GOOD PRACTICE GUIDELINES

Safe Work with Precast Concrete

CONSULTATION DRAFT

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

ACKNOWLEDGEMENTS

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KEY POINTS

Precast concrete is widely used in the New Zealand construction industry.

Handling, transporting and erecting precast concrete 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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SECTION 1: INTRODUCTION

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

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

1.1 SCOPE

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

These guidelines are for persons conducting a business or undertaking (PCBUs), workers, upstream PCBUs (such as designers, manufacturers, suppliers, installers and importers), and other people involved in handling, transporting and erecting precast concrete elements. The guidelines do not cover design of the completed structure, nor do they cover 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
- 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 the uncontrolled collapse of precast concrete 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
- inadequate concrete strength, due to:
    - lifting before the concrete has reached its design strength
    - manufacturing errors

- elements that have been damaged or weakened (eg by modifications or repairs)
- faulty lifting inserts 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 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), and the Health and Safety at Work (General Risk and Workplace Management) Regulations 2016 (GRWM Regulations).

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, and also refer to other legislation such as the Building Code. When planning how to work with precast concrete, always check any industry-specific guidance (eg New Zealand's Crane Safety Manual) as well.

Some requirements and recommendations in the guidelines are based on benchmarks set by New Zealand and Australian standards for working safely with precast concrete. 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. To purchase standards, go to the Standards New Zealand website: www.standards.co.nz or email: enquiries@standards.co.nz.

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

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

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, manufacturing, handling, transporting, storing, and erecting.

Key hazards are listed at the start of several sections. However, there may be hazards at your workplace that are not identified in the lists of key hazards in these guidelines. So you will still 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, an in-ground or on-ground mass block is also referred to as a deadman; a lifting insert may also be known as a lifting anchor.

1.4.1 DUTY HOLDER

A duty holder is a person who has a duty under HSWA. There are four types of duty holders – 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*

www.worksafe.govt.nz

1.4.2 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.

1.4.3 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.

For more information

WorkSafe's fact sheet *Reasonably Practicable*

www.worksafe.govt.nz

1.4.4 USE OF 'MUST' AND 'SHOULD'

Term	Definition
Must	Legal requirement that has to be complied with.
Should	Recommended practice or approach.

Table 1: Requirements in this guidance

1.5 HSWA REFERENCES

References to relevant sections of HSWA are in shaded boxes.

SECTION 2: ROLES AND RESPONSIBILITIES

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.

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*

www.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 - for example, a precast concrete manufacturing business
- Undertakings are usually not profit-making or commercial – for example, 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.

EXAMPLES OF A PCBU

- is responsible for consulting with designers and main contractors to make sure that 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)
- 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 co-ordination 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 and 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
- ensuring that health and safety procedures or processes are in place, including for emergencies
- making sure that adequate training and communication practices are in place
- planning all aspects of the site work to ensure precast 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 co-ordinating with other PCBUs such as designers, precast manufacturers, transport contractors and crane contracting businesses throughout the duration of the project.

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

2.1.1 PRIMARY DUTY OF CARE

A PCBU has the 'primary duty of care' – the primary responsibility for people's health and safety at work. The primary duty of care includes, so far as is reasonably practicable:

- providing and maintaining
    - a physical and psychological work environment that is without risks to health 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 workers

- providing information, supervision, training, and instruction 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.

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. For example, a PCBU should secure a construction site each night so that unauthorised people cannot get in.

2.1.2 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 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, co-operate with, and co-ordinate activities with other PCBUs to meet their shared duties.

EXAMPLE

A PCBU must ensure that:

- adequate first aid equipment is provided for the workplace
- each worker has access to the 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 persons who have been trained to administer first aid.

The head contractor and crane sub-contractor on a construction site are both PCBUs.

This means that they both have to ensure access on site to first aid equipment, first aid facilities and people who can administer first aid.

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 fact sheet *Reasonably Practicable*

www.worksafe.govt.nz

2.1.3 ADDITIONAL DUTIES FOR UPSTREAM PCBUS

PCBUs in the supply chain are known as 'upstream' PCBUs. Upstream PCBUs have a duty to ensure, so far as is reasonably practicable, that the work they do or the things they provide to other workplaces don't create health and safety risks.

Sections 39 – 43 of HSWA specify the additional duties of upstream 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.

Upstream PCBUs can influence and sometimes eliminate health and safety risks through designing or manufacturing products that are safe for the end user. Importers must ensure imported goods meet all New Zealand regulatory requirements.

Upstream PCBUs have duties under HSWA around testing, analysis, and information provision. For example, an upstream PCBU must provide information on how to use the structure, substance, or plant in a way that is safe and healthy to each person they provide it to. The downstream PCBU may engage with that upstream PCBU to make sure the downstream PCBU's needs are understood.

