GOOD PRACTICE GUIDELINES

Safe work with precast concrete

HANDLING, TRANSPORTATION AND ERECTION OF PRECAST CONCRETE ELEMENTS

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New Zealand Government

WORKSAFE NEW ZEALAND | MAHI HAUMARU AOTEAROA

These guidelines offer advice on the safe handling, transportation and erection of precast concrete elements.

ACKNOWLEDGEMENTS

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Safe work with precast concrete

KEY POINTS

- Precast concrete is widely used in the New Zealand construction industry.
- Handling, transporting and erecting precast concrete elements are high-risk activities that have resulted in deaths and serious injuries to New Zealand workers.
- Every person working with precast concrete has health and safety duties.
- Everyone should clearly understand their roles and responsibilities when working with precast concrete.

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1.0 Introduction

IN THIS SECTION:

These good practice guidelines offer advice for keeping workers healthy and safe when handling, transporting and erecting precast concrete elements.

They also provide guidance on how to meet the requirements of the Health and Safety at Work Act 2015 (HSWA).

1.1 Scope

Precast concrete is first cast and later moved into its final position. A precast concrete element means any item made of precast concrete (including, for example, a beam, column, floor slab, wall panel, or cladding panel).

These guidelines are for persons conducting a business or undertaking (PCBUs) including designers, manufacturers, suppliers, installers and importers, as well as workers and any other people who handle, transport or erect precast concrete elements.

The guidelines do not cover detailed design of the completed structure, individual components used in the manufacture, handling and erection of precast concrete elements, or dismantling and demolishing precast concrete structures.

Risks to health and safety come from people being exposed to hazards (sources of harm). These guidelines:

- outline the risks associated with handling, transporting, and erecting precast concrete elements
- describe good practices for managing those risks
- provide practical suggestions for keeping workers safe and reducing the risk of injuries and fatalities.

The most significant hazards during work with precast concrete elements are uncontrolled collapse of the elements and being crushed between a precast concrete element and another object. These hazards may cause serious injuries or death.

Factors that may contribute to uncontrolled collapse or other risks to workers include:

- faulty design
- adverse weather conditions
- handling before the concrete has reached adequate strength
- manufacturing errors

- elements that have been damaged or weakened (eg by modifications, repairs, or seismic activity)
- faulty lifting anchors or connectors
- incorrect lifting and erection practices, including unsafe rigging and inadequate or unsafe lifting equipment
- poorly secured loads
- incorrect loading or unloading methods
- inadequate temporary storage facilities (eg racking systems, suspended floors or beams)
- inappropriate or unstable work areas for cranes
- inadequate structural capacity of foundations.

These guidelines provide advice for dealing with these factors.

All work with precast concrete must comply with the requirements of the Health and Safety at Work Act 2015 (HSWA), and all relevant regulations, including (but not limited to):

- the Health and Safety in Employment Regulations 1995 (HSE Regulations)
- the Health and Safety in Employment (Pressure Equipment, Cranes, and Passenger Ropeways) Regulations 1999 (PECPR Regulations)
- the Health and Safety at Work (General Risk and Workplace Management) Regulations 2016 (GRWM Regulations)
- the Health and Safety at Work (Hazardous Substances) Regulations 2017.

1.2 How to use these guidelines

These guidelines represent the current state of knowledge (the best available at the time of publication) on safe handling, transportation, and erection of precast concrete in New Zealand. They explain relevant legal requirements of HSWA and applicable regulations, as well referring to other legislation such as the Building Regulations 1992 containing the Building Code. When planning how to work with precast concrete elements, always check any industry-specific guidance as well (eg the Crane Association of New Zealand's *Crane Safety Manual*).

Some requirements and recommendations in the guidelines are based on benchmarks set by New Zealand and Australian standards for working safely with precast concrete elements. The guidelines have also drawn on other sources that address precast concrete health and safety matters, including manufacturers' instructions.

Appendix A lists standards and other technical references that may be relevant for the design, manufacture and erection of precast concrete elements. To purchase standards, go to the Standards New Zealand website: standards.co.nz or email: enquiries@standards.co.nz

Good practice guidelines offer advice – they are not legally binding. However, if a duty holder deviates from good practice they should have well-thought-out reasons why. The duty holder should be able to explain why they took alternative action, and provide appropriate evidence to back this up.

Good practice guidelines can be used in legal proceedings as evidence of whether or not a duty or obligation under HSWA has been complied with. They may be cited by WorkSafe New Zealand (WorkSafe) as a current expected standard of practice if poor practice is being alleged.

1.3 Structure of guidelines

The guidelines are divided into ten sections:

- Sections 1 and 2 introduce key terms and concepts, including roles and responsibilities under HSWA.
- Section 3 covers identification, assessment and management of work risks.
- Section 4 briefly covers worker training and identifies factors that can affect worker competence.
- Sections 5–10 cover site management, design, documentation, manufacturing, handling, storing, transporting, and erecting.

Key hazards are listed at the start of several sections. There may also be other hazards. You will need to identify and assess the health and safety risks arising from your own work.

The appendices provide additional information, including a glossary of terms, and resources such as templates and checklists.

1.4 Key terms

These guidelines use terms that are in common use in New Zealand. Key terms are explained below. The glossary in Appendix B explains other technical and legislative terms used throughout the guidelines.

WorkSafe is aware that the construction and manufacturing sectors sometimes use different terms to refer to the same object or practice. Wherever possible, the guidelines identify these alternative terms. For example, a deadman may also be referred to as an in-ground or on-ground mass block; a lifting anchor may also be known as a lifting insert.

Duty holder

A duty holder is a person who has a duty under HSWA. There are four types of duty holders – PCBUs, officers (see Section 2.3 of these guidelines), workers and other persons at workplaces.

For more information

WorkSafe's special guide *Introduction to the Health and Safety at Work Act 2015*

worksafe.govt.nz

Competent person

In these guidelines, a 'competent person' is a person who has the relevant knowledge, experience and skill to carry out a particular task using appropriate techniques and procedures; and:

- has a relevant qualification proving that they have the knowledge, experience, and skill required; or
- their PCBU has evidence (such as training records) demonstrating that the person has the required knowledge, experience, and skill.

Reasonably practicable

There are two parts to 'reasonably practicable':

- You first consider what is possible in your circumstances to ensure health and safety.
- You then consider, of these possible actions, what is reasonable to do in your circumstances.

You need to achieve a result that provides the highest protection that is reasonably practicable in your circumstances, considering factors including:

- the likelihood of the hazard or risk occurring
- the severity of the harm that may result from the hazard or risk
- what a person knows or ought to reasonably know about the risk and the ways of eliminating or minimising it
- how available and suitable control measures are
- the cost of eliminating or minimising the risk and whether the cost is grossly disproportionate to the risk.

For more information

WorkSafe's guidance *Reasonably Practicable*

worksafe.govt.nz

Use of 'must' and 'should'

These guidelines use 'must' and 'should' to indicate whether an action is required by law or is a recommended practice or approach.

TERM	DEFINITION
Must	Legal requirement that has to be complied with
Should	Recommended practice or approach

TABLE 1: What 'must' and 'should' mean

1.5 HSWA references

References to relevant sections of HSWA are in shaded boxes.

2.0 Roles and responsibilities

IN THIS SECTION:

Everyone has responsibilities under the Health and Safety at Work Act 2015 (HSWA).

All PCBUs must ensure, so far as is reasonably practicable, the health and safety of workers and that other people are not put at risk from the work of the business or undertaking. This is the primary duty of care as set out in Section 36 of HSWA.

HSWA defines the roles and responsibilities of different duty holders. These include PCBUs, officers, workers and other persons at workplaces.

For more information

WorkSafe's special guide *Introduction to the Health and Safety at Work Act 2015*

worksafe.govt.nz

2.1 Person conducting a business or undertaking (PCBU)

A PCBU is a 'person conducting a business or undertaking'. In most cases a PCBU will be an organisation (eg a business entity such as a company), although a PCBU may be an individual person (eg a sole trader).

- Businesses are usually run to make a profit (eg a precast concrete manufacturing business).
- Undertakings are usually not profit-making or commercial (eg a government department or a school).

A client, a head contractor, a sub-contractor and a self-employed person at a precast operation are all PCBUs.

In these circumstances, the **PCBU**, among other things:

- is responsible for consulting with designers and main contractors to make sure health and safety matters are considered in all aspects of precast concrete work
- outlines expectations for contractors to develop and implement relevant project-specific safe work practices, and health and safety management systems (HSMSs; see Appendix C of these guidelines for a checklist)
- ensures that competent people are engaged to carry out the work. The client will often engage a head contractor to manage a construction project.

The head contractor

The head contractor managing a construction project is usually responsible for coordination on-site, and monitors and liaises with key parties during construction. WorkSafe expects the PCBU at the top of a contracting chain to be a leader in encouraging and promoting good health and safety practices throughout the chain.

The head contractor's role includes:

- sharing information about the site
- reviewing site-specific documentation, such as shop drawings
- making sure that adequate training and communication practices are in place

- ensuring that health and safety procedures or processes are in place, including for emergencies
- planning all aspects of the site work to ensure deliveries, handling and temporary works are carried out safely
- advising sub-contractors of specific requirements for handling, transport and erection
- ensuring that contractors develop and put in place safe work practices and HSMSs
- representing the client
- consulting and coordinating with other PCBUs such as designers, precast concrete manufacturers, transport contractors and crane contracting businesses throughout the duration of the project.

Roles and responsibilities of other PCBUs (eg designers, manufacturers, importers, suppliers, installers or erectors and transport contractors) are outlined in the relevant sections of these guidelines.

Primary duty of care

A PCBU has the 'primary duty of care' – the primary responsibility for ensuring people's health and safety at work and also ensuring that persons (including 'other persons') are not put at risk by the work being undertaken. The primary duty of care includes, so far as is reasonably practicable:

- providing and maintaining:
  - a work environment that is without risks to health (both physical and mental) and safety
  - safe plant and structures
  - safe systems of work
- ensuring safe use, handling and storage of plant, structures and substances
- providing adequate and accessible facilities for the welfare of workers while at work
- providing information, training, instruction or supervision necessary to protect all persons from risks to their health and safety from work
- monitoring workers' health and workplace conditions to prevent injury or illness arising from the conduct of work.

Further, a PCBU managing or controlling a workplace must also ensure, so far as is reasonably practicable, the workplace, the means of entering or exiting the workplace, and anything arising from the workplace are without health and safety risks to any person.

PCBUs with overlapping duties

More than one PCBU can have a duty in relation to the same matter. Where this happens the PCBUs have overlapping duties. This might happen in:

- a shared workplace (eg a building site), where more than one PCBU and its workers control and influence the work on the site
- a contracting chain, where contractors and sub-contractors provide services to a head contractor and client (although they don't necessarily share the same workplace).

PCBUs that share no contractual relationship may still share overlapping duties when they work on the same site.

PCBUs must discharge their overlapping duties to the extent they have the ability to influence and control the matter. Where duties are shared, they must consult, cooperate with, and coordinate activities with other PCBUs to meet their shared duties. See Section 34 of HSWA.

Example

Under the GRWM Regulations, a PCBU must ensure that:

- adequate first aid equipment is provided for the workplace
- each worker has access to that equipment and access to first aid facilities
- an adequate number of workers are trained to administer first aid at the workplace; or workers have access to an adequate number of other people who have been trained to administer first aid.

In this example, the head contractor and crane sub-contractor on a construction site are both PCBUs.

This means they both have to ensure access on-site to first aid equipment, first aid facilities and first aiders.

The head contractor decides to provide the first aid facilities (including equipment and first aiders) on the construction site. The head contractor and the crane sub-contractor agree that if the crane sub-contractor's workers need first aid while on-site they will use the construction site's first aid facilities. This is an example of a PCBU entering into a reasonable agreement with another PCBU to meet the duty to provide first aid to workers.

For more information

WorkSafe's quick guide *Overlapping Duties*

WorkSafe's guidance *Reasonably Practicable*

worksafe.govt.nz

Additional duties for upstream PCBUs

Sections 39 – 43 of HSWA specify the additional duties of PCBUs who:

- design plant, substances or structures
- manufacture plant, substances or structures
- import plant, substances or structures
- supply plant, substances or structures
- install, construct or commission plant or structures.

Structural designers, precast concrete manufacturers and erectors are all examples of 'upstream' PCBUs. Upstream PCBUs can influence and sometimes eliminate health and safety risks through designing or manufacturing products that are safe for the end user.

Sections 39 – 43 of HSWA are in the appendices of these guidelines. In summary, these sections say that:

- PCBUs who are **designers, manufacturers, importers or suppliers** must, so far as is reasonably practicable, make sure that the plant, substances, and structures designed, manufactured, imported or supplied (as relevant) are without health and safety risks when they are used, or could reasonably be expected to be used, in a workplace. They also have duties around testing, analysis, and information provision. Importers must also ensure imported goods meet all New Zealand regulatory requirements.
- PCBU **installers, constructors and commissioners of plant and structures** must, so far as is reasonably practicable, make sure that the way that the plant or structure is installed, constructed or commissioned is without health and safety risks to specified people.

Table 2 is based on Sections 39-43 of HSWA. It further explains the duties of designers, manufacturers, importers, suppliers, installers, constructors and commissioners. These duties do not apply to the sale (by suppliers) of second-hand plant sold as is.

	DUTIES OF PCBU DESIGNERS, MANUFACTURERS, IMPORTERS AND SUPPLIERS OF PLANT, SUBSTANCES AND STRUCTURES	**DUTIES OF PCBU INSTALLERS, CONSTRUCTORS AND COMMISSIONERS OF PLANT AND STRUCTURES**
Duty to, so far as is reasonably practicable, ensure plant, substances, or structures are without health and safety risks	Make sure, so far as is reasonably practicable, the plant, substance or structure designed/manufactured/imported/supplied is without health and safety risks to people who: – use the plant, substance or structure at a workplace for its designed or manufactured purpose – handle the substance at a workplace – store the plant or substance at a workplace – construct the structure at a workplace – carry out reasonably foreseeable workplace activities (such as inspection, cleaning, maintenance or repair) in relation to: - the manufacture, assembly or use of the plant, substance or structure for its designed or manufactured purpose - the proper storage, handling, decommissioning, dismantling or disposal of the plant, substance or structure – are at or in the vicinity of a workplace, and are exposed to the plant, substance or structure, or whose health and safety may be affected by a work activity listed.	Make sure, so far as is reasonably practicable, the way that the plant or structure is installed, constructed or commissioned is without health and safety risks to people who: – install or construct the structure at a workplace – use the plant or structure at a workplace for its installed, constructed or commissioned purpose – carry out reasonably foreseeable workplace activities in relation to the proper use, decommissioning, dismantling, demolition or disposal of the plant or structure – are at, or in the vicinity of, a workplace, and whose health and safety may be affected by a work activity listed.
Duty to test	Carry out calculations, analysis, tests or examinations needed to make sure the plant, substance or structure designed/manufactured/supplied is without health and safety risks so far as is reasonably practicable (or arrange the carrying out of such tests).	
Duty to provide information	Provide adequate information to people who are provided with the design or the plant, structure or substance manufactured/imported/supplied. This includes information about: – each purpose for which the plant, substance or structure was designed or manufactured – the results of any calculations, analyses, tests or examinations carried out to ensure the plant, substance or structure is without health and safety risks (in relation to a substance, this includes any hazardous properties of the substance identified by testing) – any conditions necessary to make sure the plant, substance or structure is without health and safety risks (when used for its designed or manufactured purpose, or when being inspected, cleaned, maintained or repaired, etc). On request, make reasonable efforts to give the current relevant specified information to a person who carries out or is to carry out work activities listed above with the plant, structure or substance.	

TABLE 2: Overview of duties of PCBU designers, manufacturers, importers, suppliers, installers, constructors and commissioners

A PCBU who buys or uses products or services from an upstream PCBU should consider health and safety implications and make reasonable enquiries about structures, substances and plant they are buying or commissioning for use at work. This is particularly so where the PCBU buys from an unfamiliar or overseas supplier, buys in bulk, or commissions a plant or structure.

If a PCBU identifies a design or manufacturing fault that has contributed to a health and safety work risk, they should raise this with the designer, manufacturer, importer, or supplier. The PCBU will also have to manage that risk.

Worker engagement, participation and representation

All PCBUs must engage with their workers on work health and safety, so far as is reasonably practicable.

PCBUs can more effectively ensure healthy and safe work when everyone involved in the work:

- communicates with each other to identify hazards and risks
- talks about any health and safety concerns
- works together to find solutions.

PCBUs have two main duties under HSWA:

- to engage with workers on health and safety matters that affect or are likely to affect them, so far as is reasonably practicable
- to have practices that give workers reasonable opportunities to participate effectively in the ongoing improvement of work health and safety.

Appendix D summarises a PCBU's worker engagement and participation duties.

PCBUs are expected to have deliberate, planned ways to engage and support participation. Each PCBU can determine the best way to meet its duties, depending on workers' views and needs, the size of the organisation and the nature of its risks.

How a PCBU engages with workers

A PCBU engages with workers by:

- sharing information about health and safety matters so that workers are well-informed, know what is going on and can contribute to decision-making
- giving workers reasonable opportunities to have a say about health and safety matters
- listening to and considering what workers have to say
- giving workers opportunities to contribute to the decision-making process relating to a health and safety matter
- considering workers' views when decisions are being made
- updating workers about what decisions have been made.

If workers are represented by a Health and Safety Representative (HSR), engagement must involve that representative.

Health and Safety Representatives (HSRs) and Health and Safety Committees (HSCs) are two well-established methods of representation. Workers can also be represented by unions, community or church leaders, lawyers, respected members of ethnic communities, or people working on specific projects.

HEALTH AND SAFETY REPRESENTATIVES

A Health and Safety Representative (HSR) is a worker elected to represent the members of their work group on health and safety matters. HSRs play an important role in keeping workers healthy and safe. They provide a voice for workers who might not otherwise speak up. By representing workers, HSRs provide a link between workers and management.

A PCBU must engage with its workers when electing an HSR and/or establishing an HSC.

HSRs have legally defined functions and powers to improve worker health and safety. After completing initial training, trained HSRs also have the power to:

- issue a Provisional Improvement Notice (PIN). A PIN is a written notice issued to a person, telling them to address a work health and safety matter that breaks the law
- direct workers to cease unsafe work where there is a serious risk to health and safety from an imminent or immediate exposure to a hazard.

Any worker can ask for an HSR and any business can choose to have an HSR. There are some businesses that must arrange an election for an HSR if asked.

HEALTH AND SAFETY COMMITTEES

Health and Safety Committees (HSCs) support the ongoing improvement of health and safety across the whole workforce. They:

- enable businesses and worker representatives to meet regularly and work co-operatively to improve health and safety at work
- bring together workers and management to develop and review work health and safety policies and practices
- make it easier for the business and workers to co-operate on ways to ensure workers' health and safety.

For more information

WorkSafe's interpretive guidelines *Worker Representation through Health and Safety Representatives and Health and Safety Committees*

WorkSafe's good practice guidelines *Worker Engagement, Participation and Representation*

WorkSafe's pamphlets:

- *Worker Representation*
- *Health and Safety Committees*
- *Health and Safety Representatives*.

Part 3 of HSWA covers worker engagement, participation, and representation.

2.2 Workers

A worker is an individual who carries out work in any capacity for a PCBU, and includes employees, contractors, sub-contractors, apprentices and trainees, and volunteer workers.

Workers' responsibilities include:

- taking reasonable care of their own health and safety
- taking reasonable care that what they do (or fail to do) does not cause harm to any other person
- co-operating with any reasonable health and safety policy or procedure of the PCBU
- complying, so far as is reasonably able, with any reasonable instruction given by the PCBU, so the PCBU can comply with the law

- in relation to personal protective equipment (PPE):
  - using or wearing PPE in accordance with any information, training or reasonable instruction given by the PCBU
  - not intentionally misusing or damaging the PPE
  - telling the PCBU when they become aware the PPE is damaged or defective, or when it needs to be cleaned or decontaminated.

For more information

WorkSafe's guidance *Worker health and safety rights and responsibilities*, available in English, Māori, simplified Chinese, Hindi, Samoan and Tongan.

worksafe.govt.nz

2.3 Officers

An officer is a person with a specific role in an organisation (such as a company director) or a person with the ability to exercise significant influence over the management of the business or undertaking. Organisations can have more than one officer. Officers could include, for example, the chief executive or director of a scaffolding company.

Officers have a duty to ensure the PCBU complies with its duties under HSWA. Each officer has a duty – it is not a joint duty.

As part of this duty, officers must exercise due diligence and take reasonable steps to ensure the PCBU has appropriate resources and processes to meet their health and safety duties, and verify that those resources and processes are used.

2.4 Other people at the workplace

Other people at a workplace must take reasonable care of their own health and safety and ensure that they do not adversely affect others' health and safety.

Other people at a workplace potentially at risk from work activities include volunteers, customers, passers-by and visitors.

2.5 Other regulations

As well as complying with HSWA requirements, work with precast concrete must comply with other relevant regulations, including the HSE Regulations, the PECPR Regulations and the GRWM Regulations. These regulations are referred to throughout these guidelines.

For example, the GRWM Regulations set out a number of duties around general workplace issues, including:

- facilities
- first aid
- personal protective equipment (PPE)
- emergency plans.

Other regulations cover different aspects of work health and safety. For example, the HSE Regulations relevant to precast concrete work include requirements relating to noise, machinery, working at height, and scaffolding.

3.0 Identifying, assessing and managing work risks

IN THIS SECTION:

Risks to health and safety arise from people being exposed to hazards (anything that can cause harm).

Risk management is not just hazard-spotting.

Identify all risks before work commences and put control measures in place. Involve workers in this process. Make sure workers understand the risks and how the control measures should be used.

3.1 Risk management

Due to their size and mass, precast concrete elements pose a significant risk to anyone working with them and to other people nearby.

PCBUs must manage health and safety risks. This will involve consulting, co-operating and co-ordinating with other PCBUs. PCBUs must also engage with workers and their representatives when identifying and assessing risks, and when deciding how to eliminate or minimise the risks.

Identify hazards and then assess which work risks to take care of first. Wherever possible, identify health and safety risks early and deal with them at the design stage. It is good practice to record decisions made.

Good design can result in significant reductions in work-related ill-health and injuries as well as enhancing the health, wellbeing and productivity of workers.

The most effective risk control measure – eliminating hazards – is often cheaper and more practicable to achieve at the design or planning stage than managing risks later in the lifecycle. See Section 3.6 (Health and Safety by Design) of these guidelines.

> Section 30 of HSWA covers management of risks.

To manage risks:

- identify hazards that could reasonably foreseeably create a risk to health and safety
- eliminate the risk so far as is reasonably practicable; if it is not reasonably practicable to eliminate the risk, minimise the risk so far as is reasonably practicable by putting control measures in place
- maintain the implemented control measures so they remain effective
- review – and if necessary revise – control measures to maintain, so far as is reasonably practicable, a work environment that doesn't have risks to health and safety.

WorkSafe encourages PCBUs to use the PLAN-DO-CHECK-ACT approach shown in Figure 1 to assess, manage, monitor and review work risks. Engage with workers and their representatives at every step.

FIGURE 1: The PLAN-DO-CHECK-ACT approach

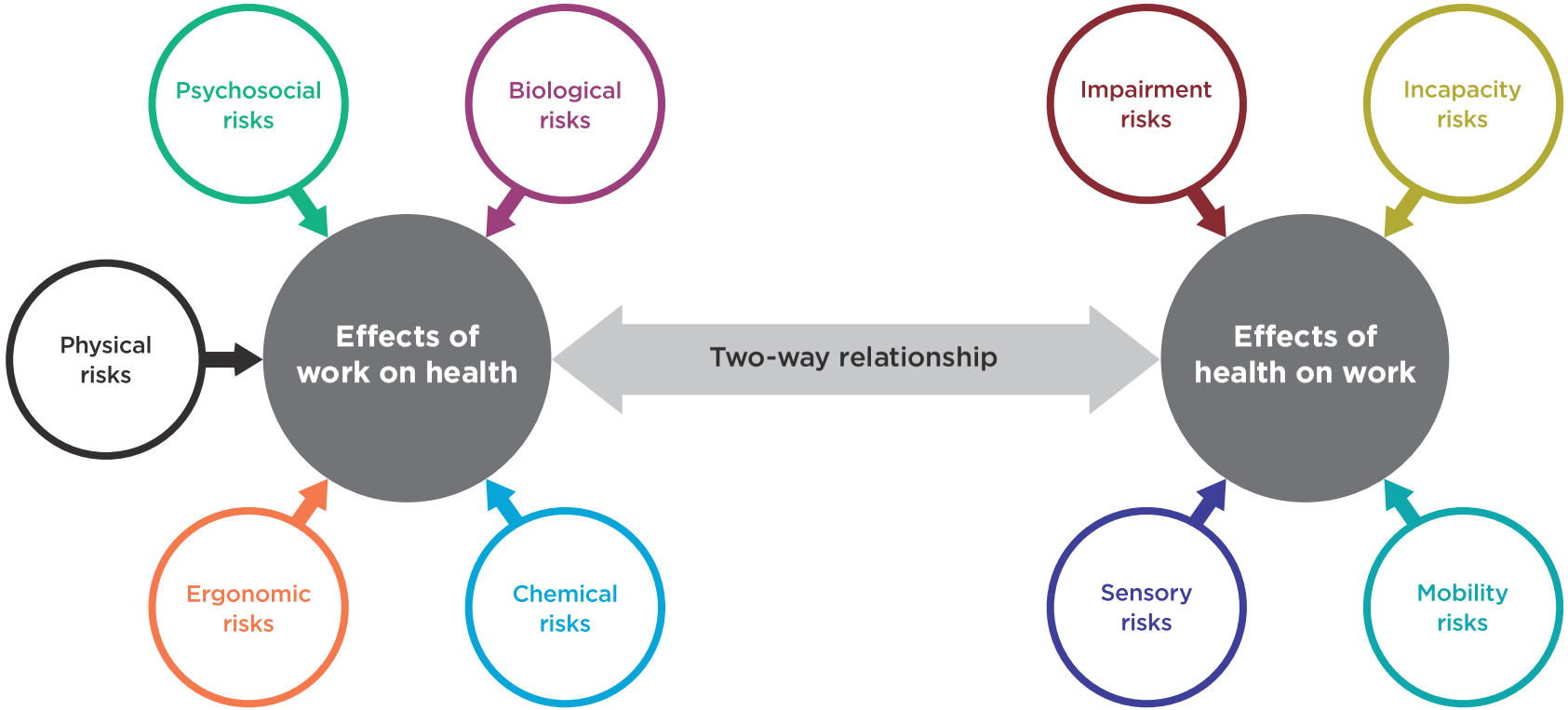
3.2 Plan: Identify hazards, assess risks, select control measures

Work has the potential to harm a person's health, and a person's health can affect safety at work. Identify hazards which could injure or harm anyone during any stage of precast concrete work. Risks need to be controlled effectively even though harm may not be evident for months or years.

Look at the following areas when considering the effects of work on people's health:

- physical hazards (eg noise, vibration)
- biological hazards (eg bacteria, viruses)
- chemical hazards (eg adhesives)
- ergonomic hazards (eg manual handling)
- psychosocial hazards (eg bullying, tight deadlines, other stress factors).

Figure 2 shows examples of work-related health risks and health-related safety risks.



WORK-RELATED HEALTH RISKS ('EFFECTS OF WORK ON HEALTH')					HEALTH-RELATED SAFETY RISKS* ('EFFECTS OF HEALTH ON WORK')			
Biological risks	**Chemical risks**	**Ergonomic risks**	**Physical risks**	**Psychosocial risks**	**Impairment risks**	**Incapacity risks**	**Mobility risks**	**Sensory risks**
Blood borne viruses (eg Hep C)	Asbestos	Manual handling	Noise	Bullying and work behaviours	Fatigue	Poorly controlled diabetes	Physical frailty	Colour vision deficiency
Animal bacteria (eg Leptospira)	Solvents	Shift work	Vibration	Excessive workload	Stress or mental distraction	Poorly controlled heart disease	Bone and/or joint conditions	Reduced visual acuity
Bacterial infection	Pesticides	Job design	UV radiation (eg sun exposure)	Lack of autonomy	Drugs/alcohol consumption	Poorly controlled high blood pressure	Severe obesity	Reduced hearing capability

FIGURE 2: Examples of work-related health risks and health-related safety risks

* Health-related safety risks are specific to the tasks, situation and work environment that they exist within and are not a risk in all circumstances.

Risk of collapse or crush injuries

Significant harm can be caused by:

- uncontrolled collapse of precast concrete elements, including while elements are temporarily braced, when brace configuration is being modified, or when braces are being removed
- a person being caught between a precast concrete element and another object (eg mobile plant) while elements are being handled.

The advice in these guidelines will help to minimise the likelihood of these situations occurring.

Consider all hazards on the site

Identify hazards, risks and the related control measures before work begins so that the control measures are ready to put in place when needed.

Consider all hazards on the site, including places where people could fall, hazardous materials and hazards associated with underground and overhead services (eg gas, water, storm water, sewerage, telecommunications, electricity). Other hazards associated with precast concrete work are shown in the *What could go wrong?* tables throughout these guidelines. There may be hazards at your workplace that are not identified in these tables. You will still need to identify and assess health and safety risks arising from your own work.

Know and understand the hazards and risks associated with manufacturing and construction work in general, for example:

- Noise: many manufacturing and construction tasks, tools and equipment produce high noise levels, which can lead to hearing damage.
- Vibration: repeated vibrations from hand and power tools can cause permanent injuries to blood vessels, nerves and joints.
- Silica dust: silica is found on construction sites in materials such as concrete, bricks, rocks, stone, sand and clay. Dust containing silica is created when these materials are cut, ground, drilled or otherwise disturbed. Exposure to respirable crystalline silica can cause serious lung disease.
- Fatigue: fatigue is a state of physical and/or mental exhaustion (extreme tiredness) which reduces a person's ability to stay alert and work safely. PCBUs don't have the sole responsibility to manage fatigue at work. Workers must take reasonable care of their own health and safety. Fatigued workers may make mistakes that lead to work incidents and injuries. Everyone should learn to recognise the signs and symptoms of fatigue.

See worksafe.govt.nz for more information about these topics.

Hazard identification methods

Methods to identify hazards include:

- workplace inspections – could someone be injured by precast concrete activities, or could your work create hazards for others on-site?
- looking at guidance, standards and industry resources
- studying records of incidents, accidents and near misses at your own and other workplaces
- reading instruction manuals and chemical safety data sheets
- asking qualified professionals (eg engineers, occupational hygienists) to assist
- looking at:
  - your work processes (eg what harmful substances do you use or generate?)
  - the workplace itself (eg ground conditions, underground services)
  - worker behaviour, including how equipment is used.

Assess work risks

PCBUs must assess and manage work risks, taking the views of workers and their representatives into account. Decide which work risks need to be dealt with first and choose effective control measures to manage them.

PCBUs must eliminate risks so far as is reasonably practicable. If a risk can't be eliminated, it must be minimised so far as is reasonably practicable.

Consider whether a small incident could escalate to a serious situation. For example, could failure of a single prop supporting a precast concrete element lead to a progressive collapse of adjoining elements?

Certain risks must be dealt with in a particular way. For example, there are specific requirements in the GRWM Regulations about managing risks associated with working with raised objects and objects that may fall from height.

GRWM Regulations 24 and 25 specify that a PCBU must manage risks associated with:

- work being done under any raised or lifted object (including objects lifted by crane), and
- objects that may fall from height, such as equipment, material, and tools.

PCBUs must follow a prescribed risk management process to manage these risks. See Section 10.8 of these guidelines: Lifting Operations. If PCBUs can't eliminate these risks, they must minimise the risks, so far as is reasonably practicable.

Record how risks are being managed

It is good practice to keep written records of how work risks are being managed. When reviewing your risks, look at these records. You can also refer to the records when training workers about risks and control measures.

3.3 Do: Put control measures in place

Put the most effective control measures in place.

The hierarchy of controls in Figure 3 ranks control measures from most to least effective.

