Tilt-up and precast construction

Code of Practice

2026

DELIVERING FOR QUEENSLAND

Queensland Government

Contents

Foreword

This Tilt-up and precast construction Code of Practice 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).

Under section 26A of the WHS Act, a person conducting a business or undertaking (PCBU) must:

- comply with an approved code of practice, or
- manage hazards and risks arising from the work carried out as part of the business or
- undertaking in a way that is different to the code but provides an equivalent or higher standard of work health and safety than the standard required in this 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.

Code terminology

This Code includes references to the legal requirements under the WHS Act and WHS Regulation. These references are not exhaustive and are included for convenience only. They should not be relied on in place of the full text of the WHS Act or the WHS Regulation.

The words '**must**', '**requires**' or '**mandatory**' indicate that a legal requirement exists that must be complied with.

The world '**should**' is used in this Code to identify the standard required in this Code. PCBUs can only manage the identified hazard or risk in a different way if doing so provides an equivalent or higher standard of work health and safety than the standard required in this Code.

The word '**may**' is used to identify an optional course of action.

Scope and application

This Code of Practice provides practical guidance to PCBUs on how to comply with their health and safety duties relating to the design, manufacture, lifting and installing of tilt-up and precast elements. It does not consider all issues in this type of construction but focuses on the primary safety issues. This Code of Practice does not discuss pre-tensioning and post-tensioning of concrete elements.

1. Introduction

1.1 What are tilt-up and precast panels/elements?

Tilt-up and precast panels/elements are prefabricated concrete elements:
- Tilt-up panels being cast on site and moved by cranes to the erection location.
- Precast elements are manufactured off-site and transported by road transport.

Examples of prefabricated concrete elements used in construction include wall elements, columns, beams, flooring and façade units, concrete pipes, bridge beams or culverts.

Prefabricated concrete construction is a method of prefabricating concrete in discrete elements and erecting and incorporating them by crane into their final position in the building structure.

This Code does not generally refer to the generic definition of prefabricated concrete elements, given the distinct differences in erection methods used for precast and tilt-up panels/elements with potentially different hazards.

1.2 Who has health and safety duties in relation to tilt-up and precast construction?

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.

Designers, manufacturers, importers and suppliers (distributors)
The PCBU that designs, manufactures, imports or supplies plant or a structure, including a temporary structure, that is to be used at a workplace must ensure, so far as is reasonably practicable, that the plant or structure is designed, manufactured, imported or supplied to be without risks to the health and safety of persons who:
- construct or use the structure at the workplace
- carry out any reasonably foreseeable activity at the workplace in relation to the manufacture, assembly or use of the structure or demolition or disposal of a structure; and
- are in the vicinity of the workplace and whose health or safety may be affected by the activities mentioned above.

The PCBU that designs, manufactures, imports or supplies plant or a structure must carry out, or arrange the carrying out of, any calculations, analysis, testing or examination that may be necessary for the performance of the duty and give adequate information to each person provided or supplied with the plant or the design of the plant or structure.

A PCBU that installs, constructs or commissions plant or a structure that is to be used at the workplace must ensure that the way in which the plant or structure is installed, constructed or commissioned is without risks to the health and safety of persons who:
- install or construct the plant or structure
- use the plant or structure at the workplace
- carry out any reasonably foreseeable activity at the workplace in relation to the use, decommissioning or dismantling of the plant or demolition or disposal of the structure; or
- are in the vicinity of the workplace and whose health or safety may be affected by the activities mentioned above.

Under the Work Health and Safety Regulation 2011 (WHS Regulation), a PCBU must manage the risks of an object falling on a person by either preventing the object from falling or implementing a system to arrest the fall of the object. A suitable control would include providing an exclusion zone that persons are prohibited from entering. In addition, the person with management or control of plant at the workplace has duties to ensure that lifting or suspending loads is carried out safely.

A **PCBU with management or control of a workplace** must ensure, so far as is reasonably practicable, that the workplace, the means of entering or exiting the workplace, and anything arising from the workplace are without risks to the health and safety of any person. This duty holder is also referred to as a 'person with management of control of a workplace'.

A **PCBU with management or control of fixtures, fittings of plant at a workplace** must ensure, so far as is reasonably practicable, that the fixtures, fittings and plant are without risks to the health and safety of any person. This duty holder is also referred to as a 'person with management or control of plant at a workplace'. **Officers of a PCBU**, such as company directors, have a duty to exercise due diligence to ensure the business or undertaking complies with the WHS Act and 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 plant.

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 the risks associated with tilt-up and precast construction?

WHS Regulation sections 34-38: To manage risk, a PCBU 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 section 36 of the WHS Regulation
- 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.

WHS Regulation sections 201: A PCBU that installs, constructs or commissions plant must ensure that the plant is installed, constructed or commissioned having regard to:

- the information provided by the designer, manufacturer, importer or supplier of the plant under the Act and this regulation; or
- the instructions provided by a competent person to the extent that those instructions relate to health and safety.

WHS Regulation sections 204: A person with management or control of plant at a workplace must ensure that a person who installs, assembles, constructs, commissions or decommissions or dismantles the plant is:

- a competent person
- is provided with available information for eliminating or minimising risks to health or safety
- The person with management or control of plant at a workplace must ensure that the processes for the installation, construction, commissioning, decommissioning and dismantling of plant include inspections that ensure, so far as is reasonably practicable, that risks associated with these activities are monitored.

Due to their size and mass, tilt-up and precast elements can be vulnerable to uncontrolled collapse. This can cause workers and others to be seriously injured or even killed. Uncontrolled collapse can occur for a range of reasons including:

- faulty concrete element design
- inadequate crane capacity and placement
- inadequate concrete strength for lifting and bracing inserts
- quality control issues during manufacture
- incorrect components
- inadequate or incorrectly designed or installed temporary support systems.

All duty holders involved in the use of tilt-up and precast concrete elements in construction have a role in managing the associated risks to health and safety. To determine whether health and safety risks are being adequately managed, identify hazards, assess risks and monitor controls. Where a risk is not being adequately managed, a PCBU must take action to eliminate or minimise the risk, so far as is reasonably practicable.

To properly manage risks, a PCBU must:

- **identify the hazards**. Many things can pose a hazard in a construction project using tilt-up and precast elements, such as deficient design, faulty components, unauthorised modifications to elements, poor lifting practices and inadequate temporary support.

Consider each stage of the project lifecycle and identify potential hazards. For example:

- Review proprietary documentation such as designer's safety reports, design drawings, shop drawings and erection instructions to identify hazardous tasks and the sequence of work.
- Observe work locations and look for interactions with other activities, vehicles, pedestrians, structures or underground essential services.
- Consider the environment and check for features such as sloping ground, rough surfaces, holes, excavations, trees, underground watercourses or other structures.
- Ask workers and other duty holders about any problems they encounter or anticipate when working with prefabricated concrete elements.
- Review any inspection, maintenance, incident and injury records, including information on near misses.
- Review high risk construction work needs.

Information about hazards should be recorded and given to those involved in later stages of the structure's lifecycle to enable effective consultation and risk management (model Guide to managing risk in construction: Prefabricated Concrete, September 2019).

Assess the risks: If a hazard has been identified, the PCBU should use a risk assessment to determine how large the risk posed by the hazard is, what action is necessary to control the risk, how urgently the action needs to be taken and who is responsible for implementing the control measure. In some cases, the risks and related control measures will be well known, but in other cases a more comprehensive assessment will be required.

Control measures: decide on control measures to prevent, or minimise the level of, the risks and implement control measures. Monitor and review the effectiveness of the measures.

Control measures need to be regularly reviewed to make sure they remain effective, taking into consideration changes, the nature and duration of work and that the system is working as planned.

Further information on the risk management process is in the How to manage work health and safety risks Code of Practice.

1.3.1 Consulting workers

WHS Act section 47(1): The PCBU 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. 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.

1.3.2 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 a PCBU 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 exchange information to find out who is doing what and work in a cooperative and coordinated way so that all risks are eliminated or minimised as far as reasonably practicable.

Further guidance on consulting, cooperating, and coordinating activities is available in the Work health and safety consultation, coordination and cooperation Code of Practice.

1.4 Safe work method statements

WHS Regulation section 299: When carrying out high risk construction work, a PCBU must ensure that a safe work method statement is prepared or has already been prepared by another person.
WHS Regulation section 300: A PCBU that includes the carrying out of high risk construction work must put in place arrangements for ensuring that high risk construction work is carried out in accordance with the safe work method statement for the work.

Where the activity involves high risk construction work, a safe work method statement (SWMS) must be prepared before the work starts. High risk construction work means construction work:

- involving a risk of a person falling more than two metres
- carried out on a telecommunications tower
- involving demolition of an element of a structure that is a 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 metres
    - a tunnel

- involving 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 or 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 the risk of drowning
- involving diving work.

Where the circumstances of the high risk construction work are the same, or very similar, to work undertaken in the past, the SWMS can be based on a previously used SWMS, subject to the SWMS being reviewed and, as necessary, revised. However, where the high risk construction work differs from work undertaken in the past (i.e. the type of lift is unique or more complicated), a new site-specific SWMS should be prepared.

Examples of complex circumstances include lifts involving:

- tilt-up and precast concrete panel jobs
- multiple crane lifts
- lifting of workboxes with personnel in them
- installation of bridge beams
- working near power lines
- lifting large pressure vessels or tanks
- cranes used on barges
- mobile plant retrieval following an incident
- erection of tower cranes
- heavy lifts (such as bridge beams (10 tonnes or more) or other lifts where the load is 50 tonnes or more (see section 8.2.5 of the Mobile crane Code of Practice 2024).

If it is not clear that a SWMS based on a previous SWMS is appropriate for the circumstances, a site-specific SWMS should be prepared. Where a SWMS is required, 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. Where a documented lifting procedure has been prepared, information required for a SWMS may be incorporated into the lifting procedure or vice versa. Information on documenting lifting procedures is provided in section 7.5 of the Mobile crane Code of Practice 2024.

1.5 Information, training, instruction and supervision

WHS Act section 19(3)(f): A PCBU 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 sections 39(2) and (3): A PCBU 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 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 two years previously—the worker has carried out construction work in the preceding two years.

All workers exposed to work health and safety risks should be provided with information about:

- work health and safety legislation
- their organisation's work health and safety policy or program
- work health and safety risk management processes
- which control measures are in place to minimise exposure to risks associated with workplace hazards
- correct use of risk control measures and how to ensure they are kept in working order
- any known residual risk
- safe work procedures
- how to use and maintain equipment
- any special safety information needs.

Suitable and adequate training is a way of managing the risks associated with hazards. Training should be appropriate to the type of work to be performed. In some cases, formal training will be required, in others, on-the-job training may be more appropriate. The individual needs of workers should be taken into account in deciding on the structure, content and delivery of training. This assessment should include literacy levels, work experience and specific skills required for a job (refer to Appendix F Familiarisation training checklist).

References to other legislation

This Code includes references to the *Electrical Safety Act 2002* (ES Act) and Electrical Safety Regulation 2013 (ES Regulation). These references are not exhaustive and are included for information only. They should not be relied on in place of the full text of the ES Act or the ES Regulation. While this Code includes information about electrical safety, it is not an approved code under the ES Act.

This Code includes references to the *Professional Engineers Act 2002* (PE Act), which regulates 'professional engineering services' provided by a registered professional engineer. These references are not exhaustive and should not be relied on in place of the full text of the PE Act. Both the WHS Regulation and this Code refer to certain tasks being performed by a competent person, which in some circumstances must be a registered professional engineer under the PE Act. For further information about the PE Act and registered professional engineers, refer to bpeq.qld.gov.au.

2. Concrete element design and manufacture

Tilt-up and precast elements are designed for two types of loading conditions: loads when they are initially lifted, stored, transported and installed and loads experienced when they form part of the completed building or structure (i.e. 'in-service loads'). The loads applied to the element, when lifted off the casting bed, stored, transported, installed and temporarily braced, are different from loads experienced as part of the final structure. The design engineer(s) needs to design the element for all types of loading conditions.

Where an element is particularly large or has cut-outs, the use of 'strongbacks' may be specified by the engineer to prevent failure of the element when it is being lifted and/or rotated. It is extremely important that strongbacks are bolted so that they are hard up against the element, or they may not be able to adequately resist the bending moment applied to the element and the element will be damaged.

2.1 Cast–in lifting and bracing inserts

The design and installation of lifting and bracing inserts should:

- meet the factors of safety outlined in AS 3850.1 prefabricated concrete elements
- comply with the insert manufacturer's and panel designer's specifications for minimum edge distances, insert spacing, embedment depth, panel thickness, concrete strength and additional reinforcement (e.g. tension bars)
- include an adequate number of inserts in the correct locations to ensure the inserts are not overloaded and to ensure the element is suspended in the way specified by the design engineer for the prefabricated element.

Lifting inserts typically experience high loads when the element is lifted from its horizontal position on the casting bed and the bond with the bed is broken. The proper application of a quality bond breaker will greatly reduce the bond strength that must be overcome by the lifting force. Insert manufacturers typically require edge lifters to be installed beneath the perimeter bar, or for an additional shear bar to be provided to prevent cracking in the panel at first lift.

All inserts require a minimum distance from the edge of the element to develop their maximum strength. The insert type and the other information mentioned above should be clearly specified on the element drawings and certified by an engineer (or a certification letter with a list of drawings should be supplied).

2.2 Concrete strength and curing time

Tilt-up panels should only be lifted when the concrete has cured long enough for the panel to be safely lifted. The **minimum** concrete strength at which this can be achieved, for most proprietary brand lifting inserts, ranges between 15 and 25 MPa based on manufacturer's specifications. Some inserts may require a higher strength concrete specification to achieve appropriate strength at initial lift. Tilt-up panels are usually cast in stacks so the panels cannot be lifted until the last panel to be cast, on top of the stack, has reached adequate strength.

As a general rule, concrete will usually achieve its design (characteristic compressive) strength, for practicable purposes, after a period of 28 days. However, even after this period, concrete can still increase in strength to a small degree.

In some situations, the panel installer may cast the last panels on the stack with higher strength concrete (e.g. 40–50 MPa, 28-day strength) so the top panels can be lifted after a shorter period of time while ensuring the panels do not fail as they are lifted.

Additional water is sometimes added to the concrete to make it easier to work. This will weaken the concrete and affect its potential to reach the specified design strength. It is very important to strictly control the amount of water added to the mix, and this should only be added with the approval of the design engineer.

The element manufacturer should provide written documentation to verify that the concrete has reached the minimum acceptable strength before elements are erected on site. There should be a sampling and concrete testing procedure in place to verify the concrete meets its design specification. Guidance on sampling and testing systems for concrete is provided in AS 1379 – Specification and supply of concrete.

It should be noted that the compressive strength of laboratory cured test specimens may differ from the actual compressive strength achieved on site due to factors such as temperature and humidity on site, poor curing techniques and the addition of water to the mix. Some element installers may choose to have test samples on site to give an indication of the variation between 'on site' tests and laboratory tests.

For low strength/early age concrete panels, and floor slabs/deadman anchors used to brace panels, it is critical that the test samples are stored in similar conditions to the construction element to ensure the test result matches the actual concrete strength at the time of the lift.

Much of the concrete supplied for casting concrete elements is designated as 'special class concrete'. However, irrespective of whether the concrete mix is a special or normal mix, a sampling and testing program should be implemented.

Documentation verifying the following should be available on site:

- Specification of concrete supplied for use in elements.
- Confirmed concrete strength (i.e. 28 days) of concrete used in elements and/or slabs that elements are braced off.
- Minimum concrete strength to be achieved prior to lifting of elements (information for the inserts should be available that specifies the minimum concrete strength required for using the insert).
- Results of a sampling program that demonstrates the concrete is of an appropriate strength.
- Casting dates for each element and earliest date when the element can be lifted (each element should be numbered, and written records made).

An element checklist listing all the relevant information on elements, should be supplied to the site (see Appendix B for an example checklist).

3. Drawings

Detailed drawings should be provided that include information on the following areas:

- Design of the element itself for the in-situ application as part of the final structure.
- Design of the element for lifting and other installation loads.
- Design and location of footings and slab for the building or structure.
- Layout of the elements and installation sequence during construction of the building or structure with temporary bracing installed.
- Layout of the building or structure in its completed form with temporary bracing removed and permanent connections detailed.

The builder and/or element installer will often determine how many groups of drawings are to be provided for the project. However, all of the information above should be clearly shown on the drawings and is to be checked and approved by a suitably qualified engineer.

3.1 Concrete element drawings

Drawings for the element design should include the following information:

- Date and issue number of the drawing.
- Location, orientation and depth of lifting and other inserts.
- Project location.

- Surface finish.
- Element number and element mass.
- Dimensional tolerances.
- Element dimensions.
- Centre of gravity.
- Type, size and brand of lifting inserts.
- Additional instructions for lifting inserts, such as edge distance, tension bar. reinforcing details and proximity of reinforcement.
- Type, size and location of steel or other reinforcement.
- Required concrete cover for reinforcement steel.
- Strongback details (where required).
- Strongback fixing inserts details.
- Concrete strength required both for lifting, and as part of the final structure, in accordance with AS 3600 – Concrete structures.
- Review and approval for construction by a registered professional engineer of Queensland (RPEQ).

3.2 Concrete element installation drawings

Drawings for the installation of the elements should include details on how the elements are to be placed and secured into position. Information to be shown on these drawings include:

- Date and issue number of the drawing.
- Project location.
- Position of brace connection points on the element and connection details (e.g. bolt specifications and torque requirements)~~.~~
- Detailed specification of how the base of the panel is to be secured (e.g. dowel bar specification, structural steel connection details).
- Brace specifications and/or required capacities.[1]
- Levelling pad details.
- Relative locations of elements and sequence of installation.
- Details for brace footings including dimensions, location, anchor type, and concrete strength at time of installation.
- Details on knee and lateral bracing (if applicable).
- RPEQ engineer's review and approval for construction.

Drawings can either include the full engineering certification on the drawing, or the drawings should be accompanied by a letter from the engineer to the builder certifying the concrete element or temporary bracing layout as provided in Appendix A – sample of engineer's certification letters.

[1] If the drawing only specifies the required brace capacities, then the element installer should be able to demonstrate the braces being used have adequate capacity for the brace extension being used (the brace manufacturer may supply this information but there should be engineering input into the brace design).

4. Braces

The safe erection of concrete elements relies on the integrity of braces and their correct installation. The different types of bracing for wall panels (elements) are illustrated in figure 1 and figure 2.

