necessary revise, risk control measures so as to maintain, so far as is reasonably practicable, a work environment that is without risks to health and safety.

This code provides guidance on how to manage the risks of persons falling from one level to another by following a systematic process that involves:

- identifying hazards that may cause injury
- if necessary, assessing the risks associated with these hazards
- implementing risk control measures
- reviewing risk control measures to ensure they are effective.

Guidance on the general risk management process is available in the *How to manage work health and safety risks Code of Practice*.

#### **Consulting workers**

Consultation involves sharing of information, giving workers a reasonable opportunity to express views and taking those views into account before making decisions on health and safety matters.

**Section 47:** The WHS Act requires that you consult, so far as is reasonably practicable, with workers who carry out work for you who are (or are likely to be) directly affected by a work health and safety matter

**Section 48:** If the workers are represented by a health and safety representative, the consultation must involve that representative.

You must consult your workers and their health and safety representatives at every step of the risk management process. By drawing on their experience, knowledge and ideas, you are more likely to identify fall hazards and develop effective control measures.

#### **Consulting, co-operating and co-ordinating activities with other duty holders**

**S. 46:** The WHS Act requires that you consult, co-operate and co-ordinate activities with all other persons who have a work health or safety duty in relation to the same matter, so far as is reasonably practicable

Sometimes you may share responsibility for a health and safety matter with other business operators who are involved in the same activities or who share the same workplace. In these situations, you should find out who is doing what and work together with other duty holders in a

co-operative and co-ordinated way so that all risks are eliminated or minimised, so far as is reasonably practicable.

For example, the owner of a transport company with large trucks should consult the goods suppliers as well as the businesses having the goods delivered about how the risk of falls will be controlled during loading and unloading. This may include checking whether suitable equipment is available at each site so that workers do not have to climb on top of loads on the truck and be at risk of falling.

Further guidance is available in the *Work health and safety consultation, co-operation and co-ordination Code of Practice*.

## 2. Managing the risk of falls

### 2.1 How to identify fall hazards

You must identify all locations and tasks that could cause injury due to a fall. This includes access to the areas where work is to be carried out. Tasks that need particular attention are those carried out:

- on any structure or plant being constructed or installed, demolished or dismantled, inspected, tested, repaired or cleaned
- on a fragile surface (for example, cement sheeting roofs, rusty metal roofs, fibreglass sheeting roofs and skylights)
- on a potentially unstable surface (for example, areas where there is potential for ground collapse)
- using equipment to work at the elevated level (for example, when using elevating work platforms or portable ladders)
- on a sloping or slippery surface where it is difficult for people to maintain their balance (for example, on glazed tiles)
- near an unprotected open edge (for example, near incomplete stairwells)
- near a hole, shaft or pit into which a worker could fall (for example, trenches, lift shafts or service pits).

#### **Inspect the workplace**

Walk around the workplace and talk to your workers to find out where work is carried out that could result in falls. A checklist may be useful in this process. Key things to look for include:

- surfaces:
  - the stability, fragility or brittleness
  - the potential to slip, for example where surfaces are wet, polished or glazed
  - the safe movement of workers where surfaces change
  - the strength or capability to support loads
  - the slope of work surfaces, for example, where they exceed seven degrees.
- levels—where levels change and workers may be exposed to a fall from one level to another
- structures—the stability of temporary or permanent structures
- the ground—the evenness and stability of the ground for safe support of scaffolding or a work platform
- the working area—whether it is crowded or cluttered
- entry and exit from the working area
- edges—protection for open edges of floors, working platforms, walkways, walls or roofs
- holes, openings or excavations—which will require guarding
- hand grip—places where hand grip may be lost.

In some situations, advice may be needed from technical specialists, such as structural engineers, to check the stability of structures or load bearing capacity.

### Review available information, including incident records

You should check your records of previous injuries and 'near miss' incidents related to falls. Information and advice about fall hazards and risks relevant to particular industries and work activities is also available from regulators, industry associations, unions, technical specialists and safety consultants.

## 2.2 How to assess the risk

A risk assessment will help you determine:

- what could happen if a fall did occur and how likely it is to happen
- how severe a risk is
- whether any existing control measures are effective
- what action you should take to control the risk
- how urgently the action needs to be taken.

A risk assessment is unnecessary if you already know the risk and how to control it.

When assessing the risks arising from each fall hazard, the following matters should be considered:

- the design and layout of elevated work areas, including the distance of a potential fall
- the number and movement of all people at the workplace
- the proximity of workers to unsafe areas where loads are placed on elevated working areas (for example, loading docks) and where work is to be carried out above people and there is a risk of falling objects
- the adequacy of inspection and maintenance of plant and equipment (for example, scaffolding)
- the adequacy of lighting for clear vision
- weather conditions—the presence of rain, wind, extreme heat or cold can cause slippery or unstable conditions
- the suitability of footwear and clothing for the conditions
- the suitability and condition of ladders, including where and how they are being used
- the adequacy of current knowledge and training to perform the task safely (for example, young, new or inexperienced workers may be unfamiliar with a task)
- the adequacy of procedures for all potential emergency situations.

### Generic risk assessment

If you are responsible for a number of different work areas or workplaces and the fall hazards are the same, you may perform a single (or generic) risk assessment. However, you should carry out a risk assessment on individual fall hazards if there is any likelihood that a person may be exposed to greater, additional or different risks.

## 2.3 How to control the risk

There are a number of ways to control the risks of falls. Some control measures are more effective than others. Control measures can be ranked from the highest level of protection and reliability to the lowest. This ranking is known as the *hierarchy of control*. The WHS Regulation requires duty holders to work through this hierarchy to choose the control that most effectively eliminates or minimises the risk in the circumstances. This may involve a single control measure or a combination of two or more different controls.

In managing the risks of falls, the WHS Regulation requires the following specific control measures to be implemented, where it is reasonably practicable to do so:

1. Can the need to work at height be avoided to eliminate the risk of a fall?

- Carry out any work that involves the risk of a fall on the ground.
2. Can the fall be prevented by working on solid construction?
- A building or structure that is used as an existing place of work and includes safe access and egress from which there is no risk of a fall from one level to another, for example properly constructed stairs with fixed handrails, flat roofs with a parapet or permanently installed guard rails around the edges.
- It is usually not necessary to implement additional control measures to manage the risk of falls for workplaces in buildings that already comply with the requirements of the National Construction Code of Australia, for example in relation to stairs, mezzanines and balconies.
3. Can the risk of a fall be minimised by providing and maintaining a safe system of work, including:
- providing a fall prevention device (for example, installing guard rails) if it is reasonably practicable to do so
  - providing a work positioning system (for example, an industrial rope access system) if it is not reasonably practicable to provide a fall prevention device
  - providing a fall-arrest system, so far as is reasonably practicable, if it is not reasonably practicable to provide a fall prevention device or a work positioning system.

In some cases a combination of control measures may be necessary, for example using a safety harness while working from an elevating work platform.

Control measures are needed where there is a risk of injury irrespective of fall height. For low falls, you should assess the risk and provide reasonably practicable measures that reflect the risk. For example, there may be a risk of injury to workers standing on a narrow 1.7 metre high platform next to a production line where they have to work with their back to the open edge or where there is a risk of falling onto an uneven surface with sharp edges or protrusions. In this situation it may be reasonably practicable to install a guard rail along the edge of the platform.

Sometimes it may not be reasonably practicable to provide guard rails, for example at the edges of railway platforms or vehicle inspection pits. Other safe systems of work to provide adequate protection should be implemented, for example brightly painted lines to designate edges. Work of long duration and higher frequency will usually require control measures higher up the hierarchy to provide adequate protection, for example using a mobile scaffold instead of a ladder.

You should also ensure that the control measures you select do not create new hazards, for example electrical risks from contact with overhead power lines or crushing and entanglement from plant such as elevating work platforms.

### Implementing and maintaining control measures

**WHS Regulation 37:** You must ensure that the control measures you implement remain effective. This includes checking that the control measures are fit for purpose; suitable for the nature and duration of the work; are installed and used correctly.

To allow the chosen control measures to operate effectively, you should:

- *develop work procedures* on how to correctly install, use and maintain the control measure. The procedures should include a planned program of inspections and maintenance for the control measures. The inspection regime should include details of:
  - the equipment to be inspected (including its unique identification)

- the frequency and type of inspection (pre-use checks, detailed inspections)
- action to be taken on finding defective equipment
- means of recording the inspections
- training of users
- the system of monitoring the inspection regime to verify that inspections are carried out appropriately.

The manufacturer and/or supplier of the equipment should be consulted for any product specific requirements. If any signs of wear or weakness are found during the inspection, the components or means of attachment must be withdrawn from use until they are replaced with properly functioning components.

- *provide information, training and instruction* to workers, including procedures for emergency and rescue. You should also cover:
  - the type of control measures used to prevent falls
  - procedures for reporting fall hazards and incidents
  - the correct selection, fitting, use, care, inspection, maintenance and storage of fall-arrest and restraint equipment
  - the correct use of tools and equipment used in the work (for example, using a tool belt instead of carrying tools)
  - control measures for other potential hazards (for example, electrical hazards).
- *provide supervision* by ensuring that workers exposed to a risk of a fall are adequately supervised by a competent person, especially if they are undergoing training or are unfamiliar with the working environment. Check that:
  - only workers who have received training and instruction in relation to the system of work are authorised to carry out the work
  - workers use the fall control measure in the correct manner.

## 2.4 How to review control measures

The control measures that are put in place to prevent falls must be reviewed, and if necessary revised, to make sure they work as planned and to maintain an environment that is without risks to health and safety.

**WHS Regulation 38:** A person conducting a business or undertaking must review and as necessary revise fall control measures:

- when the control measure does not control the risk so far as is reasonably practicable
- before a change at the workplace that is likely to give rise to a new or different health and safety risk that the control measure may not effectively control
- if a new hazard or risk is identified
- if the results of consultation indicate that a review is necessary
- if a health and safety representative requests a review.

Control measures may be reviewed using the same methods as the initial hazard identification step.

Consult your workers and their health and safety representatives and consider the following:

- Are the control measures working effectively in both their design and operation?
- Are all fall hazards being identified?
- Are workers using the control measures in accordance with the instruction and training that has been provided?

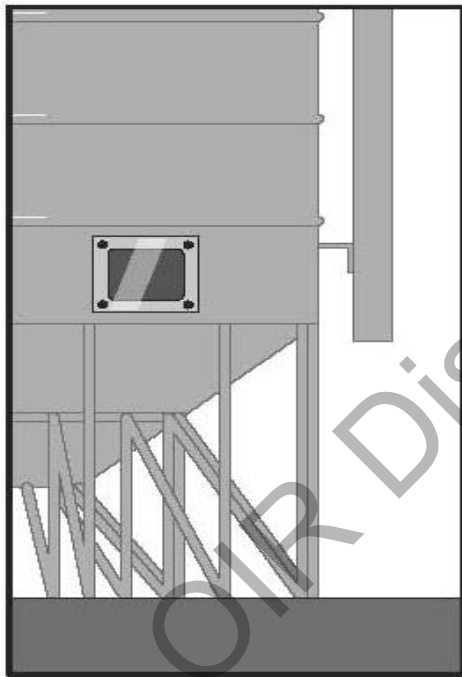


## 3. Work on the ground or on a solid construction

### 3.1 Work on the ground

Eliminating the need to work at height is the most effective way of protecting workers from the risk of falls. Examples of eliminating the risk by working on the ground include:

- prefabricating roofs at ground level
- prefabricating wall frames horizontally, then standing them up
- using mechanical tarp spreaders to cover loads on trucks from the ground
- fitting outlets, inlets and controls of large tanks and silos near the ground (see Figure 1)
- reducing shelving heights so that workers can access items from ground level
- using tools with extendable handles, such as paint rollers (the risk of musculoskeletal disorders will need to be considered when deciding whether to use such tools)
- installing windows that pivot to enable cleaning from a safe position inside a building
- lowering a concert hall chandelier to repair it.