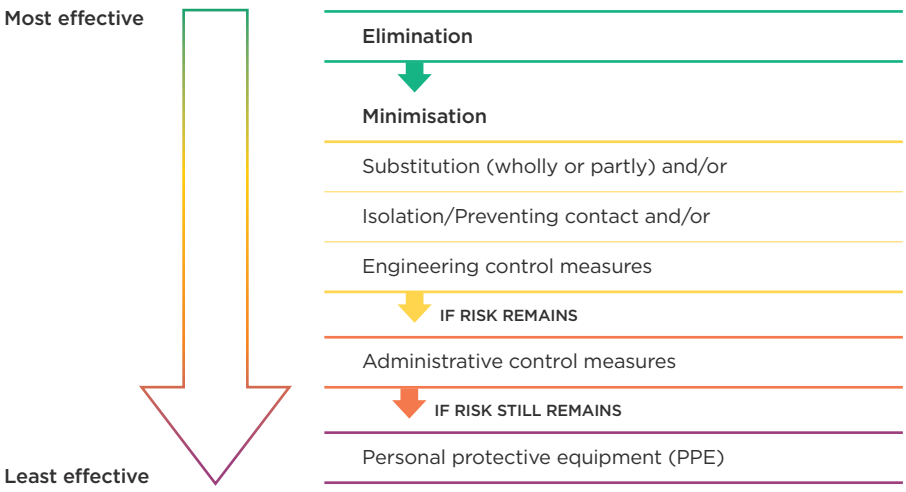


FIGURE 3:
Hierarchy of controls

If the risk is not specified in regulations, the PCBU decides how to manage the risk. PCBUs should:

- find out if there are widely used control measures (eg industry standards) for particular risks, and
- check whether these control measures will effectively manage their risks.

Elimination

Elimination is the most effective control measure. First the PCBU should always try to eliminate a risk by removing the source of harm, if this is reasonably practicable. For example, by removing faulty lifting equipment or a broken A-frame.

Minimisation

If elimination is not reasonably practicable, the PCBU minimises the risk so far as is reasonably practicable. One or a combination of the following approaches can be used:[1]

SUBSTITUTION

Use an alternative design, product, or work practice that decreases the risk. For example:

- with the crane controller, consider using a different crane
- use a different product.

ISOLATION

Isolation prevents contact with or exposure to the hazard. For example:

- stand (erect) precast concrete panels on a day when the only workers on the site are the team doing the erection.

ENGINEERING CONTROL MEASURES

Use physical control measures that include mechanical devices or processes. For example:

- build panels of a different size or shape
- change the propping design to reduce the risk.

ADMINISTRATIVE CONTROL MEASURES

Use safe methods of work, processes or procedures designed to minimise risk. For example:

- complete a lift plan
- develop a policy for dealing with fatigue.

Example

A fatigue policy should cover:

- maximum shift length and average weekly hours
- procedures for reporting fatigue
- procedures for managing fatigued workers
- work-related travel.

The policy could mention that the Land Transport Act 1998 sets limits to the work time hours for drivers of particular vehicles. (See NZTA Compliance in Section 9.5 of these guidelines.)

[1] For prescribed risks, one or a combination of these approaches **must** be used. For more information, see Appendix Q (GRWM Regulations 24 and 25) or WorkSafe's interpretive guidelines *General Risk and Workplace Management, Part 2*. See Section 2: The prescribed risk management process.

PERSONAL PROTECTIVE EQUIPMENT (PPE)

Wear PPE appropriate for the task to reduce exposure to, or contact with, the hazard. For example:

- wear hearing protection for work in noisy areas
- wear safety helmets in any area where workers could be hit or struck by falling objects.

Other PPE suitable for working with precast concrete elements may include steel-toed boots, gloves, safety glasses and high-vis vests.

PCBUs must provide any PPE needed to carry out work, and ensure workers know how to wear, use, and care for it.

PPE is the least effective type of control measure. It should not be the first or only control measure considered.

As soon as possible after deciding what the most effective control measures are:

- put the control measures in place
- make sure that workers know:
  - the potential risks
  - the control measures to manage the risks
  - why it's important to use the control measures, and
  - how to apply them
- review and update emergency procedures/plans if needed.

3.4 Check: Monitor performance of control measures

Control measures should remain effective, be fit for purpose, be suitable for the nature and duration of the work, and be used correctly by workers.

Monitor the performance of control measures to confirm their effectiveness.

Encourage appropriate reporting. Make it easy for workers to report incidents, near misses, or health and safety concerns.

The PCBU should regularly review the effectiveness of control measures (eg through workplace inspections). This is likely to involve engaging often with workers and their representatives to check if the control measures are eliminating/minimising work risks. All policies, processes and systems should have a scheduled date for a review/audit process to check that they're being followed and are still fit for purpose.

3.5 Act: Take action on lessons learnt

The PCBU should investigate incidents and near misses to identify their causes and what needs to change to prevent them from happening again.

The PCBU can use the results of ongoing worker conversations, reviews/audits, investigations and any workplace/worker health monitoring to continually improve the effectiveness of control measures.

If problems are found, go back through the risk management steps, review the information and make further decisions about control measures.

3.6 Health and Safety by Design

Health and Safety by Design is the process of applying risk management methods during design to eliminate or minimise risk for the end users of products.

Workers have the right to the highest level of protection, so far as is reasonably practicable. Managing risks during the product design phase is an effective way of providing the best protection for workers and others. It is more effective than, for example, retrofitting a product later in its lifecycle.

How is Health and Safety by Design applied?

The way Health and Safety by Design is applied will vary depending on the nature of the design or work system and its intended use. The key principles underpinning the approach are:

- **A capable, multidisciplinary team** with a mix of knowledge, skills, expertise and experience, and team members who consult, co-operate and co-ordinate with each other.
- **A lifecycle approach** choosing inherently safer and healthier options at every stage - from the initial concept design through to decommissioning and disposal. Consider costs and benefits.
- **A systematic risk management approach** to identify, assess and manage risk. Apply the hierarchy of controls, if appropriate, focusing first on eliminating risk.
- **Good documentation, communication and information transfer**.
- **Frequent monitoring and review, allowing for change if needed**.

Example

Critical considerations for Health and Safety by Design for precast concrete may include but are not limited to:

- stability and strength of precast concrete elements during manufacture, erection and support of temporary works
- precast channels/ducting (penetrations) for services designed-in so that workers don't have to cut channels or holes in concrete later; this helps workers to avoid creating silica dust and noise
- cast-in components designed-in so that workers don't have to drill them in later
- the size of the crane/s and the space available to erect the elements
- the ability to sequence the works and place the elements safely.

For more information

WorkSafe's quick guide *Identifying, Assessing and Managing Work Risks*

WorkSafe's interpretive guidelines *General Risk and Workplace Management, Part 1 See Section 4: Using PPE to manage risk*

WorkSafe's guidance *Reasonably Practicable*

WorkSafe's good practice guidelines *Health and Safety by Design – An Introduction*

worksafe.govt.nz

legislation.govt.nz

4.0
Worker training

IN THIS SECTION:

Training helps people working with precast concrete elements to gain the skills and knowledge they need to work safely.

PCBUs must ensure, so far as is reasonably practicable, all persons (workers and others) are provided with any information, training, instruction or supervision needed to protect them from work-related health and safety risks.

4.1 What could go wrong?[2]

WHAT COULD GO WRONG?	POSSIBLE CAUSES
Injuries, ill-health or death result from the actions of: – untrained or poorly trained workers – inexperienced workers who are not adequately supervised.	– Workers are not adequately trained to carry out work tasks (eg the training and/or induction process does not cover all the information workers need to know, such as hazards on-site, control measures, PPE use). – The training is not understood by workers – perhaps it was not adapted to suit their numeracy (number), literacy (reading/writing) or language skills. – Workers have not undergone regular refresher training and their skills are declining or out-of-date. – Inexperienced workers are without a supervisor who is responsible for monitoring their work and ensuring compliance with regulations and recommended practice.

TABLE 3:
Worker training:
What could go wrong

Section 36 of HSWA covers the primary duty of care. This duty means a PCBU must ensure the health and safety of workers and that other people are not put at risk by its work.

4.2 Training

Training ensures that each person - and the team as a whole – can operate safely. Training includes providing information or instruction.

PCBUs must:

- make sure that workers have the appropriate experience and training needed for precast concrete work
- engage with workers when making decisions about providing information and training.

Provide ongoing training as needed, including refresher training so that skills and knowledge are kept up-to-date. Skills decline if they are not used regularly.

[2] There may be hazards that are not identified in this table. You will need to identify and assess health and safety risks arising from your own work.

Training should be carried out by a competent person or approved training organisation. Consider asking experienced workers who understand the risks involved in the work to assist with training.

Work with precast concrete that may require higher levels of information, training, instruction or supervision includes:

- handling and lifting
- transporting
- bracing and propping
- erection and installation.

Customise training

Training should be customised and fit for purpose. Use the prompts below when planning what training to offer and how and where to provide it. Adequate time should be allowed for training to take place.

PLANNING TRAINING: WHAT TO CONSIDER
Timing and location – When and where will training take place? – Will training be carried out internally or externally?
Trainer expertise – Who will deliver the training? – What experience and competencies do trainers or supervisors need? – Who will supervise workers receiving on-the-job training?
Training delivery and content – Will training be paper-based, audio-visual, and/or computer-based (including on a tablet or smartphone)? – How will learning objectives be identified? – Will new and/or inexperienced workers be trained thoroughly for all tasks they may need to carry out, or will training happen on a task-by-task basis as needed? – Will training cover identification of hazards related to: - using plant and equipment? - handling, transporting, storing, and erecting precast concrete? - working at height? – Will training cover selecting, fitting, caring for, using and storing the required PPE and equipment? – How will trainers tailor training to meet learners' needs? (Take into account workers' language skills, including their reading and writing skills and their ability to work with numbers.)
Training outcomes – Will feedback be provided to workers who attend training? – How will workers demonstrate understanding? – Can workers gain recognised qualifications?
Post-training – How will learning be supported after training? – How will workers be reminded about safe work practices? (Consider standard operating procedures (SOPs), posters or flash cards summarising the key points.)

TABLE 4: Planning training: What to consider

For more information

WorkSafe's guidance *Providing Information, Training, Instruction or Supervision for Workers*

WorkSafe's good practice guidelines *Writing for Health and Safety*

worksafe.govt.nz

4.3 Worker competence

Always assess the competence of any new worker on the site.
Consider the following questions as a starting point:

- What is the worker's level and depth of experience carrying out the tasks required to work with precast concrete elements?
- What industry-specific training and/or qualifications does the worker already have?
- Is the worker able to identify the common hazards of precast concrete work and use effective control measures to manage the risks?
- Is the worker familiar with:
  - common health and safety terms and practices?
  - industry-specific terms and practices?
- Does the worker have the physical skills needed to carry out the tasks required?

Answers to these questions will help with decisions about what training and supervision new workers need. A worker with less experience can be involved in precast concrete work if they are adequately supervised. The supervisor is responsible for monitoring work and ensuring compliance with regulations and recommended practice.

Next consider:

- What is the worker being asked to do?
- What machinery, equipment and substances will the worker need to use?
- Does the worker have difficulty reading? If so, how else will you share the information they need to know?
- Is the first or preferred language of the worker a language other than English?

Even if workers are well-trained other factors can affect a worker's competence. For example, a lack of sleep, poor diet, relationship issues, money problems, alcohol and drug abuse, ill-health and uncertainty about the continuity of work can all affect people's ability to work safely.

Work should be well-planned and scheduled to avoid undue pressure on workers. Allow enough time for work-flow changes due to unexpected events such as machinery breakdowns or adverse weather. If workers are exposed to extreme temperatures or intense physical demands, consider if tasks can be rotated to minimise the effects.

4.4 Industry qualifications

One way of demonstrating competence is through nationally recognised qualifications, or components of them. For further information on concrete-related training and qualifications, contact the Building and Construction Industry Training Organisation (BCITO). BCITO is appointed by the government to develop industry qualifications and set standards for the New Zealand building and construction sector.

NZQA's New Zealand and National Certificates and Diplomas recognise skills

and knowledge that meet nationally endorsed unit and achievement standards.

Example

The National Certificate in Precast Concrete (Level 3) is designed for people wanting to work as precast concrete product manufacturers, as well as providing a means of recognising the current competence of people already working in the concrete industry.

For more information

www.nzqa.govt.nz

www.bcito.org.nz

4.5 Training records

WorkSafe recommends that PCBUs keep training records. These records are a good way to keep track of what training workers have received, who provided the training, when refresher training is needed, and who has specific skills. Even if a worker has attended similar training previously (eg at a different site), they may still need site-specific training at a new workplace.

Consider how to document each worker's achievements (eg in a training register or log). Details to record could include:

- date of training
- material covered
- name of trainer and/or institution
- location and length of training
- any qualifications obtained
- other relevant information.

For more information

WorkSafe's interpretive guidelines *General Risk and Workplace Management (Part 1)* See Section 3: *Information, training, instruction and supervision*

WorkSafe's special guide *Introduction to the Health and Safety at Work Act 2015*

WorkSafe's guidance *Providing Information, Training, Instruction or Supervision for Workers*

worksafe.govt.nz

5.0
Site management

IN THIS SECTION:

Precast concrete work usually takes place as part of a larger project. PCBUs must work with other PCBUs and workers to control work-related risks.

The PCBU responsible for the site typically assigns someone to be the site manager. Site management includes ensuring that the required PPE, equipment and facilities are in place, as well as handling site-specific issues such as traffic management.

5.1 Safe systems of work

PCBUs must, so far as reasonably practicable, provide and maintain safe systems of work. A safe system of work is a formal procedure carried out by a person with sufficient knowledge and experience to provide and maintain safe work practices. This involves examining a task to identify risks that arise from carrying it out, identifying control measures to eliminate or minimise risks, and putting in place methods to safely carry out the task.

Put a safe system of work in place before work starts. This ensures the work happens in the right location with the right plant and equipment on the site and with the right workers with relevant competencies.

The PCBU must engage with workers carrying out the work and their representatives when developing the safe system of work. All PCBUs must consult, co-operate and co-ordinate with other PCBUs working together at the same location or through a contracting chain, so far as is reasonably practicable.

A safe system of work should include:

- assigning responsibilities
- completing a Job Safety Analysis (JSA) to document chosen control measures – see the template in Appendix E of these guidelines
- consulting a competent person regarding any temporary works design
- identifying health and safety hazards and risks
- describing how any identified risks will be controlled, eliminated or minimised, including procedures for unexpected events such as bracing failure
- describing how control measures will be monitored and reviewed
- having effective communication systems (so that workers can regularly confirm that they are safe)
- using incident investigation and reporting methods
- having an emergency plan and procedures.

Engage with workers about any proposed changes to the safe system of work.

Every safe system of work needs regular reviews. The review process should take into account matters such as:

- advances in technology
- incident reports
- any new hazards or risks identified
- new industry guidelines or new legislation
- effectiveness of control measures
- work environment monitoring results
- worker health monitoring results.

For more information

WorkSafe's guidance *Reasonably Practicable*

worksafe.govt.nz

5.2 Site assessment before work begins

Carry out a site assessment before work begins.

INITIAL SITE ASSESSMENT: WHAT TO CONSIDER
Site conditions - What is the nature and condition of the ground, surface or structure on which the precast concrete element will be erected?
Worker facilities - Are there adequate facilities for workers' welfare (eg drinking water, toilets, and break facilities)?   - **If not**, what will be put in place?
Environmental conditions - Will the precast concrete element/s be subject to environmental loads such as earthquakes, wind, snow, or vehicle impact? (See Appendix F of these guidelines.) - What weather conditions are expected during the project (eg seasonal changes)?

Site access, safety and security
- How will workers access the site?
- Is pedestrian access through the site required?
  - **If yes:** How will this be managed?
- How will vehicles access the site?
- Is a site-specific traffic management plan required?
- Will persons other than workers have access to the site?
  - If so, how will these persons be protected from health and safety risks arising from the work?
- Is there a need to set up:
  - exclusion zones (defined areas where people are not allowed to go when particular work is being done)?
  - covered walkways?
  - barriers or fencing?
- How will the site be protected from unauthorised access?

INITIAL SITE ASSESSMENT: WHAT TO CONSIDER
Storage – Is there a secure and protected location for storage? – Is there enough space to store precast concrete elements? – Is there enough space to store other materials needed on-site? – Is there enough space to store equipment? – How will workers and vehicles access the storage area/s?
Services – Are service mark-outs shown in plans or other information, for example, showing the location of overhead and underground services? – Are there electrical conductors or cables nearby? - **If yes**: Could workers come into contact with the conductors or cables at any stage (eg during delivery to the site, erection, or other work activities)?
Permits, consents and notifications – Are there local authority requirements? – Are other permits or consents required? – Does the work need to be notified to WorkSafe? (See Appendix G of these guidelines.) – Are there others who should be notified about the intended work activities? For example, other PCBUs at the site, neighbours, the airport if a crane boom will affect flight paths.
Site-specific documentation – What site-specific documentation is required? This may include, but is not limited to, the items shown in the following list. (See also Section 7 of these guidelines.) – Does the site require: - a health and safety policy? - a summary of the workplace safety plan? - an emergency plan? (See Section 5.3 of these guidelines.) - a visitor and workplace induction register? - an accident/incident register, including near misses? - injury/ill-health/incident reporting? - hazard identification? - risk assessments? - standard operating procedures? - drawings (eg shop drawings, contract drawings, structural drawings)?
Other PCBUs on-site (See Section 2.1 of these guidelines) – What other PCBUs will be on-site? – How will the PCBUs – so far as is reasonably practicable – consult, co-operate and co-ordinate activities with other PCBUs (eg to manage risks from shared activities)? – What potential risks may arise from other work being carried out on-site?

TABLE 5: Initial site assessment: What to consider

5.3 Emergency plan

The PCBU must have an emergency plan for the workplace covering any likely type of emergency. Emergency plans should be developed with workers: the PCBU must engage with workers on health and safety matters that affect them. To remain effective, the plan needs to be maintained, regularly tested, and improved (if and when required).

Workers should be trained in the emergency plan. The plan should be available and accessible to the people who need it. To ensure a co-ordinated response to an emergency, the emergency plan should be included within any broader construction project emergency plan, and be communicated to all workers. Identify all potential emergency conditions and develop a suitable response for each one.

Sites should be vacated:

- after a major incident, such as a panel collapse or propping failure
- after a notifiable incident
- after a severe weather event
- after an earthquake.

EMERGENCY PLAN: WHAT TO CONSIDER
Coverage Does the emergency plan cover what to do in an emergency, including: – in specific areas? – with specialised equipment? – support required by disabled workers?
Roles and responsibilities Are roles and responsibilities (eg of managers, wardens) clearly outlined?
First aid and emergency supplies Are trained first aiders identified? Does the plan say where to find: – first aid supplies? – other emergency supplies? – the nearest emergency centre?
Alarms, extinguishers, escape routes, assembly points Does the plan identify: – the location of alarms? – the location of fire extinguishers? – escape routes? – assembly points?
Contact details Does the plan include up-to-date lists with emergency contact details? For example, phone numbers for workers, emergency services, clients, suppliers, insurance companies.

TABLE 6: Emergency plan: What to consider

For more information

WorkSafe's quick guide *Electrical Safety on Small Construction Sites*

WorkSafe's interpretive guidelines *General Risk and Workplace Management, Part 1 See Section 3: Information, training, instruction and supervision*

WorkSafe's special guide *Introduction to the Health and Safety at Work Act 2015*

WorkSafe's quick guide *Identifying, assessing and managing work risks*

WorkSafe's guidance *Providing information, training, instruction or supervision for workers*

worksafe.govt.nz

WorkSafe's *Emergency Management Flipchart*: hazardoussubstances.govt.nz

6.0
Design

IN THIS SECTION:

Make sure that all design phases take health and safety into account.

A PCBU who designs plant, substances or structures has additional health and safety duties under HSWA.

Section 39 of HSWA specifies the duty of a PCBU (a designer) who designs plant, substances, or structures.

6.1 Duty of designer

As an upstream PCBU, a designer has a duty to, so far as is reasonably practicable, make sure that any plant, substance or structure they design is without health and safety risks to people who use it for its intended purpose and those at the workplace who:

- handle the substance
- store the plant or substance
- construct the structure
- or carry out other reasonably foreseeable activities such as inspection, cleaning, maintenance or repair.

In summary, Section 39 says that:

- the designer must confirm that what they design is without risks, by carrying out – or arranging to have carried out – any calculations, analysis, testing, or examination needed
- the designer must share the results (of any calculations, analysis, testing, or examination needed) with people who will use their designs
- the designer must provide adequate information about the purpose for which the plant, substance or structure was designed and any particular conditions related to use of the design.

Read Section 39 of HSWA in Appendix H of these guidelines to find out about the specific duty of a designer.

A competent person should provide written site-specific verification confirming that design requirements have been complied with.

6.2 Role of designer

Within these guidelines a designer is a competent person, such as an engineer with experience in such matters, engaged to carry out one or more stages of design.

So far as is reasonably practicable, the design ensures that precast concrete elements and supporting structures are able to resist any reasonably foreseeable static, dynamic and impact loads. Use the highest appropriate factor of safety that can be applied when specifying any cast-in components that may be used for lifting precast concrete elements.

When stages of design are undertaken by individual designers, each designer has responsibility for the stage over which they have control. In these circumstances, the designers must consult with each other on the health and safety implications of the design. In precast concrete work this includes, but is not limited to, the structural designer, as well as other people responsible for erection design and temporary works. For example:

- designer/s of a system that provides safe temporary support of precast concrete elements until they are fully supported by the completed works
- designer/s who contribute to the development of a safe system of work for the erection of precast or tilt panel concrete elements.

Designers are in a strong position to help create healthy and safe workplaces. Eliminating or minimising risks in the design stage is an effective way of providing the best protection.

WorkSafe recommends using a Health and Safety by Design process, outlined in Section 3.6 of these guidelines. This process applies risk management methods and allows early identification of risks that can be addressed through design. For example, designing channels or ducting for services before elements are manufactured means that workers avoid exposure to the silica dust and noise created when concrete is cut to add channels for electricity or other services.

6.3 Design phases

Design should be site-specific. Precast concrete design can be divided into three distinct design phases:

- **Structural design** for the in-service performance of a precast concrete element as part of the complete structure. The structural designer is usually engaged by the client. They are sometimes known as the project design engineer or in-service designer.

  The structural designer:

  - produces the structural design, and issues the structural drawings
  - may recommend design loads for temporary works
  - designs and specifies any permanent structural connections (eg connections to the permanent structure)
  - reviews the shop drawings
  - checks stability of the structure during construction (when requested), particularly before removing temporary supports
  - provides recommended wind and seismic design loads for temporary works.
- **Design of the manufacturing and transport process**, including design of:
  - layout of the precast concrete production facility
  - precast beds
  - access to and protection of the beds and moulds
  - moulds
  - demoulding
  - handling, storage, and transport of the precast concrete elements
  - cranage
- **Design of the site offloading and erection process**, including design of:
  - access
  - lifting
  - storage
  - erection and temporary support of the precast concrete elements, considering the loads imposed.

The head contractor typically ensures that one or more competent persons are engaged to check that aspects of handling and placing of precast concrete elements have been considered. For example, the competent person responsible for erection design should:

- liaise with the head contractor, precast manufacturer and erector to agree on the erection procedure and sequence
- ensure the precast concrete elements can resist foreseeable issues with erection and environmental loads
- provide the precast manufacturer with information showing lifting anchor locations, orientations and specifications required (including any additional reinforcement/strongbacks designed by an engineer)
- produce the rigging configuration, erection sequence and drawings (including brace specifications)
- review the completed shop drawings.

PRECAST CONCRETE DESIGN: WHAT TO CONSIDER
Size, shape, reinforcement, foundations Does the design cover: – determination and specification of the size and shape of the precast concrete elements? – additional reinforcement (where required)? – strongbacks (where required)? – brace foundations, deadmen, footings and other foundations (where required)?
Loads Does the design deal cover loads, including: – the effect of suction and adhesion at separation from the formwork or casting bed (lift off)? – dynamic and impact loading during transportation, where applicable? – erection and bracing loads? – construction loads, including any backfill and surcharge loads? – permanent, imposed and other loads on the precast concrete element and any temporary support or bracing system, in accordance with appropriate sections of the AS/NZS 1170 series (seismic, wind and snow)?

TABLE 7: Precast concrete design: What to consider

ERECTION DESIGN: WHAT TO CONSIDER
Size, shape, loads Does the erection design address: – the size and shape of the precast concrete elements? – erection loads? – design of the supporting members to cater for the erection loads?
Anchors, braces, other components and requirements Does the design cover: – lifting anchors? – cast-in components (such as connectors)? – grouting requirements? – requirements for additional reinforcement? – foundations to brace any vertical precast concrete elements during construction? – dimensioned locations of braces or props and their cast-in components? – the size and type of cast-in components to be used for brace or prop connections?

ERECTION DESIGN: WHAT TO CONSIDER
Base restraints, drilled piles, deadmen Does the design cover: – base restraint details to be incorporated? – strength of the deadmen? (See Section 10.5 of these guidelines.) – minimum dimensions of drilled piles or deadmen? **Note**: The dimensions should allow for the spacing and edge distance requirements for the number and type of cast-in components being used. WorkSafe recommends a minimum diameter of 600 mm (round) or 600 mm x 600 mm (square) unless specified by a competent person.

TABLE 8: Erection design: What to consider

General considerations

All aspects of design should be carried out in accordance with any relevant legislation, such as the Building Code. If the temporary support system of precast concrete elements will be in place for six months or less, the design of that system is to be based on:

- 1 in 100 years annual probability of exceedance for ultimate limit states for wind and seismic loads, and
- 1 in 50 years for snow loads. Design for the serviceability limit state is to be based on a 1 in 25 years event.

Competent persons should design:

- handling processes
- transport processes
- erection processes
- temporary support systems.

Allowance is to be made for all reasonably foreseeable load conditions including – but not limited to – the conditions outlined in Section B1.3.3 of Schedule 1 of the Building Code. (See Appendix F of these guidelines.)

6.4 Temporary works and falsework

Within these guidelines:

- 'temporary works' means temporary facilities (such as fencing, site offices and workers' facilities), and objects such as scaffolding, safety barriers and falsework, that are required on-site only until the permanent works are completed.
- 'falsework' means the temporary structures and/or systems used to support a permanent structure during erection and until it becomes self-supporting.

Temporary works and falsework may include propping systems, bracing systems, frames, scaffolding, backpropping, beams, bearers and ties, and sometimes proprietary systems and specifically engineered systems. Typical elements for falsework supporting precast concrete elements may include wall panels, beams, columns, floors and roofs (eg when constructing buildings, bridges, stadiums and reservoirs).

Falsework should be designed to support loads imposed by the precast concrete elements along with environmental and other imposed loads. The structural designer should specify wind and seismic design loads. This is particularly important for multi-storey work where the derivation of the loads is complex and needs to take into account many influencing factors.

Loads are transmitted through the falsework to the supporting structure or to the ground. Backpropping may be required to distribute the loads through a partially completed structure and is typically applied to multi-storey construction.

For flooring systems and certain proprietary products, the structural designer should provide sufficient information for the design to be undertaken, including the applied loads and the expected performance of the precast concrete elements (such as deflections and vibration).

Information should be provided about the ground conditions and the effect any temporary support systems may have on them.

Falsework is to be designed by competent persons who calculate the imposed loads, determine an appropriate solution, check stability and settlement, and provide documented information for the erection, maintenance and dismantling of the falsework. Information should include:

- design loads
- dimensional set out
- falsework componentry (with manufacturer's details where applicable)
- erection sequencing
- criteria for removal
- removal procedures.

Design to resist loads

Where the falsework affects loading to the completed structure, the structural designer should be consulted.

All foundations should be designed to provide full support to the loads imposed on them by the falsework.

Falsework and temporary works should be designed to resist all reasonably foreseeable loads, including:

- construction loads
- differential settlement
- wind loads for temporary structures in accordance with AS/NZS 1170.2
- seismic loads for temporary structures in accordance with AS/NZS 1170.5.

Falsework should be fixed to a solid, flat concrete surface or another surface capable of resisting the applied loads. Falsework foundations are normally floor slabs, footings, or deadmen.

Falsework and fixings should be designed to ensure the overall system can support the applied loads. A competent person should sign off the design prior to erection.

6.5 Size and shape of elements

When deciding the size and shape of precast concrete elements, designers should take into account:

- manufacturing restrictions
- crane safety (see also Section 10.7 of these guidelines)

  Consider:

  - the size and capacity of crane(s) required for lifting and erection
  - positioning of a tailing crane on-site (if tailing crane required to rotate a large panel)
  - the effect of the panel size on lifting restrictions set by the crane manufacturer, such as reduced wind ratings or safe working radius limits

  - a large panel may lean towards the crane and its operator when placing; a smaller panel may allow the crane to reach further, allowing the crane operator to be clear of the lift
  - wind rating; this can be calculated by a competent person, or by using the crane manufacturer's recommended calculation for a specific crane
- site location and environment (eg site access, location and proximity of power lines)
- requirements for temporary support systems
- transport restrictions.

6.6 Design of the manufacturing, transport and erection processes

Designers should consider all reasonably foreseeable loads imposed on the precast concrete element during all stages from manufacturing the element through to its final position in the completed structure. As the loads can differ during various stages, the structural designer should consider whether precast concrete elements could buckle or become unstable.

The design should consider all reasonably foreseeable physical conditions likely to be experienced during each phase of the process, such as:

- variations in load distribution (with time)
- variations in propping loads due to the effect of pre-stressing
- loading on bracing props, lifting anchors, lifting gear and precast concrete from the dead load, the sling angles, and any dynamic load or impact load applied through handling
- lifting requirements, based on the type of lifting appliance (eg mobile crane, crawler crane, truck loader crane, pick and carry crane, gantry crane, or digger)
- wind loading on large precast surface areas – some elements may not be able to be lifted until the wind speed reduces
- sliding failure (a panel kicking in or kicking out) during erection – this can be prevented by base restraint. See Section 10.5 of these guidelines.

Rigging design

The design should ensure that the precast concrete element and associated rigging is capable of supporting the loads at all stages of the lift. For elements undergoing rotation during the lifting operation, all conditions listed above should be taken into account.

The designers need to show the rigging systems that they took into consideration. A competent person makes sure that the rigging is set up as designed.

Loads on lifting anchors and stresses within precast concrete elements vary with changes to the rigging.

When the design requires a particular sling length or lifting system, the designer should communicate that information to the rigger or the lifting supervisor. See Section 10.10 of these guidelines for information about rigging practices and configurations.

Concrete weight and strength

Concrete strength increases over time and is affected by curing conditions, environment and temperature. The design should consider the concrete strength required for each stage, including:

- lifting from moulds
- destressing

- factory handling
- transport
- site handling
- temporary fixing.

Refer to the NZS 3112 series (*Methods of test for concrete*) as needed. For example, NZS 3112.1 covers methods of sampling fresh concrete and methods of test for unit mass, workability, consistency, bleeding, air content and setting time of fresh concrete.

The structural designer will provide the concrete strength required for a precast concrete element to meet the requirements of the final structure, based on strength or durability requirements. Concrete needs to be at sufficient strength to fulfil its purpose. The minimum concrete strength at removal from the mould, rather than a minimum length of time, should be specified.

To achieve the concrete strength required at the time of lifting, precast concrete elements may be manufactured with a concrete strength higher than specified on the shop drawings. The required concrete strength of the precast element should be noted on the shop drawings. Although using concrete of a higher strength than the structural designer specified does not normally have a negative impact on the structure, in some cases it can adversely affect the overall performance by changing the load distribution. If higher strength concrete is needed to achieve the capacity of the lifting anchors or bracing anchors, the structural designer should approve the change.

Only with approval from the structural designer may higher strength concrete be used:

- to allow early removal from moulds
- to meet handling requirements
- to accommodate construction loads.

Some lifting anchors may not be able to take their full load if they are not embedded deeply enough or the concrete is not strong enough when the element is being lifted. Greater concrete strength may be needed to safely handle the precast concrete element.

The precast manufacturer and the structural designer may help reduce the weight of individual precast concrete elements by altering the size, varying the concrete density, or using other appropriate design procedures.

If a precast concrete element is to be erected, the head contractor and the erector should be given the following information before erection:

- the element's weight
- the element's centre of gravity
- any special handling requirements (eg if load equalising measures or strongbacks are required).

Friction and suction loads

Suction loads occur when precast concrete elements are being lifted off the casting bed or stacks, adding direct loading to crane lifting equipment and lifting anchors. Note that suction loads are based on the surface area rather than the panel weight.

Friction or suction to the mould can increase the force required to lift or release an element from the mould. Suction loads can cause lifting equipment failure, structural crane damage or crane instability. Suction loads can also damage precast concrete elements.