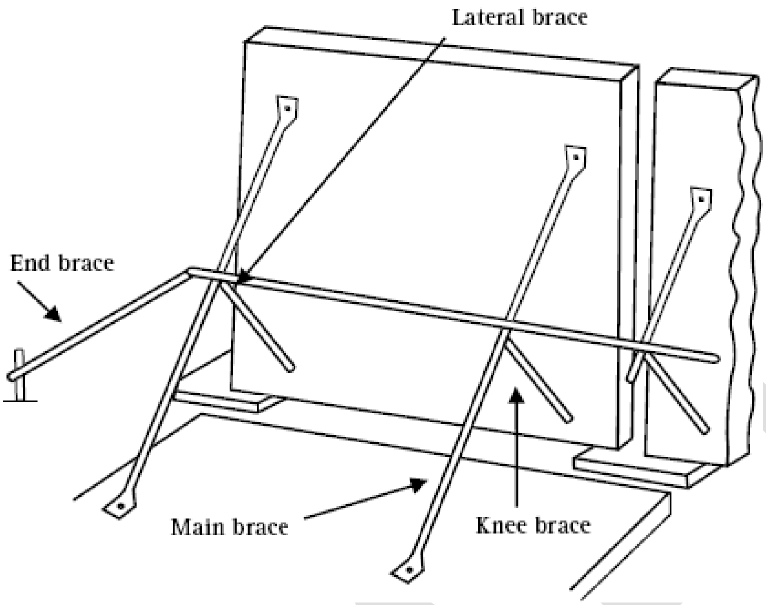

Figure 1 *Bracing types*

Figure 2 *Panel bracing showing alternative method of knee bracing (bi-pod bracing)*

The following factors relating to the design and use of braces should be addressed:

- Braces should be designed, tested and certified by an engineer in accordance with

AS3850.1– prefabricated concrete elements.

- Braces should be permanently marked with the manufacturer's name or trademark, the model type and the working load limit for maximum and minimum extensions.
- Engineering certification should be available, and braces should be designed to have adequate strength and stiffness and allowance for wind loadings. Drawings and specifications which clearly show the type, position, method of fixing and installation angle should be on site.
- Braces should be as specified by the manufacturer and not have parts interchanged with other makes or models of brace (i.e. feet changed, smaller pins or bolts used, different tube wall thickness used).
- Prior to use, all braces should be inspected to check there is no damage and to verify the braces are complete and functional (i.e. extendable and foot length can be adjusted).
- Bolts or nuts used to secure the brace to the footing or element should be provided with washers of the correct grade and size.
- The anchor bolt and washer combination on the foot of the brace should have adequate bearing capacity. Sometimes the bolt head and washer are too small for the slot size on the brace foot. This can cause the washer to collapse and the element to move. As a general principle the slot width on the brace foot should not exceed the diameter of the thread or sleeve on the anchor bolt by more than 2 mm - unless otherwise stated by the anchor supplier. In addition, the head of the anchor bolt should be large enough to be able to apply adequate load to the foot of the brace. If there is doubt about the ability of the bolt head to do this, the anchor supplier should be contacted and requested to supply guidance, such as the use of a suitable structural washer. Diagram 2 illustrates the issue.

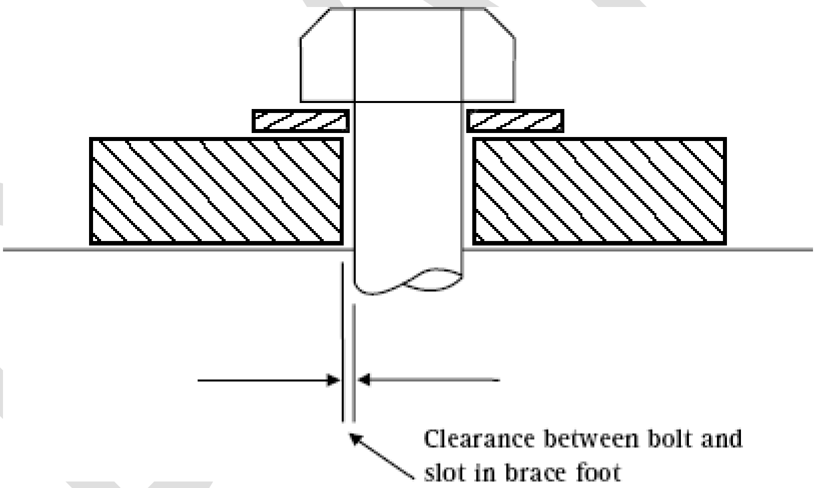

Figure 3 *Adequate bearing capacity should be provided by the bolt head and washer*

- Adjustable feet on braces should have stops on the threads to prevent over extension.
- Locking pins should be provided with retaining devices to prevent unintentional dislodgement of the locking pin. Locking pin retaining devices that require a tool or key to remove should be used.
- A minimum of two braces should be secured to each element unless specified by the engineer and indicated on the erection drawings. Where only one brace is used there should be a minimum of two fixings at each end (this may be difficult to achieve because of the lack of suitable feet and the need to maintain adequate separation distances for anchors).
- Where knee bracing and/or lateral bracing is required by the engineer, it should be installed as soon as possible after the elements have been placed in position and the primary braces secured.

5. Wind and other loading for bracing

Wind loading on elements will vary depending on the size of the elements, wind speed and wind direction. The location will also have a bearing on the severity of the wind. In built-up or hilly areas, the wind effect may be less than on open plains. Different areas in Queensland will also have an effect - in cyclone prone areas the potential wind loading applied to elements will be higher.

AS/NZS 1170.2 structural design actions – wind actions provides information for the engineer to calculate the design wind pressure so that the resultant wind force and wind actions applied to the element face can be calculated. This information is then used by the engineer to design the temporary support systems including the brace characteristics, brace anchor details and footing or deadman design. The design wind pressure is based on a number of multipliers depending on topographical characteristics of the site, duration of the installation, element characteristics and the location in Queensland.

It should be noted that an increase in wind pressure is not directly proportional to an increase in wind speed. Instead, wind pressure varies directly to the square of the wind speed. For example, if the wind speed doubles the resultant pressure and force applied to the element face will quadruple.

Basic regional wind speeds for different zones in Australia are specified in AS/NZS 1170.2. Figure 4 shows the zones for Queensland. Four regions apply to Queensland as follows:

- Region A0 – covers most of the state but no coastal areas (includes Mt Isa).
- Region B1 – covers 200 km wide coastal strip south of Bundaberg (includes Brisbane, all of Gold Coast and Sunshine Coast).
- Region B2 – includes coastal areas north of Bundaberg and a narrow band behind region.
- Region C– includes all coastal areas north of, and including, Bundaberg.

In addition to the areas in Queensland, AS/NZS 1170.2 also specifies five different terrain categories that should be considered by the engineer when designing the temporary support systems including the brace size, brace anchor details and footing or deadman design. The terrain categories range from very exposed open terrain with few or no obstructions to terrain with numerous large, high and closely spaced structures.

Heavier duty braces and possibly a greater number of braces, may be required for elements being erected on a coastal area in the North Queensland in comparison to an inland area.

Figure 4 *Wind regions for Queensland*

5.1 Wet concrete loading on concrete elements and bracing

The load imposed on a concrete element (e.g. wall panels) can be significant when wet concrete is poured against the element. Some examples where this occurs are:

- a transfer slab poured against or into a braced precast wall panel
- a deep concrete beam poured against or into a braced wall panel
- a formed concrete wall or column poured against or into a braced wall panel.

Failure of the concrete element itself can occur due to extreme pressures associated with the head pressures of wet concrete. In this situation the element functions as single sided formwork.

Potential failures can occur if the applied loads are not considered in the design of the brace, bracing insert and anchors, element and element connections.

The PCBU must ensure when concrete is poured against a precast element, an engineer with the appropriate experience has checked and confirmed in writing:

- the bracing and bracing inserts have adequate capacity to retain the element while concrete is placed against the element
- the connections at the base of the element have adequate capacity
- the structural capacity of the precast element is adequate to contain the wet concrete without cracking and failure.

It may be necessary for the engineer to nominate a pour sequence to minimise the load on the bracing system and the element itself. In some cases (e.g. for lightly reinforced panels and rebated panels) it may be impractical to alter the precast design sufficiently to withstand substantial increases in loading. In these cases, work systems that reduce any loading to acceptable limits may need to be implemented. A temporary works engineer with formwork expertise may be engaged to work with both the site structural engineer and the engineer responsible for the bracing to develop methods to reduce the loads being applied to the bracing and the precast element. Engineering certification, verifying that the concrete element and bracing system can withstand the additional loading should be available.

6. Purpose-built brace anchorage systems

6.1 Concrete deadmen

Buried concrete blocks 'deadmen' are sometimes used to anchor braces and prevent elements (i.e. panels) falling over due to wind loads or other factors. An example of a concrete deadman is shown in figure 5.

A concrete deadman relies both on its mass and cohesion with the surrounding soil to resist wind loads which tend to pull the deadman out of the ground (i.e. wind blowing on to the back face of the panel).

It is not a simple process to estimate the required size of a concrete deadman for a particular panel based on a deadman block of known size for a smaller panel. This is because the mass of the deadman is not directly proportionate to the surface area of a braced wall element (i.e. the mass of the required deadman does not double if the surface area of the braced wall element doubles). Additionally, cohesion with the surrounding soil depends on the surface area of the deadman block in contact with the soil. Cohesion between the deadman and surrounding soil changes with the mass of the deadman, however this effect is not directly proportional (e.g. when the mass of a concrete deadman is doubled, its vertical surface area that will be in contact with the soil does not double).

Wind blowing onto the front face of the element will result in a compressive force in the brace which will tend to push a deadman further into the ground. Of the two different loading cases, the case where the wind tends to pull the deadman out of the ground is the more critical. It should also be noted that, with this load situation, there is a horizontal component of the force that will tend to pull the deadman through the ground, but this will usually not be the critical factor in the design of the deadman.

Soil that is stiffer will provide greater cohesion and better resistance to pull out loads than loose or sandy soils. For instance, stiff clay will provide better cohesion and resistance to pull out loads than gravel. Sand will provide very little cohesion and the use of deadmen in sand may not be the best option. Generally, the greater the water content of the soil, the less effective a deadman will be to resist loads applied by the element brace.

It should also be noted the effectiveness of the cohesion between the deadman, and soil also depends on the effective contact between them. For instance, in clay there will not be effective cohesion between the deadman and soil where the ground has been disturbed at the top of the hole.

The adequacy of the concrete deadman to resist wind loads is based on both its mass and cohesion with the ground. Consequently, the mass of the deadman is not directly proportionate to the surface area of a braced wall element.

Concrete deadmen are typically cast using low strength concrete (e.g. 20–25 MPa) and there will usually be a need to leave them for a substantial amount of time to ensure the cast-in or post-installed anchors do not pull out.

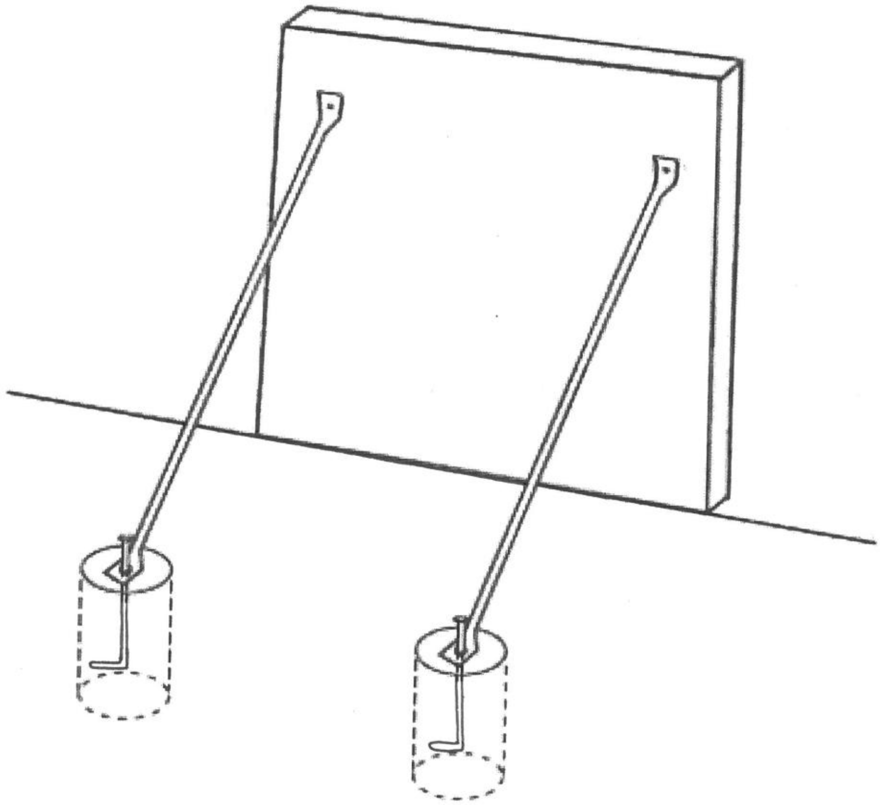

Figure 5 *Concrete deadman for anchoring braces*

A concrete deadman is usually provided with a cast-in reinforcement bar to connect the brace foot to the concrete block. The bar will often be bent at right angles in the deadman, and this greatly assists the strength of the bond between the steel and concrete. Sometimes the steel bar is not bent but is simply a straight bar that is pushed into the wet concrete. In this situation it is critical to ensure the engineer has checked the design of the steel insert and the correct section of steel is inserted to the minimum required depth during construction of the deadman. If the steel is not inserted correctly, or is not long enough, it can either pull out of the deadman or cause the concrete to fail.

Cast-in anchor bars are the preferred option for concrete deadmen. However, where post-installed anchors are used to attach braces, the edge distance of the anchor is to equal or exceed that specified by the anchor manufacturer. The engineer should also check the deadman will not break if the top part of the deadman is pulled out of its hole. This may require steel reinforcing to be added to the deadman.

The PCBU must ensure the following information is available on site:

- Drawings that show deadman dimensions, concrete strength, steel content and location (if applicable), minimum ground bearing capacities to ensure safe function of the deadmen, and soil type.
- Documentation that verifies each of the deadmen have been constructed in accordance with the drawings and the concrete has obtained its minimum required strength prior to installation of the braces and/or installation of post-installed anchors.
- If post-installed anchors are used, documentation that verifies the anchors have been installed in accordance with the manufacturer's installation instructions, and the risk of the deadman breaking has been controlled.
- A geotechnical engineer's report that verifies the ground characteristics are suitable for

the type of deadmen being used.
- Technical verification to demonstrate the anchors will remain effective if the ground were to become water logged (e.g. after heavy rains or from ground water levels raising in tidal areas).
- Verification that the deadmen are able to resist wind loadings on the concrete elements in accordance with AS/NZS 1170.2.

The verification should either be in the form of an engineer's written certification for that particular site or in the form of test results. The engineer's written certification should state that the deadmen can adequately withstand wind loadings specified in AS/NZS 1170.2. Where the verification is in the form of test results, there should be correlation between the test results and the actual conditions on site. The test should be performed by an independent competent person under the supervision of the engineer who designs the deadman.

In some situations, elements may be erected in locations where solid rock exists. In such locations alternative methods of anchoring the braces to the ground may be used, but these should be specified and certified by an engineer.

6.2 Slab cast-in anchor systems

Where proprietary cast-in anchor systems are used, they should be designed to and tested to confirm compliance with AS 3850.1.

They must then be installed in accordance with the manufacturer's instructions, including:

- only using compatible componentry (e.g. correct specification of threaded bar)
- ensuring any required component reinforcing is installed
- confirming the concrete slab has achieved the minimum acceptable concrete strength at time of bracing
- ensuring the correct installation and tightening techniques are followed
- following the manufacturer's and AS3850 recommendations in relation to regular inspection requirements.

To ensure cast-in anchors achieve the required pull-out capacity, it is critical that the concrete that they are cast into attains the minimum strength specified by the bracing designer, based on the manufacturer's specifications. However, these systems are often rated for use in lower concrete strengths (e.g. 12MPa), and it is known that concrete strengths can be highly variable across a slab at these lower strengths as the slab is still rapidly curing, potentially by as much as plus or minus 25 per cent.

As such, when it is proposed to brace off cast-in anchors in concrete strengths of less than 20MPa, it is critical that there is a system in place to ensure the specified minimum concrete strength is achieved prior to bracing. At a minimum, this system should incorporate:

- concrete test cylinders to be stored and cured in the same environmental conditions as the brace footing concrete on-site
- sufficient compaction to be achieved around the cast-in bracing insert locations
- sufficient concrete tests to be performed to confirm the required concrete strength has been achieved
- concrete test results to be received at site in writing.

The builder/principal contractor should verify to the panel installer that the minimum concrete strength required at the brace insert locations has been achieved.

6.3 Auger type brace anchorage systems

Auger type anchors are also sometimes used as deadmen to anchor braces to the ground. Auger anchors specifically designed for anchoring wall braces are sometimes constructed from a relatively long shaft that passes through a pipe and an auger blade fitted to the bottom of the shaft. A spade bit is fitted to the top of the pipe. As the auger rotates it pulls the pipe downwards so that the spade bit is pulled down into the ground, without being able to rotate. Auger anchors are designed so that they will not remove all of the soil when drilled into the ground. Instead, the blades anchor themselves into the ground and rely on resistance provided by the ground to resist pull out forces applied by the braces. However, as the auger anchor is drilled into the ground, usually by a hydraulic rotator on an excavator or similar, the ground will be disturbed to some extent.

Caution should be used when deciding to use auger type brace anchors because their effectiveness rely on the auger being able to be fully drilled into the ground. In rocky ground it is very unlikely they will be able to be installed correctly. For example, their use may be limited to alluvial ground on a flood plain or in other locations where soil sampling indicates very low presence of rock. Where auger type brace anchors are used, the following must be available on site:

- Manufacturer's documented instructions on the installation method, verification that these instructions have been followed, and the safe design capacity of the anchorage system.
- Manufacturer's instructions regarding ongoing monitoring and periodic inspections have been followed (especially after major weather events).
- A geotechnical engineer report that verifies the ground characteristics are suitable for the use of the specific type of auger anchor being used.
- Technical verification to demonstrate the anchors will remain effective if the ground were to become water-logged (e.g. after heavy rains or from ground water levels raising in tidal areas).
- Verification that the anchors are able to resist wind loadings on the concrete elements in accordance with AS/NZS 1170.2 (refer section 6.1 for further detail).

7. Post-installed anchors

7.1 Post-installed anchors for brace connections

Post-installed anchor is the term used to describe any anchor that is inserted into a hole drilled into concrete. Most post-installed anchors require a minimum concrete strength of between 20 and 25 MPa to achieve their specified capacities. Where post-installed anchors are used, these are to be recommended by the anchor manufacturer as being suitable for securing braces and may be of the following types:

- Undercut type anchor that does not rely on friction to function.
- Torque-controlled expansion anchors of the high-load slip type. These anchors retain a significant percentage of their initial applied preload and are generally suitable for structural tensile loads.
- Chemical anchors. Chemical anchors should not be used for brace fixings unless each fixing is individually proof-tested to 120% of the Working Load Limit (WLL). Testing should be carried out by a method specified by the anchor manufacturer.