**Figure 1:** A silo showing sight glass and ground delivery tube

### 3.2 Work on a solid construction

Working on a solid construction provides an environment where the likelihood of a fall may be eliminated. 'Solid construction' means an area that:

- is structurally capable of supporting workers, material and any other loads applied to it
- is provided with barriers around its perimeter and around any openings from or through which a person could fall
- has an even, accessible surface and gradient
- has a safe means of entry and exit.

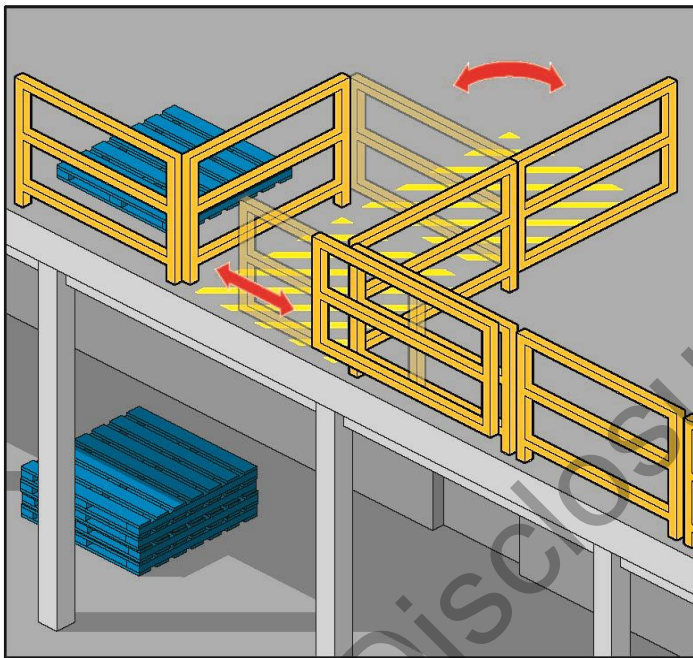
#### **Structural strength**

Different types of work involve different loads on the supporting surface. The surface and its supports must be able to safely carry the expected loads, including workers, materials, tools and equipment. When in doubt, have a structural engineer determine the safe load capacity before use.

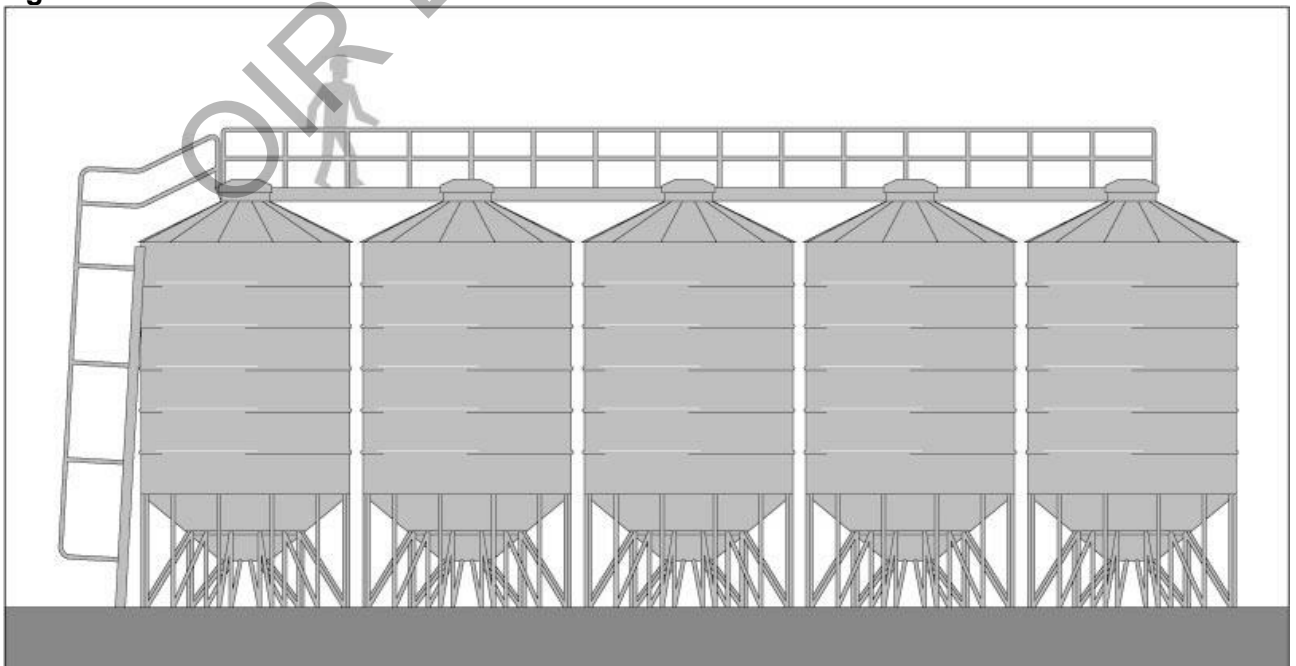
### Barriers

Barriers (or edge protection) to prevent a person falling over edges and into holes should be provided on relevant parts of a solid construction. These include:

- the perimeters of buildings or other structures
- mezzanine floors (see Figure 2)
- openings in floors
- the open edge of a stair, landing, platform or shaft opening (see Figure 3).



**Figure 2:** A barrier on a mezzanine floor



**Figure 3:** A platform with guard rails installed above silos

The barrier should be designed and constructed to withstand the force of someone falling against it.

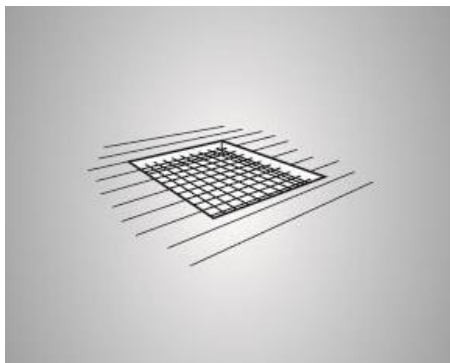
Edge protection should consist of guard rails, solid balustrades or other structural components, for example wire mesh supported by posts and provided with a reinforced top edge. The top of the guard rail or component should be between 900 mm and 1100 mm above the working surface. If a guard rail system is used, it should also have mid-rails and toe boards or wire mesh infill panels.

If access is required to equipment (for example, a hoist) it should be protected with gates, safety chains or other means to prevent a person falling.

### Protection of openings and holes

Holes, penetrations and openings through which a person could fall should be made safe immediately after being formed.

If a cover is used as a control measure, it must be made of a material that is strong enough to prevent persons or objects falling through and must be securely fixed to prevent any dislodgement or accidental removal.



**Figure 4:** 4mm mesh embedded in the concrete floor. The hole should also be covered to prevent things falling through



**Figure 5:** Example of the type of danger sign to be affixed to the hole cover

### Surface and gradient

Surfaces of solid construction should be non-slip, free from trip hazards and should generally not exceed seven degrees (one in eight gradient). Cleated surfaces, which provide greater slip-resistance, should not be steeper than 20 degrees (one in three gradient).

If grid mesh or checker plate flooring is used for walkways and working platforms, ensure that:

- flooring panels are securely fixed and assembled in accordance with manufacturer's specifications
- where possible, they are fitted to the structure prior to it being lifted into permanent position
- each panel is fixed securely before the next panel is placed in position
- during installation, this type of flooring is secured by tack welding, panel grips or other means to prevent movement before being fixed permanently
- if panels of grid mesh or checker plate flooring are removed, edge protection is provided and the gaps left due to removed panels are protected.

### **Entry and exit**

The solid construction must have a safe means for people to get to, from and move around the work area, for example permanently installed platforms, ramps, stairways and fixed ladders.

Further guidance is available in *AS 1657 Fixed platforms, walkways, stairways and ladders – Design, construction and installation*.

Safety considerations include:

- exposure of access systems to the weather (for example, rain can make surfaces slippery and strong winds can cause loss of hand grip)
- the provision of adequate natural or artificial lighting to all access ways
- the clearance of obstructions so that persons are able to move easily to and from the workplace.

Portable ladders should only be used where the use of safer systems is not reasonably practicable.

## 4. Fall prevention devices

A fall prevention device is any equipment that is designed to prevent a fall for temporary work at heights, and once in place does not require any further adjustment by workers using the device.

### 4.1 Temporary work platforms

A 'temporary work platform' is a working platform, other than a permanently installed fixed platform, used to provide a working area for the duration of the job. The design of the platform prevents workers from falling. Temporary work platforms include scaffolds, elevating work platforms, mast climbers, workboxes, building maintenance units, portable or mobile fabricated platforms or any other platform that provides a working area and is designed to prevent a fall.

#### Scaffolding

Scaffolding can be very effective protection in preventing falls; however, there are specific requirements that apply to some types of scaffold under the WHS Regulation.

**WHS Regulation 225:** A person with management or control of a scaffold must not allow the use of a scaffold from which a person or object could fall more than four metres unless a competent person provides written confirmation that the scaffold has been completed. The person must also ensure that:

- the scaffold and its supporting structure is inspected by a competent person before use, after any incident that could affect its stability (such as a severe storm), after any repairs, and at least every 30 days
- unauthorised access is prevented on scaffolding that is incomplete and left unattended (for example, by attaching danger tags and warning signs at appropriate locations).

The WHS Regulation sets out requirements for erecting and dismantling scaffolding in construction work.

Scaffolding work platforms are generally rated as light, medium or heavy duty. Safety considerations include:

- scaffolding conforms to AS/NZS 4576 *Guidelines for scaffolding* and the AS/NZS 1576 *Scaffolding series*
- all scaffolding is erected, altered and dismantled by competent persons. Any scaffold from which a person or object could fall more than four metres must be erected, altered and dismantled by or under the direct supervision of a licensed scaffolder.
- prefabricated scaffolds are of the same type and not mixed components, unless the mixing of components has been approved by the manufacturer
- safe access to and egress from the scaffold is provided
- edge protection (hand rails, mid-rails and toe boards) is provided at every open edge of a work platform (see Figure 5).

#### Information, instruction and training for workers using scaffolds

Where work is performed from a scaffold, you must ensure that the relevant workers understand:

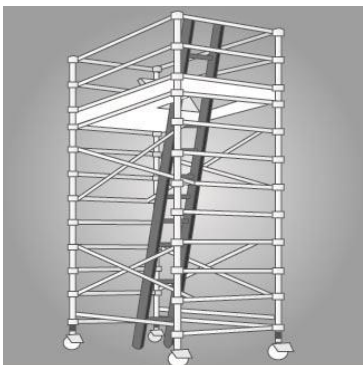
- what loads the scaffold can safely take
- not to make any unauthorised alterations to the scaffold (such as removing guard rails, planks, ties, toe boards and braces)
- that working platforms need to be kept clear of debris and obstructions along their length, and
- that incomplete or defective scaffolds must never be accessed.