Designers should consider the effects of suction loads to ensure safety and the integrity of the precast concrete elements.

Factors that increase suction include:

- failing to use an effective release agent (bond breaker)
- failing to apply the release agent effectively by missing some parts of the bed or by applying inadequate amounts of release agent
- failing to allow for a profiled or textured surface in the design.

Make sure that friction or suction loads do not overload lifting devices or anchors, or exceed the concrete strength at the time of lifting.

Both friction and suction can be reduced by applying a suitable, high quality mould release agent. To reduce friction, mould sides should be detailed with adequate draw, or be released to allow them to spring back.

Suction on flat mould surfaces is increased by the presence of water. Suction pressure can be relieved by lifting gently at one end or edge of the element.

If excessive force is used for initial release from the mould, the sudden release of strain energy may cause high impact loads, shock loading and unpredictable sudden movements. Take particular care if the lifting force applied exceeds the weight of the precast element by more than 10%.

Factors of safety and dynamic loads

FACTORS OF SAFETY

The factor of safety is the ratio between the working load limit (WLL) and the characteristic strength.

Recommended minimum Factors of Safety for lifting anchors are shown in Table 9. These are the values traditionally used in New Zealand and are referenced in suppliers' literature.

Designers should confirm the Factors of Safety associated with the lifting anchor manufacturer's stated working load capacity.

SITUATION	MINIMUM FACTOR OF SAFETY
General lifting	3.0
Repetitive lifting (of elements that will be lifted multiple times during their service life)	5.0

TABLE 9: Factors of safety for lifting anchors

DYNAMIC FACTORS

Precast concrete elements are subject to dynamic loads during handling and transportation. The dynamic influence increases the action on the lifting anchors, clutches, concrete and rigging, as well as on the crane. The dynamic influence has to be incorporated in the design by multiplying the action imposed by a dynamic factor. The magnitude of the dynamic factor depends on the lifting equipment and the ground condition.

Table 10 provides recommended minimum dynamic factors for general use with the Factors of Safety defined in Table 9.

WorkSafe recognises that lower dynamic factors than those specified in Table 10 may be used with appropriate control measures where manufacturers and designers have placed conditions on the use and handling of particular equipment. For example: 'Here is your precast concrete element, and here are the conditions under which you should lift it.'

In controlled environments such as a precast yard, tests can be conducted and documented to determine the appropriate dynamic factor for the specific yard, lifting equipment, and processes used.

SITUATION	DYNAMIC FACTOR WILL BE A MINIMUM OF:
Lift and place loads	
Lift and place loads using a tower crane, mobile crane, overhead crane running on rails, portal crane or excavator	1.0
Lift, travel and place loads	
Lift, travel and place thin-walled civil products under the conditions listed below	1.2
Lift, travel and place loads using tracked or rubber tyre equipment over prepared even surfaces (including asphalt or concrete)	2.0
Lift, travel and place loads over rough terrain, such as unprepared natural ground	4.0

TABLE 10:
Dynamic factors[3]

Conditions

A dynamic factor of a minimum of 1.2 may only be used for civil type products (such as pipes, manholes, catch pits, culverts and wing walls) when **all** the following four conditions are defined and clearly communicated by the designer, manufacturer or supplier of the precast concrete element(s):

1. Lifting with mobile plant (such as an excavator or similar) where equipment is specifically exempt from the requirements of the PECPR Regulations 1999, subject to the conditions outlined in the New Zealand Gazette, No. 104, September 2015

   and

2. Lifting, travelling and placing over rough or uneven ground where anchor failure is not anticipated to cause harm or injury, by adopting procedures such as:
   a. transporting the element as close as practical to ground level
   b. establishing and maintaining exclusion zones
   c. transporting only precast concrete elements that are unlikely to topple if they were to hit the ground
   d. inspecting lifting anchors both after transportation and before final lifting into place

   and

3. Element wall thickness prevents the use of larger cast-in components

   and

4. The element is manufactured in a manufacturing yard with appropriate quality assurance protocols (such as ISO 9001 accreditation) to confirm characteristics such as:
   a. concrete strength
   b. reinforcing placement
   c. consistency of product.

[3] The dynamic factors above have been derived from dynamic factors defined in similar regulatory regimes.

Repetitive lifting

Lifting anchors in precast concrete elements that will be lifted multiple times during their service life should be designed using a minimum factor of safety of 5.0.

For example, the lifting anchors in concrete barriers, service lids and crane counterweights should stand up to repetitive lifting.

Additional reinforcement

The design should specify any additional reinforcement required to accommodate forces during handling, transport and erection. Additional reinforcement may be used:

- at temporary support points where stresses are greater than those the final structure was designed for
- for handling precast concrete elements that don't achieve their full strength until built in (eg partial-height precast beams)
- near the base of precast concrete elements where necessary to resist load concentrations from levelling shims or other temporary supports
- at the edges and around openings in the precast concrete element to resist thermal and shrinkage stresses and reduce potential cracking resulting from handling elements
- when there is a chance of load reversal resulting from handling during transport or erection.

During handling and transportation, precast concrete elements can be subject to stresses that exceed the design stresses caused by the final loading of the element. There is a chance of unintentional overloading and elements being damaged. The erection design should incorporate the effect of the lifting loads on the structural integrity of the precast concrete element. If required, additional reinforcement or strongbacks (see below) should be added to strengthen the element.

Precast concrete elements may be at risk of buckling if the vehicle transporting them tilts on a curved road surface. They can also buckle and become unstable during lifting and erection. A designer should consider the placement of lifting anchors, the use of strongbacks and spreaders, or the use of additional reinforcing to ensure that compression flange buckling (eg of a slender column) cannot occur. This is particularly important when sling angles cause compression in the element and when long thin elements have the potential to rotate.

Strongbacks

Strongbacks are temporary supports used to:

- strengthen precast concrete elements while being lifted
- support precast concrete elements during construction
- prevent out-of-plane rotation of oddly shaped concrete elements.

For example, a strongback may be bolted onto a precast concrete element to allow it to be lifted safely without cracking. Figure 4 shows strongbacks on a precast concrete element.

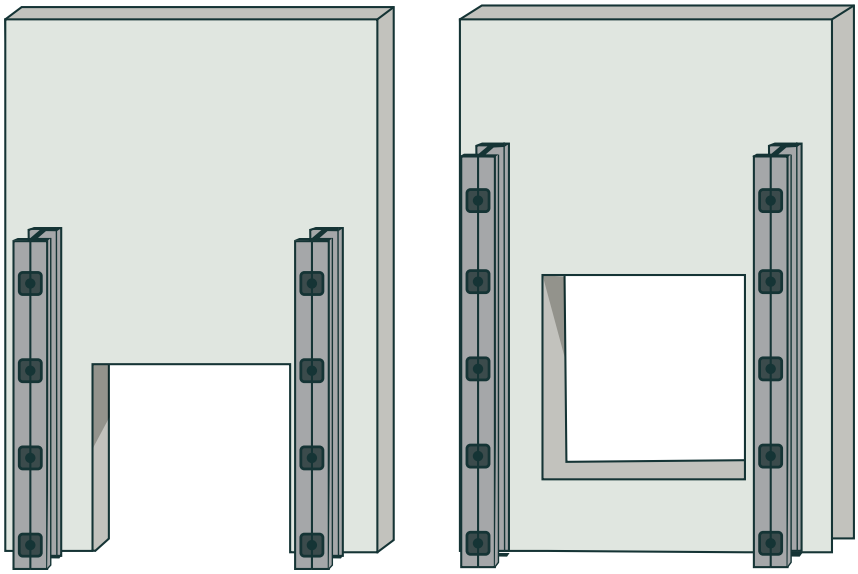


FIGURE 4:
Strongbacks

Large or awkwardly shaped precast concrete elements may require the use of strongbacks to limit concrete stresses to acceptable levels during handling. If the strongback itself is to be used as an attachment for lifting, it should be specifically designed, certified and rated for this purpose. Materials to be used for the manufacture of strongbacks should be designed to a relevant standard such as NZS3404 and NZS3603.

Strongback connections to the precast concrete element should be by way of a cast-in anchor or structural expansion anchor. If structural expansion anchors are used, the working load should be less than the clamping force provided by the anchor.

A Chartered Professional Engineer (CPEng) should consider the size, shape, weight and connection details of precast concrete elements when designing strongbacks.

Strongbacks should be designed for strength and/or for deflection. Strongbacks limit deflection and prevent the precast concrete element exceeding its rupture strength and cracking when it is being handled or lifted.

Design should also take into account:

- any lifting gear attached to the precast concrete element, and the method of lifting
- the centre of gravity, to ensure that the precast concrete element is lifted in the appropriate position
- out-of-plane loads during lifting and rotation.

When calculating the weight of a precast concrete element and its centre of gravity for lifting purposes, include the weight of the strongback/s.

When an object is hooked onto a strongback it becomes a lifting beam and should then comply with the requirements within WorkSafe's *Approved Code of Practice for Load-Lifting Rigging*. The design of lifting beams, spreaders and frames must be certified by a Chartered Professional Engineer or Design Verifier approved by WorkSafe. A Design Verifier is employed by an inspection body to carry out the functions referred to in the PECPR Regulations, and is the holder of a relevant certificate of competence.

This means that all strongbacks with lifting points used during the movement of precast concrete elements should be:

- designed, marked and tested by a CPEng or Design Verifier, and
- thoroughly examined by a competent person before use (such as a qualified and experienced rigger who can carry out a lifting inspection).

A competent person should:

- certify strongback design and connections to precast concrete elements
- consider placement and type of the appropriate insert when fixing strongbacks, for example, cast-in inserts or torque-controlled expansion post-installed fixings
- approve any changes to the specified strongback system before the changes are carried out.

Strongbacks used for lifting must be rated with a working load limit (WLL).

For more information

WorkSafe's *Approved Code of Practice for Load-lifting Rigging*

worksafe.govt.nz

AS 4991 – Lifting Devices

Lifting anchors

Lifting anchors within a precast concrete element should be specified as cast-in products.

Every individual item of lifting equipment should be clearly marked with its working load limit (WLL), the manufacturer's identifier, and a unique numbering system. This allows the item to be easily identified after the lifting anchors are cast into the precast concrete element.

Where cast-in inserts are unusable after casting, obtain approval from a competent person (such as an engineer) to use an alternative rigging or fixing method.

The design of any cast-in componentry for connecting the precast concrete element to roof framing and other structural members should be in accordance with the appropriate New Zealand standard and the Building Code.

As noted earlier, use a minimum factor of safety of 5.0 for applications requiring repetitive lifting of a concrete element during its service life (such as a precast concrete road barrier).

Lifting anchors that are used for lifting and handling during all stages of manufacture, delivery and installation should be designed to a minimum factor of 3.0. The applied load needs to include the mass of the precast concrete element as well as the influences from suction, dynamic impact loads, and rigging angles.

Failure of lifting anchors and systems is a significant hazard and should be considered during the design. As with lifting clutches, lifting anchors should be manufactured and tested in accordance with a valid international standard or technical reference (such as the VDI/BV-BS 6205 series[4]).

The load capacity and strength of lifting anchors is affected by many factors. Development, production, testing, inspection and application of lifting anchors and lifting anchor systems should meet acceptably high and consistent standards to ensure that they are fit for purpose.

[4] Lifting inserts and lifting insert systems for precast concrete elements.

WorkSafe recommends that designers using proprietary lifting anchors in their designs ensure their design loads are within the supplier's recommended load limits. Factors to consider include load direction, concrete strength at the time of loading, embedment depth, and edge distance.

When choosing the number and size of lifting anchors to use, designers should refer to the list below. It identifies the key factors to consider.

LIFTING ANCHOR DESIGN: WHAT TO CONSIDER
Lifting anchor design Does the design include: – the number, location and placement of lifting anchors, adequate to resist the tension and shear forces (static and cyclic) imposed on the connections? – reduction of anchor capacity when placed near an edge or an opening? – component reinforcement? – adequate cover to all cast-in inserts? – ductile behaviour and robustness of the anchor? – concrete strength required to reach the required anchor capacity?
Number and size of lifting anchors Have these factors been considered when selecting the number and size of lifting anchors required: – lifting anchor capacity? – whether the precast concrete element will be lifted repetitively over its design life? – total weight of the element? – length and height of the element? – position of any cut-outs and openings? – rigging arrangements? – possible influences of suction and friction during demoulding? – influence of dynamic factors when lifting on-site? (See Section 6.6 of these guidelines.)

TABLE 11: Lifting anchor design: What to consider

EDGE- OR FACE-LIFTING

Face-lifted precast concrete elements that are to be fixed vertically should be designed to hang no more than 10 degrees from the vertical. If this isn't possible, consider using edge-lifting or a combination of face-lifting and edge-lifting.

Lifting anchors for precast concrete elements may be placed in the face or edges of the element. When the element will be tilted about an edge using lifting anchors placed in the element face, the geometric centre of the face-lift anchors needs to be above the element's centre of gravity.

Rated capacities of edge-lifters should be checked to ascertain the appropriate rating.

ADDITIONAL LIFTING ANCHORS

Additional lifting anchors are often added for multiple lifts, for demoulding, handling, transport, and erection. When fixed length multi-legged slings are used for lifting precast concrete elements, any two of the lifting anchors should be able to support the total load.

6.7 Imposed actions

Design for site processes should consider any reasonably foreseeable actions imposed on precast concrete elements during handling, lifting, storage and temporary support.

Competent persons should consider the requirements for strongbacks, spreaders, additional reinforcing or other measures to avoid buckling during erection of the precast concrete elements.

Wind and seismic loads should be specified by the structural designer. These loads must be derived in accordance with the relevant requirements in the AS/NZS 1170 series.

Factors considered in the determination of these loads include (but are not limited to): the terrain, height above ground, wind direction, shielding, topography, shape of the precast concrete element, position on structure, surface roughness, site subsoil classification, hazard factor, return period, near fault factor and period of vibration.

Seismic assessment of precast concrete elements on multi-storey structures requires a detailed structural analysis by a competent person. The design of the temporary support system should be in accordance with the 'Parts and Components' section of AS/NZS 1170.5.

For more information

Building Regulations 1992: Schedule 1: The Building Code

legislation.govt.nz

Relevant standards

NZS 3101 – Part 1	*The Design of Concrete Structures*
NZS 3101 – Part 2	*Commentary on the Design of Concrete Structures*
AS/NZS 1170	*Structural Design Actions* set (individual Parts 0, 1, 2, 3 and 5 and associated Supplements and Amendments)
NZS 3104	*Specification for concrete production*
NZS 3112 series	*Methods of test for concrete*

7.0 Documentation

IN THIS SECTION:

Designers (as well as manufacturers, importers, and suppliers) must provide health and safety information about their designs to other PCBUs.

All information should be clearly communicated and timely.

Documentation relevant to precast concrete work is likely to include construction documents, shop drawings, erection documentation, permits, specifications and detailed project plans that communicate the processes used to achieve the finished product.

7.1 On-site documentation

A competent person should provide written site-specific verification confirming that design requirements have been complied with.

The following information should be available on-site:

- drawings showing the location, dimensions, concrete strength and reinforcement of all deadmen
- verification that:
  - all foundations have been constructed in accordance with the drawings
  - the concrete has reached the specified design strength
  - allowable bearing pressures have been checked.

7.2 Construction documents

Construction documents:

- are issued by the client to the head contractor, and by the head contractor to the precast manufacturer
- may include specifications and drawings for the precast concrete element
- include dimensions, material properties and fixing details
- specify design loads and performance requirements for precast concrete elements that require additional design by the manufacturer, such as hollow-core flooring.

7.3 Shop drawings

Shop drawings provide all the information needed to manufacture the precast concrete element. They:

- are used by the **precast manufacturer** to confirm details of the precast concrete element to the head contractor and client
- are used by the **client** to ensure their design has been accurately interpreted
- are used by the **head contractor** to ensure dimensional accuracy and all relevant cast-in items have been included
- show how **production workers** should prepare the mould for each precast concrete element
- define **critical material aspects** such as:
  - concrete grade and strength required at the time of lifting
  - reinforcing details
  - specifications for the lifting points
  - penetrations
  - surface finishes
  - cast-in items
  - the transfer strength required for pre-stressing.
- are **approved by competent persons** representing the precast concrete designer, head contractor, crane controller and client.

Shop drawings may include:

- date and issue number
- project name and location
- identification and number of precast concrete elements
- volume and mass of precast concrete elements
- concrete element dimensions and centre of gravity
- concrete design strength
- minimum concrete strength required for lifting

  Note: to achieve the strength required for lifting, precast concrete elements may need to be manufactured with strength grades higher than specified on the structural drawings. The structural designer should approve these changes.
- type, size, configuration and location of reinforcement or strands
- type, size and configuration of any additional reinforcement required for transport and lifting
- make, type, size and location of lifting anchors.

There may be temporary works drawings covering bracing, propping, and arrangement of the elements in their final location. See Section 6.4 of these guidelines for information about temporary works and falsework.

The structural designer should check the shop drawings against the structural drawings for consistency, and mark up any amendments. Amendments should be reviewed, signed and dated by the structural designer and returned to the precast manufacturer to incorporate into the manufacturing process/design.

The approved shop drawings should be marked ‘for construction’ and kept by the manufacturer.

7.4 Site offloading and erection information

Information about site offloading and erection can be included in one or more of the following documents:

- documents describing the site access and cranage
- shop drawings
- the work programme (sequencing)
- documents describing the rigging and lifting; special lifts may include rotation of precast elements and multiple crane lifts
- documents describing the temporary supports, including propping, back propping, access and bracing
- documents describing the erection processes and responsibilities.

7.5 Erection documentation

Precast concrete elements should be erected according to a documented and planned sequence. Information required for erection should be prepared by a competent person with specific training and experience in erection. The documentation should include, where applicable, every aspect of the erection process:

- scheduled dates (eg for delivery and erection)
- the lift plan, which covers how to carry out crane lifts, including (but not limited to) such details as the:
  - weight of loads
  - lifting methodology
  - equipment to be utilised
  - limitations
  - hazards
  - areas of operation
- bracing and propping details for each precast concrete element:
  - type and angle (as designed and certified by a competent person)
  - configuration and size of erection braces and, where applicable, knee braces, cross-bracing, and any other secondary bracing that may be required
- on-site lifting and handling requirements
- any specific requirements, such as:
  - special lifting and handling procedures (eg to protect non-standard finishes)
  - preferred lifting and handling system to suit available equipment
  - additional reinforcing for handling, transport or for other reasons
- all anchors and other components to be cast in for lifting, handling or fixing
- type, make and location of all required lifting anchors; if additional reinforcement or tension bars are required for the lifting anchor to reach the full capacity, specify size, length and location of the reinforcement
- type, make, capacity and technical specifications (as applicable) of:
  - the rigging system
  - lifting anchors
  - bracing and cast-in components, including type and capacity
  - strongbacks (if required)
  - size and grade of bolts to be used for any temporary erection cast-in components

- orientation (position relative to each other) of the precast concrete elements
- location, orientation and depth of anchors, and the size, configuration and concrete cover of any component reinforcement required

  Note: details for edge-lift and other cast-in inserts requiring reinforcement should be obtained from the supplier
- requirements for erection brace footings (and prop footings, if required), brace fixings, and concrete strength of the brace footings (including slabs) at the time of erection
- site access, conditions and limitations, for example:
  - local street access
  - ground conditions
  - access roads
  - crane platforms
  - railway lines
  - energy supply locations (eg power cables)
  - overhead obstructions
  - location of any plumbing, electrical or cabling channels
  - requirements for grouting and location of grouting ducts
  - lateral restraint details
- transport requirements (including any special provisions).

The lift plan is usually developed by an engineer or similarly competent person, in conjunction with designs supplied by the precast manufacturer. It may be used as an addition to – but not as an alternative to – a Job Safety Analysis (JSA) or Safe Work Method Statement (SWMS).

7.6 Project-specific checklists and forms

PCBUs may choose to use other project-specific checklists and forms, such as the examples described below. It is good practice to refer to Health and Safety by Design principles when completing such checklists and forms. (See Section 3.6 of these guidelines.)

Panel design/information for propping request form

During the design phase, some PCBUs use a request form that covers details such as the terrain category, designed compressive strength, preferred strengthening methods (eg strongbacks) and the design required for footing. A sample form is shown in Appendix I of these guidelines.

Lift design request form

Some PCBUs use a ‘lift design request form’ to enable a lift design to be produced.

See Appendix J of these guidelines for an example.

Although the precast manufacturer knows how to lift and load precast concrete elements for transport from their own facility, requirements on a construction site may differ.

The form requests details such as mass unit weight, type and position of lifting inserts, rigging requirements (eg the number and type of cranes needed during demould, first lift or installation) and any design or certification requirements.

Tilt-up and precast concrete daily checklist

Some PCBUs ask sub-contractors to complete a daily checklist during the installation of tilt-up or precast concrete panels. See Appendix K of these guidelines for an example.

The checklist identifies who is responsible for each item (eg drawings, pre-erection checks, panel lifting and erection, and temporary bracing). The responsible party initials each section, or attaches documentation, to confirm that each item has been inspected and/or actioned.

DOCUMENTATION FOR STRUCTURAL DESIGNER: WHAT TO CONSIDER
Shop drawings and plans Has the head contractor given the structural designer: – shop drawings? – drawings showing the supporting structure of precast concrete elements? – a work plan, setting out how the work will be carried out, along with any related information, instructions or diagrams? – a site and services plan? – an emergency plan?
Other documentation Has the head contractor given the structural designer: – erection documentation? – structural and precast concrete element documentation? – loading information? – instructions for use, storage and maintenance of plant and equipment (where applicable)? – a copy of any report, licence or authority required?

TABLE 12: Documentation for structural designer: What to consider

7.7 Other documentation

Other documentation that should be accessible on-site includes the emergency plan (tailored to the work and workplace) and other site-specific documents, and records.

8.0 Manufacturing

IN THIS SECTION:

The precast manufacturer and other PCBUs involved in the design, transport and erection processes should work together to plan the intended construction and erection sequences before the precast concrete elements are manufactured.

As an upstream PCBU, a precast concrete manufacturer must, so far as is reasonably practicable, make sure the elements they manufacture are without health and safety risks.

Section 40 of HSWA specifies the duty of a PCBU who manufactures plant, substances, or structures.

8.1 What could go wrong?[5]

WHAT COULD GO WRONG?	POSSIBLE CAUSES
Precast concrete elements breaking during manufacture	– Manufacturing and/or design errors. – Inadequate concrete strength. – Inability to handle transport stresses. – Inability to handle rotating stresses. – Incorrect installation of lifting anchors. – Incorrect installation of steel reinforcing.
Workers suffering musculoskeletal injuries (eg sprains and strains, back injuries, abdominal hernias) when handling precast concrete elements	– Using inappropriate techniques when handling precast concrete elements (eg not using the right equipment for the job).
Workers being exposed to substances harmful to health at unsafe levels	– Not using appropriate control measures to minimise exposure to substances commonly used in precast concrete manufacture (including concrete, curing compounds and release agents).

TABLE 13: Manufacturing: What could go wrong

[5] There may be hazards that are not identified in this table. You will need to identify and assess health and safety risks arising from your own work.

8.2 Duty of precast concrete manufacturer

As an upstream PCBU, a precast concrete manufacturer has a duty to, so far as is reasonably practicable, make sure the precast concrete elements they manufacture (eg pipes, beams or panels) are without health and safety risks.

In summary, Section 40 says that:

- the manufacturer must ensure that the precast concrete elements are without risks, by carrying out – or arranging to have carried out – any calculations, analysis, testing, or examination needed
- the manufacturer must share the results (of any calculations, analysis, testing, or examination needed) with people who will use the elements
- the manufacturer must provide adequate information about the purpose for which the elements were manufactured and any particular conditions related to use.

These guidelines do not specify which tests manufacturers should use. As part of their internal quality assurance processes, manufacturers must carry out whatever tests they consider appropriate to meet their duty.

Examples of testing and examinations that may be carried out

- visual inspection of a precast concrete element for damage, cracks or other defects
- measuring to ensure the dimensions are correct
- visual inspection to confirm that lifting anchors are correctly placed
- crushing cylinders from the same mix to decide if it is safe to lift the precast concrete element; although the concrete strength of the cylinders may be different, the results can be used as a guide.

Read Section 40 of HSWA in Appendix L[6] of these guidelines to find out about the specific duty of a precast concrete manufacturer.

Good planning will ensure that precast concrete elements are manufactured efficiently, safely and to specification, and that resources are properly allocated. Information about the work to be undertaken should be readily available and clear.

8.3 Role of precast concrete manufacturer

The precast concrete manufacturer and other PCBUs involved in the design, transport and erection processes should work together to plan the intended construction and erection sequences before the precast concrete elements are manufactured.

The construction programme and any updates should be communicated to the precast manufacturer promptly. Changes to the construction programme may cause storage or production problems.

[6] Appendices M and N show the related HSWA Section 41 (Duty of PCBU who imports plant, substances, or structures) and HSWA Section 42 (Duty of PCBU who supplies plant, substances, or structures).

The precast manufacturer needs to know the client's requirements. The head contractor gives the precast manufacturer the relevant drawings, specifications and work programme. This includes any amendments, notices to tenderers, agreed variations and all other information.

The precast manufacturer manufactures the precast concrete element once a competent person has approved the shop drawings.

All lifting should be carried out in accordance with standard operating procedures and work plans.

The precast manufacturer:

- makes sure the appropriate concrete strength is achieved before demoulding and lifting
- ensures all lifting anchors (including those with special designs) have been installed in accordance with the manufacturer's installation instructions and in compliance with the approved shop drawings
- determines and ensures safe lifting and handling of precast concrete elements in the precast yard
- provides relevant paperwork to the head contractor before the precast concrete element leaves the precast yard/is offloaded at site; this may include a Manufacturer's Statement of Compliance.

Plant and equipment should be laid out well to ensure efficiency and safety for workers. For example, casting beds should be located to ensure a sensible flow of work and safe lifting.

Workers must be given appropriate training, or be adequately supervised, to ensure they understand their roles and responsibilities. For example, workers in charge of plant and equipment must be appropriately trained and certified.

8.4 Shop drawings and approvals

Shop drawings (see Section 7.3 of these guidelines) should include all details needed to manufacture a precast concrete element.

The head contractor, the structural designer, the precast manufacturer and the erection sub-contractor should together decide on propping, bracing and any special lifting requirements.

The head contractor should check and approve the drawings before concrete is cast, and give the shop drawings to the structural designer for approval or review.

If the precast manufacturer suggests using a concrete grade and/or additional reinforcing that differs from the structural designer's specifications, the head contractor should ask the structural designer to approve the change before the precast concrete element is manufactured.

If additional cast-in components are required, the head contractor has to clearly communicate the requirements to the precast manufacturer in time to incorporate them into the manufacturing process.

8.5 Optional precast concrete manufacturer's statement of compliance

Before supplying a precast concrete element, the PCBU who manufactured the element should be satisfied that the element was manufactured in accordance with the approved shop drawings and to the design/specifications specified by upstream designers.

The precast concrete manufacturer may prepare a Statement of Compliance before transporting or erecting precast concrete elements, although this is not a requirement. This may take the form of a Producer Statement PS3 – Construction. This may fulfil the manufacturer's duty to provide health and safety information about their products or designs to other PCBUs.

See Appendix O of these guidelines for an example of a Statement of Compliance.

8.6 Moulds and casting beds

Moulds

Formwork or mould design can have a direct bearing on how precast concrete elements are cast and handled, and on the loads imposed during manufacture. Note that:

- Surface finish requirements can influence the preferred orientation of a precast concrete element in the mould.
- Moulds for elements like beams and columns may require specialist provisions to accommodate pre-stressing.
- Suction and friction can be reduced by using high quality mould release compounds.
- Suction on flat mould surfaces is increased by water presence.
- Friction forces are increased by vertical or near-vertical sides on a mould.

Precast manufacturers should be aware of the hazards and risks of the stressing operation and have adequate control measures.

Vertical moulds and tilting moulds

Thin, lightly reinforced precast concrete elements are often cast in vertical moulds, or horizontal moulds tilted to vertical before the element is lifted out. Elements cast in this way should be stored, transported and handled near-vertical at all times. If laid flat, they may be damaged by their self-weight alone.

Surface finishes

Surface finish requirements can determine the preferred orientation of a precast concrete element in the mould. The finish quality of a vertical mould face may be less than that cast against a horizontal surface. Two-stage casting is often used to avoid this problem.

Assembly and release

Removable sections of moulds are normally attached with bolts, clamps, magnets or wedges. Major items of embedded hardware, threaded inserts and dowel connectors are often bolted to the mould. There should be a system for checking all bolts are removed before lifting the precast concrete element from the mould. Failing to remove bolts is a common cause of lifting anchor failures.

8.7 Manufacturing tolerances

Table 5.1 in NZS 3109 (Concrete Construction) gives tolerances for precast concrete elements.

Additionally, the table below shows the recommended tolerances for location of lifting anchors cast into precast concrete elements.

TYPE OF UNIT	ANCHOR LOCATION
Piles	150 mm along the length
Flooring units	150 mm along the length
Beams	200 mm along the length 50 mm across the width
Columns	200 mm along the length On the end: 50 mm
Wall panels	On the face: 50 mm in any direction On edges: 50 mm longitudinally, 10 mm across the thickness **Note**: Location across the thickness may be restricted by edge reinforcing or edge details and the distance to the nearest edge will affect the capacity of the anchor.

TABLE 14: Recommended tolerances for location of lifting anchors cast into precast concrete elements

9.0 Handling, storing and transporting

IN THIS SECTION:

Handling, transporting and erecting precast concrete elements can pose a risk to people's safety, and a risk of damage to the elements.

The possibility of progressive collapse should be considered at all stages.

Methods of handling and storing will depend on the type of precast concrete element. Careful planning is required.

9.1 What could go wrong?[7]

WHAT COULD GO WRONG?	POSSIBLE CAUSES
Precast concrete elements falling or collapsing and causing severe crush injuries (eg the uncontrolled collapse of elements, or a person being caught between an element and another object)	– Poorly stored precast concrete elements (eg inadequately maintained A-frames or other storage equipment, incorrectly stored frames, elements stacked the wrong way). – During transportation: - uneven, unsecured or overloaded racks or support frames - noncompliant lifting systems - damage to precast concrete elements - vehicles tipping due to a high centre of gravity causing roll-over. – Adverse weather conditions (eg strong wind). – Difficult site access, poor ground conditions or uneven terrain causing the vehicle or load to become unstable.
Workers suffering musculoskeletal injuries (eg sprains and strains, back injuries, abdominal hernias) when handling precast concrete elements (eg when lifting, lowering, pushing, pulling, carrying, throwing, moving, restraining, or holding elements)	– Using inappropriate techniques when handling elements (eg not using the right equipment for the job).
Workers being exposed to substances harmful to health at unsafe levels	– Handling precast concrete elements that are still contaminated with substances commonly used in precast concrete work, including curing compounds and release agents.
Workers falling from height (eg from A-frames) when handling precast concrete elements	– Not using appropriate equipment to reduce the risk of a fall. – Equipment not being inspected or well-maintained.

TABLE 15: Handling, storing and transporting: What could go wrong

[7] There may be hazards that are not identified in this table. You will need to identify and assess health and safety risks arising from your own work.

For more information

WorkSafe's best practice guidelines *Working at Height in New Zealand*

worksafe.govt.nz

9.2 Handling, storing and transporting

Handling, storing and transporting precast concrete elements includes:

- removing precast concrete elements from moulds
- transporting precast concrete elements to temporary storage
- moving precast concrete elements from temporary storage and loading for transportation
- loading precast concrete elements onto the means of transportation (eg a trailer)
- transporting by road, rail or over water
- moving precast concrete elements from the transportation to temporary site storage
- moving precast concrete elements from temporary site storage.

9.3 The handling process

HSWA requires that workers handling precast concrete are adequately trained or supervised to carry out all required tasks. This may include:

- slinging
- using any lifting devices (eg gantry cranes)
- moving precast concrete elements without causing harm or injury to themselves or others.

The handling process depends on the:

- position of the casting mould (that is, vertical vs. horizontal casting)
- minimum concrete strength for demoulding, delivery and erection
- adequacy of the design reinforcement to resist handling stresses
- size and weight of the precast concrete element
- number, size and location of lifting points and type of anchors
- lifting method, type of lifting equipment and crane capacity
- support points for storage and transportation.

To avoid excessive stress or damage, handle precast concrete elements appropriately for their shape and size. Minimise the chance of precast concrete elements colliding with one another.