All post-installed anchors used for anchoring brace feet should be certified by the anchor manufacturer as being compliant with the testing procedures specified for torque-controlled expansion anchors in AS 3850.1. The test procedures set out in AS 3850.1 are comprehensive and apply an additional factor of safety of 2.25 to post-installed anchors used for anchoring braces in tilt-up and precast construction. The engineer specifying the brace anchors should not use anchors that have not been tested and certified to AS 3850.1.

Torque-controlled expansion anchors (also referred to as load-controlled) have a wedge and expansion-shield system where the wedge is directly connected to the applied load. Increases in load above the retained preload (obtained from the initial torque) will increase the expansion force on these anchors.

All post-installed anchors should be stamped with the manufacturer's name or symbol and be visible after installation.

Documentation from the anchor manufacturer stating both the anchor specifications and the installation instructions is to be available on site. All post-installed anchors should be specified and installed in accordance with the anchor manufacturer's instructions which should be available on site.

It should also be noted that the capacity of the anchor is restricted by the slot size (fixing hole) on the foot of the brace. Standard anchor sizes step from M12 to M16 bolt threads (approx. 12 and 16 mm thread diameter). The shield diameter for an expansion anchor using an M16 bolt will be too large to fit into many brace feet. A brace installer may tend to use an expansion anchor incorporating an M12 size bolt. The permissible tensile load on an expansion anchor incorporating an M12 bolt will generally be far less than the minimum capacity required for the application, particularly after the 2.25 factor of safety specified in AS 3850 is applied to the anchor. In addition, the washers used on a post-installed anchor using an M12 bolt may not provide adequate bearing capacity on the brace foot (refer figure 2). In such instances the engineer specifying the brace anchor will have to specify the use of an anchor with a higher capacity that will fit in the brace foot (e.g. a purpose designed expansion anchor using a stepped shaft and an M14 bolt).

The following types of post-installed anchors **should not be used** for anchoring braces:

- Deformation controlled expansion anchors including drop–in type anchors.
- Sleeve anchors. These anchors usually have thin shields and may not reliably retain more than 20 - 40 percent of the initial pre-load.
- Screw bolts – that cut a thread in the concrete

Deformation-controlled anchors should not be used because they:

- have no additional expansion (and hence no additional load capacity) after the initial setting process
- fail without demonstrating ductility
- cannot be checked on site for correct installation once the brace is in place, and
- are highly sensitive to installation procedures.

Screw bolt anchors, where the anchor cuts a thread in the concrete hole, rely on tight tolerances on the drilled hole and overtightening could damage the thread cut into the concrete by the anchor. A high-quality torque-controlled post-installed anchor can tolerate some minor variations in the hole diameter because the wedge shield expands as the anchor is tightened. However, in the case of a screw bolt, the diameter of the bolt and its thread is fixed. The pull-out resistance is based on the effectiveness of the grooves that are cut by the bolt's thread during installation. If the hole is too large, the grooves cut by the thread will not be deep enough and the anchor will not achieve adequate pull-out resistance.

7.2 Anchor setting torque for undercut and expansion anchors

Verification of setting torque for all post-installed undercut and expansion anchors should be documented and available on site. Torque-controlled type anchors depend on correct torque setting to operate correctly. Manufacturers of these anchors will not guarantee the anchors if the setting torque is incorrect. Under-torquing the anchors will mean their maximum pull out strength cannot be achieved and over-torquing the anchors may damage them (i.e. strip the thread).

A calibrated torque wrench should be used to tighten these anchors to the manufacturer's torque specification. Many modern impact wrenches (rattle guns) have output torques that far exceed the setting torque for these anchors. If impact wrenches are used for installation, a robust system of work must be followed to ensure the torque applied during installation does not exceed the setting torque specified by the anchor manufacturer. If an impact wrench is used, its output torque should be lower than the setting torque of the anchor, and a calibrated torque wrench should be used to complete the installation of the anchor.

Written records verifying the setting torque for all expansion and undercut post-installed anchors should be available on site.

Following initial installation, brace anchors should be checked at least weekly and after major weather events to verify the anchors remain at the correct setting torque.

7.3 Post-installed anchors for lifting

In some situations, post-installed anchors are used for lifting elements. This may be the case where the cast-in insert is defective or placed in the wrong position, or where older elements are being lifted. Lifting with post-installed anchors is not the preferred method of lifting elements due to the following reasons:

- Difficulty experienced in drilling holes of the correct depth and location due to the presence of steel in the element.
- Potential problems in ensuring the correct setting torque is applied.
- The reliance on friction or bonding strength to maintain the anchors' integrity.

Where post-installed anchors are used for lifting elements, an additional factor of safety of 2.25 to 1 should be applied to the rated capacity of each anchor unless the anchors have been certified by the anchor manufacturer as being compliant with the testing procedures specified for torque-controlled expansion anchors in AS 3850.1.

Where chemical anchors are used for lifting elements, in tension or partial tension, an additional factor of safety of 2.25 to 1 should be applied to the rated capacity of each anchor. In addition, every chemical anchor should be proof-tested to 120 per cent of the working load limit prior to lifting taking place. Records of the proof testing should be documented.

The lifting lug plates used with post-installed anchors should have a factor of safety of 4 to 1.

It is recommended that a register for anchors be kept, signed off by the responsible person.

8. Engineer and verification issues

8.1 Engineer certification

A suitably competent engineer or engineers should certify in writing that the design of the precast element complies with AS 3850 for each of stage of the element's lifecycle. AS 3850 states that the in-service design provides for the performance of the element as part of the permanent structure, whilst the erection design provides for all prior stages of the element's life, from manufacture and initial lift, to storage, transportation, lifting, temporary bracing, and any construction loading prior to incorporation into the permanent structure.

The builder or principal contractor is typically responsible for ensuring that a suitably competent engineer or engineers have certified each of these stages.

It is now common practice for cast-in ferrule/bracing insert suppliers to provide engineering certification for a bracing design for the element. It should be noted that this certification often only covers the bracing inserts and bracing design and does not cover all elements of the erection design. The builder or principal contractor should ensure that an engineering certification exists for each stage of the erection design prior to commencing panel erection.

Persons providing design certifications should be professional engineers with sufficient knowledge and suitable experience in the design of precast concrete elements and temporary bracing. The engineer's area of practice should be civil, structural or construction engineering.

A person performing professional engineering services in Queensland, or for a Queensland based project, must also be a registered professional engineer of Queensland under the *Professional Engineers Act 2002*.

Engineers should provide specific signed statements about the compliance of the system with AS 3850.

The following documentation and certification should be provided on site:

- In addition to certification for the final structure, certification is also required for the concrete element design through the stages from manufacture (e.g. loads applied when an element is lifted off the casting bed), storage, transportation, lifting and temporary bracing.
- A design for how the panel is to be safely rigged to enable the rigger on site to select and apply appropriate rigging equipment to lift the element.
- Specifications for the concrete footings used to support concrete elements in their final position (e.g. footings for the walls).
- Drawings for the element design, temporary bracing layout, final building layout and footing details (see section 4 'Drawings'). The drawings should be signed by an engineer or be accompanied by a certification letter that lists the element drawings and drawing revision numbers.
- Design certification for the temporary support system. This should include certification for:
  - panel base connection details (dowels, angle iron etc)
  - brace specification including capacity, type, extension, installation angle
  - brace top anchor bolt specification, type, capacity, setting torque
  - brace foot anchor specification, type, capacity, installation details and
  - footing structure design (footing/slab, deadman block, auger type) design including steel content, concrete strength and minimum edge distances for cast-in inserts or post-installed type anchors.
- Any other instructions that may be required to ensure the safe installation and securing of the elements - i.e. the engineer may need to endorse the procedure for brace removal and connecting the elements to the building's structural steel, particularly if the steel structure is not complete prior to removal of the braces.
- If any braces or brace anchors are removed from elements prior to all permanent structural members being attached, the engineer will need to provide any instructions on ensuring safety of workers including maximum wind speed for this activity.

Two examples of engineer certification statements are included in Appendix A. One statement refers to the design of an element to resist lifting and in-situ loading while the other refers to the temporary bracing of elements and their ability to resist wind loading.

8.2 Verification

The total design of the element installation system should be overseen by engineer(s). This includes design of the elements, temporary bracing systems and securing of elements prior to removal of braces. For precast units cast on site such as tilt-up, stairs, hobs, shaft lids etc., an appropriate system that verifies compliance with the design should be implemented. On-site audits will assist to verify factors such as:

- the correct grade of concrete is being used, and elements are being left to cure for the appropriate amount of time prior to lifting
- use of the correct type and number of cast-in inserts and installation in accordance with the manufacturer's specifications
- installation of reinforcement steel in accordance with the drawings - both in the elements, cast-in inserts/anchors (where required) and deadmen
- installation of element braces in accordance with the engineer's and manufacturer's specifications.

Persons on-site may be delegated to verify and document that the design has been complied with. This decision is sometimes made in cases where the construction process is of a repetitive nature.

If the person on-site is not an engineer, this person should be a competent person and should only verify that the engineer's specifications and drawings have been complied with. This person should not authorise variations to the design unless he or she is a suitably qualified and experienced engineer. However, it should be noted that the person verifying compliance with the engineer's specifications would need to be experienced in tilt-up and/or precast construction and competent in reading drawings.

Two checklists that may be used for on-site verification are included in Appendix B and C. The 'Tilt-up and precast concrete element checklist' relates to the structural integrity of the concrete elements themselves both for in-situ and lifting and temporary bracing loads during installation. This checklist may be used for either precast or tilt-up elements and should be completed prior to elements being lifted. In the case of precast elements, the completed checklist would usually be supplied when elements are delivered to the site. The 'Tilt-up and precast concrete element lifting and temporary bracing checklist' applies both to the safety of the lifting system used by the element installers and to the integrity of the temporary bracing system. The first part of the checklist under the 'element lifting' section should be completed before lifting takes place when the crane is on-site. The second part can be filled in as the elements are being installed and should be completed prior to the element installer leaving the site on that particular day.

The appropriate design engineer should carry out some on-site audits to assist compliance with the design specifications and to help the engineer become familiar with difficulties experienced on site. It may be advisable for the engineer to visit the site during the following phases of construction:

- Casting of the wall footings or other footings used to support tilt-up or precast elements.
- Pouring of the deadman or footing/slab design to which element braces will be attached.
- Pouring of tilt-up or precast elements.
- Temporary bracing of elements on site.
- Kust prior to the removal of temporary braces from the elements (after elements have been attached to the building's internal structure).

Prior to the removal of temporary bracing from the elements, an inspection of the building should be made by a competent person, such as a suitably qualified and experienced structural engineer with knowledge of the in-service design of the structure, to ensure that all permanent structural members and brackets have been attached to the elements in accordance with the engineer's instructions. Where the permanent structural connections incorporate on-site structural welds (including welded stitch plates) the welds should be inspected by a suitably competent person (such as a welding inspector) and written certification of these welds should be provided to the builder/principal contractor prior to removal of the temporary bracing.

A sign off procedure should be implemented to verify that this has been done, and temporary braces can be removed. Where projects are staged, inspections and approvals should be undertaken progressively.

8.3 Variations from the design

All variations from the design, relating both to the concrete element and support system, should be checked by the engineer and either be:

- certified by the engineer as being acceptable (i.e. complying with AS 3850) in writing, if the engineer can verify this is the case, or
- altered in accordance with the engineer's written directions so as to comply with AS 3850, within a time frame specified by the engineer.

Some of the variations that may apply include:

- Two braces anchored to one deadman when the engineer's original specifications state that each brace is to have a separate deadman (note: this cannot be done unless the deadman is substantially larger because of the minimum separation and edge distances required between cast-in or post-installed anchors).
- The brace angle in the vertical plane is not within the range specified in the installation drawings.

- The brace angle in the horizontal plane exceeds 5 degrees from the perpendicular.
- The absence of knee and/or lateral bracing when this had been specified originally by the engineer.

Only one brace is provided on narrow elements, when AS 3850 states there should be a minimum of two (note: AS 3850 permits the use of one brace if the engineer specifies this can be the case. However, the standard also states that two anchors are to be provided on each end of the brace. This cannot be done on brace feet that only have provision for using one anchor).

8.4 Consultation

A structural engineer for the building will have the responsibility for the final sign-off for the total structure after consulting with the other engineers involved in the construction.

9. Non–standard concrete elements

The installation of non-standard elements may require the use of specialised lifting and bracing techniques. This may be the case when there are special architectural features on the building or cut-outs in the element. Specific instructions highlighting special installation and support procedures should be endorsed by the engineer and available on site. Two examples where specific procedures may be required are as follows:

- An element in the shape of an inverted ‘L’ is to be lifted and placed in position. The element may require strongbacks to ensure it does not fail when lifted (see figure 6). The position of the lifting inserts and rigging set-up will need to be specified so that the element hangs vertically and not on an angle (i.e. with bottom edge horizontal). To ensure the element will not fall over, it may need to be suitably propped under its unsupported side.
- An element has braces attached so that one or more braces have to be removed prior to the element being attached to structural steelwork. A work system will be required to ensure the element does not become unstable when the braces are removed.

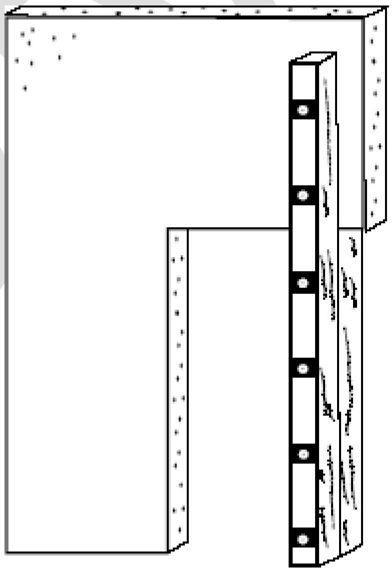

Figure 6 *Unstable element requiring method of support*

10. Delivery and storage of concrete elements

10.1 Transport to site

Precast concrete elements should be transported to site safely and loaded onto trucks in a safe manner to prevent the elements from falling off the semi-trailer, making the vehicle difficult to drive or the elements difficult to unload. Elements should be restrained on the trailer by a system that ensures the load is evenly distributed and withstands movement of the elements during transport.

Elements should also be loaded and secured so that they will not become unstable when the restraint system is released on site (i.e. on an A-frame so that the elements lean inwards against the frame when the chains are undone).

In addition to the primary means of restraining the elements for road travel on an A-frame, each individual element should be provided with an independent restraint that is not released until the sling lifting hooks are attached to the element. For example, in addition to the transport chains that pass over the top of the elements, each element could be provided with a horizontal webbing strap that passes along the face of the element and is anchored back to the A-frame, except for the first element to be lifted off the trailer.

Guidance on suitable methods of restraining loads on road transport vehicles is provided in the following guide:

- Load restraint guide –produced by the National Heavy Vehicle Regulator.

The truck driver should be adequately trained and experienced in the transport of concrete elements. Permits for over-sized loads should be obtained prior to the semi-trailer travelling to site. When selecting the route from the precast yard to the construction site, the following issues should be considered:

- Low bridges.
- Height of power and other lines.
- Train lines.
  Roundabouts and reverse camber corners.

10.2 Unloading from the truck

When unloading elements from an A-frame, the semi-trailer should be located on firm, level ground. The side slope should be minimal and not exceed 2 degrees (2 degrees is usually just discernible to the human eye). If the ground is not level, it may be necessary to use supports under the wheels of the trailer that are adequate to withstand the applied load. The truck's park brake will need to be applied before lifting takes place. The trailer should be unloaded in a progressive manner that ensures any tilt of the trailer is kept to a minimum and the precast elements do not topple from the trailer. For example, on an A-frame where there is more than one panel on each side, one panel should be removed from one side then one removed from the other side. It may be necessary to lower the front support legs of the semi-trailer prior to removing the elements—this will help to reduce movement of the trailer.

The semi-trailer should never be moved after the restraint system is released.

During unloading, only persons involved in the unloading should be in the area around the vehicle, and others should be excluded. No persons should stand beside the vehicle in an area where they would be struck by an element if it were to topple from the A-frame, or the vehicle were to be knocked or move.

10.3 Safe access to sling the load

Precast elements will normally be provided with lifting inserts on the top edge of the element delivered to the site. This could mean that the dogger or rigger slinging the load is required to work more than two metres above the ground. The use of ladders to sling the load is unacceptable because the dogger/rigger needs both hands free to sling the load and because it is difficult to secure the ladder. The provision of a work platform for the dogger to work from should be provided. Some of the alternatives for providing safe access for the dogger are:

- a walkway along the length of the A-frame or layover frame that prevents a fall occurring (i.e. the dogger has a barrier at least 900 mm high on both sides of the A-frame), in this instance access could be provided to the walkway by a secured ladder at the rear of the trailer)
- a boom type elevating work platform where the basket can be moved close to the sling connection points on the element
- a mobile scaffold provided with edge protection and safe access
- a loading bay beside the semi-trailer.

10.4 Storage of concrete elements

Where concrete elements are not lifted directly into position, they should be stored so that they are stable even in windy conditions. The following factors should be considered when storing concrete elements:

- An engineer is required to provide guidance on storing elements as the loadings applied to the element when moving it into the storage position may be very different than those applied as part of a wall.
- Where laid out flat, concrete elements should not be stored directly on the ground as this can damage the wall element or make it very difficult to lift. A minimum of two support points, such as timber bearers, should be provided under the element (more supports may be required for larger elements to prevent the element cracking).
- When elements are stacked horizontally on top of each other, the support points should be directly above each other unless otherwise specified by the engineer.
- The stacked height of elements should be limited to ensure the ground bearers and lowest elements can support the load.
- The stacked height should not be higher than twice the minimum element width unless specifically documented by a competent person.
- When concrete elements are stored on their edge (e.g. a blade column resting on its long narrow edge), the vertical dimension of the panel at rest should not exceed three times the least base width to ensure the panel is inherently stable. If this 3:1 ratio is exceeded then the element should be prevented from falling over with engineer designed bracing or frames.
- Where an element is stored on a suspended floor slab, this should be approved in writing by the design engineer of the suspended slab.
- Elements should be stored in a location where they are unlikely to be struck by mobile plant or vehicles (e.g. not next to roads).

11. Crane issues

The information relating to cranes in this document relates specifically to the use of cranes for tilt-up and precast element installation. Verification that the crane is appropriate for the task and the site, is normally determined by the crane company supplying the crane in consultation with the concrete element installer.

The selection of an appropriate crane, preparation of the site and correct location of the crane are crucial in ensuring the safe installation of concrete elements. Mobile cranes used for this type of construction are usually required to work close to their maximum capacity and with high luff angles and boom length due to the large size and mass of concrete panels. These factors increase the likelihood of the crane overturning, particularly if the ground is not level.

Further guidance on the safe use of mobile cranes is provided in the Mobile crane Code of Practice 2024.