Where work is performed using mobile scaffolds, workers should be trained to ensure the scaffold:

- remains level and plumb at all times
- is kept well clear of powerlines, open floor edges and penetrations
- is not accessed until the castors are locked to prevent movement
- is never moved while anyone is on it
- is only accessed using internal ladders (see Figure 7).



**Figure 6:** Perimeter scaffold with a fully decked working platform, guardrails and toeboards.



**Figure 7:** Mobile scaffold with an access ladder and trapdoor to provide the largest possible hazard-free working platform.

### Light duty suspended scaffold

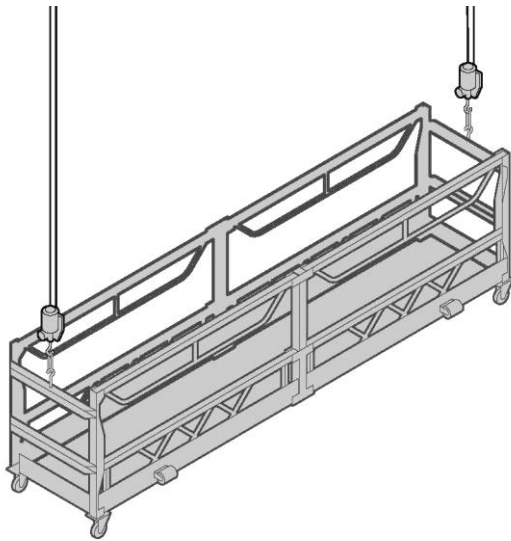
A suspended scaffold incorporates a suspended platform that is capable of being raised or lowered when in use (see Figure 8). Common types of suspended scaffolds include:

- swing stages which have cradles supported by a single row of suspension ropes
- double rope scaffolds, with cradles supported by two rows of suspension ropes
- work cages which are small cradles supported by one suspension rope only
- false cars, which are specialised forms of suspended scaffolding and are often used in the construction of lifts before lift cars are installed.

There are specific safety considerations for swing stages, including that:

- the working load and specifications are in accordance with AS 1576.4 *Scaffolding – Part 4: Suspended Scaffolding*
- persons operating light duty suspended stages are trained in safe operation
- persons installing or servicing a light duty suspended stage hold a licence for advanced rigging or advanced scaffolding
- where the swing stage is suspended by two wire ropes to each winch, a safety harness and restraint lanyard is attached to a suitable anchor point of the swing stage.

Further guidance on the safe design, erection and use of scaffolding, including suspended scaffolding, is available in the *Scaffolding Code of Practice*.



**Figure 8:** Example of a light duty suspended scaffold with two wire ropes to each winch. The platform must remain horizontal when moving it up or down.

### Elevating work platforms

Elevating Work Platforms (EWPs) include scissor lifts, cherry pickers, boom lifts and travel towers.

There are battery powered and internal combustion engine types. Some are designed for hard flat surfaces only, while others are designed to be operated on rough terrain.

Safety considerations include that:

- workers operating the platform are trained and instructed in safe operating procedures for the particular brand and type of equipment, as well as the safe use of fall-arrest equipment and emergency rescue procedures
- the platforms are only used as working platforms and not as a means of entering and exiting a work area unless the conditions set out in [AS 2550.10 Cranes, hoists and winches - Safe use – Part 10: Mobile elevating work platforms](#) are met
- unless designed for rough terrain, the platforms are used only on a solid level surface
- the surface area is checked to make sure that there are no penetrations or obstructions that could cause uncontrolled movement or overturning of the platform
- the manufacturer's or supplier's instructions are consulted for information on safe operation
- persons working in travel towers, boom lifts or cherry pickers wear a properly anchored safety harness
- workers are licensed when operating boom-type elevating work platforms with a boom length of 11 metres or more.



**Figure 9:** An example of a boom-type elevating work platform. The safety harness and lanyard assembly are not shown for purposes of clarity. The lanyard should be as short as possible and should be attached directly to the designated anchor point on the EWP, not to the handrail.



**Figure 10:** An example of a scissor-lift elevating work platform.

### **Mast climbing work platforms**

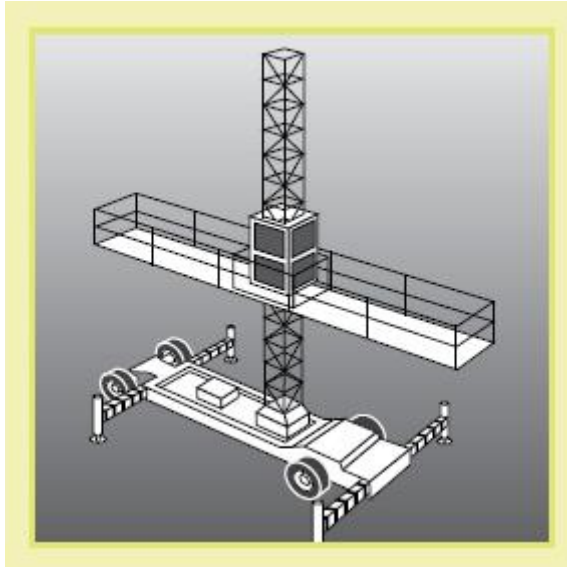
Mast climbing work platforms are hoists with a working platform that is used to raise workers and material to a temporary working position. They use a drive system mounted on an extendable mast, which may need to be tied to a building under circumstances prescribed by the manufacturer.

Mast climbing work platforms can be set up in either single-mast or multi-mast configurations. They are generally not suitable for use if the profile of a structure changes at different elevations (for example, if the upper floors of a building ‘step’ back or balconies protrude from the building).

The erection and dismantling of mast climbing work platforms must be carried out, or be directly supervised, by a person holding an appropriate rigging or scaffolding licence.

Further information on mast climbing work platforms is provided in AS 2550.16 *Cranes—Safe Use—Part 16: Mast climbing work platforms*.





**Figure 11:** An example of a typical mast climbing work platform.

### Workboxes

A workbox is designed to be supported by a crane, hoist, forklift truck or other mechanical device to provide an elevated work area for persons working from the box. It consists of a platform surrounded by an edge protection system and should be designed in accordance with AS 1418.17 *Cranes (including hoists and winches) — Part 17: Design and construction of workboxes*.

Where reasonably practicable, other working platforms, such as an elevating working platform or scaffold, should be used as an alternative to the workbox.

The safety requirements and considerations include that:

- the workbox is not suspended over persons
- the workbox is designed for the task and securely attached to the crane. The workbox, lifting attachments and records should be checked by a competent person before use
- the workbox is fitted with a suitable anchorage capable of withstanding the fall forces specified in AS/NZS 1891.4 *Industrial fall-arrest systems and devices— Part 4: Selection, use and maintenance*. Workers must be attached to the anchorage by a lanyard and harness unless the workbox is fully enclosed
- workers remain within the workbox while they are being lifted or suspended
- workers do not enter or leave the workbox when it is suspended (except in an emergency)
- the crane is fitted with the means to safely lower it in an emergency or a power supply failure
- the crane is suitably stabilised at all times while the workbox is used
- the crane has 'drive up' and 'drive-down' controls on both the hoisting and luffing motions and those controls are used. No declutching allowing free fall is to be used while a workbox is in use
- an effective means of communication between any person in the workbox and the operator is provided
- the crane is fitted with a safety hook and moused (lashed) accordingly
- the operator remains at the controls of the crane at all times.

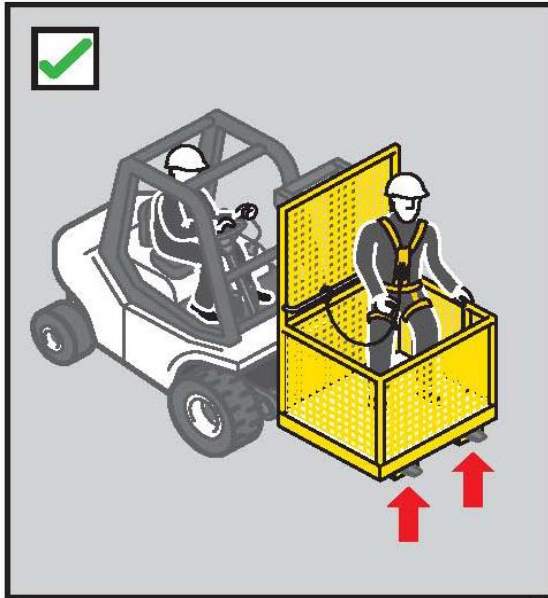
For specifications for the use of crane workboxes refer to AS 2550.1 *Cranes, Hoists and Winches—Safe Use— Part 1: General Requirements*.

### Forklifts with a work box

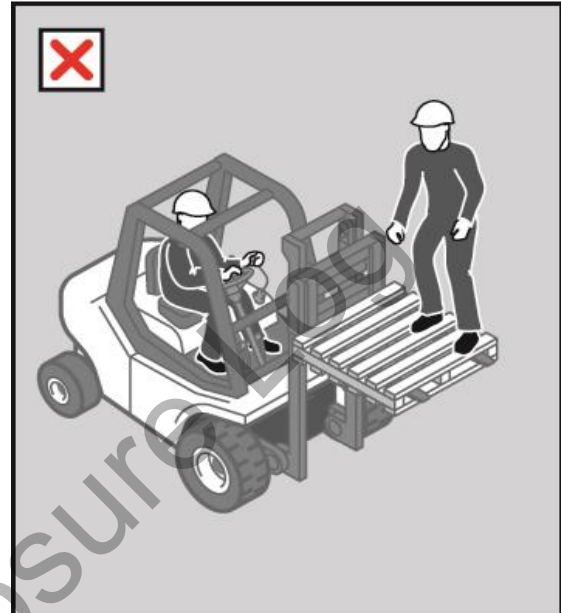
A workbox fitted to a forklift must be securely attached to the forklift carriage and engineer-designed and constructed in accordance with AS 2359 *Powered Industrial Trucks series* (see Figure 11).

Safety considerations include that:

- people are not raised on the tynes of forklift trucks or the pallet
- no other device (for example, ladder or pallets) is used to gain additional height (see Figures 13 and 14)
- the safety gate is self-locking and kept shut when in the elevated position.



**Figure 12:** An example of an engineer-designed workbox with safety harness and lanyard assembly, correctly positioned on the forklift tynes.



**Figure 13:** Using a forklift as a working platform or to gain extra height by standing on the tynes or a pallet is an unacceptable practice.

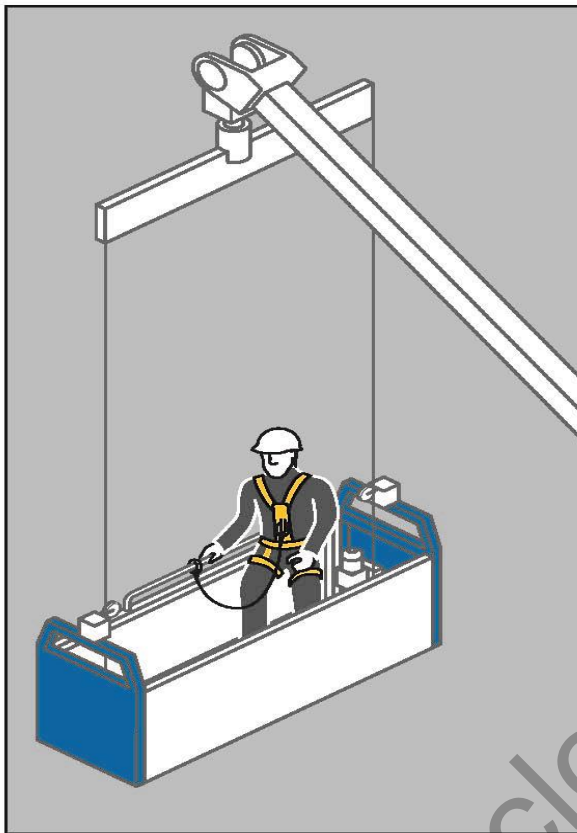


**Figure 14:** Unacceptable practice with ladder on forklift.

### Building maintenance units

Designers of buildings should consider the methods by which maintenance, repairs or cleaning will be undertaken on buildings or structures.