Different sets of lifting points and cast-in devices may be used for various handling stages.

Concrete strength for handling

The precast manufacturer may use a Manufacturer's Statement of Compliance to confirm the concrete strength to the person transporting and/or erecting precast concrete elements. The concrete strength may be determined by crushing a sample of cylinders from the same mix, historical records, or impact hammer tests. Concrete test cylinders should be stored close to the precast concrete element so that they are kept in exactly the same conditions.

Poor curing conditions (such as letting concrete dry out, or prolonged cold weather) can slow the strength gain of concrete.

To minimise the risk of damage during handling:

- remove precast concrete elements from moulds only after the concrete strength has reached the minimum strength required for lifting
- a competent person should give approval before a precast concrete element is lifted.

Provide temporary bracing or strongbacks for precast concrete elements where required.

Avoid multiple handling and relocation

A precast concrete element could be damaged every time it is handled or moved. The erection sequence should minimise multiple handling. See Section 10 of these guidelines for information about erecting.

Careful planning and scheduling will reduce the need to handle and relocate precast concrete elements. WorkSafe recommends lifting precast concrete elements into their final position when they are delivered, rather than putting them in temporary storage on-site.

Talk with the head contractor before handling or relocating a precast concrete element. Make sure all control measures for safe handling, storing and transportation are in place.

If multiple handling is necessary, use the method that will require the least number of moves. For example, stack precast concrete elements as near as possible to their final positions.

9.4 Storing, stacking and securing

Incorrect stacking and storage – even for a short time – can damage precast concrete elements. The damage may not be obvious right away.

Storing or supporting precast concrete elements the wrong way can cause permanent deformation that makes elements unusable. A competent person (such as an engineer) should:

- decide how precast concrete elements are stored
- design and certify racking systems.

The design of storage and transport frames should meet standards outlined in:

- NZS 3101: New Zealand concrete structures standard series
- NZS 3404: New Zealand steel structures standard series
- AS/NZS 1170 series: New Zealand structural design actions standard series.

Store precast concrete elements on suitable supports on firm, level ground that is not likely to collapse under the weight of the elements. The ground conditions in the precast yard or on the site will influence how high the elements can be safely stacked. Wind zones may affect the stability of stored elements. Stability can also be affected by heavy rain, which may soften the ground.

Obtain approval from a competent person before storing a precast concrete element on a suspended floor slab or beam.

Precast concrete elements should not be stacked at a height that could make the stack unstable, particularly if uneven settlement could cause the stack to lean.

Stack precast concrete elements of similar length together, to avoid the need to climb onto stacked elements to secure chains or other means of lifting. Consider how high a person can reach to pass lifting chains or slings around the elements.

If precast concrete elements are stored in areas where vehicles are moving, protect the elements with bollards or other physical barriers, and provide appropriate warning signs.

If support points are critical for stacking precast concrete elements, transport or long-term storage, the locations for dunnage or support should be noted on the shop drawings or on the precast layout drawing. 'Dunnage' (see below) is the term used to describe timber or other material used as bearers under or between precast concrete elements.

When stacking precast concrete elements, run bearers at 90° to the span of the floor on which they are placed. When possible, place bearers above the wall supporting the precast flooring.

When storing multiple precast concrete elements, follow any specific instructions. For example, manufacturers may specify the maximum number of items in a racking or storage system, or the maximum weight of stored elements.

Avoid placing further loads on floors already carrying stacked components (eg bricks, blocks, or other building materials).

Place precast concrete elements that have details (eg holes) at the top of stacked elements, or stack them separately, to prevent damage.

If infill blocks are not loaded on pallets, stack them on sheet plywood or similar material to prevent fracture. Place infill blocks above the bearing walls, or in a similar location, to ensure good load distribution. They should not be stacked at mid-span.

Dunnage

In these guidelines, 'dunnage' means timber or other material used under or between precast concrete elements to prevent damage or instability during storage and transportation, or to allow access for unloading or handling.

Precast concrete elements should be separated by suitable dunnage to:

- keep elements off the ground
- allow access between units to fit lifting forks or strops
- prevent damage from concrete-to-concrete contact.

Arrange dunnage to avoid twisting or distorting the elements.

Each level of dunnage in a stack should be directly over the dunnage beneath, so the weight of all elements is transferred directly through the dunnage to the ground. The bottom level of dunnage should transfer the load to the ground or whatever surface it is on without overloading it or causing excess settlement or deflection. Settling can crack some types of precast concrete elements.

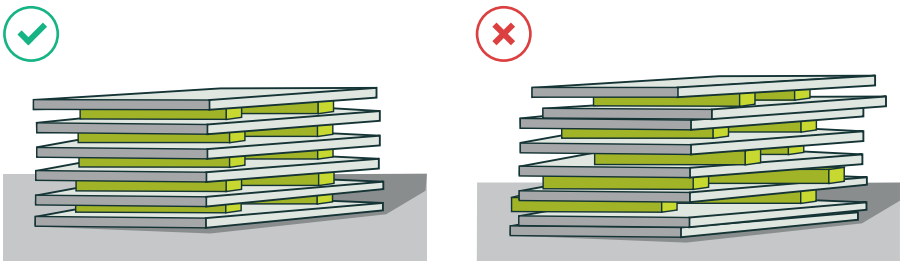


FIGURE 5: Stack and store precast concrete elements correctly

Precast concrete elements will cure at different rates when stacked, which may result in temporary staining or discolouration that could take some time to fade. Use non-staining materials for dunnage on surfaces that will be visible in the finished structure.

Stack and store correctly

Stack and store precast concrete elements correctly to avoid damage and distortion.

Elements stacked on the ground have to be supported at appropriate locations. Prestressed elements in particular can be damaged if supported inappropriately.

Store precast concrete elements so that they retain their correct shape and appearance. If elements are out of shape while stored, or stacked incorrectly, even for short periods, concrete creep can cause permanent distortion. Even minor misalignment can make elements unusable.

The younger the age that precast concrete elements twist, deflect or deform, the greater the permanent creep deformation.

Time in storage can increase cambers of eccentrically prestressed elements to unacceptable levels.

If unplanned storage is needed, PCBUs should agree together on an acceptable storage method and location. If the precast concrete elements are to be transported to storage, be clear about the type of elements to be transported and check that the transport will be fit for purpose.

STORAGE: WHAT TO CONSIDER
Have PCBUs storing precast concrete elements on-site consulted, co-operated and co-ordinated with each other about: – storage design? – what the elements will be bolted to? – what the elements will be landing on? – how the elements will be protected during storage? – how the elements will be protected from being knocked over? – how often the elements will be lifted or moved prior to final placement?

TABLE 16: Storage: What to consider

Storage racks and frames

An engineer should approve design of all static storage racks and frames used to store or transport precast concrete elements, including ‘toast racks’ and A-frames.

Storage racks, frames and supports should be designed for the shape, size and weight of the precast concrete element, and to resist the loads and forces applied to them. Design should consider wind zones and ground conditions, and refer to the latest version of the following standards:

- New Zealand concrete structures standard (NZS 3101)
- New Zealand steel structures standard (NZS 3404)
- New Zealand structural design actions standard (AS/NZS 1170)
- The appropriate standard for the materials used.

Frames used to support precast concrete elements during transport, whether they are part of the transport vehicle or an add-on, should be secured to the truck or tray to prevent movement during transport. Frames should be secured and designed to withstand any forces applied during loading, transport and unloading.

Figure 6 shows a typical A-frame.

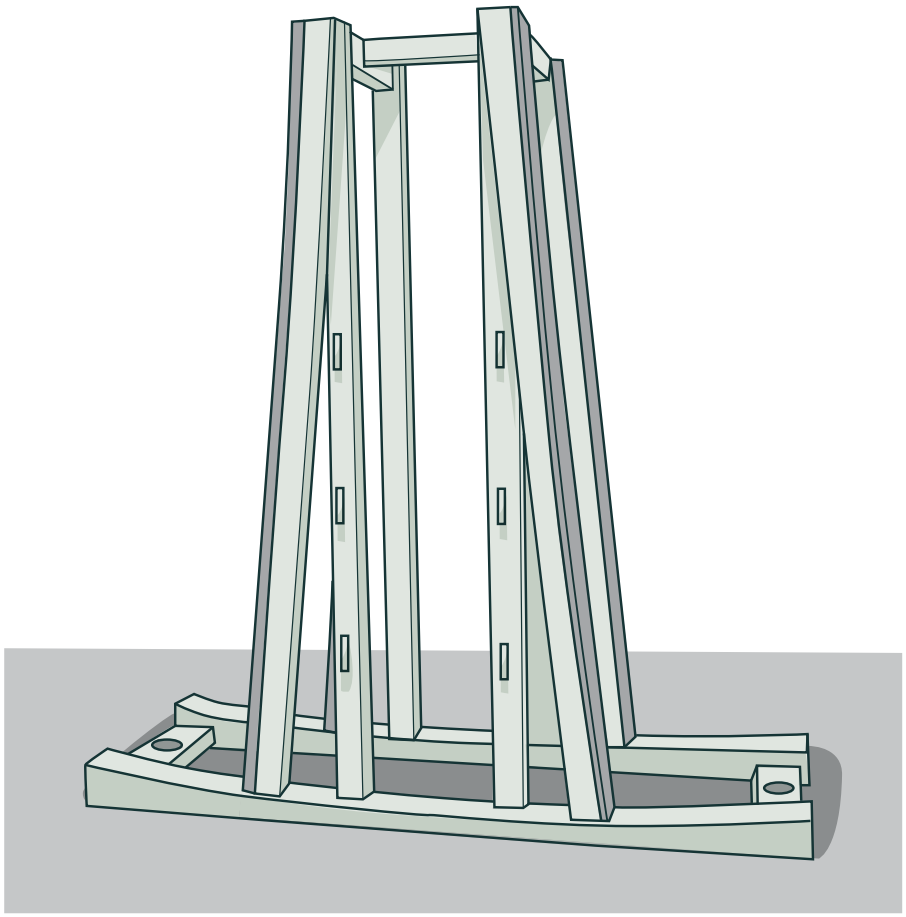


FIGURE 6:
A typical A-frame

A competent person should construct racks and frames, and complete annual certification requirements. They should check that racks and frames will remain stable when precast concrete elements are placed on them.

Workers loading the rack should be able to see, or quickly access, the certificate and rating. The certificate should show:

- the loading and configuration used as the basis for design
- maximum load capacity/rating – and any restrictions
- maximum size and weight of individual precast concrete elements that can be stored
- whether work can be done on the elements while in the racks
- limits on ground slope, if relevant
- required ground strength, if relevant.

Some racks used for on-site storage can also be put on the back of trucks. If so, this should be specified within the transport requirements. Note that A-frames designed to hold precast concrete panels in a yard in a static environment have totally different loading stresses applied to them when used for transportation.

Rack lifting points should also be rated and certified by a competent person. People loading the rack should have quick access to this certificate and rating.

WorkSafe recommends that a Job Safety Analysis (JSA) or similar process is carried out before loading and unloading precast concrete elements into and out of racks and frames.

Only work on precast concrete elements in a racking system when:

- no-one can be injured by falling elements
- there are no other significant hazards, such as other people working near the storage area.

Where a precast concrete panel is to be supported by a frame but will not bear onto both feet of the frame, particular care is required to ensure the frame remains stable.

Make sure the frame is not destabilised by overloading on one side at any stage during loading or unloading.

9.5 Transporting

Selection of a suitable transport operator

A transport operator transports precast concrete elements from the production facility. The transport operator may be part of the manufacturer's organisation, the customer organisation, or a third party contractor.

A suitable transport operator will have:

- the appropriate Transport Service Licence (TSL)
- appropriate vehicles and equipment
- compliance with NZTA requirements
- documented standard operating procedures (SOPs)
- documented staff training
- industry experience transporting precast concrete elements.

Transport operator's responsibilities

The transport operator is responsible for:

- planning the delivery route
- planning for contingencies
- obtaining any permits needed
- communicating with the supplier and delivery site
- safely securing the load for transportation
- transporting the precast concrete element from the precast yard to the delivery site.

New Zealand Transport Agency (NZTA) compliance

The transport operator should be familiar with NZTA requirements:

- Land Transport Act 1998
- Land Transport Rule: Heavy Vehicles 2004
- Land Transport Rule: Vehicle Dimensions and Mass (VDAM) 2016
- Land Transport Rule: Work Time and Logbooks 2007
- *The Official New Zealand Truck Loading Code*
- *Load Pilot Driver Code 2017*
- *Code of Practice for Temporary Traffic Management (CoPTTM).*

If precast concrete elements will be cast off-site, the designer should consider NZTA authority limits on length, width, height and weight, and available transport equipment.

The Land Transport Act 1998 sets limits to the work time hours for a driver of a vehicle that requires a class 2, 3, 4, or 5 licence, or is used in a transport service (other than a rental service), or carries goods for hire or reward. For example, when truck drivers or mobile crane operators are driving to and from a site, PCBUs must allow time for the required rest breaks. See the NZTA website for information about work time and logbook requirements.

Plan ahead

Safe transport and delivery of precast concrete elements requires planning and co-operation between PCBUs, particularly the transport operator, the head operator and the erector.

Notify the transport operator about transportation and delivery requirements, as well as any limitations, so that suitable vehicles and drivers can be scheduled.

The following factors need to be taken into consideration to ensure the stability of the load on the vehicle:

- mass
- mass distribution (that is, the location of the centre of mass)
- height
- width
- length.

The dimensions of the precast concrete elements must include the length of all protruding reinforcing steel.

These factors will also determine the need for a load pilot(s) to accompany the transport vehicle, and the requirements for any overweight and/or overdimension permits.

Confirm that the precast concrete element has reached sufficient strength before transportation. Consider specific design components that may affect transportation, including:

- the stability of long or unusually shaped elements
- the need for strongbacks (see Section 6.6 of these guidelines)
- the need for transport supports (eg a device, beam or girder temporarily fixed to a precast concrete element to give it extra support and/or provide stability during transport).

Vehicles and trailers

Although a purpose-built trailer should be the first choice for transport, precast concrete elements are not always transported on specialised trailers. Flat panels such as flooring, and stairs, are usually transported on a standard flat-deck vehicle. See Figure 7.

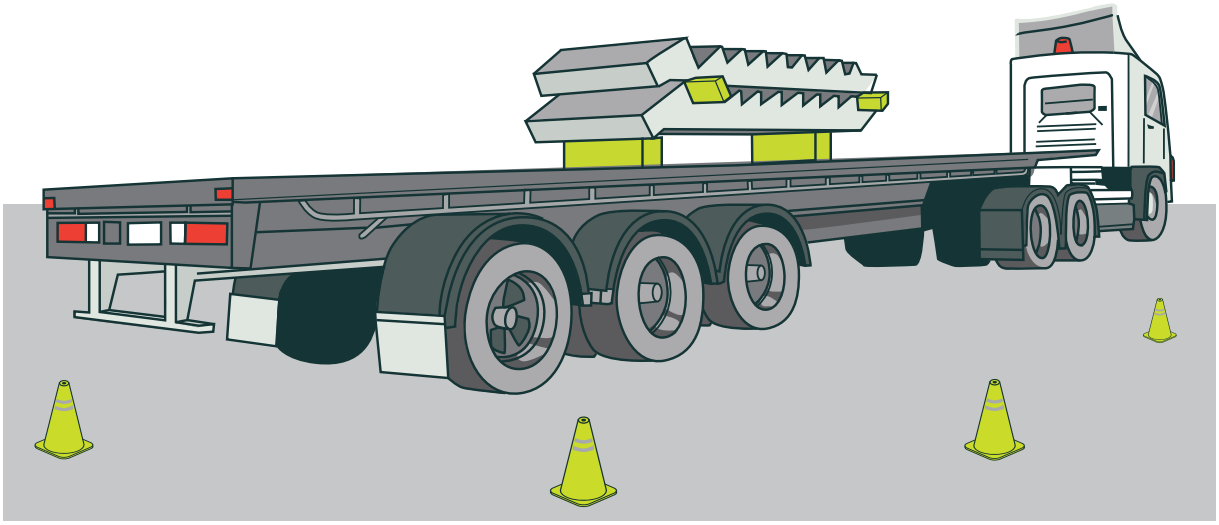


FIGURE 7: A standard flat-deck trailer

Figure 8 shows a typical A-frame trailer that may be suitable for carrying precast concrete panels.

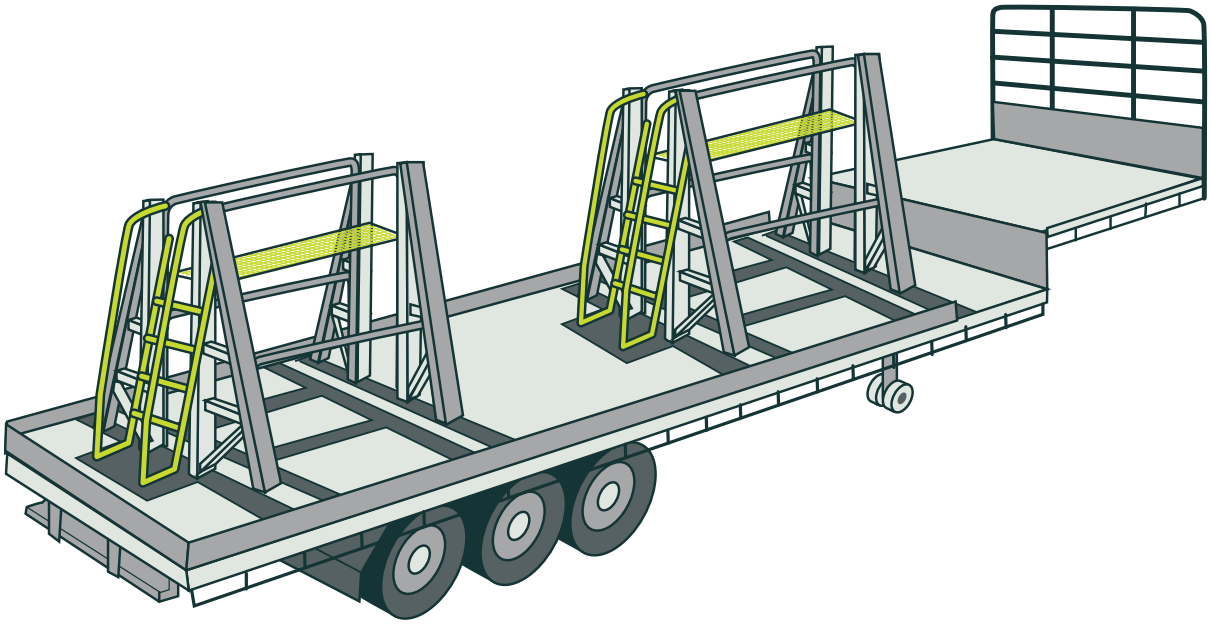


FIGURE 8: An A-frame trailer

Purpose-built trailers have a significantly lower centre of gravity as the precast concrete panels sit either in a well in the centre of the trailer or on an outrigger on the side of the trailer. This lowers the centre of gravity of the vehicle and the load. A lower overall centre of gravity results in a more stable vehicle.

Figure 9 shows a purpose-built super-low loader with a rear-loading U-shaped chassis to carry tall precast concrete panels. The panels are secured within the body by hydraulic clamps.

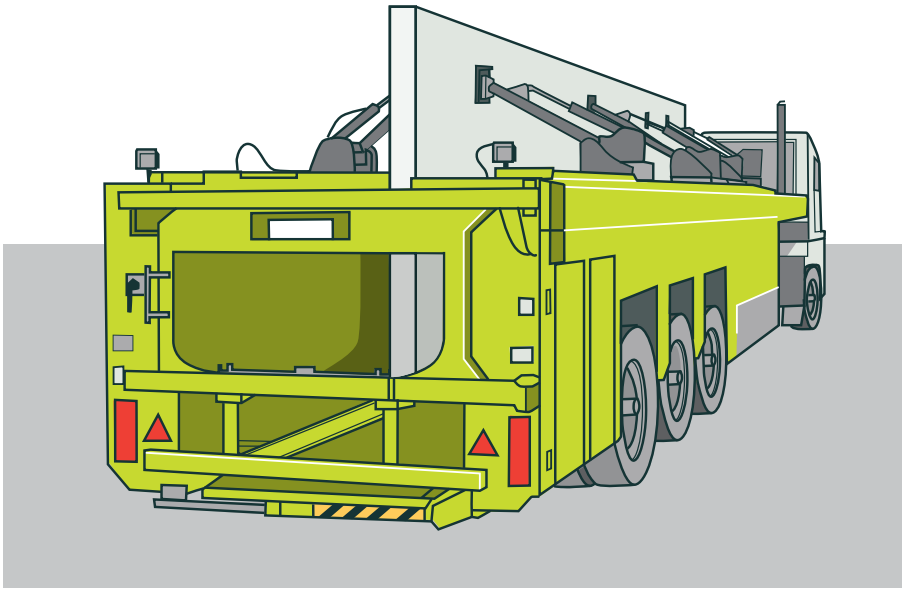


FIGURE 9:
Purpose-built super-low loader with rear-loading U-shaped chassis

Figure 10 shows an inverted A-frame trailer, also known as a porcupine trailer.

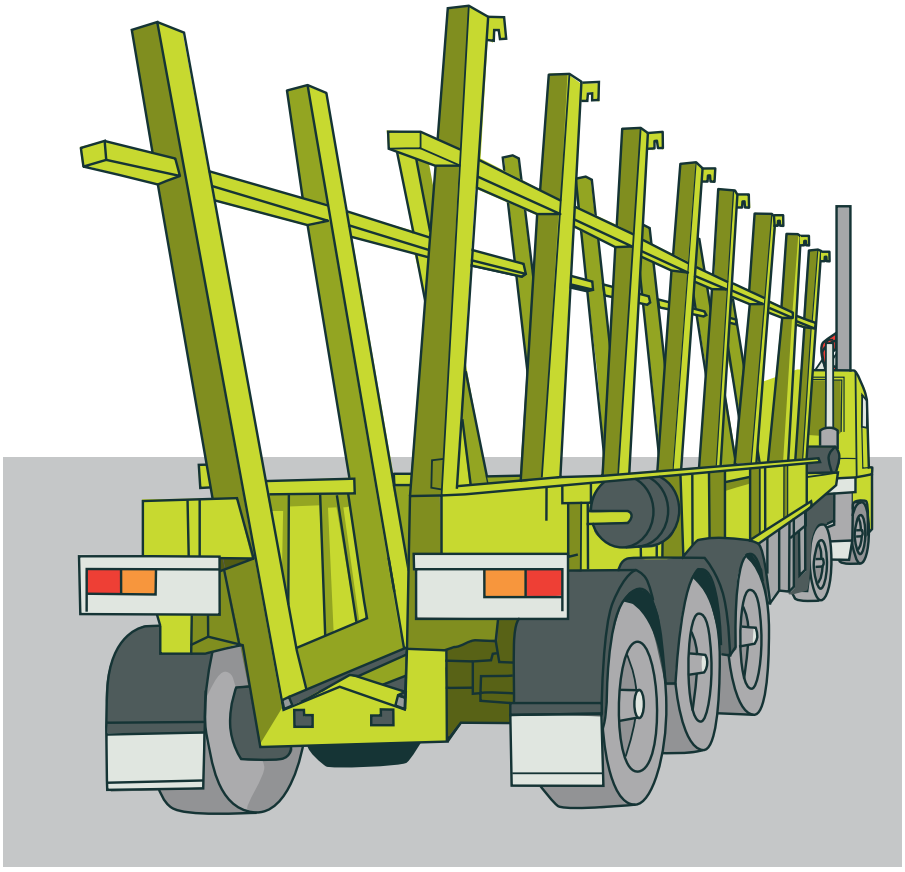


FIGURE 10:
Inverted A-frame trailer (porcupine trailer)

Plant and equipment

Plant and equipment used during transport includes:

- trucks, trailers, fork hoists, cranes and other lifting devices
- slings and lifting chains
- storage racks, frames and supports (including A-frames and vertical storage racks)
- dunnage (see Section 9.4 of these guidelines)
- load restraints (such as chains and load binders).

TRANSPORTATION: WHAT TO CONSIDER

Transport operator
Has the transport operator considered:
– equipment needed?
– truck requirements and availability?
– permits required?
– transport routes, taking account of:
  - bridges?
  - winding roads?
  - power lines – on the way to the site, as well as on the site itself?
– recognised routes for over-dimensional loads?
– differential road cambers (bends, rises etc) that may cause instability through leaning, or distortion in long concrete elements?
– size, shape and weight of load/s?
– weight distribution and load stability?
– loading arrangements, including any load restrictions?
– loading system (eg racks or A-frames)?
– methods to adequately fix and secure precast concrete elements to prevent movement during transportation?
– how to avoid high impact loads on precast concrete elements?
– site access limitations?
– a site-specific traffic management plan?
– delivery sequence and timing?

Drivers Are drivers: – trained to transport precast concrete elements? – aware of hazards, risks and control measures? – aware of any documentation they need to have before loading? – clear about who will give them any required documentation, and what they need to do with it? – clear about the delivery transport plan? – inducted into supplier and delivery sites? **Note**: see also Table 19

TABLE 17: Transportation: What to consider

Site-specific traffic management plan

The head contractor on the construction site should, as part of the HSMS, provide a site-specific traffic management plan. The head contractor on the construction site should ensure that the traffic management plan is available on-site at all times when work is being carried out.

Before entering the site, a driver should consult the traffic management plan.

SITE TRAFFIC MANAGEMENT: WHAT TO CONSIDER
Does the site traffic management plan include: – layout and traffic flow on-site? – designated areas for loading, unloading, reversing, turning around? – a designated safe area for drivers while loading/unloading takes place? – speed management? – access under power lines; clearance required from power lines during lifting? – the shape, size, height and mass of the precast concrete elements? – other activities on-site when the precast concrete elements are being transported? – other vehicles on the site? – on-site safety of workers and other persons (eg the public)? – all-weather access for the delivery vehicle? – any permits needed (eg road closures)? – the capacity of any permanent structures to carry transport loads? – provision for temporary storage, if required? – barriers, walkways, signs or other requirements to guide traffic?

TABLE 18: Site traffic management: What to consider

Loading and unloading

Vehicle loading must comply with NZTA's *The Official New Zealand Truck Loading Code*: nzta.govt.nz

A geotechnical report may be required for the loading zone, the unloading zone and the crane zone.

LOADING AREA

The loading area should be on firm level ground. Even a balanced load can tip over if it is on uneven ground.

LOADING

Load precast concrete elements so that:

- identification marks are visible before and during unloading
- unloading can be carried out in the proper sequence
- weight is evenly distributed, and the load is stable
- the vehicle is not overloaded
- the load is properly secured
- each element in a multiple-element load is individually secured.

UNUSUAL OR IRREGULAR SHAPES

A competent person may need to assess loading and restraint of precast concrete elements with unusual or irregular shapes, high or 'off-centre' centres of gravity.

SECURE AND RESTRAIN PRECAST CONCRETE ELEMENTS WELL

Any load carried on a vehicle must be sufficiently restrained to prevent movement caused by the forces described in NZTA's *The Official New Zealand Truck Loading Code*: nzta.govt.nz

Restrain precast concrete elements on transport vehicles so that:

- elements do not move while they are being transported
- each element is individually secured with a safety restraint to prevent it falling from the vehicle during unloading
- elements do not become unstable when the restraint system is released on-site.

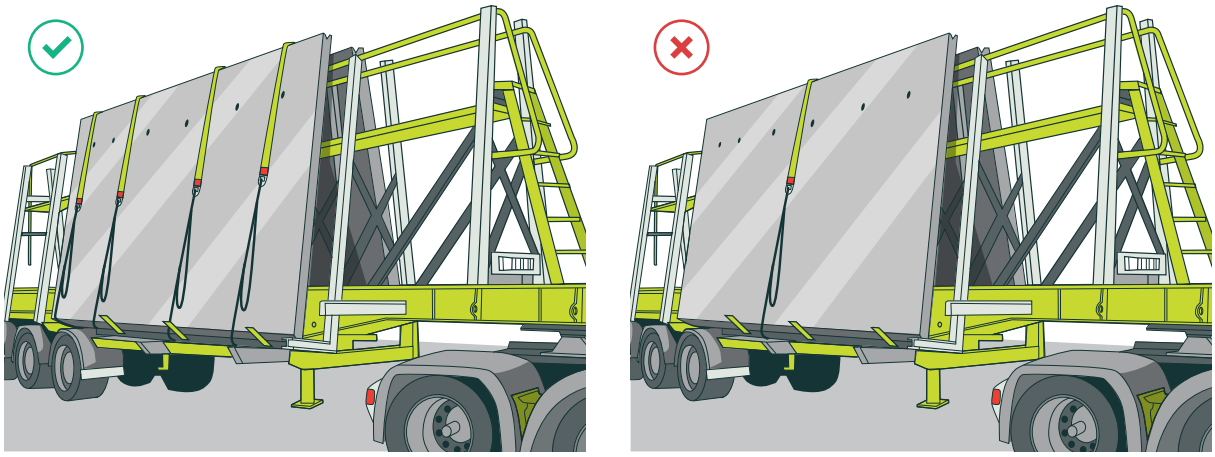


FIGURE 11: Loads must be well-restrained to prevent movement

The restraint (eg chains, webbing straps) used should meet the requirements of *The Official New Zealand Truck Loading Code* and suit:

- the type and size of precast concrete elements being transported, and
- the type of vehicle being used.

For example, precast concrete pipes which can be loaded safely within the legal load width limit or overdimension general permit should be loaded across the vehicle, as shown in Figure 12[8]. For more information about positioning and transporting concrete pipes, see *The Official New Zealand Truck Loading Code*: nzta.govt.nz

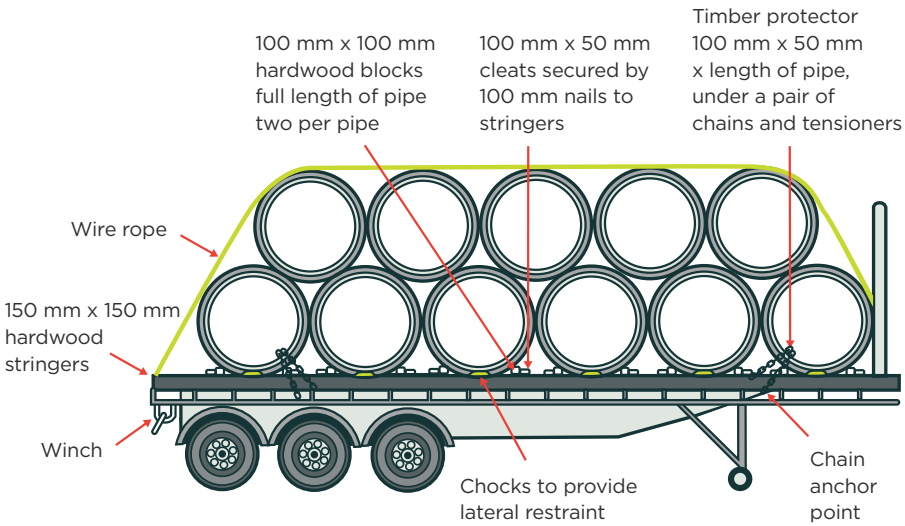


FIGURE 12: Concrete pipes – loaded crosswise

[8] Image reproduced with permission from NZTA.

Consider whether special restraints or packing are needed:

- for long precast concrete elements, especially when transporting over large distances
- for unusually shaped elements
- for overdimension loads
- to protect corners, sharp edges, or other details
- to protect infrastructure (eg overhead wires).

Workers should not detach restraints until the vehicle has stopped in the area agreed for unloading.

If a vehicle is required to be moved during unloading, all remaining precast concrete elements on the vehicle must be restrained to meet the requirements of *The Official New Zealand Truck Loading Code* and the requirement for an individual safety restraint on each element.

UNLOADING

The head contractor and the transport operator should together decide the most suitable unloading sequence. Consider:

- how the precast concrete elements were loaded
- how the elements will be unloaded to avoid causing instability:
  - of the delivery vehicle
  - of its load.

Check whether there is:

- a designated unloading area
- an exclusion zone around the unloading area (to prevent people who are not involved in unloading from entering the area).

Keep precast concrete elements restrained until their weight can safely be taken by the crane. Do not release any safety restraint until the crane has taken the initial load of that element.

The precast concrete element must not be lifted from the vehicle until the driver is in the designated safety area. This is a marked area where people can safely stand while a vehicle is being loaded or unloaded.