11.1 Lifting and installation procedures

A lift plan should be prepared prior to lifting tilt-up or precast elements. The crane company supplying the crane should provide the lift plan in consultation with the builder and concrete element installer. The plan should show a dimensioned site plan with the following information detailed:

- Crane set-up position(s) on site.
- Locations where the elements are to be lifted from and to, with the operating radius of the crane shown.
- Areas on site where obstacles such as walls or braces may be in the travelling or slew path of the crane.
- Areas where the crane cannot be set up (i.e. trenches and covered penetrations on site).
- Maximum allowable bearing capacity of the ground specified by a geotechnical engineer and verified on-site.
- Maximum ground pressure applied by the crane (for crawler cranes this will be a function of the track area in contact with the ground and, with mobile cranes on outriggers, a function of the pad or bog mat area in contact with the ground).

The lift plan should specify the type and set up of lifting gear to be used and should have been developed in consultation with the engineer responsible for designing the element to resist all lifting forces. Responsibilities for rigging, dogging and spotting duties (i.e. ensuring the crane does not contact obstacles) should be specified.

In some cases, the lifting and installation procedures may need to be certified by an engineer as in the case of temporary support of precast bridge beams.

Work involving tilt-up and precast construction work 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 introduction).

11.2 Crane capacity

The crane capacity should be adequate for the largest element mass, radius and boom length that is used. It should be remembered that a mobile or tower crane’s maximum rated capacity rarely gives a practical indication of the load the crane can actually lift as this capacity is taken at a distance very close to the slew centre of the crane.

When lifting a panel using face lifters, the panel’s centre of gravity will be at a greater radius than the bottom edge of the panel. The crane being used should have adequate capacity to safely suspend the panel at the greater radius. Figure 7 illustrates the point. As a general guide, at least 1.5 metres should be added to the working radius of the crane. This may need to be increased for very tall panels.

As a general guide, mobile cranes used on tilt-up construction usually have a maximum rated capacity of at least three times the mass of the heaviest panel to be lifted. As an example, with a tilt-up panel of 20 tonnes mass, a mobile crawler crane with a maximum rated capacity of 60 tonnes will generally have adequate capacity. It should be remembered that this is a guide only. For instance, a much larger crane may be required where the crane cannot be positioned close to the casting bed or final position of the panels. The crane operator should be able to show the load being lifted is within the capacity specified in the rated capacity chart. The load to be lifted includes the panel weight, lifting gear weight and dynamic factors. When a mobile crane is used, the hook block weight is also to be added to the load to be lifted as per the manufacturer’s instructions unless the rated capacity chart specifies otherwise.

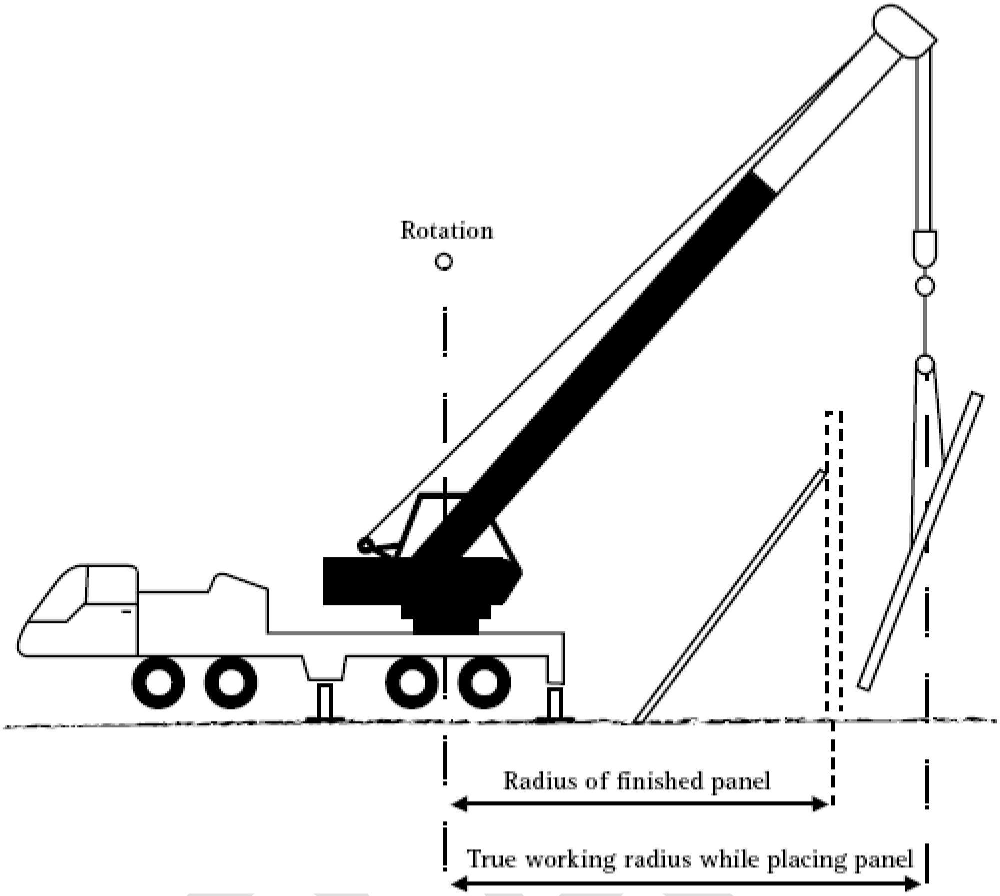

Figure 7 *Increased crane operating radius for lifting tilt-up panels*

Note: The true working radius from the centre of rotation to the hook will depend on actual details.

11.3 'Pick and carry' cranes

There are generally three types of pick and carry mobile cranes – lattice boom crawler cranes, articulated non-slewing cranes and rough terrain hydraulic slewing cranes. Rough terrain cranes can also be used on outriggers but are not used very often on tilt-up construction.

Lattice boom crawler cranes are used on the majority of tilt-up jobs due to their large lifting capacity and good stability characteristics.

Articulated non-slewing cranes are rarely used to lift concrete elements for the following reasons:

- The lifting capacity is generally too low for most element jobs.
- These cranes are more prone to overturning than crawler cranes due to:
    - being articulated
    - being supported by rubber tyres that compress
    - having wheels that are more prone to enter ground depressions than tracks
    - having hydraulic booms that are heavier than lattice booms.

The rated capacity chart for a mobile crane is to be based on AS 1418.5 – Cranes, hoists and winches – Mobile cranes.

11.4 Slewing cranes on outriggers

Slewing cranes set up on outriggers are being used to an increasing extent for tilt-up construction due to the availability of larger capacity cranes and 'all terrain' type cranes that can more readily gain access onto the site. Cranes of this type used for panel work usually have hydraulic booms or are lattice boom models. The drawback with using this type of crane is that they must remain in one position while performing a lift, unlike a pick and carry crane. A crane on outriggers has to be located so that the casting bed and final position of the panel are within the safe operating radius of the crane for the particular panel being lifted.

When using mobile cranes on outriggers for tilt-up construction, it is particularly important to ensure the crane is set up in the best location where the potential risk of the crane causing damage to the structure is minimised. The crane should be positioned so that the counterweight cannot contact any obstructions, including panels and panel braces, when the crane slews. If this cannot be achieved, suitable control measures should be implemented to prevent the counterweight contacting obstructions (see section 15 'Operation of plant near braces and elements').

The use of a larger capacity crane will reduce the necessity for repositioning the crane between lifts. However, it should be noted that using larger cranes may increase the likelihood of the counterweight contacting braces and panels. A larger crane will also be more difficult to safely manoeuvre around the site.

11.5 Ground slope and condition

The ground condition and slope are critical factors that will affect crane stability particularly when the boom is at its full length and maximum luff angle (minimum operating radius). This situation is often the case with tilt-up construction.

Where the ground slope is greater than one degree, written evidence that the crane can safely 'walk' a load for the particular gradient should be provided. The crane manufacturer should be able to provide guidance on this.

A minimal ground slope can be a major factor in causing the crane to overturn. A side slope of only two or three degrees can have a drastic effect on the stability of the crane when walking concrete elements. As an example, tests carried out by one manufacturer for a particular model of pick and carry crane indicated the crane's capacity should be de-rated by more than 70 per cent when operating on a side angle of five degrees (with maximum boom extension, luff angle and steering articulation). Soft ground, pneumatic tyres, ground depressions and spring movement (where lockouts are not fitted) will also tend to increase the side angle of the crane and make the risk of overturning greater.

A pick and carry crane should not travel on a ground slope greater than one degree unless permitted by the manufacturer.

Figure 8 *Rubber tyred pick and carry crane overturned*

Side gradients will generally be more critical than gradients in the direction of travel, but any gradient will have an effect on the maximum capacity of a crane.

Where there is doubt about the ground strength, it may be necessary to request the person in control of the site to seek verification of the ground's bearing capacity by a competent person (i.e. geotechnical or soil engineer). This is then compared with the maximum ground pressure that the crane applies to the ground. The maximum allowable ground pressure always needs to exceed the maximum pressure that the crane can apply to the ground. Note: on tilt-up jobs and when lifting precast concrete bridge beams weighing 10 tonnes or more, this needs to be done as standard practice (see section 8.2.5 of the Mobile crane Code of Practice 2024 for further information). On jobs where precast elements are lifted by mobile crane there could also be a need to follow this process:

- where the ground has not been compacted
- in muddy or very wet conditions
- where the crane and/or concrete elements are particularly heavy
- where the working radius of the crane is large
- where underground services or cavities are identified
- for backfilled ground that was previously an excavation or trench.

Further information on ground conditions and crane support is provided in section 8.2 of the Mobile crane Code of Practice 2024.

11.6 Safe support of cranes on outriggers

A variety of materials can be used to distribute the mass of the crane, and the suspended load to the ground. Lengths of timber (timbers) with rectangular cross sections are the most common form. However, timber and plastic pads are also provided for some cranes. For heavier lifts, bog mats usually consisting of steel plate, are often used under cranes. Timbers and pads are usually provided under outrigger feet, while bog mats may be used under the tracks of crawler cranes or where larger lifts are carried out.

Crawler cranes will generally apply considerably less point load to the ground than a crane on outriggers with no timbers. This is because of the large area of tracks in contact with the ground, in comparison with the smaller contact area of the outriggers, on cranes of similar capacity. However, for heavy lifts, and where the ground has poor bearing capacity, bog mats or other supporting materials may be required.

This includes ensuring timbers, pads and bog mats are of dimensions and materials as specified by the crane manufacturer. If the manufacturer has not provided this information, a competent person, such as an engineer, should specify the minimum size of the material to be used.

Generally, the following principles should be applied to timbers, pads, steel plates and bog mats:

- Timbers should have a minimum width of 200 mm and minimum thickness of 75 mm.
- Timbers should be laid together so that the width of the timber pad is wider than the outrigger foot.
- The gap between timbers is not to exceed 25 mm on the bottom and top layers and 100 mm on the intermediate layers.
- The risk of outrigger feet sliding off plastic pads or steel should be identified and controlled (i.e. when the crane is set up on a sloping road and a level pad cannot be created).
- The crane is not set up next to excavations or over ground cavities that are covered. Prior to setting up a crane on site, information on excavations and underground services should be provided by site management.
- The crane is set up so that it is level to within a tolerance of 1 degree or less - a level indicator ('bubble gauge' or electronic) should be provided to show the crane is level.

- The area of the outrigger timbers or steel plate is adequate for the loadings and bearing capacity of the ground. Particular caution should be taken on soft ground and the minimum bearing area required for outrigger support should be calculated by the crane operator, where there is doubt about the ground strength.

11.7 Lifting gear

Guidance on the use and inspection of chains, wire ropes and synthetic slings is provided in Australian Standards[2] and section 11.2.1 of the Mobile crane Code of Practice 2024.

12. Wind effect on lifting concrete elements (tilt-up and precast)

Wind can adversely affect the safe placement of concrete elements in two ways, by making the crane unsafe to operate or by endangering workers involved in the lifting operation.

In terms of worker safety, the higher the wind speed the more difficult it becomes to land and secure elements. Workers can also be at greater risk of being crushed by elements.

Gusting wind can create greater risks than a constant wind speed. In addition to the wind speed varying, the direction of the wind can change by up to approximately 30 degrees during a wind gust, which can cause additional safety issues.

In terms of crane safety, when comparing a tower crane to a mobile crane, a tower crane can withstand higher wind loadings as it is generally anchored to the ground. In comparison a mobile crane is more prone to overturning and the maximum wind speeds that a mobile crane can withstand are lower.

12.1 Safe wind speeds for mobile cranes

This risk of a mobile crane overturning due to wind increases with increasing load radius, crane boom extension, height of the crane boom and as the frontal area of the load increases. Loads that are relatively light but have a large surface area are most adversely affected by wind.

Most mobile crane manufacturers provide information on the maximum allowable wind speed for the mobile crane. This maximum wind speed is commonly 10 metres/second (36 km/h) and is based on loads with a small frontal area being lifted. In addition, some crane manufacturers provide information on the maximum wind surface area of a lifted load to determine maximum winds that the mobile crane can safely withstand without the risk of overturning. The wind surface area is the area of the lifted load against which the wind applies pressure when the load is suspended from a crane hook. This information is typically used by a professional engineer to determine the maximum allowable wind speed for a specific situation.

In determining whether the maximum allowable wind speed for a mobile crane needs to be reduced below 36 km/h, a professional engineer needs to consider factors including:

- the crane manufacturer’s information on the specific model of mobile crane
- the wind surface area of the load
- the maximum radius at which the mobile crane will operate

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[2] *AS 2759 – Steel wire rope – Use, operation and maintenance*
AS 3775.1 & AS 3775.2 – Chain slings for lifting purposes – Grade T
AS 4497.2 – Roundslings – Synthetic fibre – Care and use
AS 1353.2 – Flat synthetic-webbing slings – Care and use

- the capacity of the mobile crane at the maximum radius at which the concrete element is to be placed and how much this exceeds the actual load on the crane (e.g. the greater the margin the higher the wind speeds the crane can withstand)
- the shape of the load (i.e. shapes with a greater frontal area are more adversely affected).

As the wind surface area of the concrete element increases, there is a need to assess whether the maximum wind speed of 36 km/h needs to be reduced. For concrete wall panels of a large surface area, it is likely that maximum safe wind speed for the mobile crane will need to be lower than 36 km/h. The instructions of a suitably qualified professional engineer should be obtained to provide written instructions on this issue. Discussions on this topic need to take place between the concrete element installer, the mobile crane supplier and the builder or principal contractor.

12.2 Safe wind speeds for tower cranes

The Tower crane Code of Practice 2017 specifies a maximum wind speed of 54 km/h (15 metres/second) for tower crane operations as the generally accepted maximum wind speed in Queensland. While tower cranes may be designed to operate in winds of up to 72 km/h, this higher wind speed ignores the difficulty of a crane operator attempting to safely control a lifted load in such high winds and is considered to be largely impractical.

It should be noted that there are materials, other than concrete elements, lifted by cranes where the wind poses equal or greater risk than concrete elements that are lifted into place. For example, a timber formwork shutter will move faster due to wind than a concrete element of similar dimensions when caught by the wind. Notwithstanding this, when a concrete element is lifted onto a building under construction, it may not be easily laid down if the wind becomes excessive during the crane lift.

During the project planning stage, consultation between the principal contractor for the site, the tower crane company, and relevant subcontractors about safe load handling in windy conditions must take place.

A specific risk assessment process should be applied to lifted loads that are readily affected by the wind, including precast wall panels or elements or any other suspended load that has a large frontal area.

The risk assessment process should consider:

- current and predicted environmental conditions
- the range of loads being lifted (size, shape, weight)
- surroundings and nearby structures that could affect wind flow and wind speed
- location and complexity of the lift
- skills and experience of those involved
- any relevant manufacturer information
- any limits specific to the lift (company limits, engineer specified limits, site limits, crane limits).

The lifting and installation procedure should never require the worker who is assisting with landing and positioning the concrete element to be in a location where they could be crushed by unintended movement of the element, whether this be due to wind or crane movement (e.g. by the element spinning and crushing the worker against another object).

Risk control measures that can be implemented to help reduce the risk of injury from wind affected loads include:

- lifting smaller loads that are less affected by wind
- scheduling the lifting so that elements can be lifted into position where the dogger or rigger has a clear area to move to in the event of the load being caught by the wind (instead of being in a restrictive area where there is a crushing risk)
- applying good housekeeping practices for storage of materials so that the area where materials are to be lifted to is as clear as possible (this will minimise the risk of a dogger or rigger being crushed between a moving load and other materials)

- the use of multiple tag lines and additional doggers or riggers to control load movement and minimise the risk of crushing
- lifting precast elements that are less susceptible to wind effects including narrow columns, floor planks, stair flights and beams.

Instead of lifting loads directly to the final position (i.e. as part of the completed structure) consider laying the load down in a clear area until the wind has subsided. In this case the lay down area needs to be designed to withstand loads from the stored materials. Materials that could be easily affected by wind may need to be secured.

In the case of building developments that are spread out, consideration should be given to lifting loads to parts of a project where the wind speed may be lower or the lift area is less restricted.

For an example of a risk assessment process that can be followed, see Crane operation in high winds consultation checklist at Appendix D.

12.3 Lifting precast bridge beams

Precast bridge beams (e.g. 'Super T's') are large loads that require comprehensive lifting and installation procedures to ensure they are landed safely. While bridge beams are sometimes landed with a single mobile crane, they are often lifted into position using two mobile cranes which require careful coordination between the crane operators. Where a dual crane lift is carried out, an intermediate rigger (as a minimum) will be required to oversee the lifting operation. In some cases, the outside beams on the bridge may not be symmetrical but may have additional concrete or steelwork on one side (i.e. as the edge protection or barriers on the completed bridge). Under these circumstances, both the position of the lifting inserts and slings should be calculated so that the beams hang in a way that facilitates easy installation.

In addition, symmetrical beams can become unstable when landed and the load is taken off the crane hook. The PCBUs should supply a method of securing the beam to prevent the beam from rotating or falling over after the lift is completed. This methodology is in addition to the lift procedure. The use of side bracing is not considered to be the best method due to the risk of the bracing being damaged during the lift.

A safer alternative is the attachment of the tops of the non-symmetrical beams to the adjacent bridge beams by means of steel bars with welded connections or by means of load rated rigging gear, while the crane(s) are still holding the beams in place.

The method used to temporarily secure precast bridge beams into position is to be documented and approved by a suitably competent engineer, experienced in rigging practices associated with bridge construction. Consultation with the rigging crew is advised.

12.4 Lifting precast hollow core floor planks

Hollow core floor planks are precast, pre-stressed elements produced on a long-line bed using an extrusion or slide-forming machine. The concrete used in the extrusion process is a special mix and is designed specifically for the extrusion process. Planks are normally 1200 mm wide; thicknesses range from 150 mm to 400 mm and cores vary in shape, size and number depending on the equipment used for manufacture. Hollow core floor units are referred to as planks or slabs. The casting bed lengths are generally between 120 m and 170 m and made of steel. The planks are saw-cut on the bed to the required lengths.

Lifting inserts are rarely cast into hollow core floor planks due to difficulties in the extrusion process. Typically, hollow core is lifted using either a lifting device supplied by the hollow core manufacturer or slung using chain slings or wire mesh slings.