A building maintenance unit is a power-operated suspended working platform that is fixed permanently to a building or structure. It is used for access for building maintenance or window cleaning (see Figure 15).



**Figure 15:** An example of a building maintenance unit with safety harness and restraint line.

Safety considerations include that:

- the platform has sufficient, clearly designated safety harness anchorage points designed to withstand the forces caused by a fall of any person located anywhere on the platform
- the units are designed in accordance with *AS 1418.13 Cranes (including Hoists and Winches) — Part 13: Building Maintenance Units* and operated by competent persons in accordance with *AS 2550.13 Cranes—Safe Use— Part 13: Building Maintenance Units*.

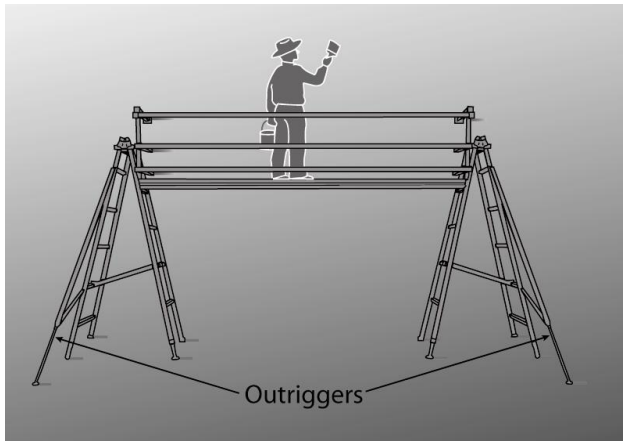
#### **Platforms supported by trestle ladders**

Trestle ladder scaffolds are only suitable for use at heights greater than two metres when guard rails and toe boards are incorporated to prevent people and material falling off the working platform. The system (including planks) should be assembled according to the manufacturer's specifications with the complete set of compatible components.

Some trestle ladder scaffolds include outriggers to increase stability (see Figure 16). Trestle ladder scaffolds are only suited to light duty tasks such as painting and rendering. Work should only be performed between the trestles. The minimum width of the working platform should not be less than 450 millimetres.

Alternatives to trestle ladders should be considered, such as small scissor lifts, light duty aluminium mobile scaffolds, boom arms and modular scaffolding.

The WHS Regulation sets out requirements on the use of platforms supported by trestle ladders in construction work.



**Figure 16:** Trestle ladder scaffold with guard rails and outriggers for stability.

## 4.2 Perimeter guard rails

Guard rails may be used to provide effective fall prevention:

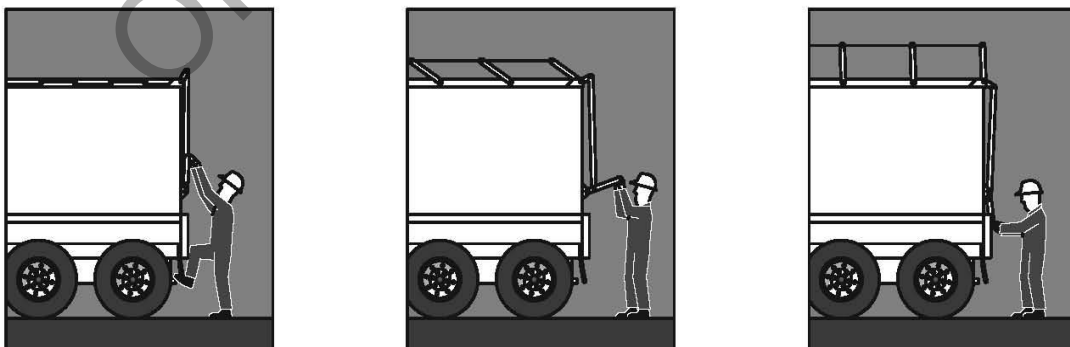
- at the edges of roofs
- at the edges of mezzanine floors, walkways, stairways, ramps and landings
- on top of plant and structures where access is required (see Figure 17)
- around openings in floor and roof structures
- at the edges of shafts, pits and other excavations.

Guard rails should incorporate a top rail 900mm to 1100 mm above the working surface and a mid-rail and a toe board.

Before using a guard rail system you should check that it will be adequate for the potential loads. The required load resistance will depend on the momentum of a falling person. For example, the momentum of a person falling from a pitched roof will increase as the pitch (or angle) of the roof increases.

*Refer to AS/NZS 4994—Temporary Edge Protection series for further guidance.*

The WHS Regulation sets out requirements on the use of edge protection in construction work.



**Figure 17:** Guard rails installed on top of a tanker to enable safe access to tank hatches.

## 4.3 Safety mesh

Safety mesh is designed to prevent internal falls through a roof. If securely fixed, safety mesh provides fall protection for roof installers and offers long-term protection against falling for maintenance and repair workers.

Safety mesh does not prevent falls from the edge of a roof or through holes in a roof, so it should always be used in conjunction with appropriate edge protection, guard rails or fall-arrest systems.

Safety mesh should comply with AS/NZS 4389 *Roof Safety mesh*, which specifies the minimum requirements for the design, construction, testing and installation of safety mesh for use in domestic, commercial and industrial building applications.

The mesh should be formed from two millimetre diameter wire of not less than 450 MPa tensile strength, welded into a mesh with the longitudinal wires not more than 150 millimetre apart and the cross wires not more than 300 millimetre apart.

Safety mesh should be installed in accordance with the manufacturer's instructions by competent persons, who should be protected against the risk of falling by using appropriate control measures such as scaffolding, elevating work platforms or fall-arrest systems.

Particular care is required to ensure that the mesh is securely connected to the structure and the overlap between adjacent sections of mesh is sufficient to generate the necessary strength to resist the force of a person falling onto it. The safety mesh should be covered by the roof cladding as soon as reasonably practicable after it has been installed.

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## 5. Work positioning systems

A work positioning system involves the use of equipment that enables a person to work supported in a harness in tension in such a way that a fall is prevented.

Work positioning systems require a high level of competency on the part of the user and supervisors to ensure safe use. Users, including supervisors, should undertake a competency based course of training.

### 5.1 Industrial rope access systems

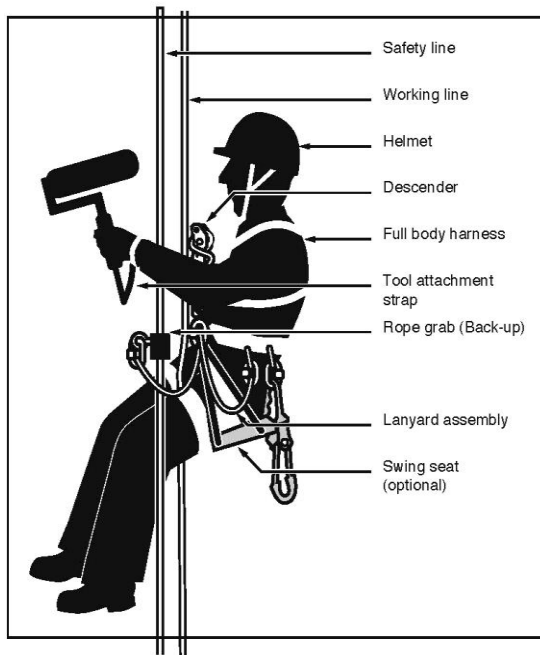
Industrial rope access systems are used for gaining access to and working at a workface, usually by means of vertically suspended ropes. Although fall-arrest components are used in the industrial rope access system, the main purpose of the system is to gain access to a work area rather than to provide backup fall protection (see Figure 18).

Other methods of accessing a workface should be considered (for example, EWP or building maintenance units) before rope access systems, as a high level of skill is needed for their safe use.

You should ensure that, where it is necessary for industrial rope access systems to be used:

- operators are competent in the technique
- operators do not work alone, in case they require assistance in an emergency
- industrial rope access systems are installed only in a location where it is possible to provide prompt assistance or rescue if required (refer to Chapter 9 of this code)
- all equipment is checked regularly by a competent person
- prior to use, all fixed anchorage points are checked by a competent person before attaching the rope access lines
- a back up system is used to protect the operator
- two independently anchored ropes are used for each person
- any person within three metres of an unguarded edge is adequately secured
- all operators wear a full body harness
- supervisors can communicate with workers
- where necessary, appropriate personal protective equipment is used, such as helmets, gloves, hearing protection, goggles and masks
- barricades and signposts are placed on all access areas below the working area and anchorage locations to exclude and alert the public and tradespeople.

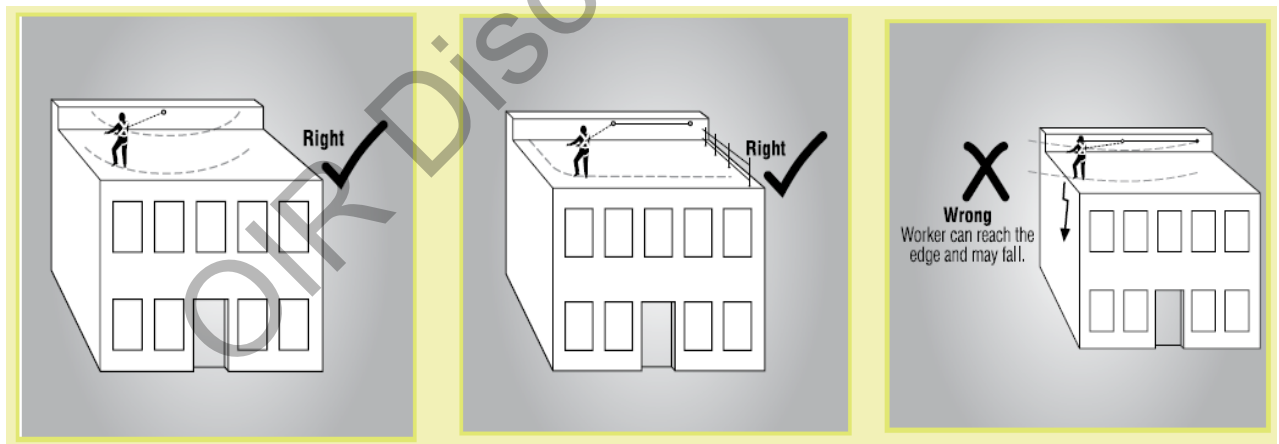
Further guidance on industrial rope access systems is available in AS/NZS 4488 [Industrial rope access systems series](#).



**Figure 18:** Operator using an ascender in an industrial rope access system.

## 5.2 Restraint technique

A restraint technique controls a person's movement by physically preventing the person reaching a position at which there is a risk of a fall. It consists of a harness that is connected by a lanyard to an anchorage or horizontal life line. It must be set up to prevent the wearer from reaching an unprotected edge (see Figure 19).