CHECK FOR DAMAGE

Look closely at the precast concrete elements to check that they were not damaged during transit. Record and report any damage found.

Driver's responsibilities

The driver should be trained and competent to manage the risks and hazards associated with transporting precast concrete elements. The transport operator must provide information, training, instruction or supervision for drivers.

Transporting precast concrete elements by road may create dynamic loads that cause the elements to shift. Once the elements are loaded on the truck the driver should make sure they are well-secured to prevent movement during transit.

Restraints tend to loosen once the load settles and can also stretch (particularly webbing straps). The driver should stop, in a suitable safe place, and check the load and restraints:

- shortly after beginning the journey, and
- again at further intervals, if travelling for more than one hour.

Make sure any surface the vehicle is going over is suitable. Transporting precast concrete elements over rough ground can damage them if they are exposed to dynamic loads higher than they were designed to handle. The ground should be strong enough to stop the wheels settling, and any slope should not make the vehicle or its load unstable.

Vehicles should be able to travel safely on the access provided at the delivery site. If a driver is concerned about the safety of the site access they should stop and contact their supervisor.

DRIVERS: WHAT TO CONSIDER
Has the driver: – checked that access is suitable for the size and weight of their vehicle? – checked that all road surfaces are suitable for vehicles to drive on, including the loading site and the delivery site? – confirmed whether the road shoulder is able to support the load? The load can roll if the driver pulls over to let cars pass and the shoulder cannot support the load. – been made aware of identified hazards (eg soft ground, uncompacted fill or overhead obstructions)? – asked for and received any documentation that relates to the element? – obtained a signature on the Proof of Delivery (PoD) document?

TABLE 19: Drivers: What to consider

9.6 Site access, conditions and limitations

Before a vehicle arrives on a work site, PCBUs (eg the transport operator and the head contractor on the construction site) should refer to the site traffic management plan and then agree on access to and around the site.

The driver should refer to the site traffic management plan before beginning the delivery journey.

ON-SITE ACCESS: WHAT TO CONSIDER
Has the head contractor on the construction site together with all relevant PCBUs: – confirmed that traffic control is in place and operating? – confirmed suitable access for the delivery vehicle(s)? – identified hazards (eg trees, power lines)? – identified risks? – identified areas where access should be restricted? – confirmed if temporary on-site storage is needed? – confirmed all loads can be accommodated – including delivery loads, placing and erecting loads? – checked: - soil strengths? - adequacy of site concrete to resist loads? – made sure all relevant workers know the erection sequence? – received (if required/available) the Manufacturer's Statement of Compliance for the precast concrete elements being delivered, confirming the elements have been manufactured in accordance with contract requirements? – checked the weather forecast for the site during the scheduled delivery time?

TABLE 20: On-site access: What to consider

10.0 Erecting

IN THIS SECTION:

Safe erection of precast concrete elements depends on careful planning. All people working with precast concrete should be aware of the risks.

Failure to erect precast concrete elements correctly and safely can result in life-changing injuries or death.

A PCBU must ensure, so far as is reasonably practicable, the health and safety of workers, and that other people are not put at risk by its work. 'Reasonably practicable' means a PCBU does what is reasonable in their circumstances to ensure health and safety.

Section 43 of HSWA specifies the duty of a PCBU who installs, constructs or commissions plant or structures.

10.1 What could go wrong?[9]

WHAT COULD GO WRONG?	POSSIBLE CAUSES
Precast concrete elements falling or collapsing and causing severe crush injuries (eg the uncontrolled collapse of elements, or a person being caught between an element and another object)	– Structural collapse. – Failure of temporary works. – Inadequate structural capacity of foundations. – Precast concrete elements have been damaged or weakened (eg by modifications or repairs). – Adverse or extreme weather conditions including strong wind and heavy rain (eg wind speed may exceed specifications for the safe erection of precast concrete elements; wet weather may cause instability in the crane platform or erection area).
The rigging fails resulting in the panel falling	– Rigging design of insufficient capacity. – Damaged or incorrectly assembled rigging. – Lifting in a way that causes the rigging to fail.
Underground and overhead services and structures (eg underground cables, water, gas or sewage pipes, overhead power lines) are contacted or damaged during erection resulting in injuries, electric shock, or death	– Crushing underground cables, water, gas or sewage pipes during digging of foundations. – Striking overhead power lines when moving a precast concrete element. – Referring to outdated service mark-outs.

[9] There may be hazards that are not identified in this table. You will need to identify and assess health and safety risks arising from your own work.

WHAT COULD GO WRONG?	POSSIBLE CAUSES
Workers suffering musculoskeletal injuries (eg sprains and strains, back injuries, abdominal hernias) when handling precast concrete elements (eg when lifting, lowering, pushing, pulling, carrying, throwing, moving, restraining, or holding elements)	– Using inappropriate techniques when handling precast concrete elements (eg not using the right equipment for the job).
Workers being exposed to substances harmful to health at unsafe levels	– Handling precast concrete elements that are still contaminated with substances commonly used in precast concrete work including curing compounds and release agents.
Workers falling from height when erecting precast concrete panels	– Not using appropriate equipment to reduce the risk of a fall. – Equipment not being inspected or well-maintained.
Objects falling from height onto workers	– Unrestrained objects (eg tools).
Vehicles injuring workers	– Inadequate site traffic management plan. – Lack of designated loading/unloading areas. – Insufficient lighting; vehicle not easily seen or heard (eg no rotating light, no reversing alarm). – Vehicles that are not well-maintained. – Inexperienced or untrained drivers.

TABLE 21:
Erecting:
What could go wrong

10.2 Duty of erector

As an upstream PCBU, the erector has a duty to, so far as is reasonably practicable, make sure that any plant or structure they install or construct is without health and safety risks.

Read Section 43 of HSWA in Appendix P of these guidelines to find out about the specific duty of an erector (as a PCBU who installs, constructs or commissions plant or structures).

10.3 Role of erector/erection team (installer)

The erector:

- works with the precast manufacturer, the head contractor and the competent person responsible for erection design (see Section 6.3 of these guidelines) to decide on the erection sequence and safe work practices
- produces and briefs erection crews on the HSMS
- inspects precast concrete elements, reviews the Manufacturer's Statement of Compliance (if provided), and reviews erection plans/rigging drawings
- confirms clutches are compatible with anchors and inspects all rigging gear prior to use (eg face-lift clutches should be used on face-lift anchors)
- erects precast concrete elements and installs temporary bracing
- checks torque on brace connection bolts where applicable
- checks lifting anchors and surrounding concrete for wear and damage, and suitability for lifting
- ensures the precast concrete elements are secured in accordance with the erection plan before handing over to the head contractor

- monitors weather conditions and takes any necessary actions; high winds, heavy rain or other events may cause problems during erection.

Any variations or modifications to the erection sequence should be approved by a competent person.

10.4 Erection planning

Erection crew

The head contractor should ensure compliance with any relevant regulations when putting together an erection crew for handling and erecting precast concrete elements. The erection crew should include:

- an erection crew supervisor responsible for safety, rigging, placement, propping and unhooking
- a competent crane operator
- a competent dogman/rigger.

Holding a national certificate is one way of demonstrating competency.
A person with dual qualifications may function as both a rigger and a dogman.

Additional skilled labour may be needed to help with precast concrete erection or placement.

A supervisor or competent person from the erection crew (such as a rigger) should be responsible for directing and co-ordinating the erection sequence.

Assign enough people to each job, taking into account the weight and distance involved.

Planning the construction and erection sequences

Before erecting precast concrete elements, the head contractor should work with other PCBUs to plan the construction and erection sequences.

The erection crew needs information about how the precast concrete elements will be handled on-site, including special rigging requirements, temporary propping requirements, and any handling restrictions.

Planning for safe erection of precast concrete elements should cover, but not be limited to:

- hazards, risks and control measures
- work plans and HSMS
- casting and delivery sequence
- erection sequence
- lift plan
- site limitations and features, such as:
  - street access
  - overhead obstructions, particularly overhead power lines at or adjacent to the site
  - suspended surfaces and basements
  - underground services
- compaction of site surface areas
- precast concrete element sizes
- crane size, configuration, mobility and access
- working radius of the crane (shown on a crane layout drawing)

- sign-off for shore loading by a competent person
- visual inspection of rigging and all associated equipment
- height access equipment appropriate to the construction methods
- structural stability during erection, including propping and bracing requirements (eg length)
- transport requirements.

ERECTION PLANNING: WHAT TO CONSIDER
Erection plan coverage – Does the erection plan address all aspects of the erection procedure?
Site conditions – Is the site clear and safe for all vehicles (including counterweight trucks) and crane/s access and assembly? – Is there a compacted hard-fill ramp at a suitable gradient? – Is a traffic management plan in place? – Are the weather conditions suitable for erection?
Crane operating area – Has the crane operating area been cleared to provide enough room for: - crane outriggers? - counterweight tail swing? - slew path and under hook height? - overhead obstructions, including overhead power lines? – Can the crane platform support the loads imposed by the crane during operation? – Has an exclusion zone been set up?
Supports, props, braces and restraints – Are support methods, including falsework: - adequate? - in the correct location? – Is there enough clear space for safely propping and bracing precast concrete elements? – Have locating dowels/other horizontal restraints been fitted before final placement of elements? – Are the recommended braces fitted to the precast concrete elements? – Have brace foundations reached their required strength before precast concrete panels are erected? – If strongbacks are required, are they correctly installed?
Other – Are control measures in place for safely working at height? – Are there enough properly trained erection crew members? – Is a Manufacturer's Statement of Compliance required?

TABLE 22: Erection planning: What to consider

10.5 Propping and bracing

The head contractor consults with the precast manufacturer and erection sub-contractors to decide what propping, bracing, on-site lifting and handling is needed, including any special lifting procedures.

The head contractor or the sub-contractors may also have special requirements for propping and bracing to ensure stability during construction.

Within the erection documentation, propping and bracing designs have to show the requirements for temporary supports.

The head contractor should monitor weather conditions. High winds, heavy rain or other adverse weather events compromise the ability of propping or bracing systems to resist loads. This may be due to loads being higher than allowed for in the design, or the capacity of support systems being reduced.

Props

A prop, whether custom-made or generic, is used to temporarily support a precast concrete element. Props are commonly used to support floors and beams.

Props may be needed to:

- provide temporary gravity load support during construction
- reduce the self-weight deflection of precast concrete flooring systems while the cast-in-place topping concrete is placed and cured
- prevent torsional instability or rotation of beams loaded along one edge
- provide fine adjustment of the precast concrete element to the correct level while freeing the crane for the next lift
- support temporary construction loads that exceed the design capacity of any part of the structure.

Unless specifically noted otherwise, all temporary propping should:

- be in place, adjusted to the correct levels allowing for any required cambers, and fully braced before beginning erection
- fully support all construction loads including the full self-weight of the completed floor system and possible local concentrations of load during construction.

Propping for beams should allow for possible changes to the load distribution during the construction process.

Permanent grouting or mortar packing of precast concrete element support points requires care and supervision to ensure that the requirements for strength and durability are met.

Braces

Braces are usually placed diagonally and firmly attached to provide stability and resist lateral loads. Lateral bracing is sometimes used to resist panel base movement, wind and other lateral forces. Braces may take the form of proprietary props (often adjustable), scaffolding, or specially designed components. If braces are to be connected to piles, then the piles should be designed to ensure the loads can be safely transferred to the soil. The dimensions are designed to allow for the connection of all anchor points and appropriate edge distances.

Other engineered systems, such as screw anchors, are available. Any proprietary system has to be designed to ensure the loads can be safely transferred to the soil.

Braces:

- may act in compression and in tension
- may have flexible end connections to adjust to different angles
- may or may not be adjustable in length
- are required to cope with cyclic loads
- are not generally used vertically
- prevent overturning and resist horizontal movement.

Braces should be designed, manufactured, inspected and maintained to a recognised standard, for example AS 3850.

Braces are commonly used when erecting precast concrete panels to resist wind and other loads until panels are permanently fixed. (Adjustable props are another form of support, typically used to support beams and floors.)

Brace connections should be designed with a factor of safety of 2.5 against failure. When post-installed drilled-in inserts are used to attach a brace, they should be designed with a factor of safety of 3.0.

Do not use deformation-controlled anchors for anchoring braces, because:

- they have no additional expansion (and therefore no load capacity) after the initial setting process
- they fail without warning and are highly sensitive to installation procedures.

Do not use bonded anchors that rely solely on chemical adhesion unless each fixing is individually proof-tested to the working load limit (WLL).

Adjustable braces should have:

- safe working loads available at zero and maximum extension
- stops on the threads to prevent over-extension.

Keep precast concrete elements **temporarily braced** until they are adequately restrained or incorporated into the final structure.

Unless deliberately designed and specified, bracing anchors should not be closer than 300 mm to the edge of the precast concrete element or the bracing support. The distance to the edge may need to be increased for larger elements, with instructions from a competent person.

Location of the bracing anchors should allow the braces to hang vertically during lifting without interfering with the lifting rigging. For the bracing anchor, a minimum horizontal displacement of 200 mm from the vertical line of the lifting anchors is acceptable.

Precast concrete manufacturers should not substitute any anchor types without written approval from a competent person.

Bracing anchor requirements and precast concrete element details should be shown on the shop drawings if cast-in at the time of manufacture.

Consider the **strength of the concrete in the brace footing** when designing bracing anchors for foundations. The concrete strength required at erection time has to be clearly specified on the erection plan.

Fix bracing to the precast concrete element **before lifting** (where possible). If braces are to be attached after the element is positioned, the crane should support the element while the braces are installed using an appropriate access system.

A **minimum of two restraints** should be used on precast concrete elements, unless clearly specified and detailed in the erection design documentation. Coupling elements together without restraints may be sufficient (subject to a competent person's approval).

Braces should be **attached to a flat surface** which is capable of withstanding the applied load.

Base restraint prevents a sliding failure (a panel kicking in or kicking out) during erection. There should be sufficient temporary base restraint to prevent a sliding failure at the base or support of the precast concrete element until the element is secured. Note that the panel weight may not provide base restraint.

Check that locating dowels and levelling shims are in the correct place.

Bracing must be installed **perpendicular** to the precast concrete panel in the plan, as shown in Figure 13 below. Skewed braces greater than +/-5 degrees to perpendicular will reduce concrete panel stability. The design and installation of skewed braces will need to be carefully reviewed to consider any induced lateral and torsional forces to the panel.

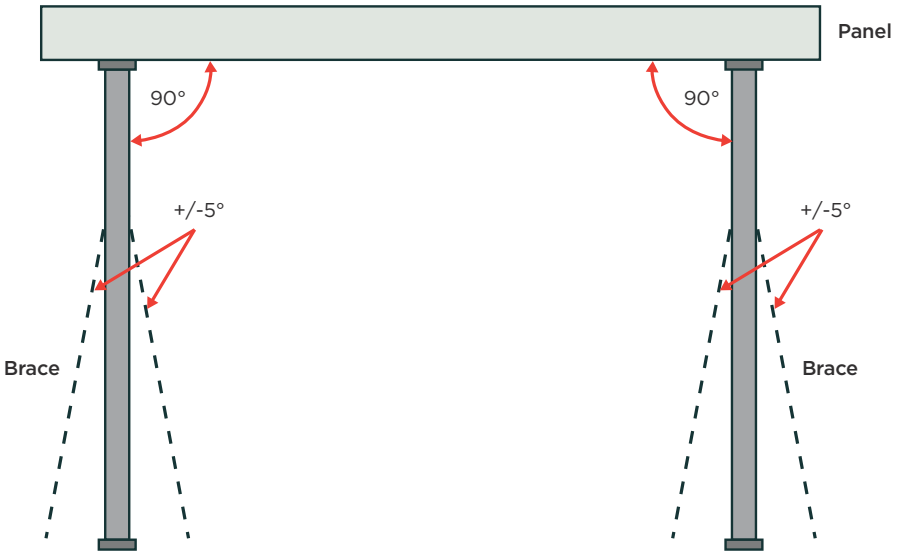


FIGURE 13:
Concrete panel bracing – panel view

IDENTIFICATION MARKS

WorkSafe recommends that braces have permanently fixed identification displaying the following information:

- the supplier
- the model
- the batch.

This allows the braces to be easily identified.

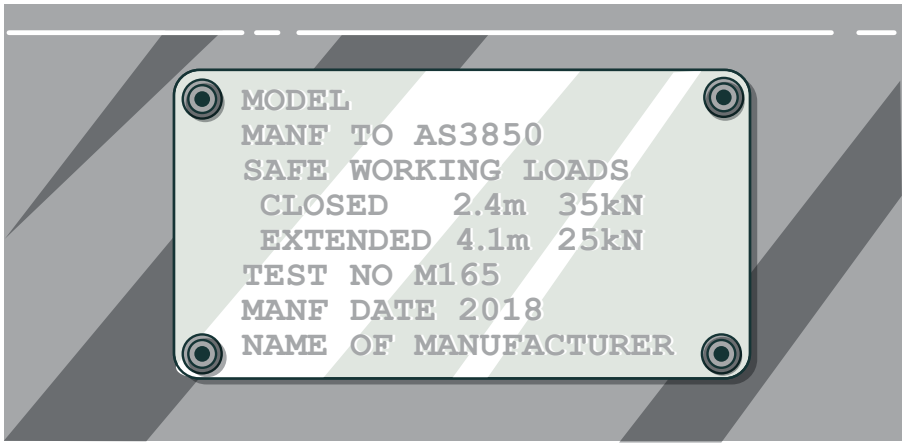


FIGURE 14:
Identification plates on bracing

DOCUMENTATION

Records should show how and when the batch was last tested.

The supporting documentation for the braces should be available on-site. It should include the following information:

- for fixed length braces, the working load limit (WLL), in kiloNewtons (kN)
- for adjustable length (telescopic) braces, the WLL, in kN, at maximum and minimum extension.

Check bracing regularly

After each use, braces should be inspected and maintained.

Check bracing immediately after any event such as an earthquake or storm. Ensure the fixings are still secure and the system still complies with the erection design.

Bracing should be inspected and approved by a competent person before work resumes. The competent person should check structural integrity, braces and connections, and fixing points.

Brace configuration

WorkSafe recommends using a minimum of two restraints to support each precast concrete element, unless the erection design documentation specifies that restraints are not required.

Precast concrete elements supported by a single brace may fail by rotating about that brace. One brace can be used where another part of the element is securely fixed to an existing part of a structure; however, this configuration needs to be specified by a competent person.

Three or more braces may be needed for larger precast concrete elements. Where more than two braces are used there is difficulty ensuring an even load distribution. The design should make allowances for the potentially uneven loading where more than two braces are being used.

It is common to use two braces at right angles for narrow wall panels or columns. When wall panels are tall and narrow, they may need to be braced with two braces perpendicular to their flat face and restrained by bracing in the other orthogonal direction for stability.

For wall panels, bracing points are typically ⅔ of the height of the panel from its base; see Figure 15. Bracing design should consider the effect of the vertical component of the brace load on the available friction at the base. Wall panels should never be braced below mid-panel height, unless carried out under strictly controlled conditions with special provisions having been made to prevent base kick-out or panel failure due to bending at the bracing point.

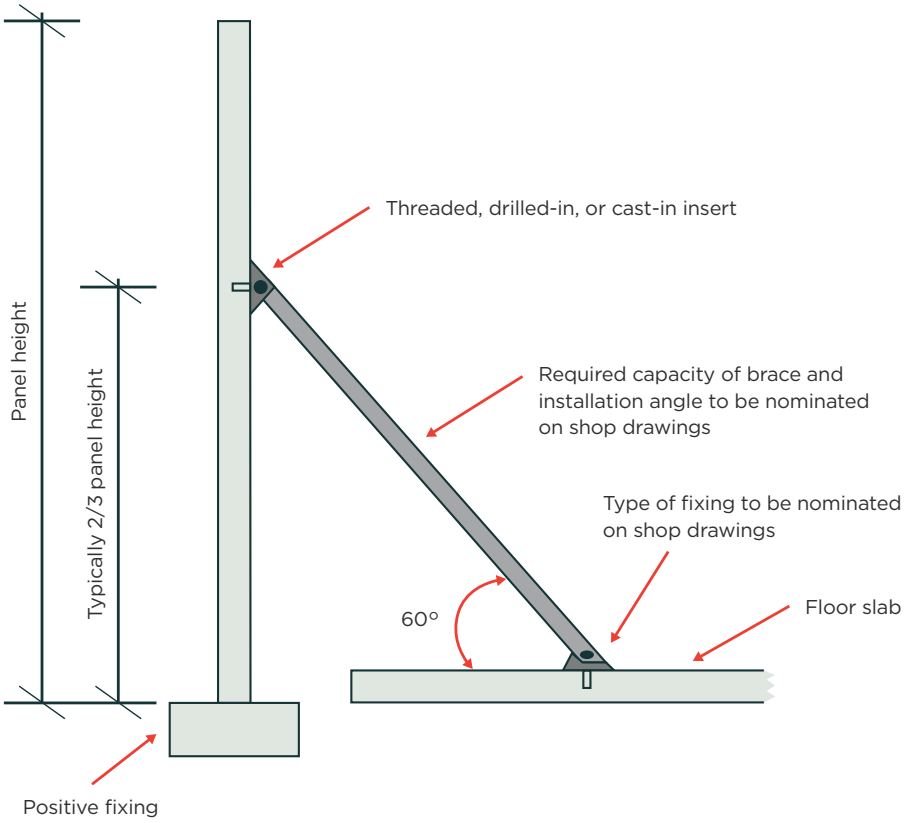


FIGURE 15: Concrete panel bracing points

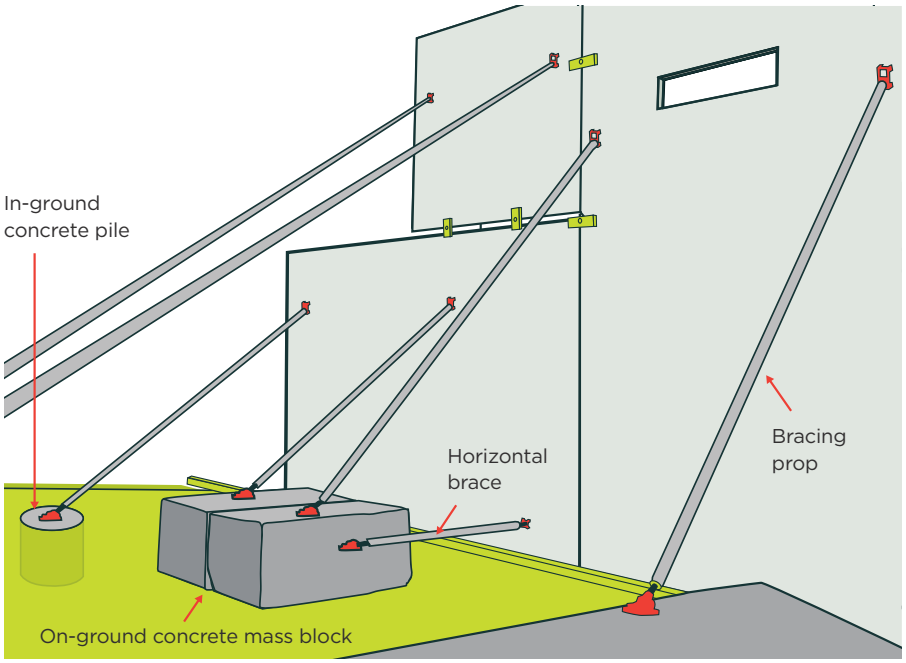


FIGURE 16: Panels and bracing props

Bracing anchors

Bracing anchors are used to connect the brace to the braced precast concrete element and the brace footing. They should be designed with a factor of safety of 2.5 against failure of concrete. If expansion anchors are used, capacity is based on a factor of safety of 2.5 against the first slip. If possible use cast-in anchors. Torque-controlled anchors can also be used.

Figure 17 shows one example of an expansion anchor acceptable for anchoring braces.

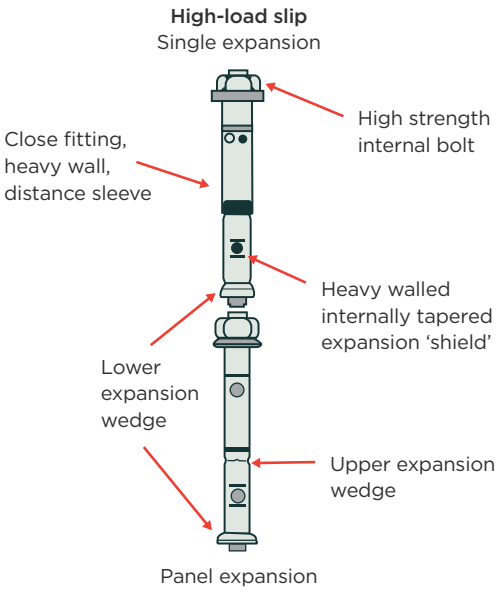


FIGURE 17: Example of expansion anchor

Expansion anchors are more prone to installation errors than cast-in fixings. Ensure the manufacturer's installation instructions are closely followed.

Post-installed fixing anchors used to connect braces should be a type known as 'heavy duty high load slip expansion fixing anchors', or 'load-controlled' where an increase in load results in increased wedging force.

Deformation-controlled fixing anchors, including post-installed fixing anchors and drop-in (setting) impact fixing anchors, should not be used as bracing anchors.

Bracing anchors should be designed to resist all reasonably foreseeable loads, including:

- construction loads
- wind loads for temporary structures in accordance with AS/NZS 1170.2.

Bracing anchor capacities are sensitive to the:

- method of installation
- strength of the surrounding concrete at the time of usage
- distance from the anchor to the edge of the precast concrete element as well as the distance to openings, recesses or edge rebates
- proximity to surrounding fixing anchors loaded concurrently.

Fixing inserts

The types of fixing inserts to be cast in to the precast concrete elements should be specified on the shop drawings. A competent person, such as an insert manufacturer or supplier, should approve any design changes. Any further modifications made on-site (such as drilling anchors not indicated in the plans) should only be done after consultation with a competent person.

For cast-in or post-installed fixings to brace foundations, the capacity of the fixing may be less than the capacity of the brace itself, requiring additional braces to support the precast concrete element. Using a fixing with higher capacities may avoid this.

Surplus concrete mass blocks

Concrete mass blocks, including those made of surplus concrete, may be used for a range of purposes on construction sites. For example, they may separate people from plant, or be used as part of a bracing system.

A concrete mass block is also one method for transferring lateral loads to the ground in conditions where floor slabs are not available to resist the brace loads.

If a concrete mass block is to be used within a bracing system, the designer of the bracing system should ensure that:

- the concrete mass block will be fit for purpose and fully meet the requirements of the bracing design
- the strength of the concrete mass block is suitable for:
  - the fixings used, and
  - the design forces applied by the bracing.

If a concrete mass block will not be cast in a single pour, and it will be used to resist bracing forces, the designer should recommend that it is reinforced.

A competent person must be satisfied that the integrity of the concrete mass block will not be compromised by poor construction joints between the different pours.

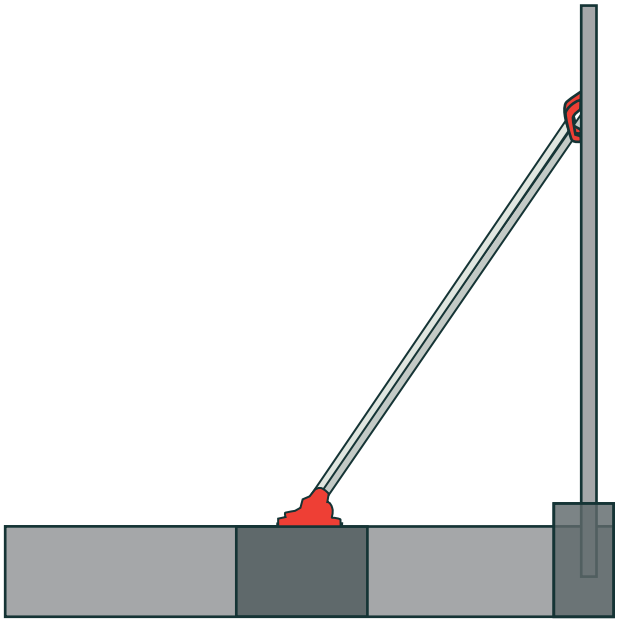


FIGURE 18:
Concrete mass block buried full-depth

If a concrete mass block is used as a bracing foundation for propping a precast concrete panel, WorkSafe recommends that it should be fully buried in the ground to prevent slippage, as shown in Figure 18.

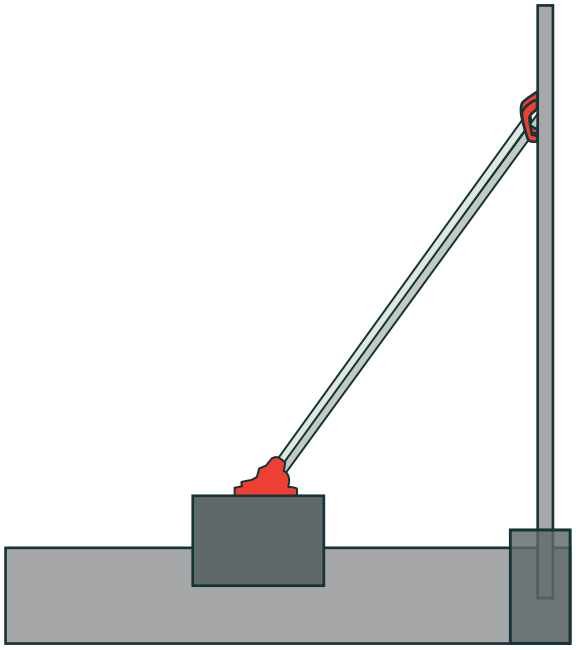


FIGURE 19:
Concrete mass block partly buried

If the ground conditions (eg soil over solid rock) are not suitable for full-depth burial, the concrete mass block should be partly buried in the ground to a depth that would prevent it from sliding under load, as shown in Figure 19.

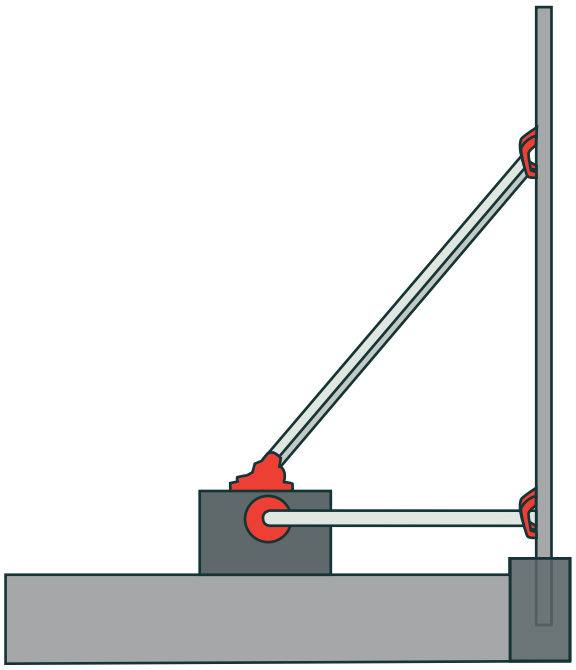


FIGURE 20:
On-ground concrete mass block with horizontal brace

If it is not practicable for the base of the concrete mass block to be fully or partly buried in the ground, it is good practice to use a horizontal brace to connect the base of the block to the panel. See Figure 20.

There is a risk that an on-ground mass block without horizontal bracing will slide when under load, causing the precast concrete panel to topple.

10.6 Levelling shims

Levelling shims carry the full load of the precast concrete element and any loads applied to it prior to permanent fixing of the element. Shims should be manufactured from a suitable durable material and be used on solid foundations.

A levelling pad (concrete footing) or a level bearing area is used to provide a level seating for the shims, as shown in Figure 21. Precast concrete elements should be designed to sit on localised shimming points when initially erected. Using multiple shimming points will not ensure uniform distribution of the load due to difficulties with construction tolerances.

Try to avoid direct concrete-to-concrete or concrete-to-steel bearing. This may result in edge spalling and cracking.

See AS3850 for additional guidance on shims.