The design of the hollow core has a tapered ribbed edge that is engineered to grip the grout that is poured into the joints after planks have been installed. Hollow core has developed a lifting device that utilises this ribbed edge of the element to grip and engage under the top rib on the edge of the element. This lifting device is recommended by the suppliers of the hollow core when lifting and installing hollow core precast floor planks and should not be used for lifting any other precast element or flooring systems.

The lifting device consists of a lifting beam or spreader bar specifically designed to enable the attachment of the hoisting grippers or clamp.

It is recommended the hollow core manufacturer supply the lifting beams to the site to ensure the hoisting gripper or clamp is designed for the particular type of extrusion plant used in the manufacture of the hollow core. The supplier of the lifting device should also provide instruction regarding the safe use of the lifting beam supplied and ensure all components of the lifting device are regularly tested and maintained to meet the testing requirements of AS 4991: Lifting devices.

Safe lifting practices should include:

- The lifting device is identified with its tare mass, rated capacity and a distinct identification number.
- The identification number is provided on the design drawing and the engineer's certificate for the lifting device.
- The lifting device should be inspected by an independent engineer or a lifting inspection company accredited with the National Association of Testing Authorities at intervals not exceeding 12 months and evidence of the inspection is provided on the tag attached to the lifting device.
- Care needs to be taken to inspect each Hollow core plank to ensure it is not damaged particularly where the lifting device clamps engage the plank.
- Lifting should not occur until there is documented evidence that the concrete is cured and has achieved the minimum strength for lifting.

13. Work systems

13.1 Exclusion zones

So far as is reasonably practicable, an exclusion zone must be established when lifting precast and tilt-up concrete elements to control the risk of falling objects (e.g. the element) from striking workers and members of the public.

Exclusion zones must be established prior to the lifting and installation of concrete elements. The PCBU with management or control of the workplace (e.g. the principal contractor in many cases) has the responsibility for ensuring effective planning, consultation, and implementation of control measures associated with the lifting of concrete elements.

The principal contractor should consult with the element installation company about the appropriate exclusion zone. The principal contractor is responsible for oversight of an exclusion zone including preparation of written procedures and implementing and enforcing exclusion zones.

An effective exclusion zone should be at least 1.25 times the height of the element measured from the centre line of the element in all directions (as the element can rotate/spin while it is lifted) and extend for a minimum horizontal distance of 1.25 times the longest dimension of the element and all around the element being lifted as it may rotate during the lift (see **Error! Reference source not found.** and **Error! Reference source not found.**). An exclusion zone of this size should accommodate the concrete element initially falling vertically and then falling over after striking the ground.

In some cases, building activity may result in part of the structure under construction extending into the exclusion zone, for example formwork frames being constructed under the floor. In this situation, the element installer is to be consulted to ensure that precast elements can be lifted, positioned and installed without adversely affecting the safety of workers within the affected part of the structure being built.

The exclusion zone applies to both members of the public and workers. The only workers permitted in an exclusion zone are workers involved in the landing of the concrete element, and these workers should approach the element being landed from the side of the element, so that they are not in the potential fall shadow.

The PCBU with management or control of the workplace (e.g. the principal contractor in many cases) has the responsibility for ensuring effective planning, consultation, and implementation of control measures for elements.

In practice, it may be impractical to establish an effective exclusion zone on many construction sites; especially when precast elements are being lifted from a public road with live traffic lanes and pedestrian access adjacent to the precast element delivery zone and load path. Section **Error! Reference source not found.** provides further information regarding additional risk controls that should be implemented where an effective exclusion zone is not reasonably practicable.

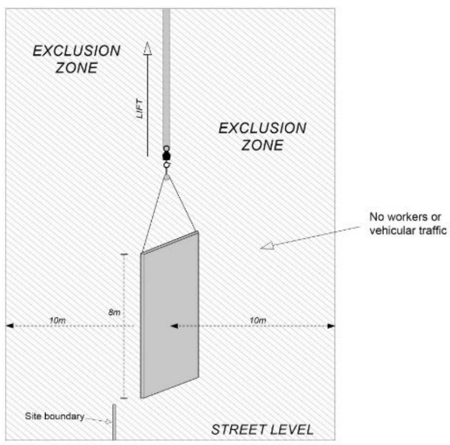

Figure 9 *Example of exclusion zone for an 8 m high precast panel elevation*

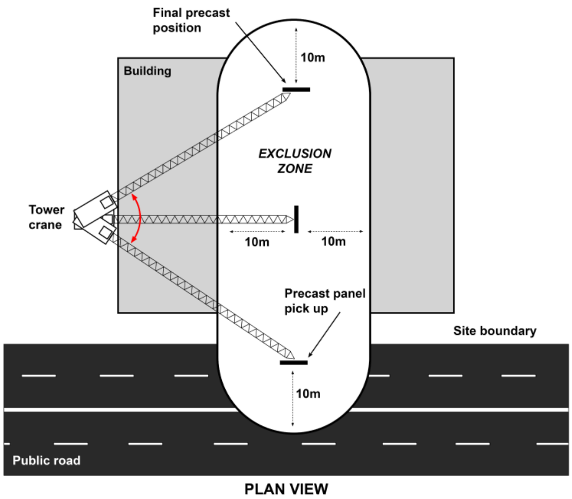

Figure 10 *Example of exclusion zone for panel in Figure 9 – plan view*

13.2 Exclusion zones for tilt–up panels installation

Only persons directly involved with the installation of tilt-up panels should be located in the area while lifting is taking place and such persons should avoid being in a position where they could be struck in the event of a crane or panel falling over.

In any type of lifting activity, the crane operator should avoid lifting the load over persons. However, with tilt–up construction the risk to persons is greater for the following reasons:

- Panels can be very susceptible to wind loads because of their shape and size.
- If a panel falls over or an insert fails, while the panel is attached to the crane, the crane may overturn. Other panels may also be struck and fall over. The potential consequences of an incident are usually more serious when lifting a panel than lifting other items.
- There is usually greater risk when lifting a concrete element (compared to a steel object) because the integrity of the load relies on a number of factors such as concrete strength, steel content and position, lifting insert integrity and correct operation of the lifting clutch. Due to the greater number of variables, there is a greater risk of an error being made.

In view of the above, all persons not involved in the installation of the panels should be prevented from accessing the installation zone. Workers should not be located where they could be struck by the panel in the event of lifting gear failure or strong winds. An exclusion zone should be established to prevent unauthorised persons gaining access.

On some jobs this may necessitate the installation of para-webbing, signage and/or fencing depending on the ease of access and the likely presence of persons, either workers or members of the public. The exclusion zone should be established so that it includes an area where persons cannot be struck either by:

- the crane falling over
- the panel being lifted falling over, or
- another structural element failing and falling to the ground as a result of being struck by the crane or the panel being lifted.

The exclusion zone should be maintained during panel lifting until braces have been secured and the lifting slings removed.

Where a road or other vehicular access way is located in the exclusion zone, traffic should be prevented from passing through the zone while panels are being lifted and prior to securing the panels with braces.

Adjacent buildings that may collapse in the event of a panel falling should have persons removed from risk areas. If this cannot be ensured, panel lifting on that part of the job should be performed out of hours when persons are not located in the building.

13.3 Additional risk controls for lifting precast concrete elements

Where an effective exclusion zone cannot be implemented for all workers, members of the public and vehicular traffic, all five of the additional risk controls detailed below need to be adopted for lifting precast concrete elements.

It is important to note that, although the lifting of precast elements over workers is permitted when the following risk controls have been implemented, this should only be performed in limited situations where this is necessary. So far as is reasonably practicable, exclusion zones should still be implemented, even if they are not effective in all directions at all times, to minimise the risk of injury from falling objects.

Nothing in these five risk controls precludes the need for the rigger attaching lifting clutches to concrete elements from the requirement to carry out pre-use inspections of the lifting clutches and other associated lifting gear.

13.3.1 Five risk controls for lifting precast concrete elements

Risk control measure (1) – Use of locking lifting clutches for spin up elements

To reduce the risk of a lifting clutch inadvertently disengaging, a clutch with a mechanical locking mechanism that prevents disengagement from the lifting anchor should be used when precast elements are rotated (including wall panels and blade columns rotated through 90 degrees at the start of the lift, refer figure 11). **Note**: Locking lifting clutches are not required for precast elements with edge lift (plate or hairpin style) inserts orientated such that the clutch locking pin will not move from the engaged to disengaged position as the element is rotated. For example, where the body (torus) of the lifting clutch is perpendicular to the direction of rotation as shown in figure 12.

Figure 11*Spin up panel – locking lifting clutch required*

Figure 12 *Body (torus) of the lifting clutch perpendicular to direction of rotation*

All riggers must be trained in the correct use of the lifting system, with particular emphasis on the clutch and its locking mechanism—refer risk control measure (5) 'Familiarisation training for riggers'. All lifting clutches are to comply with AS 3850-1:2024.

Risk control measure (2) – Enhanced periodic inspections of lifting clutches

The following enhanced periodic inspection process should be carried out by the lifting clutch manufacturer, or a lifting gear specialist nominated by the clutch manufacturer (see section

'Who can carry out the 12 monthly inspection and proof testing?') at intervals not exceeding 12 months for all lifting clutches:

- Lifting clutches to be load tested to 1.2 times their working load limit (WLL) before the following examination and testing is performed—this will assist to show any cracks that may have developed during use.
- Clutch to be dismantled in accordance with the manufacturer's instructions, to enable all critical load bearing area[1] to be inspected.
- All critical load-bearing areas to be dimensionally checked against the manufacturer's allowable wear tolerances in accordance with the specified dimensional criteria and recommended process, as outlined by the lifting clutch manufacturer.
- Clutch components to be inspected for cracks, deformation and any other type of defect. If defects are found, defective components are to be replaced with manufacturer approved replacements. Where this is not possible, the clutch is to be destroyed and discarded.
- Where required by the manufacturer, non-destructive testing (NDT) of the lifting clutch is to be carried out using an NDT method and procedure specified by the manufacturer.
- Lifting clutch to be reassembled in accordance with the manufacturer's instructions.
- Lifting clutch is to be load tested to 1.2 times the WLL once more and re-inspected for deformation and defects and removed from service if defects are found.
- The competent person overseeing the inspection is to sign and date an inspection certificate for the periodic inspection and a durable inspection tag is to be attached to the lifting clutch. Inspection records are to be held by the lifting clutch owner for the life of the clutch.

Risk control measure (3) – Enhanced periodic inspections of snatch block sling assemblies

The following enhanced periodic[2] inspection process is to be carried out by the snatch block manufacturer (see section on 'Who can carry out the 12 monthly inspection and proof testing?') at intervals not exceeding 12 months[3] for all snatch block sling assemblies:

- Flexible steel wire rope (FSWR) lifting sling to be removed from snatch block and connectors to be removed from the sling.
- Visual examination of FSWR slings to inspection criteria specified in AS 2759-2004 Steel wire rope – use, operation and maintenance.
- Snatch block to be fully dismantled in accordance with manufacturer's instructions so that thorough inspection of all parts can be carried out (including dismantling of the swivel assembly, where this can be done, and removal of roll pin or similar where fitted).
- All load bearing areas are to be dimensionally checked against the manufacturer's allowable wear tolerances and checked for cracks, wear and other defects (this will include all parts including the suspension yoke, threads, sheaves, axles, pins, bearings and side plates).
- Snatch block assembly to be reassembled with any excessively worn, cracked or damaged components being replaced with components specified by the snatch block manufacturer. Any parts in the original assembly that are locked in place at the time of

[1] A critical load bearing area is part of the lifting clutch where the load would drop if this part was to fail. In the case of a ring type lifting clutch, the ring latch will need to be removed so that the complete ring latch can be inspected.

[2] AS 2089-2008 Sheave blocks for lifting purposes does not specify time periods between periodic inspections, nor does it specify dismantling and measuring of components during periodic inspections

[3] More frequent periodical inspections may be required based on frequency and severity of use – for further guidance the sheave block supplier should be contacted. However, at 12 monthly intervals months all snatch blocks should undergo dismantling as part of the inspection as described in this document

manufacture will need to have the same locking method reinstated (e.g. roll pins replaced with brand new roll pins complying with the manufacturer's specifications).

- The snatch block and sling combination is to be proof tested to 1.2 times its WLL—with the load applied with the two legs straight (i.e. included angle of zero degrees).
- Snatch block sling assembly to be re-inspected for defects after proof loading and removed from service if defects are found.
- The competent person overseeing the inspection is to sign and date an inspection certificate for the periodic inspection and a durable inspection tag is to be attached to the snatch block. Inspection records are to be held by the owner of the snatch block. sling assembly for the life of the assembly.

Risk control measure (4) – Enhanced inspection during precast element manufacture

To reduce the risk of precast lifting insert failure, the following additional measures should be adopted by the precast manufacturer:

- Precast manufacturers should ensure they only purchase precast lifting inserts from suppliers that can provide evidence of their products having been tested and certified as compliant with AS 3850.1:2024. Refer to the section 'Quality of lifting gear and comprehensive inspection processes' (p48) for further detail.
- Ensure lifting inserts are the same make, model and capacity as those specified on the engineered design drawings. Different makes and models of inserts with the same nominal maximum WLL can have different performance characteristics (tensile and shear capacities) for different panel thicknesses, concrete strength or tension bar length and diameter. If an alternate brand/specification is to be used, written confirmation should be sought from the design engineer to ensure the alternative make and specification of insert is acceptable.
- Ensure lifting inserts are installed in accordance with the manufacturer's recommendations and engineered design drawings, including minimum edge distances, minimum spacings, insert orientation and angle, and specified tension/shear/perimeter bar diameters and lengths.
- Do not weld lifting inserts to secure them into position without prior approval from the supplier. Welding lifting inserts can weaken or embrittle the insert and may lead to failure.
- All installed lifting inserts are to be inspected against the engineered design drawings for the precast element in accordance with the requirements of AS 3850. Once satisfied with the installation of each insert, but prior to pouring, each insert should be identified and photographed by the person conducting the pre-pour inspection. This could be the leading hand, supervisor, quality controller, quality engineer, etc. The precast manufacturer is then to provide written approval for the construction of the precast element, including a statement that the element complies with the design drawing and the lifting inserts have been correctly installed. The photographs should be kept on file for future reference.

Risk control measure (5) – Familiarisation training for riggers rotating precast elements

The intermediate rigging high risk work licence (HRWL) should provide a worker with basic skills associated with tilt-up and the lifting and installation of precast concrete elements (intermediate rigging is required for spin-up precast elements)[1]. However, the current National Assessment Instrument for Intermediate Rigging HRWL does not include detailed instruction regarding rotation of precast elements and may not detail the correct use of lifting gear associated with lifting spin-up elements.

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[1] For straight lift precast elements (not tilt-up), where only one crane is used, a Basic Rigging HRWL is required. Precast elements are sometimes rotated using two winches on a single mobile crane. In this situation an Intermediate Rigger still needs to supervise the lift.

To address this apparent gap between the intermediate rigging HRWL and current industry practices, additional familiarisation training should be provided for riggers erecting precast elements. The training should include both theory and practical training (e.g. riggers demonstrating they have the skills required) that reflects workplace conditions and industry practices.

The training should be provided by competent person(s) who have comprehensive knowledge of rotating, lifting and installing precast concrete elements. The training can be developed in-house by PCBUs (e.g. employer or precast manufacturer) or be delivered by a registered training organisation that provides training for rigging high risk work licenses.

The principal contractor should ensure all rigger(s) responsible for slinging the spin-up elements have been provided with the familiarisation training, regardless of who employs them.

Once the training has been provided and documented evidence exists, the intermediate rigger does not require additional training, provided the type of lifting clutch does not vary and the way precast elements are handled fundamentally remains the same.

However, if the intermediate rigger ceases to be involved in precast panel rotation for more than one year, new training should be provided. Refresher training will be required where there is a change in the type of lifting clutch and/or lifting methods used.

Precast element rotation familiarisation training is to address all the following matters:

- The risks associated with rotating, lifting and installing spin-up elements.
- What an exclusion zone is, why exclusion zones are required, what is the minimum size of an exclusion zone and, how to implement and maintain an effective exclusion zone.
- Familiarisation and use of the different types of lifting clutches (i.e. both ring and spherical head clutches) and snatch blocks available.
- The importance of ensuring the lifting clutch and inserts are fully compatible, including how to identify if they are not compatible.
- Pre-use inspection requirements for lifting clutches, inserts, precast concrete elements, snatch blocks, wire rope and associated lifting gear.
- How to identify if a lifting clutch inadvertently disengages during precast element rotation and the benefits of locking lifting clutches.
- How to safely attach a locking lifting clutch in accordance with the manufacturer’s safe use instructions, noting that locking clutches may have different requirements to traditional non-locking clutches.
- How to attach the rigging correctly so the lifting gear does not snag or catch, especially when the precast element is being rotated.
- How to safely control rotation of precast elements during the spin-up activity using one and two cranes.
- How to safely release the clutch from the tailing lifter following element rotation.
- Refresher training on how to read rigging drawings and interpret the rigging set up correctly.
- The concrete precast element used for the practical training is to be representative of a typical precast element that requires rotation. Scaled down or smaller precast elements should not be used for the training as they are not reflective of industry practices and workplace conditions. The competent person providing the training will be required to oversee lifting and rotation of the precast concrete element. As such, the competent person is to be an intermediate rigger (as a minimum) with experience in lifting and rotating spin-up panels. They should meet the competent person requirements outlined in section B.6 of AS 3850.2:2024.

The checklist Precast lifting familiarisation training record (Appendix F) should be completed as a record of familiarisation training undertaken that meets the criteria above. The rigger and employer should both keep a copy of the training records which are to be available for inspectors appointed under the WHS Act.

Quality of lifting gear and comprehensive inspection processes

While it is important that high quality lifting gear is used when lifting loads near workers, it is critical that high quality lifting gear is used when lifting precast elements on high rise projects adjacent to public roads/spaces.

Lifting clutches and snatch blocks could theoretically be used for thousands of lifts, provided they remain within wear limits specified by the manufacturer. It is important that the lifting gear is manufactured to high standards using manufacturing processes and quality assurance methods that will help ensure maximum durability. This includes using manufacturing methods, including forming and machining methods, that increase toughness and minimise stress concentrations to reduce the likelihood of crack formation.

Suppliers of plant and equipment such as lifting clutches and sheave blocks must give adequate information concerning any conditions necessary to ensure the plant is without risks to health and safety (section 25(4) of the WHS Act). This includes providing sufficient information on how to perform pre-use inspections, routine visual inspections and 12 monthly inspections. In relation to 12 monthly inspections, the supplier may alternatively require the clutch or sheave block to be returned to the supplier or a nominated agent for these inspections.

Lifting clutches and snatch blocks are both relatively complex items of lifting gear and require comprehensive inspection criteria, including detailed pass/fail criteria, to enable 12 monthly inspections to be performed satisfactorily. Simply stating a maximum wear rate of 10 per cent—sometimes used as a criterion for lifting chains—is unacceptable when describing an inspection process for lifting clutches and snatch blocks.