**Figure 19:** Restraint technique options.

A restraint technique is suitable for use where:

- the user can maintain secure footing without having to tension the restraint line and without the aid of any other hand hold or lateral support. When deciding whether secure footing can be maintained, consider:
  - the slope of the surface
  - the supporting material type
  - the surface texture of the surface and whether it is likely to be wet, oily or otherwise slippery
- the horizontal life lines are fitted with an industrial shock absorber when required
- the restraint system conforms with AS/NZS 1891 *Industrial fall-arrest systems and devices* series.

Restraint techniques should only be used if it is not reasonably practicable to prevent falls by providing a physical barrier (for example, a guard rail). This is because restraint techniques require a high level of user skill to operate safely and also greater supervision.

A restraint system should be installed by a competent person in accordance with the manufacturer's instructions. Restraint anchorage should be designed for fall-arrest loading.

An individual fall-arrest system should be used instead of restraint techniques if any of the following situations apply:

- the user can reach a position where a fall is possible
- the user has a restraint line that can be adjusted in length so that a free fall position can be reached
- there is a danger the user may fall through the surface, for example fragile roofing material
- the slope is over 15 degrees
- there is any other reasonably likely use or misuse of the system that could lead to a free fall.

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## 6. Fall-arrest systems

A fall-arrest system is intended to safely stop a worker falling an uncontrolled distance and reduce the impact of the fall. This system must only be used if it is not reasonably practicable to use higher level controls or if higher level controls might not be fully effective in preventing a fall on their own.

All equipment used for fall-arrest should be designed, manufactured, selected and used in compliance with *AS/NZS 1891 Industrial fall-arrest systems and devices series*.

Key safety considerations in using fall arrest systems are:

- the correct selection, installation and use of the equipment
- that the equipment and anchorages are designed, manufactured and installed to be capable of withstanding the force applied to them as a result of a person's fall
- that the system is designed and installed so that the person travels the shortest possible distance before having the fall stopped
- that workers using a fall-arrest system wear adequate head protection to protect them in the event of a fall
- that if the equipment has been used to arrest a fall it is not used again until it has been inspected and certified by a competent person as safe to use.

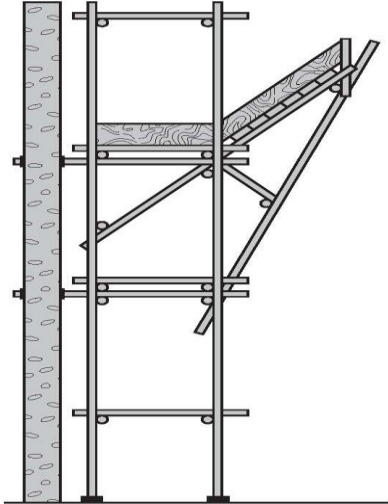
The WHS Regulation sets out requirements on the use of fall arrest harness systems in construction work.

### 6.1 Catch platforms

A catch platform is a temporary platform located below a work area to catch a worker in the event of a fall. The platform should be of robust construction and designed to withstand the maximum potential impact load. Scaffolding components may be used to construct fixed and mobile catch platforms (see Figure 20).

Catch platforms should:

- incorporate a fully planked-out deck
- be positioned so the deck extends at least two metres beyond all unprotected edges of the work area, except where extended guard railing is fitted to the catch platform
- be positioned as close as possible to the underside of the work area—the distance a person could fall before landing on the catch platform should be no more than one metre
- always be used with an adequate form of edge protection.



**Figure 20:** An example of a catch platform below a work area.  
The WHS Regulation sets out requirements on the use of catch platforms in construction work.

## 6.2 Industrial safety nets

Safety nets can provide a satisfactory means of protection while allowing workers maximum freedom of movement. They should not be used to enter or exit a work area or as a working platform.

If safety nets are used, you should ensure that:

- safety nets are securely anchored before any work starts
- safety nets are constructed of material strong enough to catch a falling person or thing
- safety nets are hung as close as is practicable to the underside of the working area, but no more than two metres below the working area
- perimeter safety nets used where there is no edge protection extend at least 2.5 metres beyond the leading edge of the working area
- the safety net has sufficient tension and clearance to prevent a falling person contacting any surface or structure below the net
- material is not allowed to accumulate in suspended safety nets
- no welding or oxy cutting is performed above safety nets
- safety nets are inspected, particularly after installation, relocation or repair
- safety nets are stored correctly in dry, shaded areas with good air circulation.

## 6.3 Individual fall-arrest systems

Individual fall-arrest systems consist of some or all of the following components:

- anchorages
- lifelines
- inertia reel
- lanyard of fixed length
- retractable lifelines
- rope grabs
- wire grabs
- rail system
- shock absorbers, both personal and industrial
- harness
- snap hooks (double or triple action to prevent rollout)

- karabiners (double or triple action to prevent rollout)
- rescue equipment.

Individual fall-arrest systems rely on workers wearing and using them correctly, and therefore workers who will use such a system must be trained in its safe use. They should only be used where it is not reasonably practicable to use higher level control measures.

Relevant Australian/New Zealand Standards for personal fall-arrest equipment require that they be permanently marked or labelled to indicate their purpose, correct use, limitations and other relevant information aimed at reducing misuse of the equipment.

### **Anchorage points**

Each anchorage point should comply with the requirements in *AS/NZS 1891:4 Industrial fall-arrest systems and devices – Part 4: Selection, use and maintenance*.

All anchorages should be tested and approved by a competent person before use—a visual inspection may not reveal the structural integrity of the anchor point (i.e. the bolt may have failed below the concrete surface).

Each anchorage point should be located so that a lanyard of the system can be attached to it before the person using the system moves into a position where the person could fall.

### **Inspect the system components**

Each component of the system and its attachment to an anchorage must be inspected by a competent person:

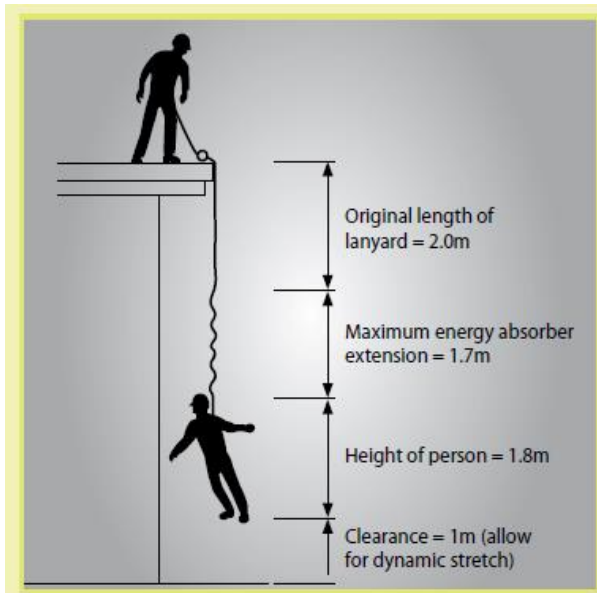
- after it is installed but before it is used
- at regular intervals
- immediately after it has been used to arrest a fall.

Inspection of all components should be conducted in accordance with the manufacturer's specifications and the relevant standards. If any signs of wear or weakness are found during the inspection, the components or means of attachment should be withdrawn from use until they are replaced with properly functioning components.

### **Limit free fall distance**

Fall-arrest systems, incorporating a lanyard, should be installed so that the maximum distance a person would free fall before the fall-arrest system takes effect is two metres. There should be sufficient distance between the work surface and any surface below to enable the system, including the action of any shock absorber to fully deploy (see Figure 21). To work out whether there is enough distance available, you should take into account:

- the worker's height
- the height and position of the anchorage point
- the length of the lanyard
- any slack in the horizontal life line
- any stretching of the lanyard or horizontal life line when extended by a fall
- the length of the energy absorber when extended by a fall.



**Figure 21:** Total fall distance before this particular configuration would be effective in arresting a fall is 6.5 metres.

Lanyards should **not** be used in conjunction with inertia reels as this can result in an excessive amount of free fall prior to the fall being arrested.

### Use suitable harnesses

In most cases, a full body harness should be worn. Harnesses must be correctly fitted. Workers should connect the fall-arrest line to the attachment point on their harness (dorsal attachment point or the chest connection) that will provide the best protection in the situation it is being used.

Consideration should be given to the potential fall distance, potential impact with the structure, body position after a fall and the need to interact with equipment such as rope-grabs.

### Maintain minimum of slack in fall-arrest lanyard

There should be a minimum of slack in the fall-arrest lanyard between the user and the attachment. The anchorage point should be as high as the equipment permits. Avoid work above the anchor point, as this will increase the free fall distance in the event of a fall, resulting in higher forces on the body and greater likelihood of the lanyard snagging on obstructions.

### Use inertia reels correctly

When considering the use of inertia reels, bear in mind that they might not be effective in certain situations. For example, if a worker falls down the inclined surface of a steeply pitched roof, the inertia reel line may keep extending from the reel—it may not lock.

Inertia reels should not be used as working supports by locking the system and allowing it to support the user during normal work. They are not designed for continuous support.

Vertical and self-retracting anchorage lines can be used as a risk control measure in connection with work performed from boatswains' chairs and ladders. Where such lines are used, only one person may be attached to any one line.

### Use compatible components

The use of non-compatible components may lead to 'roll-out' with some hook/karabiner configurations, resulting in injury or death to the user. The hazard cannot always be avoided by using components produced by the same manufacturer under the one brand name. If you are unsure whether components of a fall-arrest system are compatible you should contact the manufacturer for further information.

Snap hooks should be of the double action type, requiring at least two consecutive deliberate actions to open. Snap hooks should not be connected to each other as this could prevent the safe operation of the snap hook (for example, roll-out may occur). Some double action hooks are susceptible to roll-out. Screw gate karabiners or hex nut connectors may sometimes be appropriate. Further guidance is provided in AS/NZS 1891 *Industrial fall-arrest systems and devices series*.



**Figure 22:** Roll-out on a small diameter eyebolt.

### Ensure prompt rescue in event of fall

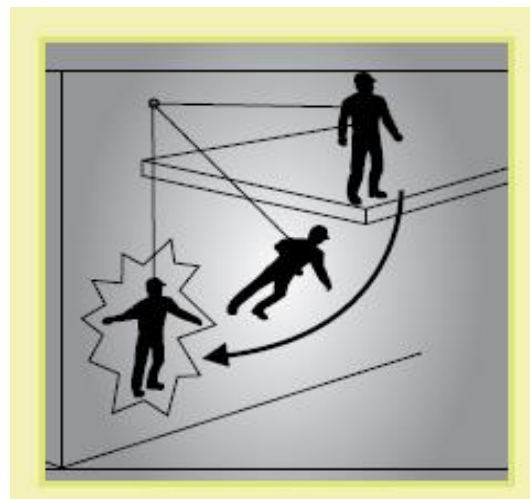
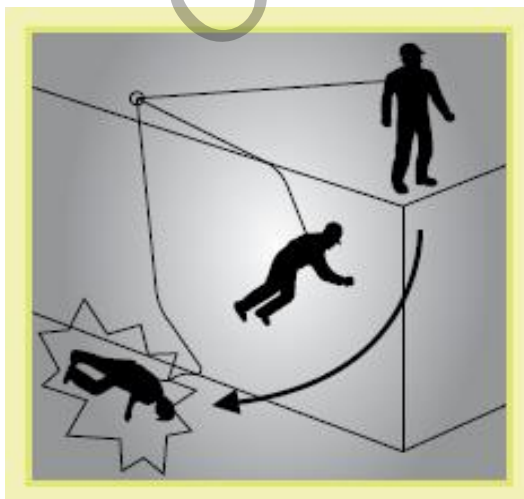
A person conducting a business or undertaking who implements a fall-arrest system as a control measure must establish emergency and rescue procedures. The rescue of a worker who is suspended in a full body harness must occur promptly to prevent suspension intolerance. A worker should not use a fall-arrest system unless there is at least one other person on the site who can rescue them if they fall.