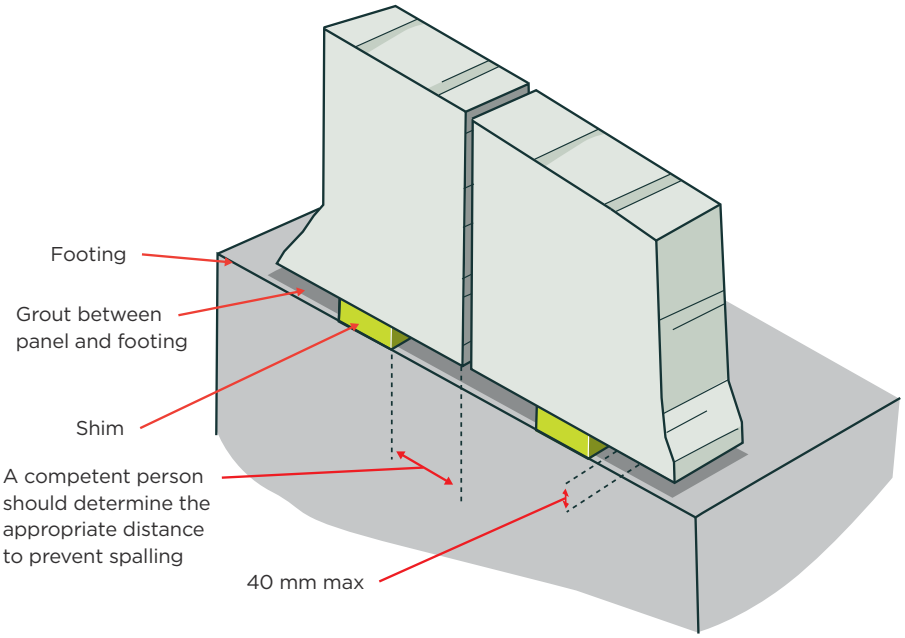


FIGURE 21:
Levelling shims

The total height of each stack of levelling shims (that is, the distance between the panel and the footing) should be a maximum of 40 mm, unless specified by a competent person.

If errors in foundations and/or panel construction lead to the height of the levelling shim being greater than 40 mm, then the shim height should be assessed by a competent person to confirm that the panel is still stable.

It is possible that the site assessment will be done by a different competent person than the structural designer.

10.7 Cranes and lifting equipment

As well as the hazards identified at the beginning of this section, other hazards faced by crane operations are shown below.

What could go wrong?[10]

WHAT COULD GO WRONG?	POSSIBLE CAUSES
The crane tips over	– The crane is set up on soft, unstable or unsuitable ground. – The crane is not set up level. – The crane is positioned above underground services. – The outriggers of a mobile crane are not fully extended or not used as directed. – Insufficient counterweights are used. – Wind effects on the load or crane during extreme weather events. – The weight of the load is calculated incorrectly.
The structure of the crane fails	– The rigging components are overloaded. – The load swings or drops suddenly. – The load hoisted is beyond the capacity of the crane. – The crane has not been maintained properly. – The crane has not been assembled properly. – The weight of the load is calculated incorrectly.
During the lift the boom of the crane hits people, structures or other plant in its path	– There is insufficient clearance between the crane and other structures or plant. – The path of the load is not carefully planned. – Exclusion zones are not maintained and unauthorised people enter the lift area.
The dogman/rigger, ground workers and/or crane operator are electrocuted	– The crane comes in contact with overhead or underground power sources. – Electrical current arcs when the crane comes close to power lines. – Minimum approach distances (MADs) are not followed.
Objects fall off the load being lifted and hit people, structures or other plant	– Material is not properly secured. – The load is rigged incorrectly. – Faulty lifting anchors or connectors are used. – Exclusion zones are not maintained and unauthorised people enter the lift area.
The load is dropped	– The lifting equipment has not been maintained. – The lifting equipment is not fit for purpose.

TABLE 23: Cranes and lifting equipment: What could go wrong

The crane controller must ensure, so far as is reasonably practicable, that the crane and all lifting equipment is specifically designed to lift or suspend the applied loads. The appropriate crane and lifting equipment is to be selected for the tasks. The plant is to be maintained. Operators and dogmen/riggers must have the appropriate skills and training.

[10] There may be hazards that are not identified in this table. You will need to identify and assess health and safety risks arising from your own work.

Crane controller, crane operator and dogman/rigger

A **controller** is the owner, lessee, sub-lessee, or bailee of a crane in a workplace (as defined in the PECPR Regulations). Controllers need to be knowledgeable about crane operations so that they can recommend the best machine for the lift. So far as is reasonably practicable, the controller must ensure that the crane:

- is safe
- is operated safely
- is operated within the limits that it was designed to operate within
- is maintained in a safe condition, and
- has a current certificate of inspection.

Crane operators must have any information, training, instruction or supervision that is necessary.

The crane should have a Load Moment Indicator (LMI) system that can indicate the load on each hook being used.

WorkSafe recommends that a crane is fitted with multiple hoist drums that have automatically applied brakes and independent winch controls.

The **crane operator** needs to have the knowledge and skills to operate the particular type of crane they are using. They can get the required knowledge and skills through a combination of training, qualifications and experience. They should follow the manufacturer's instructions contained in the rating charts, manuals and operating procedures provided with the crane. The operators should follow the controller's requirements and site policies regarding regular and pre-start checks. They should never operate a crane until they are sure conditions are safe.

The **dogman/rigger** is qualified to sling loads and direct the lifting and placing operations of a crane. They ensure that the load is safely rigged for lifting and that the crane is directed safely for all movements of the load. They should work with the crane operator to understand the crane's ability and plan the lift.

Operating safely and effectively

A crane has to be stable to operate safely and effectively. It has to be set up according to the manufacturers' specifications and sited on ground that can support the weight of the crane and the suspended load. Other factors to be considered include the slope of the ground, and wind conditions.

Winds can affect the load, which in turn can affect the crane's stability and structural integrity. Wind loading on large precast concrete surface areas should be considered. For example, wind can cause the load to move laterally. This movement could place side loading on the boom which may result in the boom collapsing.

In some wind conditions the operator will need to reduce the crane's working wind speed for large precast concrete elements. Some elements may not be able to be lifted until the wind speed reduces.

A tag line (see Figure 22) is ideal for guiding precast concrete elements during light winds. But if the wind force is so strong that a worker needs to lean and lug then the lift should not go ahead.

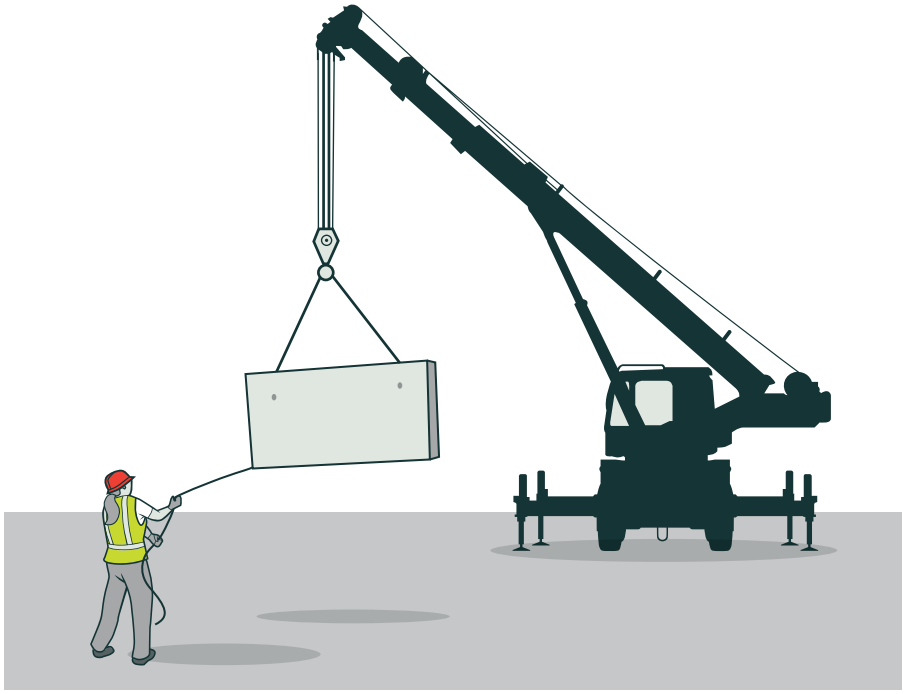
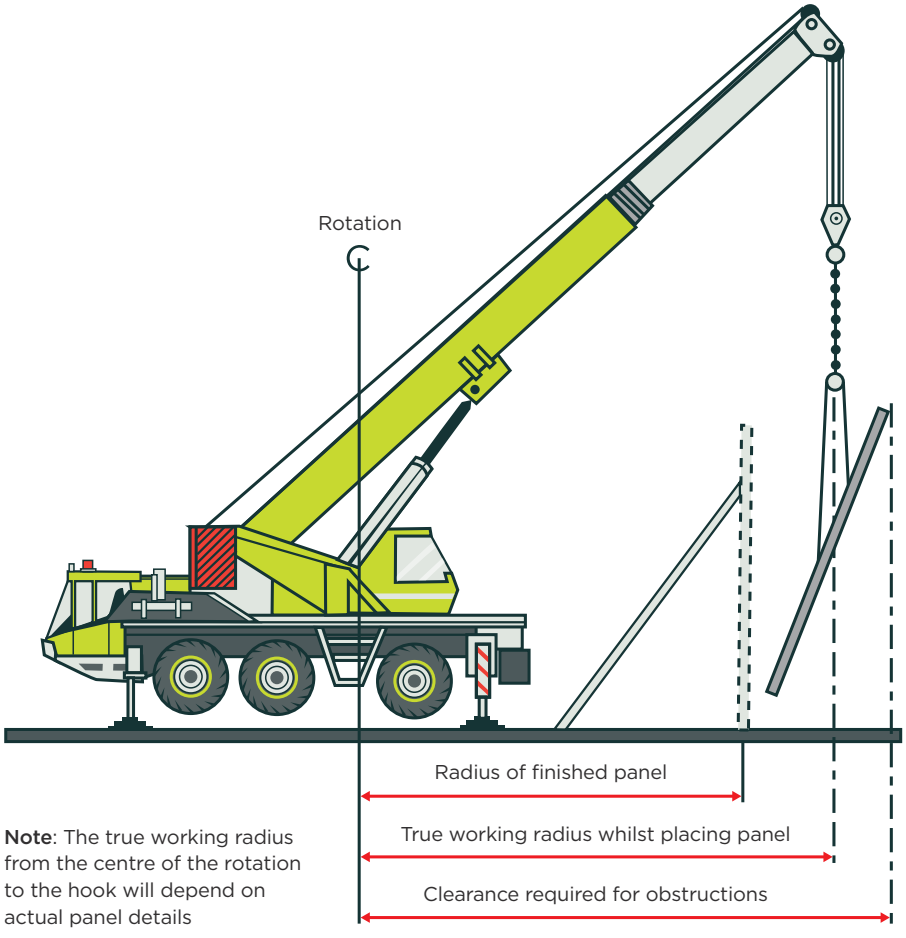


FIGURE 22:
Worker guiding panel using tag line

The crane capacity required is affected by the distance from the centre of rotation of the crane to the centre of gravity of the precast concrete element being lifted. The load capacity of a crane decreases as the distance of lift from the centre of rotation of the crane increases.

For all face-lifted tilt panels the true working radius of the crane may be up to 1.5 m more than the final position radius of the panel. See Figure 23 for more information.



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

FIGURE 23:
Crane working radius

Tilt panels

Where practicable:

- lift tilt panels so that the crane operator can keep the rigging in view at all times
- fix braces to precast concrete elements before lifting.

A competent person (such as a manufacturer or supplier) should provide a lifting anchor layout and rigging plan for tilt panels, based on the design of the panels for lifting. WorkSafe recommends that this plan is available on-site to ensure that the approved rigging system matches the lifting design. A competent person, such as a rigger, may alter the plan to suit the rigging available.

10.8 Lifting operations

Competent people should plan, supervise and carry out lifting operations. Objects falling from height can injure or kill workers or others.

The PCBU must ensure – so far as is reasonably practicable – that equipment:

- is maintained in a safe condition
- is operated safely
- is operated within the limits it was designed to operate within.

Workers must be given information and training on health risks and safe use of the equipment. Equipment must only be operated if it has a current certificate of inspection issued by a recognised inspection body. See worksafe.govt.nz for a list of recognised inspecting bodies.

In accordance with GRWM Regulations 24 and 25, a PCBU must manage risks associated with work being done under any raised or lifted object, and manage risks associated with falling objects. Raised objects include objects lifted by cranes.

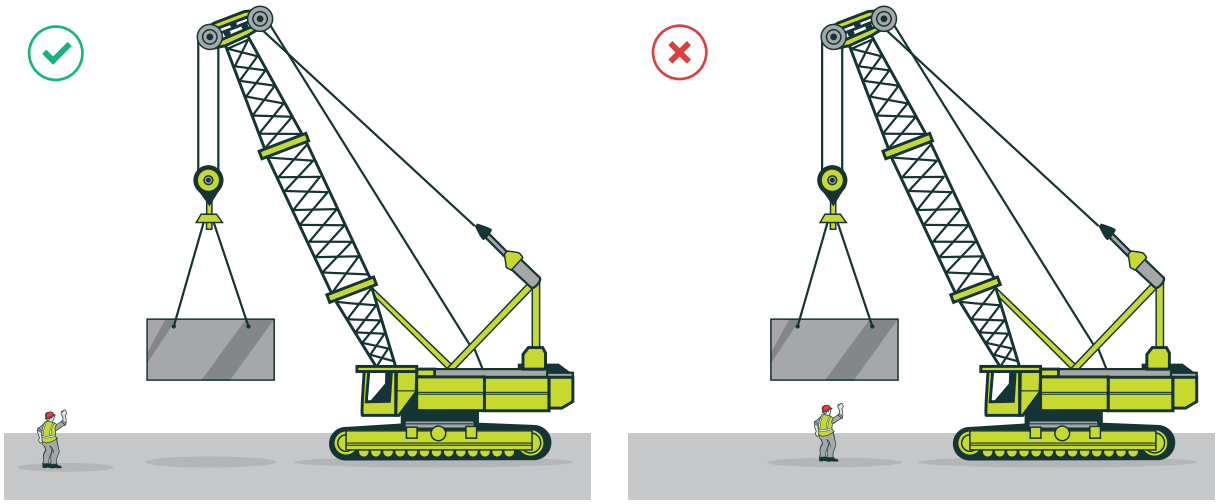


FIGURE 24: Never work underneath a raised or lifted object

PCBUs must follow a prescribed risk management process in order to:

- manage risks to health and safety from work under objects raised or lifted by any means
- manage the health and safety risks from objects that are reasonably likely to fall on and injure a person.

If a PCBU can't eliminate the risk, the PCBU must minimise it, so far as is reasonably practicable. For example by:

- limiting exposure to the drop zone under a raised object, so workers only enter the drop zone to secure braces when authorised
- securing braces to a precast concrete panel prior to lifting
- designing the panel to ensure safe placement by the crane
- establishing exclusion zones for other persons, such as workers not required for the lifting operations.

WorkSafe recommends establishing an exclusion zone in areas where it is not reasonably practicable to prevent an object from falling freely or to use a system to arrest the fall. (See Section 10.9 of these guidelines.)

For more information

WorkSafe's interpretive guidelines *General Risk and Workplace Management, Part 2*. See Section 2: *The prescribed risk management process*

WorkSafe's *Approved Code of Practice for Cranes*

WorkSafe's *Approved Code of Practice for Load-lifting Rigging*

worksafe.govt.nz

Crane Association of New Zealand's *Crane Safety Manual for Crane Operators and Dogmen*

Suspended slabs

Suspended slabs are not normally designed to support cranes or heavy vehicles. If a suspended slab is to be used to support a crane or heavy vehicle, a Chartered Professional Engineer (CPEng) should design the slab for the point loads applied by the crane's outriggers, wheel loads, or any other construction loads. A temporary propping system may be required for a suspended slab.

Lifting precast concrete elements

One or more cranes may be used to lift and place precast concrete elements. Figure 25 shows two cranes moving an element.

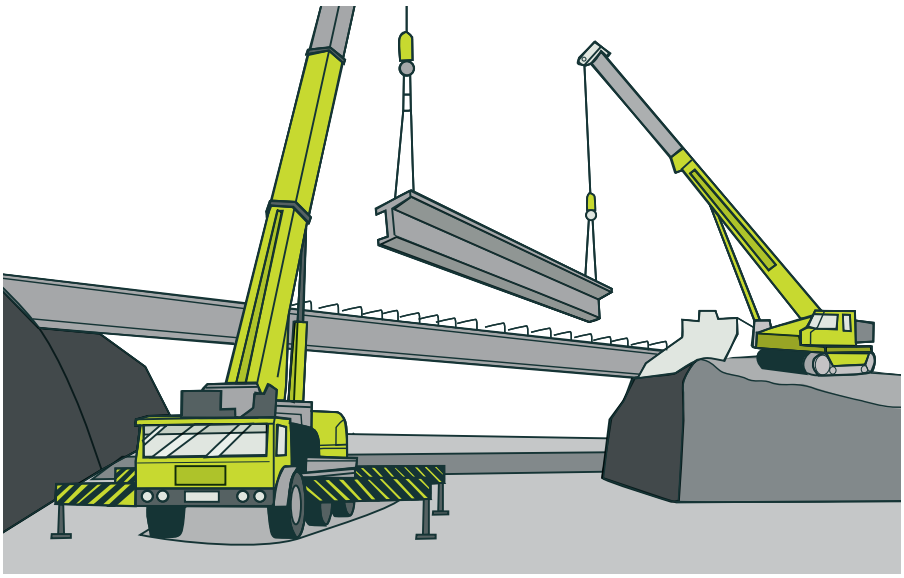


FIGURE 25:
Two-crane lift

When lifting a tilt panel, the lifting anchors and the rigging should be arranged so that when the panel is lifted it remains stable and the bottom edge remains horizontal. Tilt panels may slide during the initial lift and sliding should be controlled.

Lower loads gently to avoid sudden impact.

Lifting elements from delivery vehicle

Put a system in place to prevent workers falling from vehicles while loads are being rigged.

Check, record and report any damage to the precast concrete element before offloading.

The correct lifting equipment should be on-site to unload precast concrete elements. Equipment should be inspected before use.

Before attaching lifting equipment to a precast concrete element, check the lifting anchors to ensure they are undamaged and compatible with the proposed lifting equipment. Figure 26 shows a typical lifting clutch and foot anchor for a precast concrete element.

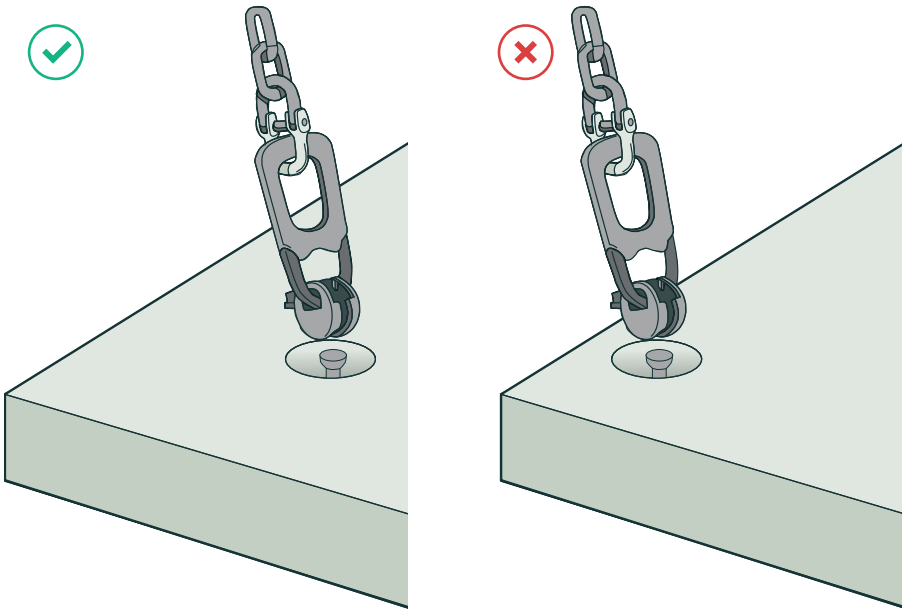


FIGURE 26:
The foot anchor should be the correct distance from the edges of the element

The rigging system used on-site for each precast concrete element should be as set out in the erection documentation. Erection documentation should cover every aspect of the erection process.

When unloading, do not release individual precast concrete elements until the crane has taken the initial load of that element. Elements transported on an A-frame should remain restrained until their weight can safely be taken by the crane.

For more information

WorkSafe's *Approved Code of Practice for Load-lifting Rigging*

worksafe.govt.nz

10.9 Exclusion zones

An exclusion zone is a defined area where people are not allowed to go when particular work is being done. Carry out a risk assessment when setting up an exclusion zone.

Use appropriate signage and/or barriers (eg perimeter fencing) to establish an exclusion zone. Consider ease of access and the likely presence of workers or others. Examples of Crane Exclusion Zone tape and a Crane Exclusion Zone 'sandwich board' are shown in Figures 27 and 28.[11]

It is good practice to have procedures in place to reinforce the messages on the tape and sandwich board. For example, preventing entry to the Crane Exclusion Zone unless people are signed onto the lift plan.

Stop all operations if the Crane Exclusion Zone is breached.

FIGURE 27: Crane exclusion zone tape

FIGURE 28: Crane exclusion zone 'sandwich board'

[11] Adapted from images provided by McLeod Cranes Limited.

People should not be in an area where they could be:

- struck if a precast concrete element falls
- caught between an element and any other hard surface.

Only people directly involved in lifting precast concrete elements (or related activities) should be in the exclusion zone when lifting takes place. The driver should be in a safe area away from the truck during unloading.

Loads should not be suspended over, or travel over, a person. If a footpath, road or other access way is located in an exclusion zone, the public and all traffic should be prevented from passing through the zone while precast concrete element work is being done, until the elements are fully secured. This should be addressed in the planning stage.

10.10 Rigging

All lifting equipment should comply with the requirements outlined in WorkSafe's *Approved Code of Practice for Load-lifting Rigging*.

The precast concrete elements as manufactured will have specific lifting and rigging provisions or requirements. They may have inserts cast in to suit a particular rigging arrangement, or they may be intended to be lifted by slings or other means without using cast-in inserts. Ensure the rigging and lifting equipment available matches the particular requirements of each element.

Setting up a rigging system requires careful pre-planning. The erector and the dogman/rigger should work together to select the rigging system that will connect the precast concrete element to the crane. They have to ensure that the system can handle the forces it may be exposed to. Current industry good practice requires the precast manufacturer (who is responsible for the lifting design) to provide the erector/rigger (via the main contractor) with proposed rigging solutions. The rigger provides comment and approval, and this is endorsed by the main contractor.

Note there could be a number of rigging systems for the same panel, at different times:

- for demoulding
- for loading to transport
- for lifting/rotating/erecting on-site.

All rigging should be inspected:

- annually by a competent person, such as a lifting tackle inspector or a Lifting Equipment Engineers New Zealand Incorporated (LEENZ) member, and
- before it is used.

The dogman/rigger should check the rigging before lifting, particularly if steel wire rope is used in the rigging system. Watch for twist in wire ropes.

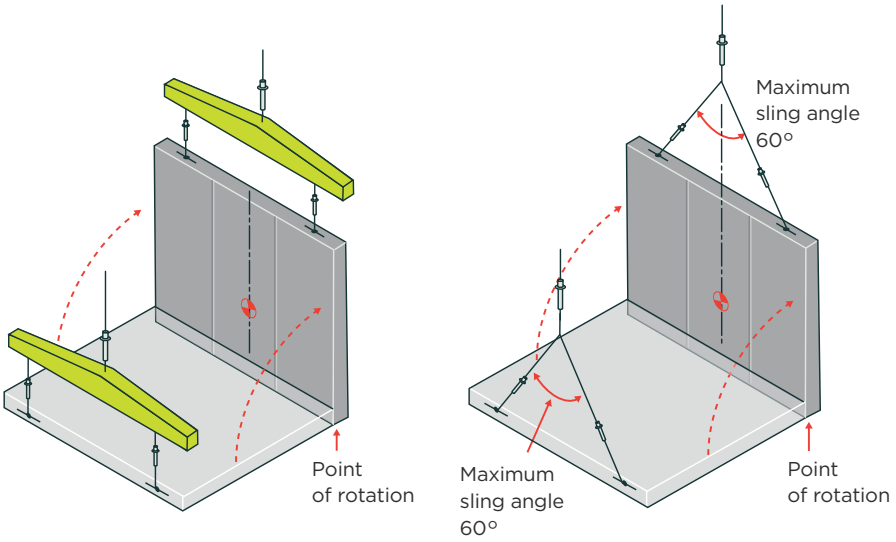
The dogman/rigger should do a visual check to ensure the rolling block collar pin is intact and the collar is not loose. The centre pin on all rolling blocks (with ball bearings or plain bearings) should be locked into position to stop rotation by using a retaining system, such as a bolt-on lock plate.

Regularly check all parts of the rigging system for damage and excessive wear or corrosion, to ensure they are suitable for the loads being lifted.

Load equalisation

Take special care with rigging arrangements where load equalisation measures are required. Decide whether to equalise loads between lifting points on precast concrete elements such as beams or flat slabs.

To provide stability the centre of gravity of the precast concrete element should be below the lifting points, as shown in Figure 29.[12]



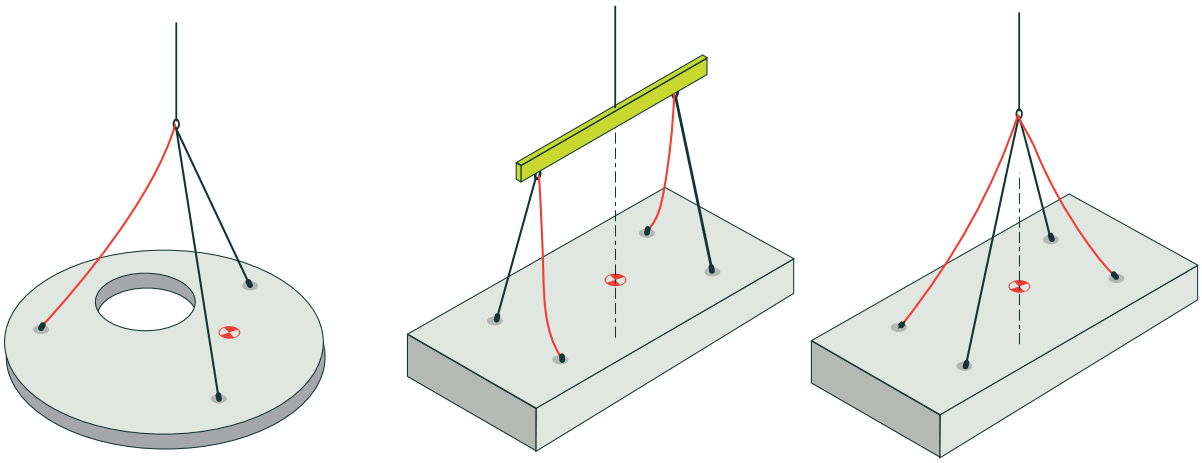
a. The load is distributed over two legs using a lifting beam (flat panel rotation from horizontal to vertical).

b. The load is distributed over two legs.

Key: Centre of gravity

FIGURE 29: Precast concrete elements with centre of gravity below centre of lift

Common lifting designs with fixed length slings require three or four lifting points for stability. However, when using multi-leg (three or more) fixed length slings connected to a common point, the full load should be taken by only two of the lifting points, as shown in Figure 30 below.



Key: Centre of gravity

FIGURE 30: Influence of non-equalised rigging systems on distribution of lifting loads

The shortest (**black**) slings share the load while the (**red**) unloaded slings are slack.

When using three lifting points, a competent person should determine the load on each individual lifting point considering the location of the centre of gravity of the precast concrete element relative to the centroid of the lifting points.

[12] Figures 29 and 30 reproduced with permission from Ancon.

Equalised loads

Figure 31 shows two possible configurations for lifting elements by using lifting equipment that equalises the loads in the slings.

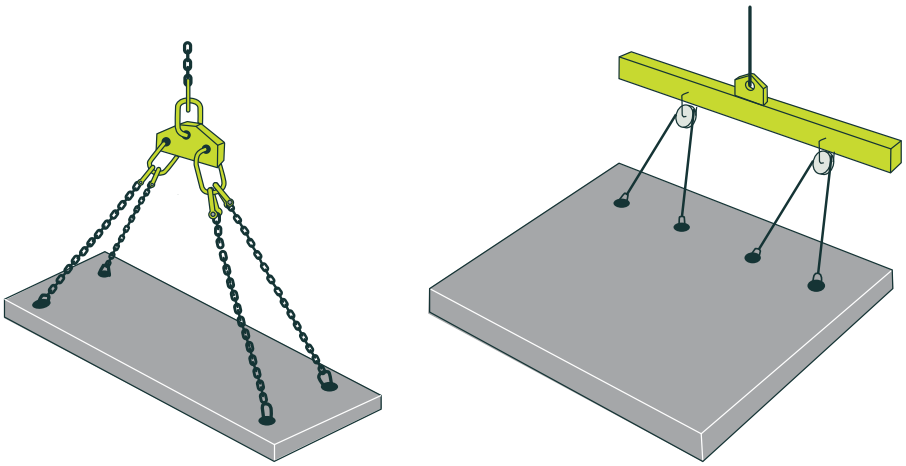


FIGURE 31: Examples of equalised loads[13]

Figure 32 shows some other possible configurations for lifting precast concrete elements. The rigging system should be designed to distribute equal loads to all lifting points. However, sometimes the design may require unequal loading on lifting points, causing an increased load to be applied to particular lifting anchors. This should be considered when selecting the anchor capacity, and the requirements should be clearly specified on the shop drawings.

See these websites for additional information and examples of other rigging arrangements:

- Crane Association of New Zealand: cranes.org.nz
- Precast New Zealand: precastnz.org.nz

[13] Image © ramsetreid®.

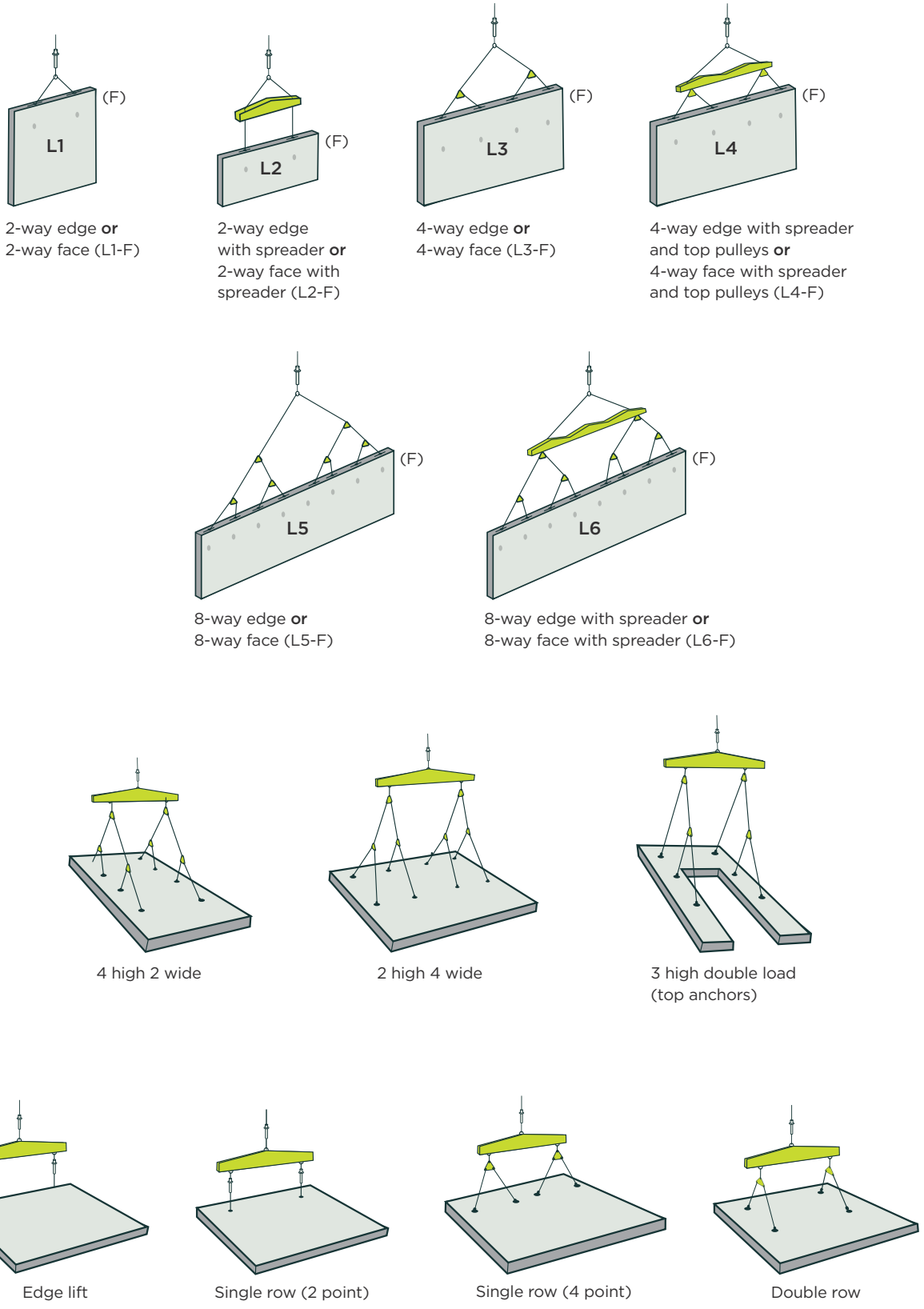


FIGURE 32: Examples of possible rigging configurations for lifting precast concrete elements[14]

Note: F means face lift

[14] Figure 32 images reproduced with permission from Smith Crane & Construction.