If the lifting clutch or sheave block supplier cannot provide comprehensive inspection criteria or inspection services, these items should be removed from service and replaced with other makes of a higher quality where the manufacturer does provide adequate information.

Who can carry out the 12 monthly inspection and proof testing?

Lifting clutches, and snatch block assemblies are to be inspected, and proof tested by competent persons who have a high level of expertise and experience in the inspection of these types of lifting gear. Either of the following two options may be used as the 12 monthly enhanced inspection process:

1. Lifting clutch or snatch block is sent back to the manufacturer for inspection and testing. Upon successful inspection and testing, the manufacturer will then provide an inspection certificate to the lifting gear owner.

2. Inspection and testing are carried out by a company with expertise in the inspection of lifting and rigging equipment that has been nominated by the clutch or sheave block manufacturer. The inspection and testing are to be carried out in accordance with a documented inspection procedure produced and supplied by the lifting clutch or snatch block manufacturer. The inspection certificate completed by the representative of the specialist company is provided to the lifting gear owner.

Sections 23, 24 and 25 of the WHS Act outline additional duties for PCBUs who manufacture, import or supply plant that is, or could reasonably be expected to be used at a workplace. This includes the duty to provide adequate information about the plant including any conditions necessary to ensure safe use of the plant, such as information on inspection and maintenance requirements.

13.4 Installing wall panels where there is no escape route

When installing a number of wall panels on the face of a structure, workers installing the panels should have an escape route if the panel falls so that they can move to the side away from the panels. However, in some situations there is no escape route as in the case of a four-sided pit or structure, with a single panel on each face. In these situations, a special work procedure that minimises the need for workers to be in the pit to install or adjust the panels is to be developed. Where a four-sided pit or structure, with a single panel on each face, with no escape route is being constructed:

- Provide all braces on the outside of the pit, if braces are used to provide temporary support for the panels, so that workers are not required to be inside the pit to attach the brace feet to their footings.
- Use edge lifting inserts on the panels so that the panels are suspended vertically.
- Ensure that the panels are landed on a concrete slab or continuous concrete strip footings under the bottom edge of the panels.
- When landing the panels in the pit, use methods that minimise the time required by workers to manipulate the bottom edge of the panels.

Braces may be used on the inside of the pit or structure, where an escape area on the outside of the pit or structure has been provided (e.g. by excavation). In this situation:

- the escape area should be a clear level area that the panel erection crew can move to in the event of a panel becoming unstable to avoid being struck by a falling panel
- the escape area is to be adjacent to the final wall panel to be installed
- in the case of the three initial panels, braces may be used on the inside of the pit
- if braces are used on the final panel to be installed the braces are to be on the outside of the structure or pit.

Nothing in the above information should be seen as discouraging engineered construction solutions and methods that negate the need to use braces as temporary support for the wall panels. However, engineered solutions should reduce the likelihood of panels falling on workers on the inside of the pit.

14. Concrete element lifting and installation

14.1 General

The actual lifting of elements is the time when the risk can be greatest. Due to the large surface area of some elements, a great deal of care needs to be taken when lifting, moving and securing elements into position. The likelihood for fatalities when an element falls over is considerable because the ground area covered by a falling element is large and the area in which the element will fall cannot be controlled. The risk is increased by the fact that the mobile crane may fall over and other elements that are struck by the crane or falling element are also likely to collapse. A domino effect can occur, and workers often will not have time to get out of the way before they are struck. With these factors in mind, it is extremely important that both the installation crew and crane operator are highly skilled and experienced in the installation of elements.

14.1.1 Lifting of tilt–up panels

Precast elements are generally smaller than tilt-up panels because they are transported from the precast yard to site by road transport, whereas tilt-up panels are cast on site. The availability of large capacity cranes has meant that larger panels are sometimes specified in tilt-up construction. The disadvantage with larger panels is that they are more difficult to handle, and greater care needs to be taken to ensure the panels do not strike braces or other panels when they are being moved.

Figure 13 *Tilt-up panel being lifted off casting stack*

The rigging configurations associated with the lifting of tilt-up panels are often complex and require a high degree of skill both on the part of the panel designer and rigging crew to ensure that panels are lifted safely. Figures 13 and 14 show a variety of rigging configurations used on tilt-up panels. Irrespective of the type of panels being lifted, the following should be ensured:

- Prior to lifting, the panel mass is to be clearly marked on the panel (this can be found on the panel drawing for tilt-up panels).
- Tilt-up panels are suspended with the face as near to vertical as practicable, so that the panel is not too difficult to place in its final position as part of a wall (usually 5-15 degrees off vertical).
- Whenever possible, braces on tilt-up panels should be attached to the concrete panel prior to lifting (reduces the need for persons to work at height and minimises the time the panel is supported by the crane).
- Once suspended from the crane, the bottom edges of tilt-up panels are to be horizontal such that a bottom corner is not noticeably lower than the other corner.
- No persons are to be located underneath the tilt-up panel while it is being lifted and moved.
- Lifting clutch release lines are fitted so that the clutches can be disengaged without the need for workers to climb on top of the tilt-up panel (see figure 14).
- Dowel pins or other means of attachments are fitted into the bottom edge of the tilt-up panel or into the footings prior to lowering. Dowel pins help to correctly locate the panel and also assist the panel to effectively resist wind loads.
- Crane support is to be maintained until all braces have been installed and effectively secured to the tilt-up panel and footings (i.e. hoist rope and lifting slings not to become slack until this is achieved), and

- Levelling shims should not exceed 40 mm height (this will assist in maintaining tilt-up panel stability).

Figure 14 *Lifting clutch release lines*

Tilt-up panels are cast on a casting bed and face lifting inserts are generally used to lift the panels off the bed. The number of face lifters will depend on the capacity of the lifters and the size of the panel and should be specified by an engineer. The following should also be ensured when the panel is being lifted:

- When lifting a panel off the bed, the force required to overcome panel suction should not be excessive. If the panel is not released when the crane indicator registers the combined weight of the panel, rigging and other suspended dead load (e.g. strongbacks), lifting should be stopped. Any wedging or jacking of the panel to assist release should be approved by the engineer.
- Lifting clutches to be fully engaged prior to the lift occurring.
- Lifting gear and sheaves shall be operable and in good condition and not become tangled as the crane hook is hoisted up.

Each tilt-up panel should be lifted so that, while suspended, it leans away from the crane. The term ‘suicide lifting’ is sometimes used in industry to describe the situation when the panel tilts towards the crane. In this situation, if part of the lifting system fails, the panel will fall against the crane and may cause the crane to overturn. Due to the high risk of injury in these situations, suicide lifting should be avoided. The only situation in which it is justified is when a crane cannot be physically relocated (e.g. because another structure or powerlines are in the way). If suicide lifting is the only option, then it may only be used to lift a minimum number of panels where the crane cannot be physically relocated.

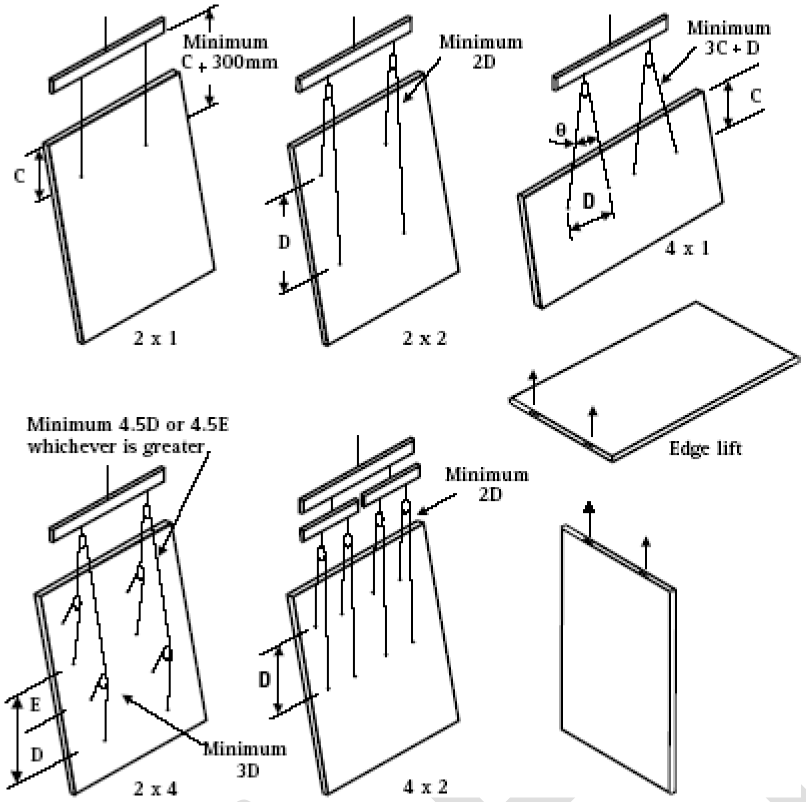

Figure 15 *Common rigging configurations*

Notes:

1. Dimensions on slings are total length through pulley
2. The lifting insert supplier may specify a maximum value for this angle

14.1.1 Lifting of precast concrete elements

Irrespective of the type of elements being lifted, the following should be ensured:

- Prior to lifting, the element mass is to be clearly marked on the element (this can be found on the drawing for precast elements).
- Lifting clutch release lines are fitted so that the clutches can be disengaged without the need for workers to climb on top of the precast element.
- Lifting clutches to be fully engaged prior to lifting occurring
- Once suspended from the crane, the bottom edges of precast elements are to be horizontal such that a bottom corner is not noticeably lower than the other corner.
- No persons are located underneath the precast element while it is being lifted and moved except in limited situations (refer section 13.2)
- Dowel pins or other means of attachments are fitted into the bottom edge of the precast element or into the footings prior to lowering. Dowel pins help to correctly locate the element and also assist the element to effectively resist wind loads.
- Crane support is to be maintained until all braces have been installed and effectively secured to the precast element and footings (i.e. hoist rope and lifting slings not to become slack until this is achieved), and
- Levelling shims should not exceed 40 mm height (this will assist in maintaining precast element stability).

14.2 Rotation of precast elements

Where positioned on an A-frame, edge lifting inserts will be cast into the elements, usually two lifters cast into the top edge and two or four in the side edge. The element is lifted off the truck using the inserts on the side edge. In order to move the element into its vertical position, the element needs to be rotated through an arc of 90 degrees, and this can be achieved using one or two cranes. This procedure requires a great deal of skill on the part of the crane driver(s). Even though the element will be suspended by two hoist ropes, more than 50 per cent of the element weight will be applied to one of the hoist ropes due to the cantilever (see figure 16).

Figure 16 *Rotation of a precast element – not to be lifted over workers*

An engineer can be approached to provide guidance on the minimum required capacity of the crane(s) used for rotating elements. However, the rule below in general use by industry may be used where such advice is not provided as long as the conditions are complied with.

Rule: Where one crane is used, the auxiliary winch should have a minimum capacity of 75 per cent of the element mass. Where two cranes are used, the crane handling the lesser load should also have a minimum capacity of at least 75 per cent of the element mass. The following conditions should be complied with:

- The distance from the auxiliary winch rope lifting point to the end of the element is not to exceed 1/4 of the element length.
- The included angle between the main hoist rope and auxiliary hoist rope is not to exceed 45 degrees.
- Elements are to be rotated such that the element is suspended in its rotated position by the main winch (if one crane is used), or the larger capacity crane (if two cranes are used).
- Where one crane is used, the element shall only be rotated when the plane of the panel is aligned with the axis (centre-line) of the crane boom to ensure there is no fleet angle between the two hoist ropes (see figure 18 Dogging and Rigging guide – Multiple hoist lifting | NSW Government)
- The combined weight of the auxiliary hook block and lifting gear is not to exceed 200kg.
- Where one crane is used, the main winch and auxiliary winch drives should be independent (i.e. have separate clutches).
- There are to be no cut outs in the half of the element closest to the main winch rope element lifting point.
- The element is to be adequately reinforced to withstand the lifting stresses.

If the conditions above cannot be complied with, an engineer should verify the minimum required capacity of the hoist ropes.

‘Rooster sheaves’ is the name given to the short boom extension and sheave set-up attached to the boom head of the crane when elements are rotated. Rooster sheaves and the associated rigging on the boom head should be designed and certified by an engineer.

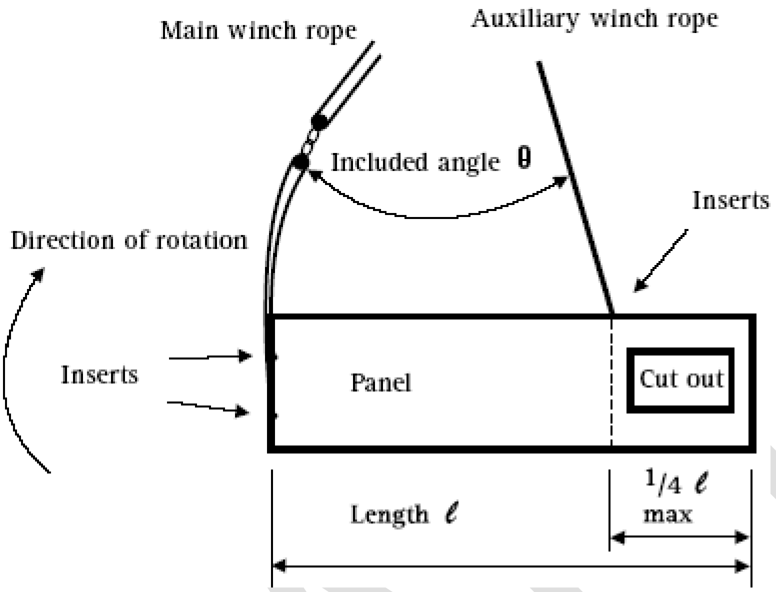

Figure 17 *Initial position of element prior to rotation*

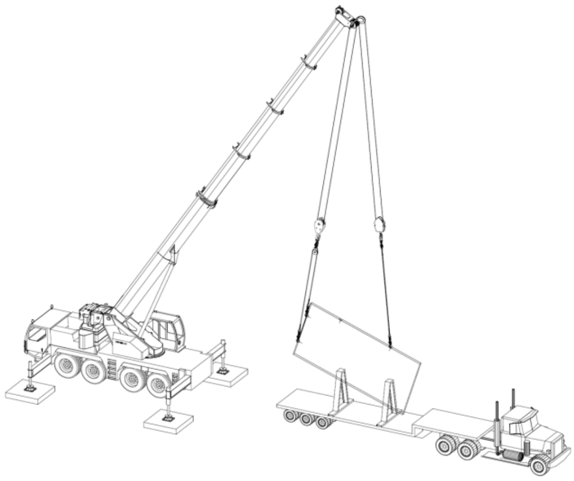

Figure 18 *Single crane, two hook operation - [Dogging and Rigging guide – Multiple hoist lifting | NSW Government]*

14.3 Suspended wall elements

Precast wall elements are sometimes attached to the outside of buildings using steel brackets.

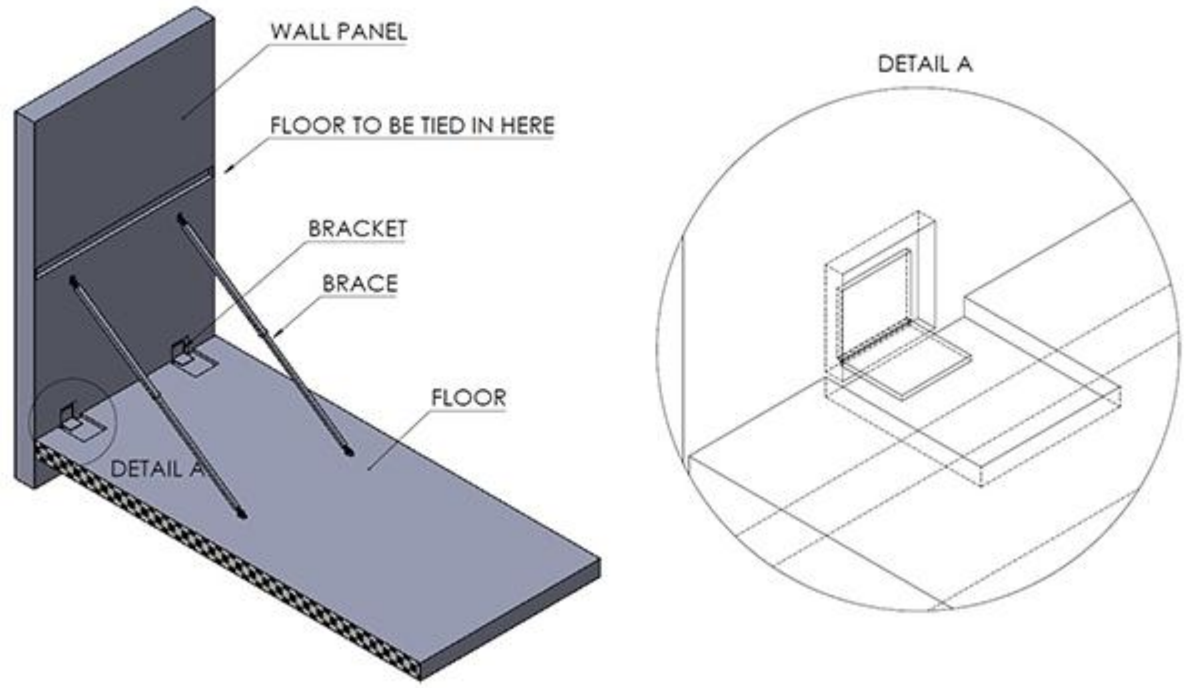

Figure 19 *Method used to attach pre-cast wall panel to floor.*

Figure 19 above demonstrates one example of how a precast concrete panel is attached to the perimeter of a building with the top part of the panel secured with two braces prior to pouring of the upper concrete floor. In this example the bottom of the panel is attached to the building floor with two angle brackets. When the upper floor is constructed, the braces will be removed. At times, the angle brackets are welded to weld plates both on the concrete elements and the building floor. It is difficult to justify the use of welding to attach element brackets to concrete wall elements, where the welded connections are critical safety connections, for the following reasons:

- Inability to prevent elements from moving during the welding process. Even slight movement of the element can cause the integrity of welds to be compromised. While this issue can be improved by attaching temporary bolted brackets during the welding process, slight element movement may still be possible.
- Difficulty for the welder to be able to insert the electrode at the correct angle and distance from the weld because the steel plates are recessed below the surface of the concrete element (see Figure 20).
- Difficulty for the welder to apply the correct heat for sufficient weld penetration to the cast in steel plates on the concrete element. Inadequate heat applied to the steel plate will cause the weld to be defective. Excess heat applied to the steel plate may cause an adverse reaction to the concrete under the plate.
- Lack of a comprehensive inspection and testing process to verify that the welds comply with the design engineer's specifications (e.g. *AS/NZS 1554.1 Structural steel welding*) prior to release of the panel from the crane. Such a process should include the welder producing test samples for destructive testing, where the test sample has been welded on site, under the same conditions encountered during the typical welding procedure. Prior to release of the panel from the crane, a qualified welding inspector would then need to inspect and certify these critical structural welds as conforming to the engineering design.