Downstream PCBUs have a duty to ensure a safe and healthy working environment. They 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 downstream PCBU buys from an unfamiliar or overseas supplier, buys in bulk, or commissions a structure.

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

2.1.4 WORKER ENGAGEMENT, PARTICIPATION AND REPRESENTATION

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

PCBUs can ensure a safe workplace more effectively 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 workplace health and safety.

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.

2.1.5 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 an HSR, engagement must involve that representative.

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

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

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*

www.worksafe.govt.nz

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 fact sheets *Worker health and safety rights and responsibilities*, available in English, Māori, simplified Chinese, Hindi, Samoan and Tongan

www.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 their 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.

SECTION 3: IDENTIFYING, ASSESSING AND MANAGING WORK RISKS

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 its size and mass, precast concrete poses a significant risk to anyone working with it and to other people in the workplace.

PCBUs must manage all 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. See Section 3.6 of these guidelines: Health and Safety by Design.

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
- 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

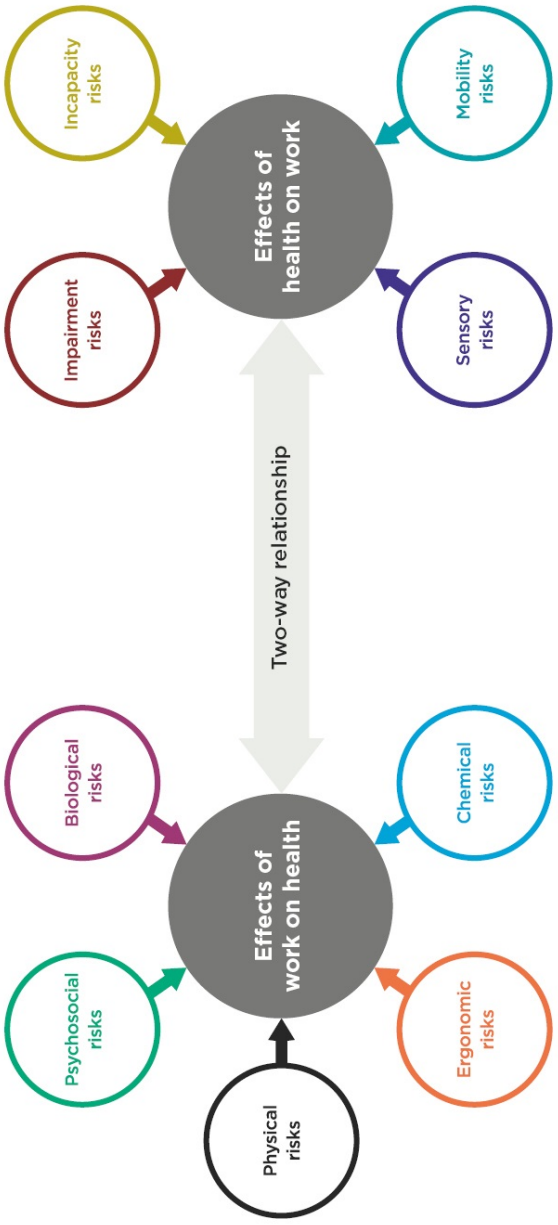
3.2 PLAN: IDENTIFY HAZARDS, ASSESS RISKS, SELECT CONTROL MEASURES

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

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.

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

3.2.1 RISK OF COLLAPSE OR CRUSH INJURIES

Significant harm can be caused by:

- uncontrolled collapse of precast concrete elements, including while elements are temporarily braced or when braces are being modified or 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 chance of these situations occurring.

3.2.2 CONSIDER ALL HAZARDS ON SITE

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

Consider all hazards on 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.

Be familiar with 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 a toxic substance commonly 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. Fatigue is a work risk that both PCBUs and workers must manage. Fatigued workers may make mistakes that lead to work incidents and injuries. Everyone should learn to recognise the signs and symptoms of fatigue.

3.2.3 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.

3.2.4 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 10.7 (Lifting Operations) for more information. If PCBUs can't eliminate these risks, they must minimise the risks, so far as is reasonably practicable.

3.2.5 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

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

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

Some control measures are more effective than others. The hierarchy of controls in Figure 3 ranks control measures from most to least effective.