### Hazards with individual fall-arrest systems

If a person using an individual fall-arrest system falls, the system may act as a pendulum, and in some situations the user may hit the ground (called 'swing down': see Figure 23) or swing back onto the building or structure (which is called 'swing back': see Figure 24).

Swing down can occur if the lanyard slides back along the perimeter edge of the roof until it is vertical. When this happens, the person may hit the ground, or the lanyard may break as a result of its contact with the edge of the roof. Measures to address 'swing down' include:

- the installation of guard rails
- placing the anchorage point at a right angle to the position of the lanyard at the perimeter edge (for example, by using a mobile anchorage)
- the installation of a second anchorage point and belay devices (intermediate anchorages).



**Figure 23:** During 'swing down' the length of the lanyard and positioning of the anchor allow contact with the ground.

**Figure 24:** During 'swing back' the length of the lanyard and positioning of the anchor contact may allow the worker to hit the structure.

## 6.4 Anchorage lines or rails

Anchorage lines or rails are temporary or permanent fall-arrest systems, which can be installed to provide continuous fall protection for persons using ladders or climbing towers. These can be used on plant, such as tower cranes, as well as buildings or structures.

Safety considerations include:

- temporary systems comply with AS/NZS 1891 *Industrial fall-arrest systems and devices* series
- the locking device is attached to the frontal attachment point of the harness and the lanyard assembly is a maximum of 300 millimetre length
- the point of connection onto the ladder by the climber is near the base of the ladder to allow the connection before ascending begins and also to provide continuous connection to the disconnecting point when at a safe higher level
- free fall is limited to a maximum of 600 millimetre
- permanent systems are of wire or rail construction and are installed according to the manufacturer's instructions.

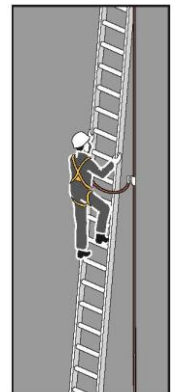
After a fall, remove the system from service and have it inspected by a competent person before it is used again.

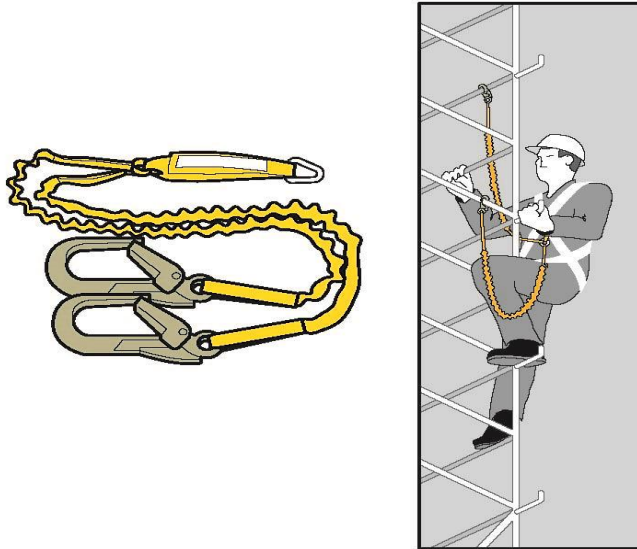
**Figure 25 (right):** With the use of an anchorage line system, the person climbing has continuous fall protection by being attached to the anchorage line and harness.

### Double lanyards

An alternative to anchorage lines or rails is the use of a double lanyard (also known as a twin tail or 'Y' lanyard). Figure 26 shows how the use of a double lanyard means that the person climbing can always be connected to the ladder or structure.

However, double lanyards are easy to misuse—there should be no back hooking, they should not be wrapped around the body or passed between the legs, the chest connection should never be higher than the highest attachment point, they are not suitable for frequent use (because of possible misuse or muscle injury) and the ladder or structure points must be capable of arresting forces generated by a fall with the double lanyard. Adequate training should be provided on their use.





**Figure 26:** Above left: An example of a double lanyard. These must have double action connectors.

Above right: Person climbing with a double lanyard. Note that in this application the connectors will slide down to the lowest point on the rail and likely be subject to side loading. Side loading can be controlled by using soft connections such as slings or the use of hooks rated to withstand side loading.

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## 7. Ladders

Ladders are primarily a means of access and egress. Many falls take place when people are working from ladders. In addition, when using a ladder:

- the working width and movement is limited
- the time involved in moving and setting up ladders is often underestimated when planning work
- the working position on ladders is often uncomfortable (the need to stretch sideways, work above shoulder height and stand on narrow rungs for a long time) and may cause musculoskeletal disorders.

For these reasons, you should consider whether an elevating work platform or scaffolding would be safer and more efficient.

The WHS Regulation sets out requirements on the use of ladders in construction work.

### 7.1 Portable ladders

Extension or single ladders should generally only be used as a means of access to or egress from a work area. They should only be used as a working platform for light work of short duration that can be carried out safely on the ladder.

#### Selecting ladders

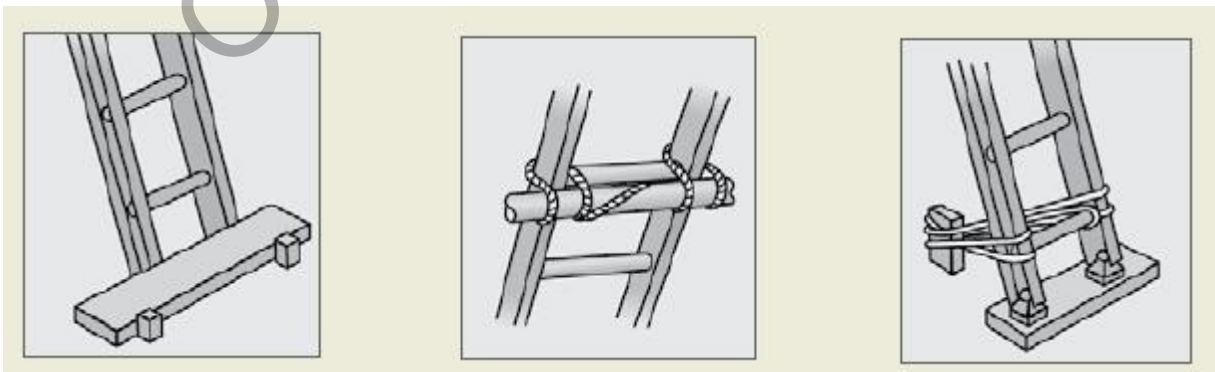
If ladders are used they must be selected to suit the task to be undertaken. In doing this, you should consider the duration of the task, the physical surroundings of where the task is to be undertaken and the prevailing weather conditions.

Ladders should have a load rating of at least 120 kilograms and be manufactured for industrial use.

#### Positioning ladders

Any ladder used at a workplace must be set up on a solid and stable surface, and set up so as to prevent the ladder from slipping. Single and extension ladders can be prevented from slipping by:

- placing ladders at a slope of 4:1, and setting up stepladders in the fully opened position
- securing ladders at the top or bottom, or if necessary, at both ends (see Figure 27).



**Figure 27:** Some effective ways of securing a ladder

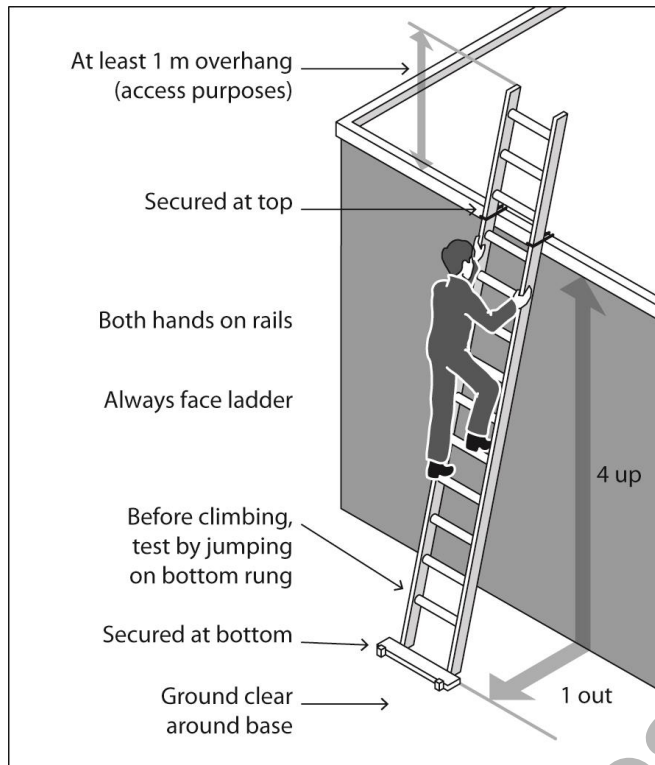
#### Access or egress

Where fixed or extension ladders are used for access or egress, you should check that:

- there is a firm, stable work platform, free from obstructions, to step onto from the ladder



- the ladder extends at least one metre above the stepping-off point on the working platform
- fall protection is provided at the stepping-off point where people access the working platform.



**Figure 28:** Example of acceptable ladder use

## Safe Use of Ladders

When a ladder is used, you should check that:

- the ladder is in good condition—the ladder should be inspected for faults, such as broken rungs, stiles and footing before it is used
- damaged ladders are removed from service
- the ladder is set up on firm, stable and level ground
- the ladder is the correct height for the task to avoid reaching or stretching
- the ladder is not too close or too far from the support structure—the distance between the ladder base and the supporting structure should be about one metre for every four metres of working ladder height (4:1 ratio)
- the ladder is secured against displacement (i.e. slipping or sliding) and/or there is another person holding the base of the ladder
- the ladder is not placed so that the weight of the ladder and any person using the ladder is supported by the rungs
- all the locking devices on the ladder are secure
- materials or tools are not carried while climbing the ladder—use a tool belt or side pouch
- only light duty work is undertaken while on the ladder, where three points of contact can be maintained and tools can be operated safely with one hand
- slip resistant base, rungs or steps are provided
- slip resistant shoes are worn
- ladders are not used without additional appropriate precautions:
  - in access areas or doorways—if necessary, erect a barrier or lock the door shut
  - on scaffolding or an elevating work platform to get extra height
  - next to power lines unless the worker is trained and authorised and the appropriate ladder is being used

- in very wet or windy conditions
- next to traffic areas, unless the working area is barricaded.