Single, double and four-leg slings are commonly used when handling precast concrete elements. When selecting the sling capacity, the increased force due to slope of the sling and the change of direction at reeving points should be considered. The included angle between slings at reeving points should not exceed 120 degrees.

Plan lifts so rotation of the rolling block under load is not required. Rolling (and other) blocks need to be equipped with thrust bearings or separate swivel bearings if rotation of rolling block swivels under load is unavoidable. Blocks with standard plain bearings are not intended to be rotated under load.

Arrange the rigging system to allow the precast concrete element to lie in or near its correct attitude (orientation) for erection into the structure.

In many cases, loads on lifting anchors will not be equal, and will vary at different stages between the initial lift and placement into its final location. This particularly applies where the orientation of the precast concrete element changes or it requires rotation.

Contact a competent person (such as an engineer) immediately if anchors are incorrectly located, faulty or missing, or if concrete is poorly compacted or cracked close to lifting anchors.

Christmas tree lifting

'Christmas Tree lifting' means lifting three or more similar objects (such as precast concrete elements) hanging one under another, as shown in Figure 33.

This allows the safe and efficient use of cranes to place multiple precast concrete elements, ribs or steel beams (eg to make up a flooring system or a roofing system).

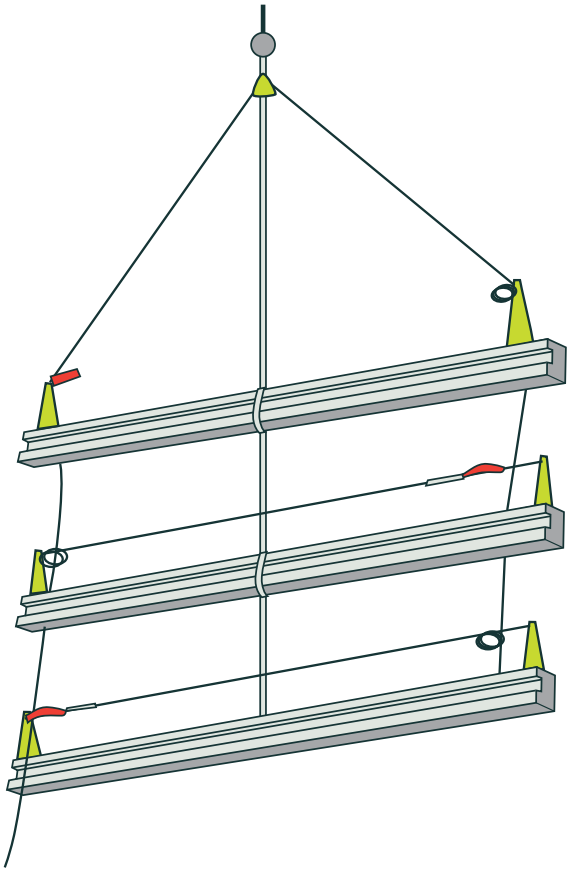


FIGURE 33:
Christmas tree lifting

Lifting multiple objects at once reduces the number of loads being lifted and slewed over the work site. Ensure that:

- the objects lifted are uniform (of similar dimensions and weight)
- the combined load does not exceed the capacity of the crane
- each object is rigged independently of the others
- each object is spaced approximately 0.5 m above the one below.

GRWM Regulation 24: Managing risks associated with working under raised objects (see Appendix Q of these guidelines).

The Job Safety Analysis (JSA) should make it clear that extra precautions are needed.

The PCBU must address the risk of workers being exposed to a suspended load. It is possible to manage this risk by ensuring that all riggers stand to the side, or at the end of the load, when placing each unit.

Confirm the rigging system

Confirm that the rigger is using the correct rigging system (as specified by the designer) and the right equipment.

LIFTING: WHAT TO CONSIDER

Crane capacity

- Are loads and reach within the capacity of the crane?
  Take into account handling and lifting equipment, load equalisation equipment, strongbacks (if required), safe working radius, crane capacity, weight of the load element including strongbacks and rigging, tilt of the panel and centre of gravity (CoG).

Lifting anchors and clutches

- Has the precast concrete element reached the specified strength for lifting, as detailed in the shop drawings?
- Is all lifting equipment certified and in good condition?
- Are the lifting clutches correctly engaged before lifting?
- Is the appropriate rigging equipment available?
  - This includes lifting beams and correct attachments for cast-in lifting anchors.
- Will lifting occur in the direction specified for the placement of the lifting anchors?
- Are lifting anchors in the correct location?
  - Contact a competent person immediately if the location isn't correct or there are faulty or missing lifting anchors.
- Have recesses been cleaned out in preparation for lifting, so that lifting clutches can correctly engage?
- Is the lifting equipment compatible with the anchors cast in to the precast concrete element?
- If the lifting clutches and the lifting anchors are from different suppliers, has the supplier of the lifting clutches or the supplier of the lifting anchors confirmed that the clutches and anchors are compatible?
- Are the lifting anchors clearly identified, to assist during loading and unloading?
- If precast concrete elements are being lifted without cast-in anchors, is appropriate equipment available?
- Are the erection crew familiar with methods and restrictions applying to precast concrete elements lifted without cast-in anchors?

Rigging system

- Is the rigging system designed to suit the spacing and layout of the lifting anchors for preferred rigging configurations?
- Is the appropriate rigging equipment available and serviceable, with a current inspection tag?
- Is the rigging system for each precast concrete element generally as set out in the erection documentation?
- Do braces interfere with the rigging?

LIFTING: WHAT TO CONSIDER

Special/additional requirements
– Are strongbacks required?
  - If required, are they correctly installed?
– Is load equalisation required?
– Is any special handling required?
– Is appropriate equipment available?
– Will precast concrete elements need to be re-aligned/repositioned after lifting from the delivery vehicle?
  - **If yes**: Is there enough room available?
  - Is the right equipment available?

TABLE 24: Lifting: What to consider

For more information

WorkSafe's *Approved Code of Practice for Load-lifting Rigging*
See Section 5.12: *Inspection*
worksafe.govt.nz

10.11 Lifting anchors and clutches

To minimise the chance of error, cast-in components should be standardised and compatible for all precast concrete elements on an individual project. If components that have been cast in for permanent fixing of the precast concrete element are to be used for lifting or handling, or any other use, ensure that such use will not compromise their long-term performance.

Do not use impact driven components, including explosive charge driven components, for lifting purposes.

Lifting anchors

Lifting anchors are referred to by their working load limit (WLL).

The actual WLL of all/any lifting anchors should be calculated by a competent person. Any reductions or limitations should be clearly communicated to the client, rigger, crane crew and anyone else involved.

The actual safe load may be less. The loading of lifting anchors may be affected by:

- proximity to edges
- proximity to openings, recesses or edge rebates
- proximity to other lifting devices that are loaded concurrently
- concrete thickness
- strength of the concrete the anchor is embedded in at the time it is loaded
- direction and type of load: shear, compression, or tension
- embedment depth
- load angles (especially for edge-lifters)
- the presence of cracks

- the proximity of reinforcement or pre-stressing tendons
- method of lifting (eg pick and carry) and type of lifting equipment to be used
- tension stresses in the concrete around the anchor
- length of chains and chain angle.

Steel reinforcing bars are not suitable as lifting loops and should not be used for that purpose. Some high tensile strength steel bars have properties that make them suitable only to resist tensile forces and they should not be used in any part of a lifting anchor.

Pre-stressing strand, while not recommended, may be used in a controlled manner if in compliance with a recognised standard such as the Queensland Government's TMR SD2059.

Every item of lifting equipment should be clearly and permanently marked with its WLL. A unique numbering system to clearly identify individual items should also be used.

Some types of lifting anchors require reinforcing to develop their required load capacity. Any reinforcing should be used according to the requirements of these guidelines, the relevant standards, and installation instructions specified by the lifting anchor manufacturer.

The reinforcing design should ensure that the lifting anchor system will give the required factor of safety.

Put in place a site procedure to follow if precast concrete panels arrive on-site with different lifting anchors or lifting anchors missing. For example:

- return the panel to the precast manufacturer, or
- ask the manufacturer to provide an alternative lifting method, and/or
- ask the manufacturer to fix it.

Lifting clutches

Lifting clutches should be designed so there is no chance of unintentional clutch release during operations such as rotation of precast concrete elements, particularly when clutches are fitted with remote-release lines.

Lifting clutches are to be:

- designed with a factor of safety of 5.0
- initially tested by the supplier to a factor of safety of 2.0
- visually inspected for damage or wear each day prior to use
- tested for loads in all directions
- used only with the type and size of anchors that they are compatible with
- made in accordance with a valid international standard or technical reference, such as VDI/BV-BS 6205 series (2012)
- inspected at least every 12 months by a competent person, and a record kept of those inspections.

Inspections should be made in accordance with either the requirements in WorkSafe's *Approved Code of Practice for Load-lifting Rigging* or the requirements specified by the manufacturer – whichever is more thorough.

Testing of lifting clutches should include testing for possible misalignment or misplacement that could cause the load to be applied in an unintended way. All testing should be documented.

All lifting clutches should have a record showing the period of test validity and maximum allowable capacity.

10.12 Rotation

When precast concrete elements need to be rotated before they are placed, carefully consider, plan and document the method of rotation.

Two cranes should be used to rotate elements, where reasonably practicable.

There are increased risks if only one crane is used to rotate elements.

If one crane is to be used for element rotation, one or more competent person/s need to be involved.

- The lifting and 'tailing' winch and hooks should have sufficient capacity to rotate the element; often the 'tailing' load can be up to 80% of the element's weight.
- The boom head on the crane should be suitable for the two hook operation.
- The elements to be rotated should be **in line** with the crane to prevent:
  - elements swinging (like a gate) when being lifted from the storage frame
  - the hoist rope being pulled off the head sheave (if the fleet angle is wrong).
- Any lift plan needs to address the significant hazard of the element either sliding forward or back towards the crane when it is being lifted.
- The boom should be placed directly over the centre of gravity (CoG) of the element and the boom angle needs to be adjusted to compensate for boom deflection.
- The included angle between the main hoist rope and the auxiliary hoist rope should not exceed 30 degrees.

Appendices

IN THIS SECTION:

Appendix A: Standards and other technical references

Applicable New Zealand and Australian standards may include, but are not limited to, the following:

NAME	DESCRIPTION
NZS 3101 Series	Concrete structures standard
NZS 3104	Specification for concrete production
NZS 3112 Series	Methods of test for concrete
NZS 3109	Concrete construction
NZS 3404 Series	Steel Structures Standard
AS/NZS 1170 Series	Structural design actions
AS 3850	Prefabricated Concrete Elements
AS 4991	Lifting devices

Technical references

NAME	DESCRIPTION
VDI/BV-BS 6205 series (2012)	Lifting inserts and lifting insert systems for precast concrete elements. (Koblenz, Germany: Bundesverband Bausysteme e.V)
CEN/TR 15728 (2016)	Design and use of inserts for lifting and handling of precast concrete elements (British Standards Institution)
TMR SD 2059	Precast Units – 19 m PSC Deck Unit (Queensland Government, Australia: Department of Transport and Main Roads)

Appendix B: Glossary

TERM	DEFINITION
A-frame	A rack shaped like an 'A' used for upright storage of precast concrete elements. An A-frame may also be used on trucks and trailers to transport precast concrete elements.
Anchor	A proprietary cast-in item or post-installed fixing used during handling, transport or erection; includes chemical anchoring systems. A post-installed fixing is also known as an Alternative Lifting Device. See also *Lifting insert*.
Base restraint	A restraint that stops a precast concrete panel kicking in, or kicking out, during the erection process.
Brace	A structural member, normally placed diagonally and firmly attached to resist horizontal movement and provide stability. Braces are commonly used as temporary members to resist lateral loads on precast concrete elements. In these guidelines, 'brace' refers to a diagonal or non-vertical member and 'prop' refers to a vertical member resisting a vertical load.
Characteristic strength	The characteristic strength for high structural reliability (eg structural steel; lifting equipment) is determined as the 5% fractile with a confidence limit of 90%. This means that people can be 90% confident that the strength will exceed the characteristic strength 95% of the time.
Chartered Professional Engineer (CPEng)	An engineer registered under the *Chartered Professional Engineers of New Zealand Act 2002* with a current registration certificate. See engineeringnz.org for more information.
Competent person	In these guidelines, a competent person is someone who has the relevant knowledge, experience and skill to carry out a particular task using appropriate techniques and procedures; and: – has a relevant qualification proving that they have the knowledge, experience, and skill required; or – evidence (such as training records) has been kept by the PCBU to demonstrate that the person has the required knowledge, experience, and skill.
Contract drawings	See *Drawings*.
CPEng	See *Chartered Professional Engineer*.
Crane	A powered device equipped with mechanical means for raising or lowering loads suspended by means of a hook or other load-handling device; and that can, by the movement of the whole device or of its boom, jib, trolley or other such part, reposition or move suspended loads both vertically and horizontally; and includes all parts of the crane down to and including the hook or load-handling device, and all chains, rails, ropes, wires, or other devices used to move the hook or load-handling device; but does not include lifting gear that is not an integral part of the crane.
Crane platform	The floor slab, suspended slab, structure or ground – and surrounding area – that is required to support a crane and its lifted load.
Crush zone	An area where a person could be crushed between a transported precast concrete element and a solid object.
Cyclic load	A recurring load, or a recurring reversing load.
Deadman	Typically an in-ground concrete pile or footing specially designed to resist lateral bracing loads. A deadman connects braces to the supporting ground.
Designer	A person who is qualified because of their training and experience to design a device, system or element to serve a specific purpose.
Dogman	A person responsible for the safe rigging and movement of a load, who knows how to use the correct sling and understands the crane they are working with. A dogman is competent to do slinging or lifting tasks and direct position loads. (See also *Rigger*.)

TERM	DEFINITION
Drawings	a. **Shop drawings**: detailed drawings of individual precast concrete elements, produced solely for the manufacture of those elements. b. **Contract drawings**: drawings forming part of the contract between the principal or client and the head contractor, including structural drawings, architectural drawings, and other drawings. c. **Structural drawings**: drawings supplied by a structural design engineer in support of a building consent application and forming part of the contract drawings. d. **Other drawings**: may include various temporary works drawings that could cover, among other items, things such as bracing, propping, location and arrangement of the precast concrete elements in their final location. There could be a whole range of other drawings used on a construction project. The drawings will vary depending on the circumstances.
Drop zone	The area where a precast concrete element would land following an uncontrolled fall. For example, during lifting or placing by a crane.
Element	See *Precast concrete element*.
Engineer	See *Chartered Professional Engineer*.
Exclusion zone	A defined area (zone) that non-essential people cannot enter when particular tasks are being carried out.
Expansion anchor	A bolt that is designed to be inserted into a hole drilled in concrete, with a device at one end that expands when the bolt is tightened to prevent it from being pulled out.
Factor of safety	The factor of safety is the ratio between the working load limit (WLL) and the characteristic strength.
Falsework	The temporary structures and/or systems used to support a permanent structure during erection until it becomes self-supporting. Falsework is a part of temporary works. See *Temporary Works*.
Fixings	Cast-in items used to hold the precast concrete element in place on the building. For example, inserts, weld plates, or channels.
Footing	See *Foundation*.
Foundation	The foundation connects a structure (eg a building) to the ground and transfers loads from the structure to the ground. Foundations include footings. A footing sits under the base of a wall or column and distributes the load.
Hazard	Anything that could cause harm, including behaviour that has the potential to cause death, injury or illness.
Health and Safety Committee (HSC)	A committee enabling businesses and worker representatives to meet regularly and work co-operatively to improve health and safety at work. HSCs bring together workers and management to develop and review health and safety policies and practices for the workplace. HSCs make it easier for the business and workers to co-operate on ways to ensure workers' health and safety.
Health and Safety Representative (HSR)	A worker elected to represent the members of their work group on health and safety matters. HSRs play an important role in keeping workplaces healthy and safe. They provide a voice for workers who might not otherwise speak up. By representing workers, HSRs provide a link between workers and management. HSRs have legally defined functions and powers. After completing the NZQA unit standard 29315, an HSR has the power to issue a Provisional Improvement Notice (PIN) and can direct unsafe work to cease.
In-ground mass block	See *Deadman*.
In situ concrete	Concrete that is cast in its final position (rather than being cast in one place and then later moved to another position).
Insert	See *Lifting insert*.
Levelling shims	Either a single thin strip or a series of thin strips of a suitable material placed under precast concrete elements to help with final positioning.

TERM	DEFINITION
Lifting beam	A beam that carries loads using two or more lifting points – while being supported from one or more different points.
Lifting clutch	A device that connects directly to the cast-in lifting anchor to enable attachment to and transfer of load to a crane, or other lifting or handling equipment.
Lifting device	A device fitted directly or indirectly to the hook or another coupling device on a crane, hoist or winch without affecting its integrity.
Lifting equipment	Equipment that connects a precast concrete element to a crane or other lifting device. (Does not include anything that is an integral part of a crane or other lifting device or is cast into the precast concrete element.)
Lifting insert	Within these guidelines a lifting insert refers to a proprietary product cast in to a precast concrete element at the time of manufacture to provide a point of attachment to the element, for example for lifting equipment, brackets or plates.
Load restraint	Lashings, baulking arrangements (eg chocks) and load friction that prevent movement of a load during transport. See the New Zealand Transport Agency's *The Official New Zealand Truck Loading Code*.
Non-standard lift	A lift that requires specific rigging or load equalisation procedures to ensure a load is distributed appropriately to the lifting anchors. Any lift requiring attachment to more than two lifting anchors in a beam, or three lifting anchors for a flat-lifted precast concrete element, will normally be a non-standard lift.
On-ground mass block	A specifically designed concrete block that supports the base of the brace. Lateral loads are resisted by the mass of the concrete block, a horizontal brace, and the friction between the concrete surface and the supporting ground.
PCBU	Person conducting a business or undertaking. In most cases a PCBU will be a business entity, such as a company. However, an individual carrying out business as a sole trader or self-employed person is also a PCBU. A PCBU does not include persons who are solely workers or officers of a PCBU, volunteer associations with no employees, or home occupiers that employ or engage a tradesperson to carry out residential work.
Plant	Includes: a. any machinery, vehicle, vessel, aircraft, equipment (including personal protective equipment), appliance, container, implement, or tool; and b. any component of any of those things; and c. anything fitted or connected to any of those things.
Precast concrete	A concrete element cast in other than its final position (see *In situ concrete*).
Precast concrete element	Any item of precast concrete (such as a precast beam, column, floor slab, wall panel, cladding panel, pile, pile cap, or cruciform).
Prop	A structural member providing temporary support for a precast concrete element. Commonly used to support floors and beams. In these guidelines, 'prop' refers to a vertical member resisting a vertical load and 'brace' refers to a diagonal or non-vertical member. (Note that diagonal bracing is sometimes referred to as a 'panel prop' or 'bracing prop'.)
Rebar	See *Reinforcing steel*.
Reinforcing steel	Steel with a circular or practically circular cross-section, suitable for reinforcing concrete. Also known as rebar (reinforcing bar). Reinforcing steel is available as bars, coils, wire strand, or mesh, depending on the application.
Reinforcement	Refers to any of the following: a. structural reinforcement, including reinforcing steel and pre-stressing tendons, as required by the contract documents b. reinforcement additional to the structural reinforcement, provided to resist forces caused by transport or erection loads, and c. reinforcement which is placed in conjunction with lifting, bracing and fixing inserts so that they can attain their design capacities.

TERM	DEFINITION
Restraint	Generally refers to something used to limit movement (including buckling), but the exact meaning will depend on the context. For example: – A *restraint line* is a sling, rope or chain attached from the suspended load to the telescopic handler and the dogman/rigger, to help to prevent the suspended load swinging back and forth. See also *Load restraint*.
Rigger	A rigger has broader responsibilities than a dogman and may be responsible for work that a dogman is not qualified to perform. A rigger is competent to sling loads and direct the lifting and placing operations of a crane. The rigger may also be competent to develop or amend a lift plan.
Rigging	Mechanical load-shifting equipment and associated gear used to: a. move, place or secure a load including plant, equipment, or members of a building or structure b. ensure the stability of those members c. set up and dismantle cranes and hoists (other than the setting up of a crane or hoist which only requires the positioning of external outriggers or stabilisers).
Safety factor	See *Factor of safety*.
Safe working load	The maximum load that can safely be lifted by a piece of lifting equipment.
Shop drawings	See *Drawings*.
Site supervisor	Someone at the workplace who has authority over operations on-site. They have delegated responsibility by the head contractor or the person responsible for the operation and safety of the site.
Spalling	The unintentional shearing off of a part of the precast concrete element (eg around lifting anchors). Normally due to a concentration of load or to sliding.
Spreader beam	A compression member that spreads lifting ropes, chains or slings while an element is being lifted to change the angle of the force applied to the lifting anchors.
Standard lift	A lift that requires no special rigging or load equalisation procedures. Generally not more than two anchors should be capable of carrying the applied load with the required factor of safety for a beam, or three anchors for a flat-lifted precast concrete element.
Strongback	A device, beam or girder temporarily fixed to a precast concrete element to give it extra strength or support during handling, transport or erection.
Structural drawings	see *Drawings*.
Tag line	A rope used to control the load during lifting or positioning. The rope needs to be of suitable strength, construction and length.
Temporary works	Temporary facilities (such as fencing, site offices and workers' facilities), and objects such as scaffolding, safety barriers and falsework, that are required on-site only until the permanent works are completed.
Tilt panel	A concrete element, normally cast horizontally at or near its final location. It is often lifted to the vertical with one edge staying on the casting floor.
Toast rack	A stand shaped like a toast rack, used for upright storage of precast concrete panels. Toast racks should be designed and installed by a competent person who specifies the rack capacity and procedures for its use.
Worker	An individual who carries out work in any capacity for a PCBU. The term 'worker' covers almost all working relationships. A worker may be an employee, a contractor or sub-contractor, an apprentice or trainee, an outworker, a person on work experience or a work trial, or a volunteer worker.
WLL	Working load limit.

Appendix C: Health and safety management system (HSMS)

An effective health and safety management system (HSMS) will help to ensure that risks are dealt with effectively.

An HSMS brings together policies and procedures to create a systematic approach for managing health and safety in a precast concrete operation, and should be part of the operation's overall management system.

The size and complexity of the precast concrete operation will determine how detailed the HSMS should be.

PCBUs produce, document and maintain an HSMS, and share it with workers. The HSMS should be available to all workers in one or more formats that are easy for workers to access and understand.

Review the HSMS periodically and make sure it is available for WorkSafe to inspect, if requested.

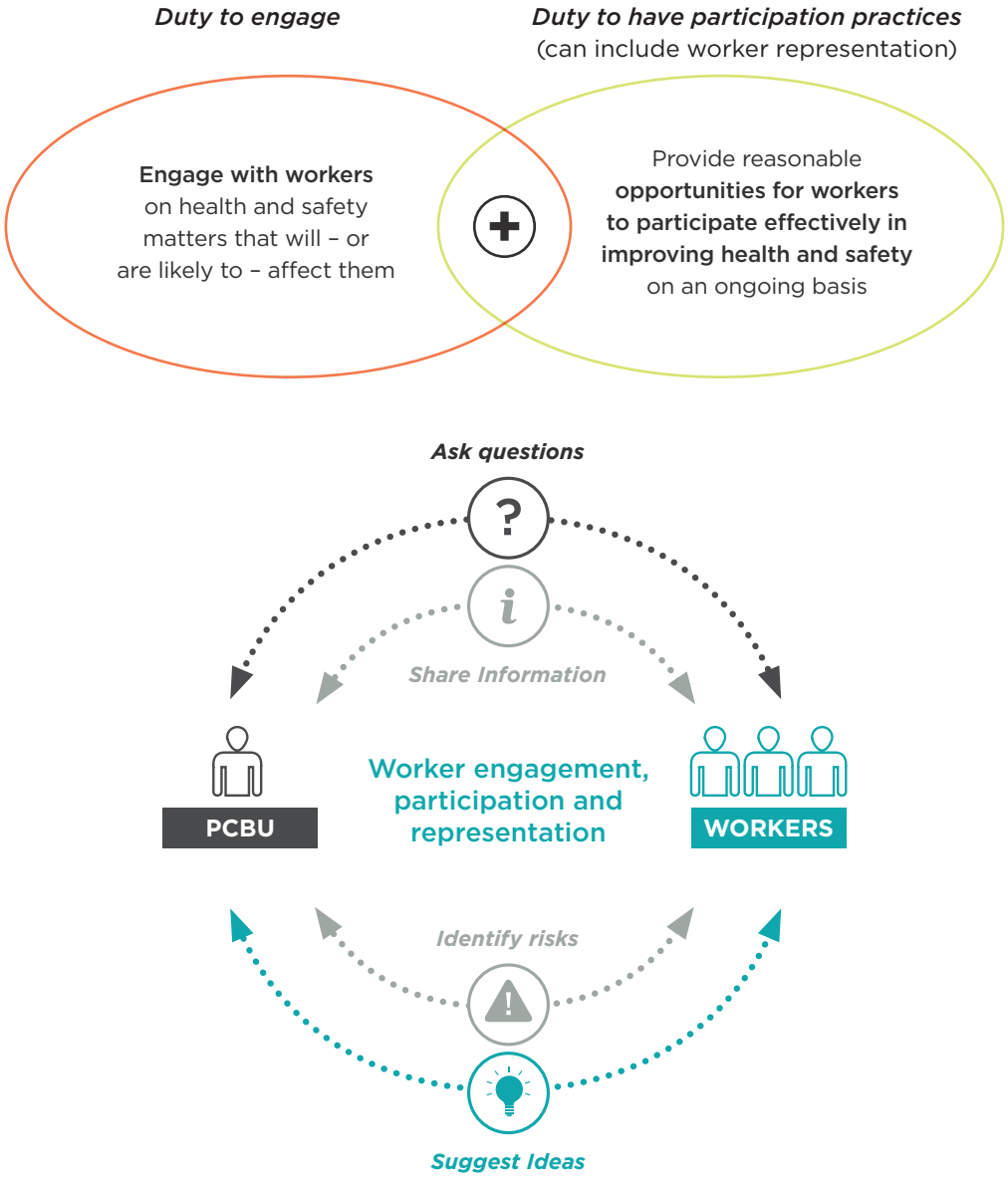
HSMS: WHAT TO CONSIDER

Does the HSMS include:

- the site's health and safety policy?
- processes for identifying hazards, assessing risks and identifying control measures to manage risks?
- the systems and procedures in place to identify changes to the operation or changes to risk levels?
- processes for monitoring, assessing and inspecting workplaces?
- processes for monitoring workers' health and safety?
- processes and plans for incident investigations?
- processes for monitoring and auditing the HSMS (that is, how the HSMS will be reviewed and audited)?
- organisational structure, responsibilities and competencies?
- processes for reporting and recording health and safety information, including key performance indicators?

Appendix D: Worker engagement, participation and representation at a glance

Related duties of a person conducting a business or undertaking (PCBU)



...effective worker participation is vital to managing health and safety issues successfully in the workplace.[*]

The best results are achieved when a PCBU and its workers work together to manage risk, improve health and safety at work, and find solutions.

* *The Report of the Independent Taskforce on Workplace Health & Safety: He Korowai Whakaruruhau* (2013) hstaskforce.govt.nz

Appendix E: Job safety analysis template

Job safety analysis (JSA)

Documenting your chosen control measures can assist with planning work that is healthy and safe for workers and others

1. Details

Job number:

Date: DD / MM / YEAR

Prepared by: (name and title)

Approved by: (name and title)

Job description:

2. JSA team members

Print name and sign below to confirm that you have read, understood and agreed to the procedures and control measures in this JSA.

Name:

Signature:

Name:

Signature:

Name:

Signature:

Name:

Signature:

Name:

Signature:

Are work permits required? ○ Yes ○ No

If yes, provide details:

Notes:

Job safety analysis (JSA)

For each step of a job, identify the hazards, the risks to deal with and their priority, and the control measure/s

JOB STEP	HAZARD/S	IDENTIFY RISKS YOU NEED TO DEAL WITH	PRIORITY/URGENCY Pay close attention to your high priority risks	CONTROL MEASURE First try to eliminate risk	CONTROL MEASURE If elimination not possible: – substitute and/or – isolate and/or – use engineering control measures	CONTROL MEASURE If any risk remains: – use administrative control measures and/or – PPE (PPE is least effective; should not be first or only control measure considered)

Identify plant, equipment and tools required for healthy and safe work for this job	
Identify worker skills, training and/or supervision required for healthy and safe work for this job	

For further information, refer to:

1. Material Safety Data Sheets
2. HSWA and relevant regulations
3. WorkSafe resources such as guidance (see worksafe.govt.nz)
4. Industry-specific guidance
5. Permit attachments

Appendix F: Extract from Section B1.3.3 (performance) of the building code*

Account shall be taken of all physical conditions likely to affect the stability of buildings, building elements and sitework, including:

- self-weight
- imposed gravity loads arising from use (for the purposes of these guidelines, this includes all imposed loads)
- temperature
- earth pressure
- water and other liquids
- earthquake
- snow
- wind
- fire
- impact
- explosion
- reversing or fluctuating effects
- differential movement
- vegetation
- adverse effects due to insufficient separation from other buildings
- influence of equipment, services, non-structural elements and contents
- time dependent effects including creep and shrinkage, and
- removal of support.

* The Building Code is contained within Schedule 1, of the Building Regulations 1992.

Appendix G: Notifications to WorkSafe

Notification of particular hazardous work

The Health and Safety in Employment Regulations 1995 require employers as well as the person who controls a place of work to provide at least 24 hours notice to WorkSafe of particular hazardous work (as defined below). This could be a PCBU or a principal employing contractors, for example.

These notices help WorkSafe plan workplace visits to promote health and safety for everyone in or near a workplace.

Notify WorkSafe by:

- filing a Notification of Particular Hazardous Work online: worksafe.govt.nz or
- phoning 0800 030 040.

Work that needs to be notified to WorkSafe

Work that needs to be notified to WorkSafe is defined in the HSE Regulations. According to these regulations, notifiable work means:

a. any restricted work, as defined in regulation 2 of the Health and Safety in Employment (Asbestos) Regulations 1998
b. any commercial logging operation or tree-felling operation
c. any construction work of one or more of the following kinds:
    i. work in which a risk arises that any person may fall 5 metres or more, other than—
        A. work in connection with a residential building up to and including 2 full storeys
        B. work on overhead telecommunications lines and overhead electric power lines
        C. work carried out from a ladder only
        D. maintenance and repair work of a minor or routine nature
    ii. the erection or dismantling of scaffolding from which any person may fall 5 metres or more
    iii. work using a lifting appliance where the appliance has to lift a mass of 500 kilograms or more a vertical distance of 5 metres or more, other than work using an excavator, a fork-lift, or a self-propelled mobile crane
    iv. work in any pit, shaft, trench, or other excavation in which any person is required to work in a space more than 1.5 metres deep and having a depth greater than the horizontal width at the top
    v. work in any drive, excavation, or heading in which any person is required to work with a ground cover overhead
    vi. work in any excavation in which any face has a vertical height of more than 5 metres and an average slope steeper than a ratio of 1 horizontal to 2 vertical
    vii. work in which any explosive is used or in which any explosive is kept on the site for the purpose of being used
    viii. work in which any person breathes air that is or has been compressed or a respiratory medium other than air

Note: There is an exception in regulation 26(4), HSE Regulations, covering specific work undertaken to deal with certain emergencies.