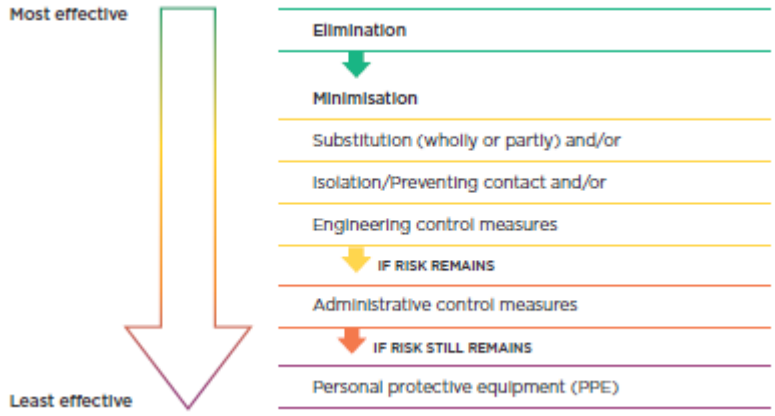


Figure 3: Hierarchy of controls

If the risk is not specified in regulations, the PCBU decides how to manage the risk. Find out if there are widely used control measures (eg industry standards) for particular risks. The PCBU should check whether these control measures will effectively manage their risks.

Elimination

Elimination is the most effective control. 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.

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]

[1] For prescribed risks, one or a combination of these approaches **must** be used.

- **Substitution**

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

  - use a larger crane
  - use a different product.

- **Isolation**

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

  - stand (erect) precast concrete panels on a day when the only workers on site will be 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 Section 9.5.2 of these guidelines: NZTA Compliance.)

- **Personal protective equipment (PPE)**

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

  - wear hearing protection for work in noisy areas.

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

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

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

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 check if they are effective.

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

3.5 ACT: TAKE ACTION ON LESSONS LEARNT

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.

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 workers and others.

The aim is to continually improve the management of risk by providing workers with the highest level of protection against harm to their health, safety and welfare, so far as is reasonably practicable.

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 life-cycle 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 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 fact sheet *Reasonably Practicable*

WorkSafe's good practice guidelines *Health and Safety by Design* [due mid-2018]

www.worksafe.govt.nz

www.legislation.govt.nz

SECTION 4: WORKER TRAINING

Training helps people working with precast concrete 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, supervision, training and instruction needed to protect them from work-related health and safety risks.

4.1 WHAT COULD GO WRONG?

WHAT COULD GO WRONG?	POSSIBLE CAUSES
Injuries, ill-health or death result from the actions of: • untrained or poorly trained workers • inexperienced workers that are not appropriately 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 the worker – perhaps it was not adapted to suit the worker's numeracy (number), literacy (reading/writing) or language skills. • Workers have not undergone regular refresher training resulting in declining or out-of-date skills. • Inexperienced workers are not adequately supervised (eg the supervisor is too far away from the worker they are supervising – that is, not within reach, or visual contact).

Section 36 of HSWA covers the primary duty of care.

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.

Training should be carried out by a competent person or approved training organisation. Consider inviting 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.

4.2.1 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 CHECK
• When and where will training take place?
• Will training be carried out internally or externally, and who will deliver it?
• What experience and competencies do trainers or supervisors need?
• How will trainers tailor training to take into account workers' language skills, including their reading and writing skills and their ability to work with numbers?
• Who will supervise workers receiving on-the-job training?
• Will training be paper-based, audio-visual, or computer-based (including on a tablet or smartphone)?
• Are there relevant formal qualifications workers can obtain?
• Will training cover identification of hazards related to:
• using plant and equipment?

PLANNING TRAINING: WHAT TO CHECK *(continued)*
• 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 workers demonstrate understanding?
• How will daily reminders of safe work practices be provided after training (eg standard operating procedures [SOPs], posters or flash cards summarising the key points)?
• 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?

For more information

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

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

www.worksafe.govt.nz

4.3 WORKER COMPETENCE

Always assess the competence of any new worker on site. As a starting point, consider:

- What is the worker's level and depth of experience carrying out the tasks required to work with precast concrete?
- 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.

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?

4.3.1 OTHER FACTORS AFFECTING WORKER COMPETENCE

Even if workers are well-trained other factors can affect a worker's competence. For example, a lack of sleep, poor diet, relationship problems, money problems, alcohol and drug abuse, health problems 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 physical demands, consider if jobs 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 National Certificates and National 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 manufacturers, as well as providing a way to recognise 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. Assess and record the level of training workers have achieved. Records could include copies of external training provider certificates, in-house or on-the-job training records and attendance lists.

NZQA requires organisations awarding a qualification to keep records of learner progress and programme completion, and the date the qualification was awarded and certificate issued.

4.6 RESPONSIBILITIES WHEN WORKING WITH TRAINEES

A trainee worker can be involved in precast concrete work as long as they are directly supervised.

What is direct supervision?

In these guidelines, direct supervision means within reach, or within visual contact. The supervisor is responsible for monitoring the work and ensuring compliance with regulations and recommended practice. They must be in a position to take immediate charge in an emergency.