**Figure 29:** A step platform can provide a stable work surface

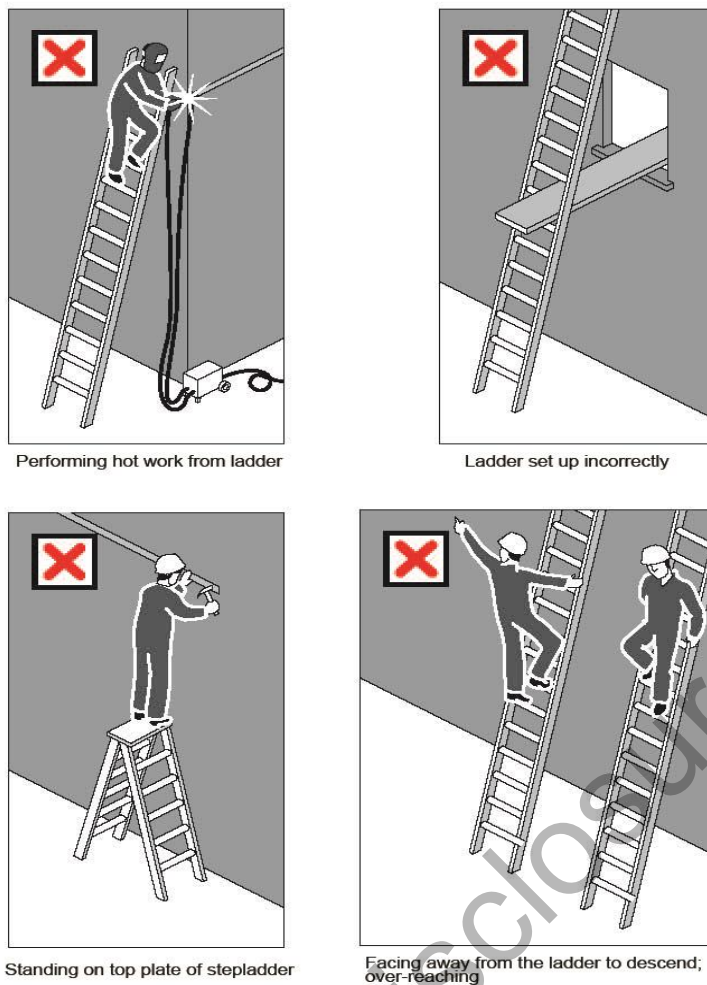
When using ladders, it is not safe to:

- use metal or metal reinforced ladders when working on live electrical installations
- carry out work such as arc welding or oxy cutting
- work over other people
- allow anyone else to be on the ladder at the same time.

Except where additional and appropriate fall protection equipment is used in conjunction with the ladder, it is not safe to:

- use a stepladder near the edge of an open floor, penetration or beside any railing
- over-reach (the centre of the torso should be within the ladder stiles throughout the work)
- use any power or hand tool requiring two hands to operate, such as concrete cutting saws and circular saws
- use tools that require a high degree of leverage force which, if released, may cause the user to over-balance or fall from the ladder, such as pinch bars
- face away from the ladder when going up or down, or when working from it
- stand on a rung closer than 900 millimetres to the top of a single or extension ladder
- stand higher than the second tread below the top plate of any stepladder (with the exception of three-rung step ladders).

Guidance on the selection, safe use and care of portable ladders is set out in AS/NZS 1892 *Portable ladders* series. The manufacturer's recommendations on safe use should also be followed.



**Figure 30:** Examples of unsafe ladder use

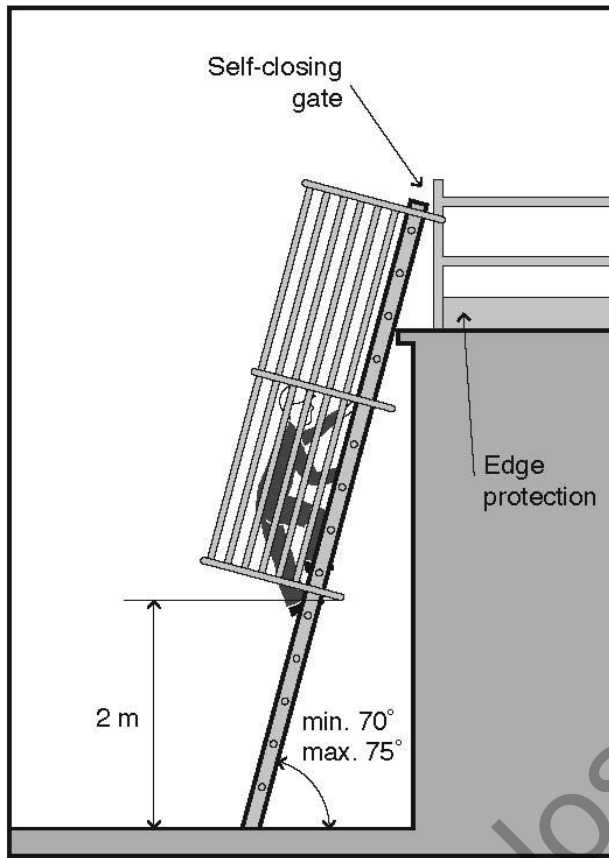
## 7.2 Fixed ladders

Fixed ladders should be installed in accordance with *AS 1657 Fixed Platforms, Walkways, Stairways and Ladders—Design, Construction and Installation*.

Ladder cages in fixed ladders do not stop a fall but simply funnel a fall and, in some cases, more injuries can occur from striking the protective backguards on the way down. The cages may also hinder rescues. Therefore, fixed ladders with angles exceeding 75 degrees to the horizontal should be fitted with a permanent or temporary fall-arrest system (anchorage lines or rails).

The angle of slope should not be less than 70 degrees to the horizontal and not greater than 75 degrees to the horizontal. **In no case should the ladder overhang the person climbing the ladder.** If the angle is more than 75 degrees, a safe system of work to prevent falls should be provided such as a permanent fall-arrest system or a full body harness with double arm lanyard.

A specifically designed rescue procedure should be developed for use in ladder cage situations. Training in rescue procedures should occur before using the fixed ladder.



**Figure 31:** Example of a fixed ladder fitted with a ladder cage

### 7.3 Ladder maintenance

Ladders should be regularly inspected by a competent person in accordance with the manufacturer's recommendations. Ladders with any of the following faults must be replaced or repaired:

- fibreglass stiles cracked, chipped or severely faded with fibres exposed
- timber stiles warped, splintered, cracked or bruised
- metal stiles twisted, bent, kinked, crushed or with cracked welds or damaged feet
- rungs, steps, treads or top plates that are missing, worn, damaged or loose
- tie rods missing, broken or loose
- ropes, braces, or brackets that are missing, broken or worn
- timber members that are covered with opaque paint or other treatment that could disguise faults in the timber
- missing, loose, bent or worn fasteners (i.e. rivets, bolts and pins)
- worn or damaged feet, including non-slip material.

## 8. Administrative controls

Administrative controls may be used to support other control measures and may include 'no go' areas, permit systems, the sequencing of work and safe work procedures. Using administrative controls exclusively to minimise the risk of falls is only appropriate when it is not reasonably practicable to use a higher order control.



**Figure 32:** Example of a sign for a 'no go' area

### 'No go' areas

'No go' areas can be an effective method of making sure people are not exposed to hazards. They require clear signs warning people not to access the hazardous area. They can be used to highlight the risks of entry to an area where there is an unguarded hazard, or to areas where work is being undertaken overhead and there is a risk of falling objects.

Relevant information and instruction should be provided about 'no go' areas with adequate supervision to ensure that no unauthorised worker enters the 'no go' area.

Barriers should be used in conjunction with signs to cordon-off areas where there is a risk of falling or being hit by falling objects. They should be highly visible and securely fixed to prevent displacement.

### Permit systems

Permit systems allow only competent persons trained in the use of relevant control measures to work in an area where there is a hazard. Examples include:

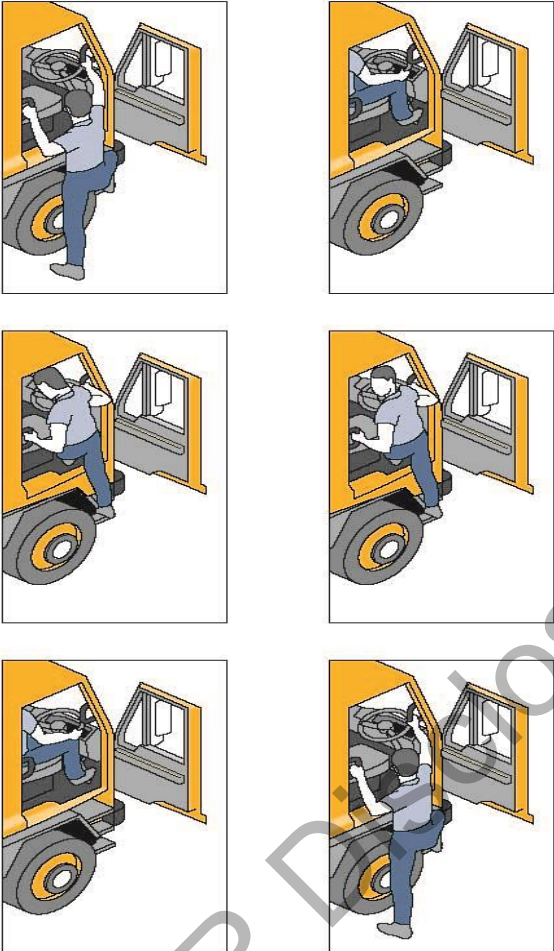
- tagging all access points to a scaffold to restrict unauthorised access during erection and dismantling, with 'only licensed scaffolders permitted on an incomplete scaffold'
- requiring permits for access to areas where travel restraint systems or fall-arrest systems are to be used.

### Organising and sequencing of work

Work should be organised so that people do not interfere with other workers or increase the risk to themselves or others. For example, you can sequence jobs so that different trades are not working above or below each other at the same time. Plan the work so tasks are not performed for extended periods from a ladder, or so that work at height is minimised in extremely hot or cold weather.

### Safe work procedures

An administrative control may be as simple as a safe work procedure that describes the steps involved in safely undertaking a task. It may also include any particular training, instruction and the level of supervision required. For example, a safe work procedure to reduce the risk of falls when entering or exiting vehicles may include instructing drivers to not jump down from the cab and always maintain three points of contact when climbing into or out of the cab (see Figure 33).



**Figure 33:** Diagrams showing the correct procedure for climbing in and out of trucks

If relying on administrative controls, it may be necessary to provide a high level of supervision to ensure that the safe work procedure is being adhered to.

## 9. Emergency procedures for falls

Whenever there are risks from working at height, appropriate emergency procedures and facilities, including first aid, must be established and provided. Typical injuries from falls can include unconsciousness and occluded airway, impalement, serious head or abdominal injuries and fractures.

A person using a fall-arrest system could suffer suspension intolerance as a result of a fall. The WHS Regulation contains a specific provision to address the need for emergency and rescue procedures for such situations.

**WHS Regulation 80:** A person conducting a business or undertaking who implements a fall-arrest system as a measure to control risk must establish emergency and rescue procedures.

The procedures must be tested so that they are effective. Workers must be provided with suitable and adequate information, instruction and training in relation to the emergency procedures.

### 9.1 Emergency procedures

In developing emergency procedures, the different types of emergency and rescue scenarios that might arise should be considered. Information from the risk assessment will help in this task.

**WHS Regulation 42:** You must ensure that workers have access to first aid equipment and facilities for the administration of first aid. You must also ensure that workers are trained to administer first aid or that workers have access to persons who are trained in first aid.

Further guidance is available in the *First aid in the workplace Code of Practice*.

The emergency procedures for falls may be incorporated into the emergency plan required for the workplace under the WHS Regulation.