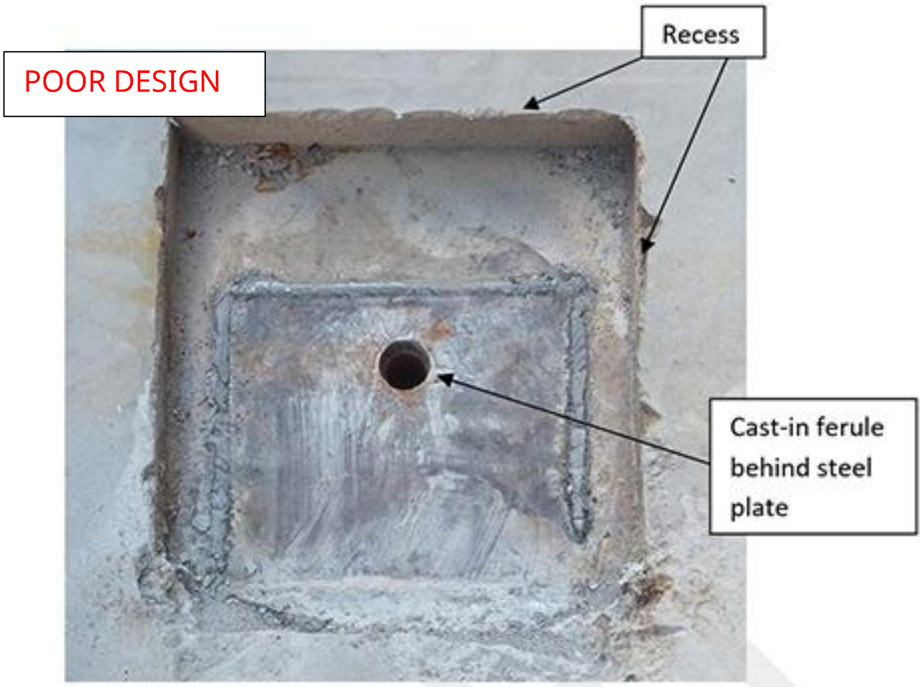

Figure 20 *Steel plate cast into panel face showing recess.*

For the reasons highlighted above, the use of welding for critical connections to secure concrete elements on building perimeters should be avoided, particularly where the design relies on these welds to prevent the element from falling off the building.

The use of bolted connections between the elements, brackets and the building is considered a more reliable method than welding.

Any system used for attaching precast elements to building perimeters is to undergo a comprehensive design process by a competent professional engineer, including a signed design verification statement to relevant design standards. In addition, a system for verifying that the design engineer's instructions have been followed should be provided. This will include inspection of the connections and sign off by a competent person.

15. Operation of plant near braces and elements

The use of mobile plant close to panel braces can be extremely hazardous due to the risk of the braces being struck and elements collapsing. Braces are designed to resist wind loads applied to elements and not to resist impact loadings with moving plant or their moving parts. When a collision with a brace occurs, and the brace is bent, the element will be pulled towards the side on which the braces are located. The braces are then exposed to part of the dead-weight of the element and are not designed to resist such high loadings. The situation is made worse by the fact that the brace has been 'kinked' and will have a much lower compressive strength than in its undamaged condition.

Braces that are struck by mobile plant are likely to collapse in a very rapid and uncontrolled fashion and there can be a very high risk of fatalities occurring both to persons operating the plant and to other persons located in the area. A falling element is also likely to strike other elements, and a 'domino' effect can occur.

This hazard can apply to all types of plant including backhoes, mobile cranes, excavators and elevating work platforms (EWPs). In particular, it can apply when a crane is being used to erect the structural steelwork that will tie the elements together. In this situation controls should be implemented to prevent parts of the crane (including the counterweights) and the suspended load from contacting the braces and elements.

The use of a dogger to assist with preventing contact may not be an effective control measure, when used alone, due to noise on site, delay in the plant operator acting on the dogger's signals and incorrect interpretation of those signals.

Mobile plant should generally not be operated, or travel close to, installed elements and braces unless there is a very good reason for the plant being there (i.e. the use of a boom lift EWP to assist in the installation or removal of braces).

Where plant is operated in close proximity to braces and elements, control measures should be implemented to prevent any part of the plant contacting a brace or element. Under no circumstances should mobile plant actually be permitted to make contact with an installed brace. Some control measures that may be used to reduce the risk of mobile plant contacting braces or elements include:

- the use of a dogger to signal the plant operator to stop the plant in the event of any part of the plant approaching a brace or element. Such a system would have to ensure that the communication method between the dogger and operator was effective. It would need to take account of factors such as noise on site, the dogger possibly being out of view of the operator and delays in communication between the dogger and the operator
- the use of a spotter to assist the operator of an EWP or scissor lift from impacting a brace or element when operating near them
- the use of hazard tape, 'para-webbing' and/or signage to make the brace position obvious, particularly where access areas are located
- the use of plant that reduces the risk of contact with elements or braces. Two examples are:
    - the use of mobile cranes that do not have to be located where slewing contact with a brace is possible, and
    - the use of boom type EWPs instead of scissor lifts (note: this may not always improve the situation).

16. Working at height

In tilt-up and precast construction, persons are required to work at height to perform the following activities:

- Attaching the elements to one another or to structural steelwork prior to removal of the braces (bolting and welding).
- Attachment and removal of braces to and from panels/elements.
- Application of caulking to the vertical joints between panels/elements.
- Patching work.

Most work at height on tilt-up construction should either be performed from platforms with edge protection - including the use of EWPs or mobile scaffolding. Straight or A-frame ladders should not be used for the installation of tilt-up and precast elements due to difficulty working one handed from a ladder.

The use of platform ladders is a safer alternative to traditional ladders as a platform ladder will allow a worker to work with both hands.

16.1 Elevating work platforms (EWPs)

On tilt-up jobs, boom type EWPs are usually preferable to scissor lifts because they have superior reach to access more awkward areas and do not have to be driven right next to an installed element to gain access.

All EWPs used on site should comply with AS/NZS 1418.10 Cranes, hoists and winches – Mobile elevating work platforms. Safe work method statements must be prepared and followed for all high risk construction work, including the operation of EWPs to perform works associated with tilt-up and precast concrete.

The following should be noted in relation to EWPs:

- The EWP should be fitted with a manufacturer's identification plate that includes:
  - unit make, model number and serial number, and
  - a statement that the unit complies with AS 1418.10.
- Persons in boom type EWPs are to wear full body fall arrest harnesses complying with AS/NZS 1891.1 Industrial fall-arrest systems and devices – Harnesses and ancillary equipment. The lanyard should include a personal energy absorber and be attached to a fall arrest anchor in the basket rated at 15 kN.
- There should be evidence that the EWP has been maintained so it is safe to use.
- The basket or platform on the EWP has its maximum capacity or safe working load clearly marked and is not being overloaded.
- EWPs are only to be operated in accordance with the manufacturer's specifications. Some units may only be driven around the site with the boom lowered so that it is just above ground level especially where the ground is uneven.
- Do not drive EWPs through doorways while operating from the platform.
- EWP controls can differ between makes and models, so operators need to know four things in particular for the type and model of EWP being used:
  - where the operator's manual is kept, and what is in the manual
  - the purpose and function of all controls
  - what safety devices are fitted that are specific to that make and model, and
  - how to lower the platform in an emergency.

The following risk controls should be in place:

- Supervisors and spotters should be trained and on site when the EWP is in use to help the operator navigate difficult obstructions.
- Movement of the EWP should always be slow, deliberate and planned, with careful use of the EWP's proportional controls.
- The EWP should only be used on a solid level surface, unless it is designed for use on rough terrain.
- EWPs that are only rated for indoor use should not be used outside or in areas exposed to wind.
- Operators should start with the large movements of driving and elevating the EWP, and finish with finer movements when closer.
- Operators should be competent and provided with adequate training, including documented familiarisation training for each specific make and model of EWP they use.
- If the EWP has a boom of 11 metres or longer, the operator must hold a high risk work licence.

Other workers should know how to use the ground controls and emergency descent devices for the type and model of EWP being used, such that they can operate them in an emergency.

Where possible, sequence the building works so that adequate room is available to safely operate the EWP and the risk of the platform or boom becoming caught on an obstruction is minimised. In situations where a building fixture needs to be installed after the main structural members are in place, it can be extremely difficult to operate an EWP safely. In these situations, alternative means of safe access should be considered.

Due to the importance of a prompt rescue, EWP operators should never operate an EWP alone.

Ensure training and instruction are provided to workers in the use of fall arrest equipment.

EWPs can apply high loadings to supporting slabs cast on ground or suspended slabs. The supporting surface should be adequate to support the point loadings applied by the EWP.

Where the maximum bearing capacity of ground on a particular site has been determined, this information should be made available to the supplier of the EWP to ensure the EWP is safely supported.

For concrete slabs on the ground or suspended slabs, verification is required that the concrete has reached its adequate strength to safely withstand point loadings applied by the EWP. In the case of suspended slabs, verification that the slab design is adequate to withstand point loading applied by an EWP is to be provided taking into consideration the age and strength of the concrete. When operating EWPs on freshly poured suspended slabs, approval from the formwork design engineer may be required.

Point loadings applied by the EWP can be obtained from the EWP manufacturer or hirer.

Where there is a risk of crushing against a fixed structure or panel brace, an effective operator protective device needs to be fitted, so far as is reasonably practicable.

These devices are commonly known as secondary guarding and may include, but are not limited to:

- physical barriers attached to the platform, which reduce the likelihood of workers being crushed against structures
- pressure sensing devices positioned over the control panel, which detect pending crush incidents and prevent further hazardous movements
- proximity sensing devices which prevent an EWP's platform from manoeuvring into high-risk areas near to fixed structures
- devices that stop the EWP when the operator's body moves suddenly.

Further guidance on the safe use of elevating work platforms is included in

- AS 2550.10 Cranes, hoists and winches –Safe use – Mobile elevating work platforms
- Safe Work Australia's model Code of Practice – Elevating work platforms [Model Code of Practice: Elevating work platforms | Safe Work Australia](#).

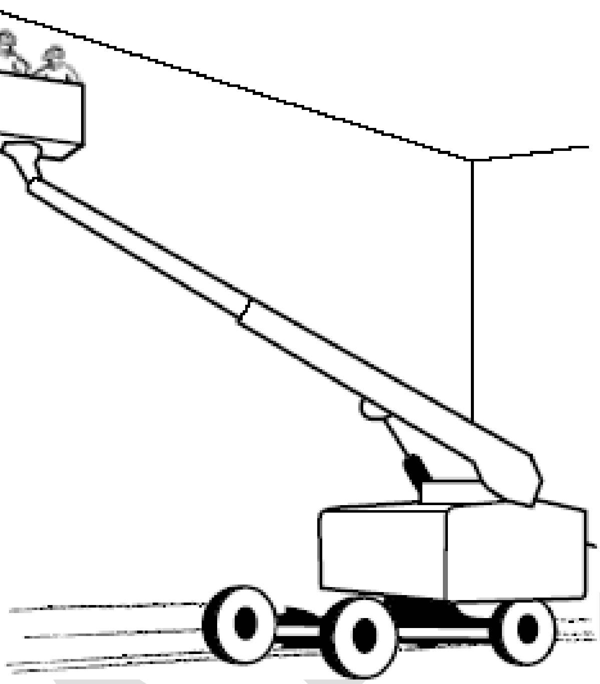

Figure 21 *Boom type EWP*

16.2 Scaffolding

Guidance on scaffolding is provided in the Scaffolding Code of Practice 2021. Some of the issues relating to scaffolding itself are:

- free standing height of scaffolding to the work platform should be no higher than the maximum height specified by the scaffolding manufacturer
- scaffolding meeting the manufacturer's instructions and being certified by an engineer
- internal access being provided on mobile scaffolding (i.e. with a trapdoor)
- standards being provided with base plates or sole boards to distribute point loading, unless the scaffold is a mobile scaffold with lockable castors
- damaged tube and components not being used–this is particularly important with aluminium scaffolding using thin walled, high tensile strength tube because dents in the tube can have a major effect on its strength
- scaffolding, where a person or object could fall four metres or more, being erected by a licensed scaffolder.

16.3 Ladders

Guidance on ladders is available in the Managing the risk of falls at workplaces Code of Practice 2021 and sections 306K to 306M of the WHS Regulation on the safe use of ladders. However, single and extension ladders should not be used for the installation of tilt-up and precast elements as they are considered impractical to comply with the requirements for ladders under the WHS Regulation.

Platform ladders should be used rather than single and extension ladders to provide a safer means of access to the work area.

17. Proximity to overhead powerlines

Contact with overhead powerlines can pose a major risk on tilt-up and precast sites due to the height of the elements, the use of mobile cranes and other plant and because workers are required to work at a height where contact with power lines may be more likely.

If it is not reasonably practicable to turn off the power or re-route the powerline, the most effective control measure to reduce the risk is to establish “exclusion zones” that prevent people, plant, equipment and materials from coming close enough to energised overhead powerlines for direct contact or flash-over to occur.

A PCBU must ensure, so far as is reasonably practicable, that any person, part of the crane or plant, or the crane or plant’s load does not enter the exclusion zone.

PCBUs should ensure that workers, plant and the load stay at least three metres away from overhead powerlines, for voltages up to 132 kV, with greater distances applying for voltages above that. These distances apply to any part of the load it is lifting. This may be achieved in several ways, including:

- setting up or operating plant in an area that keeps it outside the exclusion zone
- engineering controls such as mechanical stops or constraints to prevent the crane or plant entering the exclusion zone.

A number of factors should be considered when implementing a system to maintain an exclusion zone, these include:

- identifying the minimum clearance distance from the closest part of the crane or suspended load to the power line, such as:
    - the maximum travel distance of the plant
    - the size and shape of any load to be lifted
    - the possibility of load swing after the plant comes to rest
- allowing for sway or sag of the powerlines (sway is usually caused by wind, while sag may vary as the temperature of the line varies)
- using a safety observer (commonly known as a ‘spotter’) who observes the operation of the crane or plant and advises the operator if it is likely the crane or plant will enter the exclusion zone.

The identified minimum clearance distance may need to be greater than the prescribed exclusion zone distance to ensure there is no breach of the exclusion zone (e.g., to take into account the load swinging once the crane or plant stops moving). Additionally, electricity entities may also specify a greater distance than the exclusion zones provided in Schedule 2 of the ES Regulation, if they consider the risk warrants it.

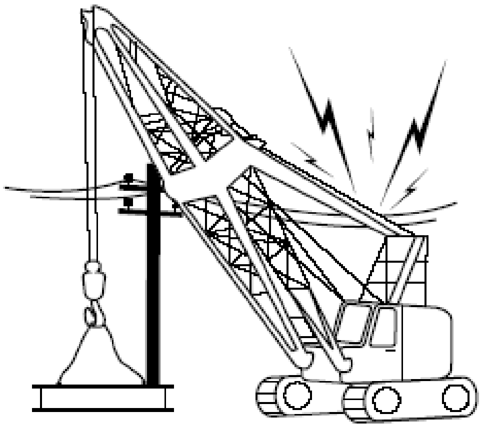

Figure 22 *Image of plant contacting overhead powerlines*

Safety observers or ‘spotters’

A safety observer or ‘spotter’ is a person who is trained and competent to observe and advise the plant operator if the plant or any part of the load it is carrying is likely to come within the exclusion zone of an overhead powerline. Safety observers should not carry out other tasks, such as dogging duties, at the time of observing plant operations.

The safety observer or ‘spotter’ should:

- have knowledge about working safely around moving plant, including an understanding of escape routes and maintaining visibility
- understand the relevant traffic management guidelines for the site
- have an understanding of exclusion zones and knowledge about how plant or cranes operate, and the limits of their movements and extensions, in order to understand the potential for the crane to encroach on an exclusion zone.

Training appropriate for those acting as a safety observer or spotter includes:

- RIIRTM203E – Work as a safety observer/spotter
- T0911 Introduction to Electrical Network Infrastructure for Authorised Persons
- UETDREL006 – Work safely in the vicinity of live electrical apparatus as a non-electrical worker.

Devices to minimise the risk from contact with overhead powerlines

Lower order administrative controls should only be considered when other higher order control measures are not reasonably practicable, or to increase protection from a hazard. There are several devices available that assist in preventing contact with overhead powerlines. These include:

- warning signs to indicate the location of overhead powerlines
- tiger tails or line markers on overhead powerlines to act as a visual aid to highlight the location of the powerline. (Note: tiger tails **do not** insulate wires)
- warning devices to warn the plant operator before the boom enters the exclusion zone.

The use of tiger tails on powerlines acts as a visual aid to highlight the location of the overhead powerline. Only low voltage lines (under 1000 volts) can be continuously covered with tiger tails, which leaves the higher voltage lines on power poles (usually at least 11,000 volts) exposed.

Limiting or warning devices may be used to prevent the plant, crane boom or load from entering the exclusion zone, or to warn the plant operator before the boom enters the exclusion zone. If a limiting device is used, the system should be designed to 'fail-safe' and comply with appropriate technical standards for safety related parts of control systems or for the functional safety of machinery.

Regardless of whether safety devices are used, the exclusion zone must not be encroached.

Further information on requirements for operating plant near overhead powerlines may be obtained in the ES Regulation and the Electrical safety Code of Practice – Working near overhead and underground electric lines or at https://www.worksafe.qld.gov.au/electricalsafety

18. High risk work licences

The concrete element installation crew must hold the following licences to perform high risk work:

- If they are carrying out rigging work involving precast concrete members of a structure, they must hold a basic rigging (RB) licence or have enrolled with a registered training organisation (RTO) and are training towards obtaining an RB licence and are under the supervision of a basic rigger.
- If they are carrying out rigging work for tilt-up construction, they must hold an intermediate rigging (RI) licence or have enrolled with an RTO and are training towards obtaining an RI licence and are under the supervision of an intermediate rigger.
- If precast concrete elements are being lifted using two cranes or winches, the rigger directing this operation must hold an intermediate rigging (RI) licence.
- Crane operators and persons performing dogging duties must hold appropriate licences.
- Trainees who carry out high risk work are not required to be licensed if they are enrolled with an RTO and in the course of their training towards a certification for the relevant high risk work class.
- Trainees must be directly supervised by a person who is licensed to carry out the relevant high risk work while conducting the high risk work activity.

The relevant licence classes for mobile crane operators, other than vehicle loading cranes, are as follows:

- CN Non–slewing mobile crane with a capacity of more than 3 tonne.
- C2 Slewing mobile crane with a capacity of 20 tonne or less.
- C6 Slewing mobile crane with a capacity of 60 tonne or less.
- C1 Slewing mobile crane with a capacity of 100 tonne or less.
- C0 Slewing mobile crane with a capacity of more than 100 tonnes.