Notifiable events

A notifiable event is any of the following events that arise from work:

- a death
- a notifiable illness or injury
- a notifiable incident.

WorkSafe must be notified as soon as possible after a PCBU becomes aware that a notifiable event has occurred. These events trigger requirements such as immediately preserving the site and keeping a record of the event for at least five years afterwards.

The notifiable incident, illness, injury or death must arise out of the conduct of the business or undertaking. It could be due to the condition of the work site, the way the work activity is organised, or the way equipment or substances are used. Notifiable events may occur inside or outside the actual work site.

A notifiable illness is when someone becomes seriously ill as a result of work; this is then a notifiable event. All work-related injuries or illnesses which require a person to be admitted to hospital for immediate treatment are notifiable. See Section 23 of HSWA for the full meaning of notifiable injury of illness and a list of injuries and illnesses that require notification.

Notifiable incidents

HSWA requires PCBUs to notify WorkSafe if there is an unplanned or uncontrolled incident in relation to a workplace that exposes a person (worker or otherwise) to a serious risk to their health and safety because of immediate or imminent exposure to:

- a substance escaping, spilling, or leaking
- an implosion, explosion or fire
- gas or steam escaping
- pressurised substance escaping
- electric shock
- the fall or release from height of any plant, substance or thing
- collapsing, overturning, failing or malfunctioning of – or damage to – any plant that is required to be authorised for use
- the collapse or partial collapse of a structure
- the collapse or failure of an excavation or any shoring supporting an excavation
- the inrush of water, mud, or gas in workings in an underground excavation or tunnel
- the interruption of the main system of ventilation in an underground excavation or tunnel
- a collision between two vessels, a vessel capsize, or the inrush of water into a vessel
- any other incident declared in regulation to be a notifiable incident.

For more information

Sections 23, 24 and 25 of HSWA: legislation.govt.nz

WorkSafe's guidance *What events need to be notified?*

WorkSafe's website for online tools, forms and other resources: worksafe.govt.nz

Appendix H: HSWA section 39

Section 39 of the Health and Safety at Work Act 2015: Duty of PCBU who designs plant, substances, or structures.

39 Duty of PCBU who designs plant, substances, or structures

(1) This section applies to a PCBU (a designer) who conducts a business or undertaking that designs—
  (a) plant that is to be used, or could reasonably be expected to be used, as or at a workplace; or
  (b) a substance that is to be used, or could reasonably be expected to be used, at a workplace; or
  (c) a structure that is to be used, or could reasonably be expected to be used, as or at a workplace.

(2) The designer must, so far as is reasonably practicable, ensure that the plant, substance, or structure is designed to be without risks to the health and safety of persons—
  (a) who, at a workplace, use the plant, substance, or structure for a purpose for which it was designed; or
  (b) who handle the substance at a workplace; or
  (c) who store the plant or substance at a workplace; or
  (d) who construct the structure at a workplace; or
  (e) who carry out any reasonably foreseeable activity (such as inspection, cleaning, maintenance, or repair) at a workplace in relation to—
    (i) the manufacture, assembly, or use of the plant for a purpose for which it was designed, or the proper storage, decommissioning, dismantling, or disposal of the plant; or
    (ii) the manufacture or use of the substance for a purpose for which it was designed, or the proper handling, storage, or disposal of the substance; or
    (iii) the manufacture, assembly, or use of the structure for a purpose for which it was designed, or the proper demolition or disposal of the structure; or
  (f) who are at or in the vicinity of a workplace and who are exposed to the plant, substance, or structure at the workplace or whose health or safety may be affected by a use or an activity referred to in any of paragraphs (a) to (e).

(3) The designer 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 imposed by subsection (2).

(4) The designer must give to each person who is provided with the design for the purpose of giving effect to it adequate information concerning—
  (a) each purpose for which the plant, substance, or structure was designed; and
  (b) the results of any calculations, analysis, testing, or examination referred to in subsection (3), including, in relation to a substance, any hazardous properties of the substance identified by testing; and
  (c) any conditions necessary to ensure that the plant, substance, or structure is without risks to health and safety when used for a purpose for which it was designed or when carrying out any activity referred to in subsection (2)(a) to (e).

(5) The designer must, on request, make reasonable efforts to give current relevant information on the matters referred to in subsection (4) to a person who carries out, or is to carry out, any of the activities referred to in subsection (2)(a) to (e).

Appendix I: Example of a panel design/information for propping request form*

Panel design/information for propping

This form to be completed by person requesting a bracing/propping design or shop drawings for a panel design.

1. Applicant details

Customer name:

Project name:

Project address:

Date submitted: DD / MM / YEAR

Email:

Mobile phone:

2. Design details

Region category for propping:

○ A ○ B
○ C ○ D

Terrain category (see Dynamic Factors table in Section 6.6 of these guidelines)

Designed compressive strength: MPa

Preferred strengthening method:

○ Strongbacks ○ Extra reinforcement

Recommended strongback type:

Brace/propping supplier:

Recommended brace type (if any):

Recommended brace type if the bracing angle cannot be 60 degrees:

Design required for footing:

○ Blocks ○ Deadman
○ Pad footing ○ Strip footing

Is geotechnical report required? ○ Yes ○ No

Type of threaded inserts preferred:

PCBU to specify product reference details:

Footing/deadman inserts/details:

PCBU to specify product reference details:

Other information:

* Form adapted with permission from Ancon.

Appendix J: Example of a lift design request form*

Lift design

This form to be completed by the relevant PCBUs.

This form would usually be filled out and sent in together with the drawings of the element to be lifted.

1. Project details

Project name:	Name:
Job reference:	Company:
Date design required: DD / MM / YEAR	Mobile phone:
Drawing or design number/reference:	Email:

Contact details of person requesting design

2. Precast, tilt-up or prestress details

	PRECAST/TILT-UP	PRESTRESS
Note: Additional reinforcing may be added to support the lifting anchors		
Mass unit weight at time of lift		
Designed compressive strength of concrete at time of first lift		
Designed compressive strength of concrete at time of installation		
Concrete cover required for lifting anchors (if different to drawing)		
Type of lift	○ Edge-lift ○ Face-lift ○ Both edge and face	○ Edge-lift ○ Face-lift ○ Both edge and face
Orientation of panel	○ Edge-lift ○ Face-lift ○ Mid-air rotation	○ Edge-lift ○ Face-lift ○ Mid-air rotation
Location of pour	○ On-site ○ Factory ○ Civil ○ Tilt-up ○ Precast	○ On-site ○ Factory ○ Civil ○ Tilt-up ○ Precast
Type of lifting inserts (threaded, lifting hoop, foot or eye)		
Prestress force (kiloNewtons)		
Prestress transfer strength (MPa)		
Position of lifting inserts (to be shown on shop drawings/construction drawings/design drawings/lifting design)		

* Form adapted with permission from Ancon.

	PRECAST/TILT-UP	PRESTRESS
Note: Additional reinforcing may be added to support the lifting anchors		
Can lifting inserts be moved with the permission of the design engineer to allow a more practical design to be completed?		
Preferred number of **load-bearing anchors**		

3. Rigging requirements

Number and type of cranes for demould or first lift

Dynamic factor required: (eg for straight lift, or pick-and carry)

Terrain category (see Section 6.6 of these guidelines)

Preferred sling angle

Sling/rigging height restriction? ○ Yes ○ No

Max sling angle is 60°? ○ Yes ○ No

Preferred strengthening method:
○ Strongbacks ○ Extra reinforcement

Spreader/lifting beams available? ○ Yes ○ No

Additional info/special lifting requirements
(eg rotation in air or with contact to ground; limit on sling length due to height restriction; use special rigging like spreader beam; load equalisation not possible)

Number and type of cranes to install on-site

Dynamic factor required: (eg for straight lift, or pick-and carry)

Terrain category (see Section 6.6 of these guidelines)

Preferred sling angle

Sling/rigging height restriction? ○ Yes ○ No

Max sling angle is 60°? ○ Yes ○ No

Preferred strengthening method:
○ Strongbacks ○ Extra reinforcement

Spreader/lifting beams available? ○ Yes ○ No

Additional info/special lifting requirements
(eg rotation in air or with contact to ground; limit on sling length due to height restriction; use special rigging like spreader beam; load equalisation not possible)

4. Specify any design and/or certification requirements (eg producer statement, batch/test certificates for lifting equipment)

5. Additional requests

Note: Drawings for non-symmetrical elements should include the location of the centre of gravity (CoG).

Appendix K: Tilt-up and precast concrete panel checklist example*

Project:	Site supervisor:
Sub-contractor:	Sub-contractor site supervisor:
Engineering company:	Engineer:
Date: DD / MM / YEAR	Panel number/s:

It is the sub-contractor's responsibility to have all sections ticked off and actioned as the item is completed. This checklist is to be completed **each day** when tilt-up or precast panels are being installed.

The completed forms and all other completed items must be given to:

Name:	Role:

Identify who is responsible for each item. The responsible party initials this section, or submits documentation, as evidence that each item has been inspected or actioned.

DESCRIPTION	**ACCEPTANCE CRITERIA** – **Include approved drawings, relevant standards, engineer's instructions, client specifications and manufacturer's instructions.** – **Attach any item-specific checklists to this form.**	**INSPECTED BY/ACTIONED BY:**		
		Name/role	**Name/role**	**Name/role**
Drawings required	Drawings certified by a competent person exist for the following: - panel design: location of lifting anchors and bracing points, steel content, panel weight, panel dimensions, panel number, location of strongbacks (where applicable), concrete strength, rigging arrangement required to suit lifting anchors - erection and temporary bracing drawings: types of braces required (primary, knee, lateral, end), brace angles, levelling pads - deadman (or floor slab) design: dimensions/depth, soil type, bearing capacity, terrain (wind) category, concrete strength, anchors required - permanent supporting structure - panel layout and erection sequence.			

* Adapted with permission from Laing O'Rourke. Copyright © Laing O'Rourke 2011. All rights reserved.

DESCRIPTION	ACCEPTANCE CRITERIA – **Include approved drawings, relevant standards, engineer's instructions, client specifications and manufacturer's instructions.** – **Attach any item-specific checklists to this form.**	INSPECTED BY/ACTIONED BY:		
		Name/role	Name/role	Name/role
Sub-contractors' documentation	The following documentation has been provided before work begins: – Tilt-up/precast panel Erection Contractor's Job Safety Analysis (JSA). – Crane/Rigging Contractor's Lift Plan/JSA showing: - crane set-up locations - location of obstacles, hazards and existing structures in proximity to the crane (especially temporary braces) - rigging procedures and equipment - spotters' duties - method of communication between operator and dogman/rigger - references to erection sequence - release of panels after braces installed - other:			
Other documentation	Other documentation providing evidence of the following: – concrete strength tests (minimum MPa when cured) – casting dates – anchor specifications for braces (panel and floor/ deadman) – brace type and specifications – lifting anchor and clutch design – pre-pour inspection of panels by competent person in accordance with design specifications.			
Qualifications	Crane operator and dogmen/riggers have appropriate training and qualifications.			
Pre-erection checks	– Concrete panels have achieved the correct strength for lifting as specified in the shop drawings. (Verification has been obtained from the builder or supplier.) – Deadmen and/or floor slab have achieved required concrete strength as specified in drawings. – Panels have been identified and marked with casting date and panel numbers. – Spreader bar and/or rigging configuration used meets load requirements for type of panel. – All lifting slings have working load limit (WLL) and current inspection tags displayed. – Lifting anchors and clutches are compatible. – Ground conditions adequate for supporting crane (level and compacted surface, outriggers used – slewing cranes only, no penetrations or pits in proximity). – Site access is adequate. – Proximity of power lines considered and appropriate action taken. – Exclusion zone has been barricaded and sign-posted to keep non-essential people away during erection and rigging. – Exclusion zones installed to mitigate risk to workers. – Wind conditions are suitable for lifting.			

DESCRIPTION	ACCEPTANCE CRITERIA – Include approved drawings, relevant standards, engineer's instructions, client specifications and manufacturer's instructions. – Attach any item-specific checklists to this form.	INSPECTED BY/ACTIONED BY:		
		Name/role	Name/role	Name/role
Panel lifting and erection	– Back-up chains fitted when using a clamp arrangement to lift elements. – Lift plan prevents side lifting or 'suicide lifting' (lifting in such a way that if the rigging fails, the panel will strike the crane and/or operator). **Note**: This should be addressed at the building design stage to ensure that the crane has the capacity to lift the panel. – Bond breakers used (no jacking or shock loading when lifting to break panel from stack). – Levelling pads installed and set at correct height and location as per design. – Locating (dowel) pins and levelling shims installed as specified in design drawings.			
Temporary bracing for panels and supporting structure	– Temporary bracing for the panels is in accordance with relevant drawings and specifications. – Temporary bracing for the structure is in accordance with relevant drawings and specifications (knee, lateral and end braces and strongbacks installed where specified by designer). – Anchors used for fixing braces to the slab or deadman are an approved type. – Minimum of two braces per panel or as otherwise specified in drawings. – Only specified or calculated number of braces fitted to each deadman (where applicable). – No mix and match braces (all braces must be of same type unless otherwise specified by a competent person). – Brace angle does not exceed 5° from perpendicular and is approximately 50-60° from horizontal (or as otherwise specified in drawings). – Batch marked with manufacturer's name and type, WLL and maximum extension. – Panels released from crane only after temporary bracing has been properly installed. – Exclusion zones have been barricaded and sign-posted to keep vehicles and plant away from temporary braces and supporting structures. – People, equipment and braces are kept clear/or at a safe distance when lifting, slewing and travelling with panels.			
Permanent structure capable of supporting panels prior to removing temporary support system	– All bracing or supporting structure fixing points have been installed and fixed as per shop drawings and engineering requirements. – The supporting structure is adequately braced or structurally sound. – A competent person inspects and confirms that the structure can adequately support panel prior to release of temporary propping or support system.			

DESCRIPTION	ACCEPTANCE CRITERIA – Include approved drawings, relevant standards, engineer's instructions, client specifications and manufacturer's instructions. – Attach any item-specific checklists to this form.	INSPECTED BY/ACTIONED BY:		
		Name/role	Name/role	Name/role
Ongoing monitoring of panels and support systems	– Regular inspections of panels, support systems, and temporary isolation barriers (eg safety inspections, health and safety committee observations, reviewing control measures to eliminate or minimise risk). – Re-inspection at intervals and after weather events.			
Grouting	– Grouting undertaken using specified product and within required timeframe.			
Training, communication and worker engagement†	– Workers are adequately trained to work with tilt-up and precast concrete panels. – Toolbox talk carried out with all relevant workers each day before work starts.			
Specify any additional requirements	– There are also other ways in place to engage with workers, share information, and support their participation in health and safety. – Workers identify health and safety risks and help to manage them. – Workers know how and when to report health and safety concerns.			

† See also 'Worker engagement, participation and representation' in Section 2 of these guidelines.

Appendix L: HSWA section 40

Section 40 of the Health and Safety at Work Act 2015 (HSWA): Duty of PCBU who manufactures plant, substances, or structures.

40 Duty of PCBU who manufactures plant, substances, or structures

(1) This section applies to a PCBU (a manufacturer) who conducts a business or undertaking that manufactures—

- (a) plant that is to be used, or that could reasonably be expected to be used, as or at a workplace; or
- (b) a substance that is to be used, or that could reasonably be expected to be used, at a workplace; or
- (c) a structure that is to be used, or that could reasonably be expected to be used, as or at a workplace.

(2) The manufacturer must, so far as is reasonably practicable, ensure that the plant, substance, or structure is manufactured to be without risks to the health and safety of persons—

- (a) who, at a workplace, use the plant, substance, or structure for a purpose for which it was designed or manufactured; or
- (b) who handle the substance at a workplace; or
- (c) who store the plant or substance at a workplace; or
- (d) who construct the structure at a workplace; or
- (e) who carry out any reasonably foreseeable activity (such as inspection, cleaning, maintenance, or repair) at a workplace in relation to—
  - (i) the assembly or use of the plant for a purpose for which it was designed or manufactured, or the proper storage, decommissioning, dismantling, or disposal of the plant; or
  - (ii) the use of the substance for a purpose for which it was designed or manufactured, or the proper handling, storage, or disposal of the substance; or
  - (iii) the assembly or use of the structure for a purpose for which it was designed or manufactured, or the proper demolition or disposal of the structure; or
- (f) who are at or in the vicinity of a workplace and who are exposed to the plant, substance, or structure at the workplace or whose health or safety may be affected by a use or an activity referred to in any of paragraphs (a) to (e).

(3) The manufacturer 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 imposed by subsection (2).

(4) The manufacturer must give to each person to whom the manufacturer provides the plant, substance, or structure adequate information concerning—

- (a) each purpose for which the plant, substance, or structure was designed or manufactured; and
- (b) the results of any calculations, analysis, testing, or examination referred to in subsection (3), including, in relation to a substance, any hazardous properties of the substance identified by testing; and
- (c) any conditions necessary to ensure that the plant, substance, or structure is without risks to health and safety when used for a purpose for which it was designed or manufactured or when carrying out any activity referred to in subsection (2)(a) to (e).

(5) The manufacturer must, on request, make reasonable efforts to give current relevant information on the matters referred to in subsection (4) to a person who carries out, or is to carry out, any of the activities referred to in subsection (2)(a) to (e).

Appendix M: HSWA section 41

Section 41 of the Health and Safety at Work Act 2015: Duty of PCBU who imports plant, substances, or structures.

41 Duty of PCBU who imports plant, substances, or structures

(1) This section applies to a PCBU (an importer) who conducts a business or undertaking that imports—

- (a) plant that is to be used, or that could reasonably be expected to be used, as or at a workplace; or
- (b) a substance that is to be used, or that could reasonably be expected to be used, at a workplace; or
- (c) a structure that is to be used, or that could reasonably be expected to be used, as or at a workplace.

(2) The importer must, so far as is reasonably practicable, ensure that the plant, substance, or structure is without risks to the health and safety of persons—

- (a) who, at a workplace, use the plant, substance, or structure for a purpose for which it was designed or manufactured; or
- (b) who handle the substance at a workplace; or
- (c) who store the plant or substance at a workplace; or
- (d) who construct the structure at a workplace; or
- (e) who carry out any reasonably foreseeable activity (such as inspection, cleaning, maintenance, or repair) at a workplace in relation to—
  - (i) the assembly or use of the plant for a purpose for which it was designed or manufactured, or the proper storage, decommissioning, dismantling, or disposal of the plant; or
  - (ii) the use of the substance for a purpose for which it was designed or manufactured, or the proper handling, storage, or disposal of the substance; or
  - (iii) the assembly or use of the structure for a purpose for which it was designed or manufactured, or the proper demolition or disposal of the structure; or
- (f) who are at or in the vicinity of a workplace and who are exposed to the plant, substance, or structure at the workplace or whose health or safety may be affected by a use or an activity referred to in any of paragraphs (a) to (e).

(3) The importer must—

- (a) carry out, or arrange the carrying out of, any calculation, analysis, testing, or examination that may be necessary for the performance of the duty imposed by subsection (2); or
- (b) ensure that the calculation, analysis, testing, or examination has been carried out.

(4) The importer must give to each person to whom the importer provides the plant, substance, or structure adequate information concerning—

- (a) each purpose for which the plant, substance, or structure was designed or manufactured; and
- (b) the results of any calculation, analysis, testing, or examination referred to in subsection (3), including, in relation to a substance, any hazardous properties of the substance identified by testing; and
- (c) any conditions necessary to ensure that the plant, substance, or structure is without risks to health and safety when used for a purpose for which it was designed or manufactured or when carrying out any activity referred to in subsection (2)(a) to (e).

(5) The importer must, on request, make reasonable efforts to give current relevant information on the matters referred to in subsection (4) to a person who carries out, or is to carry out, any of the activities referred to in subsection (2)(a) to (e).

Appendix N: HSWA section 42

Section 42 of the Health and Safety at Work Act 2015: Duty of PCBU who supplies plant, substances, or structures.

42 Duty of PCBU who supplies plant, substances, or structures

(1) This section applies to a PCBU (a supplier) who conducts a business or undertaking that supplies—

- (a) plant that is to be used, or could reasonably be expected to be used, as or at a workplace; or
- (b) a substance that is to be used, or could reasonably be expected to be used, at a workplace; or
- (c) a structure that is to be used, or could reasonably be expected to be used, as or at a workplace.

(2) The supplier must, so far as is reasonably practicable, ensure that the plant, substance, or structure is without risks to the health and safety of persons—

- (a) who, at a workplace, use the plant, substance, or structure for a purpose for which it was designed or manufactured; or
- (b) who handle the substance at a workplace; or
- (c) who store the plant or substance at a workplace; or
- (d) who construct the structure at a workplace; or
- (e) who carry out any reasonably foreseeable activity (such as inspection, cleaning, maintenance, or repair) at a workplace in relation to—
  - (i) the assembly or use of the plant for a purpose for which it was designed or manufactured, or the proper storage, decommissioning, dismantling, or disposal of the plant; or
  - (ii) the use of the substance for a purpose for which it was designed or manufactured, or the proper handling, storage, or disposal of the substance; or
  - (iii) the assembly or use of the structure for a purpose for which it was designed or manufactured, or the proper demolition or disposal of the structure; or
- (f) who are at or in the vicinity of a workplace and who are exposed to the plant, substance, or structure at the workplace or whose health or safety may be affected by a use or an activity referred to in any of paragraphs (a) to (e).

(3) The supplier must—

- (a) carry out, or arrange the carrying out of, any calculation, analysis, testing, or examination that may be necessary for the performance of the duty imposed by subsection (2); or
- (b) ensure that the calculation, analysis, testing, or examination has been carried out.

(4) The supplier must give to each person to whom the supplier supplies the plant, substance, or structure adequate information concerning—

- (a) each purpose for which the plant, substance, or structure was designed or manufactured; and
- (b) the results of any calculations, analysis, testing, or examination referred to in subsection (3), including, in relation to a substance, any hazardous properties of the substance identified by testing; and
- (c) any conditions necessary to ensure that the plant, substance, or structure is without risks to health and safety when used for a purpose for which it was designed or manufactured or when carrying out any activity referred to in subsection (2)(a) to (e).

(5) The supplier must, on request, make reasonable efforts to give current relevant information on the matters referred to in subsection (4) to a person who carries out, or is to carry out, any of the activities referred to in subsection (2)(a) to (e).

(6) This section does not apply to the sale of plant, whether or not in trade, if the plant—

- (a) is secondhand; and
- (b) is sold as is.

(7) In subsection (6)(b), as is means that the plant is sold without any representations or warranties about its quality, durability, or fitness, and with the entire risk in those respects to be borne by the buyer.

Appendix O: Example of a manufacturer's statement of compliance for precast concrete elements

A Statement of Compliance confirms that elements were manufactured in accordance with the approved shop drawings and to the design/specifications specified by upstream designers. Providing a Statement of Compliance is optional. The precast manufacturer completes this form.

Project name:	Elements have reached adequate strength for lifting and transportation ○ Yes ○ No
Construction site address:	Certification: On behalf of the manufacturer, I (please print name clearly) certify that the elements identified above were manufactured: – as specified in the shop drawings, and – to the design/s specified by upstream designers, and – in accordance with the relevant construction standards.
Shop drawing number:	
Precast manufacturer's name:	Signature:
Concrete element identification marks:	Title:
Date of transport to site: DD / MM / YEAR	Date: DD / MM / YEAR
Product type:	
Concrete grade used:	
Weight of elements:	

Source: Adapted with permission from Precast NZ's industry guide *Handling Transportation and Erection of Precast Concrete (2015)*

Note: The precast manufacturer is not responsible for the on-site rigging, handling or slinging of the precast concrete elements listed above.

Appendix P: HSWA section 43

Section 43 of the Health and Safety at Work Act 2015: Duty of PCBU who installs, constructs, or commissions plant or structures.

43 Duty of PCBU who installs, constructs, or commissions plant or structures

(1) This section applies to a PCBU who installs, constructs, or commissions plant or a structure that is to be used, or could reasonably be expected to be used, as or at a workplace.

(2) The PCBU must, so far as is reasonably practicable, ensure that the way in which the plant or structure is installed, constructed, or commissioned ensures that the plant or structure is without risks to the health and safety of persons—

- (a) who install or construct the plant or structure at a workplace; or
- (b) who use the plant or structure at a workplace for a purpose for which it was installed, constructed, or commissioned; or
- (c) who carry out any reasonably foreseeable activity at a workplace in relation to the proper use, decommissioning, or dismantling of the plant or demolition, or disposal of the structure; or
- (d) who are at or in the vicinity of a workplace and whose health or safety may be affected by a use or an activity referred to in any of paragraphs (a) to (c).

Appendix Q: Extracts from relevant regulations

Health and Safety at Work (General Risk and Workplace Management) Regulations 2016 (the GRWM Regulations)

GRWM Regulation 9: Duty to provide information, supervision, training, and instruction

Guidance

Workers should only do the tasks they have adequate knowledge or experience to do, or they should be adequately supervised.

PCBUs must ensure workers have adequate training or supervision so they can work safely. This is necessary for any work – for workers' regular tasks as well as the ones they may be called on to do (eg if a co-worker is away).

PCBUs have a duty towards every person who carries out work of any kind, uses plant of any kind, or deals with a substance of any kind that is capable of causing a work risk. They must ensure, so far as is reasonably practicable, that every worker:

- has adequate knowledge and experience of similar places, and work, plant, or substances of that kind, to ensure that the worker carrying out the work is not likely to adversely affect the health and safety or cause harm to the worker or another person, or
- is adequately supervised by a person who has adequate knowledge or experience.

PCBUs must also ensure, so far as is reasonably practicable, workers are adequately trained in the safe use of all plant, objects, substances, or equipment that the worker is or may be required to use or handle. This includes all personal protective equipment (PPE). See Section 4 of WorkSafe's interpretive guidelines *General Risk and Workplace Management, Part 1.*

PCBUs must ensure the information, training, instruction or supervision provided is suitable and adequate, taking into account:

- the nature of the work carried out
- the nature of the risks associated with the work at the time the supervision or training
- information or instruction is provided
- the control measures in place for that work.

See WorkSafe's guidance *Providing Information, Training, Instruction or Supervision for Workers* for aspects to consider when deciding what information, training, instruction and/or supervision to provide.

PCBUs must engage with workers when making decisions about procedures for providing information and training for workers.

PCBUs must ensure, so far as is reasonably practicable, the information, instruction or training provided is readily understandable to workers.

There are also requirements about having access to trained first aiders. See Section 7 of WorkSafe's interpretive guidelines *General Risk and Workplace Management, Part 1*.

GRWM Regulation 14: Duty to prepare, maintain, and implement emergency plan

GRWM Regulation 14(1) and 14(5): Preparing and implementing an emergency plan

Guidance

PCBUs must ensure that an emergency plan is prepared for the workplace. This emergency plan must be implemented in the event of an emergency.

Emergency plans should be tailored to the work and workplace:

- If the work is low risk, emergency plans don't need to be long or complicated.
- In higher risk situations more comprehensive emergency plans will be required (eg for work that deals with harmful substances or where workers work at night or alone).

If a PCBU shares a workplace with other PCBUs, they should co-ordinate their emergency planning where possible.

Note: Other regulations may have additional or separate requirements for emergency plans. For example, the Health and Safety at Work (Hazardous Substances) Regulations 2017.

GRWM Regulations 14(2) and 14(4): What the emergency plan needs to contain

Guidance

Emergency plans must include the following:

- emergency procedures including:
  - an effective response to an emergency
  - evacuation procedures
  - procedures for notifying emergency services at the earliest opportunity
  - medical treatment and assistance procedures
  - procedures to ensure effective communication between the person authorised by the PCBU to co-ordinate the emergency response and all other persons at the workplace
- testing of the emergency procedures, including the frequency of testing
- information, training, and instruction to be given to relevant workers in relation to implementing the emergency procedures.

When working out how to do this, PCBUs must take into account all relevant matters including the:

- size and location of the workplace
- number and composition of the workers
- nature of the work being carried out and the workplace hazards
- views of workers.

When thinking about what emergency procedures should be included in the emergency plan, PCBUs should consider the types of emergency situations workers may face including fire, gas leak, electricity or water outage, natural disasters, robberies and bomb threats.

The emergency plan could include a detailed floor plan showing where emergency equipment and first aid supplies can be found, and the location of utilities.

Regulations 14(3) and 14(4): Maintenance and testing of the emergency plan

Guidance

MAINTAINING THE PLAN

PCBUs must maintain the emergency plan so that it remains effective.

When working out how to do this, PCBUs must take into account all relevant matters including the:

- size and location of the workplace
- number and composition of the workers
- nature of the work being carried out and the workplace hazards
- views of workers.

Emergency plans should be tested at least yearly.

PCBUs should consider reviewing the emergency plan, and updating it:

- when there are changes to work activities or the physical workplace
- if there are changes in the workers with emergency responsibilities
- if new risks have been identified.

PCBUs should communicate the emergency plan to all workers so they know:

- who is responsible for activating and co-ordinating the emergency procedures
- what they must do to keep themselves and others safe.

TESTING THE PLAN

Testing can be a desktop exercise (eg sit down, think of a scenario such as a fire or earthquake, and work through the plan), or stage a mock emergency such as a fire drill and test how well the plan works.

If there are other businesses or undertakings that occupy the same workplace, the testing could be co-ordinated.

Following any testing, a review should be conducted to identify areas for improvement or parts of the plan that need to be updated.

Example

The PCBU 'Middlefield Crane Hire' decided to test their office's emergency plan. A PCBU representative set off the fire alarm (after telling the Fire Service), watched the workers and reported to the PCBU.

Workers forgot to check the reception area before leaving the office.

The PCBU organised a meeting with workers to remind them about the emergency plan including checking the reception area before evacuating the office.

EMERGENCY MANAGEMENT FLIPCHART

See WorkSafe's *Emergency Management Flipchart* on the Hazardous Substances Toolbox website. The flipchart includes templates that could be used at most workplaces: hazardoussubstances.govt.nz

GRWM Regulation 24: Managing risks associated with working under raised objects

Guidance

Raised objects include objects lifted by cranes, forklifts, hoists and jacks, or by hand. They commonly include objects on shelves or fixed to walls above work areas.

PCBUs must follow a prescribed risk management process to manage risks to health and safety from work under objects raised or lifted by any means. See Section 2 of WorkSafe's interpretive guidelines *General Risk and Workplace Management, Part 2*.

If PCBUs can't eliminate the risk, PCBUs must minimise it, so far as is reasonably practicable, by providing supports or other devices to be placed or used under the raised object so that the raised object can't be lowered onto or fall onto anyone underneath it.

GRWM Regulation 25: Managing risks associated with falling objects

Guidance

Objects falling from height can injure or kill workers or others. For example, equipment, material, tools and debris can fall during work at heights.

PCBUs must follow a prescribed risk management process to manage the health and safety risks from falling objects that are reasonably likely to fall on and injure a person. See Section 2 of WorkSafe's interpretive guidelines *General Risk and Workplace Management, Part 2*.

PCBUs must first try to eliminate the risk so far as is reasonably practicable:

- If they can't eliminate the risk, PCBUs must minimise the risk by providing and maintaining a safe system of work that includes measures for preventing an object from falling freely so far as is reasonably practicable.
- If it is not reasonably practicable to prevent the object from falling freely, use a system to arrest the fall so far as is reasonably practicable.
- If it is not reasonably practicable to prevent the object from falling freely or to use a system to arrest the fall, an exclusion zone that persons are prohibited from entering must be provided.

Examples of control measures to prevent objects from falling include:

- keeping tools or materials away from edges and off railings or sills, or tethering or securing them
- providing a safe means of raising and lowering objects including using waste disposal chutes for rubbish.

Examples of fall arrest measures include:

- using nets or catch platforms
- providing covered pedestrian walkways
- providing overhead protection on mobile plant
- using an inertia reel attached to a harness.

REMEMBER

PCBUs must first try to eliminate a risk if this is reasonably practicable. If it is not reasonably practicable to eliminate a risk, the risk must be minimised so far as is reasonably practicable.

Notes

Disclaimer

This publication provides general guidance. It is not possible for WorkSafe to address every situation that could occur in every workplace. This means that you will need to think about this guidance and how to apply it to your particular circumstances.

WorkSafe regularly reviews and revises guidance to ensure that it is up-to-date. If you are reading a printed copy of this guidance, please check worksafe.govt.nz to confirm that your copy is the current version.

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