When establishing emergency procedures, you should take into account the following:

Relevant considerations	Questions
Location of the work area	Is the work at height being undertaken in a remote or isolated place? How accessible is it in an emergency and how far away is it from appropriate medical facilities? Can the rescue of a person after an arrested fall be provided immediately, without the need to rely on emergency services?
Communications	How can workers working at height communicate in an emergency?
Rescue equipment	What kinds of emergencies may arise? The provision of suitable rescue equipment will depend on the nature of the work and the control measures used, for example, an emergency rapid response kit with man-made fibre rope, according to AS 4142.3 <i>Fibre ropes—Part 3: Man-made fibre rope for static life rescue lines</i> . Selected rescue equipment should be kept in close proximity to the work area so that it can be used immediately.
Capabilities of rescuers	Are rescuers properly trained, sufficiently fit to carry out their task and capable of using any equipment provided for rescue (e.g. breathing apparatus, lifelines and fire-fighting equipment)?

Relevant considerations	Questions
	Have emergency procedures been tested to demonstrate that they are effective?
First aid	Is appropriate first aid available for injuries associated with falls? Are trained first aiders available to make proper use of any necessary first aid equipment?
Local emergency services—if they are to be relied on for rescue	How will the local emergency services (e.g. ambulance) be notified of an incident? What is the likely response time?

## 9.2 Suspension intolerance

Suspension intolerance can occur with a fall-arrest system when a person has an arrested fall and is suspended in an upright, vertical position with the harness straps causing pressure on the leg veins. The lower legs' capacity to store large amounts of blood reduces the return of blood to the heart, slowing the heart rate, which can cause the person to faint. This may lead to renal failure and eventually death, depending on a person's susceptibility. This condition may be worsened by heat and dehydration.

The quick rescue of a person suspended in a full body harness, as soon as is possible, is vital. For this reason, workers should be capable of conducting a rescue of a fallen worker and be familiar with onsite rescue equipment and procedures.

Workers and emergency response workers must be trained in the rescue procedures and be able to recognise the risks of suspension intolerance and act quickly in the rescue of a person.

### Preventing suspension intolerance

To prevent suspension intolerance occurring as a result of an arrested fall, you should ensure that:

- workers never work alone when using a harness as fall protection
- workers use a harness, which allows legs to be kept horizontal
- the time a worker spends in suspension after a fall is limited to less than five minutes. When a suspension is longer than five minutes, foothold straps or a way of placing weight on the legs should be provided.
- workers are trained to do the following when they are hanging in their harness after a fall:
  - move their legs in the harness and push against any footholds, where these movements are possible. In some instances, the harness design and/or any injuries received may prevent this movement
  - move their legs as high as possible and the head as horizontal as possible, where these movements are possible.

### Training for rescues

The training for rescuing workers who have fallen should address the following factors:

- the rescue process should start immediately
- training frequency should take into account the worker's competence and their ability to retain competence through regular exposure to the equipment and skills needed to perform a rescue
- workers should not put themselves at risk during a rescue.



# 10. Design of plant and structures

## 10.1 Design considerations

Consideration of the potential risk of falls early when designing plant or structures can result in the elimination of such risks. Where elimination is not possible, one way to minimise risks at the design stage is to integrate fall prevention systems into the design.

Safety considerations at the design stage should include:

- safe entry to and exit from any work area
- designing permanent guard rails or other forms of edge protection (for example, parapet walls) for permanent fall prevention on roofs
- future maintenance requirements, especially in relation to sloping building exteriors and windows, to ensure maintenance can be carried out safely
- specifying the strength of roof members and other points to which guard rail, or anchor points for work positioning systems will be fixed
- safer building design generally, with, for example:
  - low-level mounting of roof vents
  - the location of air conditioning units and other roof-mounted plant, such as satellite dishes, away from edges
  - the location of air conditioning and similar plant at ground level
  - the specification of non-fragile material for the roof
  - the use of permanent safety mesh
  - safer gutters, for example, installing large volume gutters and down pipes to minimise the need to access the roof for cleaning, locating the gutters at ground level or away from edges, or the removal of gutters altogether, with a smooth transition from the roof to the walls with the gutters at ground level.
- specific safety requirements for particular workers doing subsequent installation, maintenance or repair work. These groups include:
  - people installing and maintaining antennae and satellite dishes
  - contractors servicing air conditioning equipment on the roof
  - window and gutter cleaners and repairers.
- designing the pre-fabrication of structures on the ground before they are lifted into position.

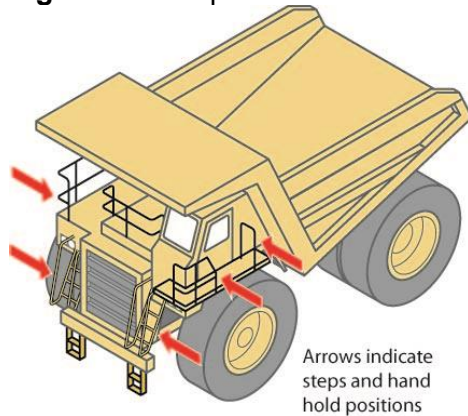
## 10.2 Plant

Safety considerations at the design stage could include:

- providing adequate steps and hand rails on vehicles (see Figure 34)
- incorporating a fall prevention system in silos and overhead conveyors
- ensuring workers who will be maintaining or cleaning the plant are able to do so safely
- considering the safety of passengers.

**Section 21:** Designers must provide information to each person who is provided with the design that includes information on the purpose for which the plant was designed and how to use the plant safely.

**Figure 34** Dump trucks



## 10.3 Buildings and structures

Designers or constructors of buildings or structures must ensure, so far as is reasonably practicable, that workers involved with the construction, use or subsequent maintenance are not exposed to the risks associated with work at height. Therefore, at the design and planning stage, it is important to consider providing fall prevention systems as part of the building or structure.

As it is unlikely that all design work on larger projects will be carried out by one designer, consultation, co-operation and co-ordination should occur between the builder and other designers to ensure the safe interaction of the different design aspects.

When risks remain in the design work, information must be included with the design to alert others to the risks. Providing information about safety issues is a key component to ensure proper, adequate and suitable design and installation.

The design and planning for the construction stage should include:

- reducing the risk for those working at heights, such as the installation of guard rails to perimeter structural members prior to erection
- reducing the time spent working at heights by pre-fabricating modules on the ground, before lifting them into position
- sequencing of the work to be performed at heights
- the location and condition of access roads, for example to enable a crane to place building materials in the most appropriate and accessible location, rather than the materials being moved manually
- preparation of the ground or floor below the work area. It should be compacted and level to support plant or equipment, such as cranes and scissor lifts
- identification of underground services including drainage, for example for the safe setting up of cranes
- provision of permanent safety mesh.

### **Planning for building maintenance**

During the planning stage, consideration should also be given to the methods by which maintenance, repairs or cleaning will be undertaken on a building or structure, for example:

- designing window cleaning bays or gangways integrated into the structural frame
- designing permanent anchorage and hoisting points into structures where maintenance needs to be undertaken at height.

### **Planning the site layout**

When planning the site layout, the following factors should be considered:

- the preparation of firm, level surfaces below work areas for the support of plant and equipment, such as scissor lifts or mobile scaffolds
- the site and condition of access roads to enable plant to place material in and pick it up from the most favourable positions, thereby reducing, for example, the need for manual handling at height
- safe access to and egress from work areas and amenities, including the provision and placement of stairways, ladders, catwalks, guardrails and barriers
- the need for adequate means of escape and rescue in the event of an emergency.

OIR Disclosure Log

# Appendix A – Terms used in fall control measures

**Anchorage:** means a secure point for attaching a lanyard, lifeline or other component of a travel restraint system or fall-arrest system. Anchorages require specific load and impact capacities for their intended use.

**Double or triple action device:** is a self-closing hook or karabiner with a keeper latch which will automatically close and remain closed until manually opened. These units have a minimum of at least two distinct and deliberate consecutive actions to manually open them.

**Free fall:** is any fall or part of a fall where the person falling is under the unrestrained influence of gravity over any fall distance, either vertically or on a slope on which it is not possible to walk without the assistance of a handrail or hand line.

**Inertia reel:** (also known as a self-retracting lanyard or fall-arrest block) is a type 2 or 3 fall-arrest device that arrests a fall by locking onto a line and at the same time allows freedom of movement.

**Karabiners:** these are metal types of connectors that can be attached to anchorage points. They come in a variety of sizes, shapes and locking mechanisms to suit various applications. They should be self-closing and self- or manual-locking and capable of being opened only by at least two consecutive deliberate manual actions.

**Lanyard:** an assembly consisting of a line and components which will enable connection between a harness and an anchorage point and will absorb energy in the event of a fall.

**Personal energy absorber (or deceleration device):** means a device which reduces the deceleration force imposed when a fall is suddenly arrested, and correspondingly reduces the loadings on the anchorage and the person's body. The energy absorber may either be a separate item or manufactured as part of the lanyard.

**Restraint line:** is the line securing workers to a point of anchorage and is used to prevent a person from reaching a point from which he or she could fall.

**Static line:** is a horizontal or substantially horizontal line to which a lanyard may be attached and which is designed to arrest a free fall.

**Total fall distance:** is the total distance a person is likely to fall during both the free and restrained parts of a fall and includes the maximum dynamic extension of all supporting components.

# Appendix B – References and other information sources

## **Australian Standards and Australian/New Zealand Standards**

AS 1418.13 *Cranes (including Hoists and Winches) – Part 13: Building Maintenance Units*

AS 1418.17 *Cranes (including hoists and winches) – Part 17: Design and construction of workboxes*

AS/NZS 1576 *Scaffolding series*

AS 1657 *Fixed platforms, walkways, stairways and ladders—Design, construction and installation*

AS/NZS 1891.1 *Industrial fall-arrest systems and devices—Part 1: Harnesses and ancillary equipment*

AS/NZS 1891.2 supp:1-2001 *Industrial fall-arrest systems and devices—Horizontal lifeline and rail systems—Prescribed configurations for horizontal lifelines (Supplement to AS/NZS 1891.2:2001)*

AS/NZS 1891.3 *Industrial fall-arrest systems and devices—Part 3: Fall-arrest devices*

AS/NZS 1891.4 *Industrial fall-arrest systems and devices—Part 4: Selection, use and maintenance*

AS/NZS 1892 *Portable ladders series*

AS 2359 *Powered Industrial Trucks series*

AS 2550.1 *Cranes, Hoists and Winches—Safe Use— Part 1: General Requirements*

AS 2550.10 *Cranes, hoists and winches – Safe use – Part 10: Mobile elevating work platforms*

AS 2550.13 *Cranes—Safe Use— Part 13: Building Maintenance Units*

AS 2550.16 *Cranes – Safe Use – Part 16: Mast climbing platforms*

AS 4142.3 *Fibre ropes—Part 3: Man-made fibre rope for static life rescue lines*

AS/NZS 4389 *Roof Safety mesh*

AS/NZS 4488 [Industrial rope access systems series](#)

AS/NZS 4488.2 [Industrial rope access systems—Part 2: Selection, use and maintenance](#)

AS/NZS 4576 *Guidelines for scaffolding*

AS 2550.16 *Cranes—Safe Use—Part 16: Mast climbing work platforms*

AS/NZS 4994 *Temporary edge protection series*

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## **British Standards Institution**

*BSEN 1263-1:2002 Safety nets: Safety requirements, test methods*

*BSEN 1263-2:2002 Safety nets: Safety requirements for the positioning limits*

Internet address: [www.bsi-global.com](http://www.bsi-global.com)