Dogging is the baseline licence to hold in the area of rigging. Once a licence holder is qualified as a dogger (DG), they can attend training and gain a basic rigging (RB) licence. A basic rigger licence holder can then attend training and gain an intermediate licence (RI). An intermediate licence holder can attend training and gain an advanced rigger (RA) licence. Each licence includes the authorisation to conduct any activities allowed for the licences below it. For instance, the holder of an advanced rigger licence can conduct any activities included in DG, RB and RI.

Any operator of a boom type elevated work platform with a boom length over 11 metres must hold a high risk work licence.

If scaffolding is used in the construction process and it is higher than 4m from the working platform, the constructor of the scaffold must hold a basic scaffold (SB) licence for modular scaffold or intermediate scaffold (SI) licence if using tube and couple type scaffold. A holder of a SI scaffold licence is authorised to perform lower high risk class of work. For instance, a licence holder with a SI high risk work licence can perform SB high risk work class activities.

A qualification register for persons involved in element installation is in Appendix E.

Appendix A: Sample of engineer's certification letters

Sample letter for temporary bracing and wind loading

Date

Hector Smith
Hector Element Erections Pty Ltd 21 Concrete Drive
Urbanville QLD

Dear Mr Smith

Pineapple Waters Project – Spiky Road, Golden Beach

I certify that the concrete elements detailed below, have been designed in accordance with Australian Standards AS 3850.2 (year) - Prefabricated concrete elements Part 2: Building Construction and AS 3600 - Concrete structures, for installation loads. I certify that the following Australian Standards have been addressed - As 1170.0 (year) – General Principles; AS1170.1(year) – Permanent and imposed action; AS1170.2 (year) – Wind Loading.

Element number	Drawing number
P-1	302 – 1 Rev 1
P-2	302 – 2 Rev 2

The lifting inserts meets the factors of safety outlined in AS *3850* provided the inserts are used in accordance with the manufacturer's specifications and the concrete has reached a minimum strength of___MPa (as recommended by the insert manufacturer).

The elements will be suitable for lifting when the concrete strength has reached__MPa.

Yours faithfully

Signature
Engineer's name
RPEQ No.

Sample letter for design certification for lifting concrete elements

Date

Hector Smith
Hector Element Erections Pty Ltd
21 Concrete Drive
Urbanville QLD

Dear Mr Smith

Pineapple Waters Project – Spiky Road, Golden Beach

I certify that the temporary bracing layout as detailed in the drawings listed below has been checked for wind loading and complies with Australian Standards *AS 3850.1 (year)* Prefabricated concrete elements Part 2: Building Construction and *AS 1170.2 (year) Structural design actions – Wind actions*. I certify that the following Australian Standards have been addressed - AS 1170.0(year) – General Principles; AS1170.1(year) – Permanent and imposed action.

Drawing description	Drawing number
Site plan showing element locations	SP - 107
Brace configurations (i.e. showing brace types, angles, extensions, etc)	BC – 1 to 23
Deadmen	DM – 1, DM 2, DM 3.

I have checked the capacity of braces, deadmen anchor blocks (or slab design), element inserts and anchors used between the brace foot and deadmen.

I have selected the following parameters from *AS/NZS 1170.2* in determining the adequacy of the temporary bracing system:

Region: ___________
Terrain category: ___________
Wind speed: ___________
Average recurrence interval ___________

Yours faithfully

Signature
Engineer's name
RPEQ No.

Appendix B: Tilt-up or precast concrete element checklist

Job address: ________________________________ Element manufacturer: _______________________

Principal contractor: __________________________ Element installer: ____________________________

Element number	Casting date	Weight (t)	Concrete spec (MPa)				Constructed as per drawing		Date suitable for lifting	Verifiers name	Initials and date
			For lifting	Design strength	Early strength result MPa@days	Concrete strength on delivery for lifting	Dimensions and steel content	Lifting & bracing inserts			

Appendix C: Tilt-up or precast concrete element lifting and temporary bracing checklist

Job address:____________________Element manuf. and ABN: ____________________

PC and ABN:____________________Element installer and ABN: ____________________

Element lifting

Crane

Item	Result	Initials	Comment
Crane has adequate capacity (if tilt-up, add lean distance to radius)			
Crane operating within recommended wind speed			
Lift plan completed – includes site plan and lifting locations			
Ground condition and slope (no more than 1 degree for 'pick and carry' cranes – cranes on outriggers adequate packing under pads – no penetrations or covered pits in area)			
Crane safety features operational (load indicator, anti-two block, boom angle indicator, hook safety catch)			
Crane maintenance logbook complete and up to date			
An anemometer is fitted to the mobile/tower crane			
Wind speed has not exceeded the engineer's recommendations on the wind loading applied to installing precast panels/elements when using a mobile crane			

Lifting gear

Item	Result	Initials	Comment
Lifting clutches compatible with inserts			
Lifting clutches and inserts marked with manufacturer's ID			
Locking lifting clutches being used when lifting spin-up elements (refer section on control measures)			
Lifting gear sheaves operational			
Lifting slings suitably marked with ID			
Lifting gear test/inspection results available			
Remote release lines fitted			
Cast-in lifting inserts have been inspected to confirm they are undamaged			
Concrete compaction surrounding the lifting and bracing inserts is sound			

Other items

Item	Result	Initials	Comment
Installation crew SWMS are complete and appropriate for this site			
Concrete element checklist completed (elements okay for lifting)			
Safe access to the precast elements lifting points has been provided (not a ladder)			
Certification – crane operator, element installers (intermediate rigger to be present and supervising element placement)			
Bond breaker functioning			
Workers not in potential crush zone (from crane or falling elements) withan exclusion zone of 1.5 times the panel height for the installation crew			
Workers wearing high visibility clothing			
Exclusion zone for members of public and other buildings set up			
The five control measures detailed in section **Error! Reference source not found.** of the Code have been implemented for lifting precast elements: • Use of locking lifting clutch for spin up elements. • Enhanced periodic inspection of lifting clutches. • Enhanced periodic inspection of snatch block sling assemblies. • Enhanced inspection during precast element manufacture. • Familiarisation training for riggers rotating precast elements.			
Power lines – adequate clearance – check legislation			

Temporary bracing certifying engineer:______________________________ABN: ________

Certifying engineer's RPEQ registration number:__________________________________

Precast delivery considerations

Item	**Result**	**Initials**	**Comment**
The transport frame has been certified by an engineer			
Truck access to site is safe and ground stable			
Ground surface for unloading is level			
Safe lifting route / flight path from truck to point of installation established			
Safe access provided to lifting points provided			
Precast unloading sequence understood, and elements secured to allow remaining elements to be secure at all times as elements are unloaded			
Elements being unloaded remain secured until crane is connected, and slack taken out of lifting chains			

Deadmen or floor slab

Item	Result	Initials	Comment
Drawing showing layout of elements and temporary bracing prepared			
Written confirmation that deadmen / slab has been constructed in accordance with engineer's specifications			

Written confirmation that deadmen / slab concrete has reached strength specified by engineer			
Cast in anchors are as specified by engineer (size, type and depth)			

Braces

Item	Result	Initials	Comment
Braces as specified by engineer or with capacity exceeding minimum specified by engineer			
Braces are in good condition with no defects			
Marked with identification plate			
Correct number of braces used			
Braces installed in accordance with engineer's specifications			
Brace locking pins fitted with retaining device			
Where access by other workers on site or members of public is possible, the retaining device has key to unlock			
Anchor head and washer size suitable for brace slot size (i.e. large enough)			
Suitable access for workers at height			

Post-installed anchors

Item	Result	Initials	Comment
Anchor type suitable (drop-in, low-load slip and screw bolt anchors not permitted)			
Anchors comply with AS3850			
Anchors as specified by engineer or with capacity exceeding minimum specified by engineer			
Documentation starting setting torque available			
Verification that correct torque has been applied to every anchor (i.e. torque wrench readings)			
Chemical anchors – documentation verifying every anchor proof loaded			

Checklist completed by (name and signature): ____

Appendix D: Crane operation in high winds consultation checklist

Project name / address:
Date:

Attendees:
Principal contractor / person with management or control of workplace representative:
Crane crew:
HSR (crane crew and trades directly affected):
Supervisor (trades directly affected):
Note: Consultation with all of the above relevant persons is required before any decisions are made regarding whether the lifting operations should or should not commence.

Crane details (type, manufacturer, model, MRC):

Crane characteristics

- Is the crane operating close to its rated capacity at the required radius for the load (lifts closer to the rated capacity increase risk of overloading due to wind effects)?

Wind characteristics

- What is the current wind speed (the effect of wind gusts will also have a different effect on the crane than a constant wind) and expected or forecasted wind speed (i.e. does the forecast indicate that it will increase or decrease during the task?).
- Where is wind being measured from, relative to the load, and how is the wind speed measured (eg: an anemometer fixed to the crane or a hand-held unit or another measure).

Site hazards

- Proximity of load to other plant/structures (things to consider – temporary bracing, powerlines, operating plant, other cranes or concrete boom pumps, scaffolding, risk of damage to plant and structures).

Load type

- Details of the load that could affect safe handling in high winds (e.g. size and shape, rigging details, surface area of the load including any loads that may be unsafe to lift at this time).
- If the load has a large surface area and is relatively light the load will be more susceptible to wind loading.

Load path

- Where is the load being lifted from and could wind affect safety of persons in the vicinity (e.g. public, load could spin and strike plant e.g gantry over access area).
- Is the path from the pickup location clear of any obstructions? Is the crane in pick and carry mode or static during the lift?

Risk control measures

- What controls are being considered to mitigate the effect of wind on the load being lifted?
- What controls are selected to mitigate the effect of wind on the load and are those controls effective?
- What controls were rejected and why?

Load placement

- Load placement details i.e. how does wind affect the load during placement (e.g wind tunnelling,

workers having to exert high forces to place the load in its final position due to the wind effect).
- Are any workers at risk of being struck / crushed between the load and other materials while the load is being positioned (eg tight or restrictive areas, limited room to manoeuvre load)?

Outcome

(include details of any concerns raised by parties involved re: the outcome or any specific conditions that were decided on):

Participants:

Name	Date	Signature

Appendix E: Qualification register for concrete element installation

Project name and address: ____

Licensing register (Licence holders)

Name	Licence class	Licence number	Activity involved in*

*i.e. crane operation, supervision, element securing, etc.

Trainee register

Trainee name	Activity involved in	Trainee logbook supplied	Supervisor	Period of experience in activity

Appendix F: Familiarisation training checklist

(Insert your organisation's branding here)

Precast lifting familiarisation training record

The training content referenced in this training record is located at	
Date of training	
Name of worker receiving training	
High risk work licence number of worker receiving training	
Details of business delivering training (legal name, address)	
Details of intermediate rigger[1] delivering training and assessing the worker (full name, high risk work licence number) ☐ Rigger delivering the training meets the competent person requirements in section B.6 of AS3850.2 -2024	
Details of intermediate rigger[2] delivering training and assessing the worker (full name, high risk work licence number) ☐ Rigger delivering the training meets the competent person requirements in section B.6 of AS3850.2 -2024	
Experience of intermediate rigger delivering training and assessing the worker	
Site address of practical training	
Crane(s) used to rotate, lift and install precast concrete element (brand, model, capacity)	

[1] The competent person providing the training will be required to oversee lifting and rotation of the precast concrete element. As such, the competent person is to be an intermediate Rigger (as a minimum) with experience in lifting and rotating precast elements. They should meet the competent person requirements outlined in section B.6 of *Australian Standard AS3850.2:2024 Prefabricated concrete elements Building construction*.

Size of precast concrete element being rotated and lifted[3] (dimensions, weight)	
Drawing number of precast concrete element being rotated (drawing title, revision/date) ☐ Drawing of precast concrete element is attached to the training record	
Engineering certification that the precast concrete element used for the training complies with AS3850.1[4] and AS3850.2 has been attached? **NOTE:** If the precast concrete element is being repetitively lifted for training purposes, then the rigging, lifting points and concrete element need to comply with the repetitive lifting load factors in section 2.5.2 of AS3850.2-2024.	

[3] The concrete precast element used for the practical training is to be representative of a typical precast element that requires rotation. Scaled down or smaller precast elements should not be used for the training as they are not reflective of industry practices and workplace conditions.

[4] *Australian Standard AS3850.1:2024 Prefabricated concrete elements General requirements*

The worker demonstrated understanding of the topic and the ability to correctly perform the following on the first or on the second occasion:

Topics	1st	2nd
1. The risks associated with rotating, lifting and installing spin-up elements.		
2. Exclusion zones: • What is an exclusion zone? • Why are exclusion zones required? • What is the minimum size of an exclusion zone? • How to implement and maintain an effective exclusion zone?		
3. Familiarisation and use of the different types of lifting clutches and snatch blocks available, including: • locking lifting clutches • ring (commonly referred to as a “donut”) clutch • spherical head clutch • snatch-blocks for spin-up panels.		
4. The importance of ensuring the lifting clutch and inserts are fully compatible, including how to identify if they are not compatible.		
5. Pre-use inspection requirements for lifting clutches, inserts, precast concrete elements, snatch blocks, wire rope and associated lifting gear.		
6. How to identify if a lifting clutch can inadvertently disengage during precast element rotation and the benefits of locking lifting clutches.		
7. How to safely attach a locking lifting clutch in accordance with the manufacturer’s safe use instructions, noting that locking clutches may have different requirements to traditional non-locking clutches.		
8. How to attach the rigging correctly so the lifting gear does not snag or catch, especially when the precast element is being rotated.		
9. How to safely control rotation of precast elements during the spin-up activity using: • one crane (main and auxiliary winch), or • two cranes.		
10. How to safely release the clutch from the tailing lifter following element rotation.		
11. Refresher training on how to read rigging drawings and interpret the rigging set up correctly.		

Assessment summary

	Date of assessment	Outcome
Knowledge (written) assessment		☐Satisfactory ☐Unsatisfactory

Practical assessment		☐Satisfactory ☐Unsatisfactory
☐ Worker's completed knowledge (written) assessment, and all relevant documents have been attached to this training record.		
NOTE: A Satisfactory outcome in both the knowledge and practical assessment must be achieved in order to successfully pass the familiarisation training.		

Worker's declaration

I ____ (worker's name) have participated and completed all of the above familiarisation training for rotating, lifting and installing precast concrete elements. In the event of being unsure of a task associated with rotating, lifting or installing precast concrete elements, I will request further training or instruction before performing the task.

_________________________________ (worker's signature) _____________________ (date)

Assessor's declaration

I ____ (assessor's name) have observed

____ (worker's name) to have participated **and** satisfactorily completed all of the above familiarisation training criteria for rotating, lifting and installing precast concrete elements.

_________________________________ (assessor's signature) ___________________(date)

Assessor's High Risk License type and number: ________________________________ [5]

[5]

Appendix G: Dictionary

Anemometer means an instrument for measuring wind speed.

Braces are structural members which are required to provide lateral stability to other structural members or transfer horizontal loads to supports. Braces resist both tensile and compressive forces. Since they can be installed at various angles to the supporting surfaces or members, they have pinned ends (swivel) thus allowing a degree of freedom for varying the angles.

Bracing insert means a component cast into the concrete element or tilt-up wall panel or cast into or fixed to a brace footing for later attachment of a brace.

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

Concrete element means any prefabricated concrete element including a precast element or a tilt-up element but does not include concrete pipes.

Design verification statement means a statement that:

a) is written and signed by a person who is eligible to be a design verifier for the design; and
b) states that the design was produced in accordance with published technical standards or engineering principles specified in the statement; and
c) includes:
    i. the name, business address and qualifications (if applicable) of the design verifier; and
    ii. if applicable, the name and business address of the organisation for which the design verifier works.

Design verifier for a design of plant, means a person who has the skills, qualifications, competence and experience to design the plant or verify the design.

Dogger means a person who holds a licence to perform high risk work in the class of dogging enabling them to carry out dogging work.

Dogging work means the application of slinging techniques including the selection and inspection of lifting gear to safely sling a load or the directing of a plant operator in the movement of a load when the load is out of the operator's view.

Engineer in relation to the performance of a task means a person who:

a) is a registered professional engineer under the *Professional Engineers Act 2002*; and
b) is competent to perform the task.

Equalising sheaves is the **sheave** found at the centre of a rope system. It exists to **equalise** the tension in the opposite part of the rope.

Installer means the company or PCBU responsible for installing the concrete elements.

Levelling shims means proprietary material used under concrete elements to support them in their correct position until the final connection is made.

Outriggers structural members that, when deployed, increase the footprint of the crane and lift the vehicles wheels off the ground.

Post-installed anchor means an anchor placed in holes drilled into hardened concrete which rely on expansion devices within the hole to prevent pull-out under load.

- **Torque-controlled expansion inserts** are the **only permissible anchor** in concrete element construction work. For further information see **Section 7.2.**
- Deformation controlled expansion anchors are not permitted in concrete element construction

work.

Precast elements is a type of prefabricated concrete element that is manufactured off-site and transported by road transport. Precast elements include precast wall panels, columns, floor planks, stairs and beams (including bridge beams).

Prefabricate means to manufacture concrete elements, either on or off-site so that they are ready for assembly on a construction site to form a structure.

Rated capacity chart means a notice fitted on a crane specifying the load that the crane is designed to lift for a given operating condition (e.g. configuration, position of the load).

Rigger is a skilled tradesperson who specializes in lifting, moving, and positioning heavy equipment, structural steel, and materials using ropes, pulleys, winches, and cranes.

Rigging work involves safely moving heavy, large loads using specialized equipment like ropes, chains, and slings, often in conjunction with cranes in construction, mining, and shipping industries.

Side de-ration chart means a load chart that reduces the allowable lifting capacity of a crane in relation to the degree of side slope that the crane is to travel on with a suspended load. These charts are to be read in conjunction with the crane's normal rated capacity chart.

Slinging techniques means the exercising of judgement in relation to the suitability and condition of lifting gear and the method of slinging, by consideration of the nature of the load, its mass and its centre of gravity.

Spreader bar has two attachment points or lugs spaced evenly on the top side of the bar, usually at each end. These lugs attach to the legs of a chain sling or synthetic sling that connects to a crane, hoist, or other lifting machine. The underside of a spreader bar usually has two or more attachment points from which the load is suspended.

Stabilisers are structural members that, when deployed, increase the footprint of a vehicle and do not lift the vehicle's wheels off the ground.

Strongback means a temporary member fixed to a concrete element to provide localised reinforcement during lifting, transport or installation.

Tagline or tail rope means the lines attached to the load being lifted, usually to control the load suspended by the crane.

Tilt-up panel means:

- a concrete wall panel, cast on site where it is to be erected
- a tilt-up panel is generally lifted using face lifters and once lifted, hangs at a slight angle to vertical (i.e. typically 5 to 10 degrees) due to the rigging configuration.

Working load limit means the maximum un-factored load that may be applied to an item, component or system.