The appropriate ratio of experienced workers to trainee workers depends on the level of experience and competence of each trainee, the complexity of the precast concrete work being undertaken, and the risks associated with any mistakes that trainees may make.

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 fact sheet *Providing Information, Training, Instruction or Supervision for Workers*

www.worksafe.govt.nz

SECTION 5: SITE MANAGEMENT

Precast concrete work usually takes place as part of a larger project. PCBUs must work together 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 responsibilities such as 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 SYSTEM OF WORK

A safe system of work means the steps a PCBU takes to eliminate or minimise work risks, so far as is reasonably practicable.

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 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 Appendix E for a template
- consulting a competent person regarding any temporary works design
- identifying health and safety hazards and risks
- describing how any identified risks will be controlled, including procedures for unexpected events such as bracing failure
- describing how control measures will be implemented, monitored and reviewed
- effective communication systems (so that workers can regularly confirm that they are safe)
- incident investigation and reporting methods
- an emergency plan and procedures.

Engage with all 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
- monitoring of the work environment
- monitoring of worker health.

For more information

WorkSafe's fact sheet *Reasonably Practicable*

www.worksafe.govt.nz

5.2 SITE ASSESSMENT BEFORE WORK BEGINS

Carry out a site assessment before work begins. (See related content in these guidelines, as indicated.)

INITIAL SITE ASSESSMENT: WHAT TO CHECK
SITE CONDITIONS (See also Section 10) • What is the nature and condition of the ground, surface or structure on which the precast concrete element will be erected?
WORKER FACILITIES (See also 2.1.1) • 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 element/s be subject to environmental loads such as earthquakes, wind, vehicle impact, or snow? (See also Appendix H)
• What weather conditions are expected during the project (eg seasonal changes)? (See also 10.1)
SITE ACCESS, SAFETY AND SECURITY (See also 9.5.5; 10.8) • 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 to isolate people?

- How will the site be protected from unauthorised access?

STORAGE (See also 9.4)

- Is there a secure and protected location for storage?

- Is there enough space to store 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 (See also 10.1; 10.6.1)

- 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 – for example, during delivery to the site, erection, or other work activities?

PERMITS, CONSENTS AND NOTIFICATIONS (See also Appendix F) • Are there local authority requirements?
• Are other permits or consents required?
• Does the work need to be notified to WorkSafe?
• Should anyone else be notified? For example, other PCBUs at site, neighbours, the airport if a crane boom will affect flight paths.
SITE-SPECIFIC DOCUMENTATION (See also Section 7) • What site-specific documentation is required, including (but not limited to):
o a health and safety policy?
o a summary of the workplace safety plan?
o an emergency plan? (See Section 5.3 of these guidelines.)
o a workplace safety induction card?
o a visitor and workplace induction register?
o an accident/incident register, including near misses?
o injury/ill-health/incident reporting?
o hazard identification?
o risk assessments?
o safe/standard operating procedures?
o drawings (eg shop drawings, contract drawings, structural drawings)?
OTHER PCBUs ON SITE (See also 2.1.2) • 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?

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 accident event
- after a notifiable incident
- after a severe weather event
- after an earthquake.

EMERGENCY PLAN: WHAT TO CHECK
Does the emergency plan identify:
• what to do in an emergency?
• roles and responsibilities (eg of managers, wardens)?
• who is trained to administer first aid?
• where first aid and medical provisions are?
• where the nearest emergency centre is?
• the location of alarms?
• the location of fire extinguishers?
• escape routes?
• assembly points?
• location of emergency supplies?
• up-to-date lists with emergency contact details (eg phone numbers for staff, emergency services, clients, suppliers and your insurance company)?

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 fact sheet *Providing information, training, instruction or supervision for workers*

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SECTION 6: DESIGN

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

PCBUs who are designers must, so far as is reasonably practicable, make sure that the plant, substances, and structures they design are without health and safety risks when they are used for their intended purpose in a workplace.

The designer must carry out – or arrange the carrying out of – any calculations, analysis, tests or examinations needed to make sure the plant, substance or structure designed, manufactured or supplied is without health and safety risks, so far as is reasonably practicable.

The designer must share this and other information with each person who is provided with the design. See Appendix G of these guidelines: Duties of designers, manufacturers, importers, suppliers, installers, constructors and commissioners.

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

6.1 DESIGNERS

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 and supporting structures are able to resist any reasonably foreseeable static, dynamic and impact loads, taking into account the required factors of safety.

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 until it is 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.

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 they 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.

6.2 DESIGN PHASES

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
  - approves stability of the structure during construction (when requested), particularly before removing temporary supports.

- **Design of the manufacturing and transport process,** including design of:

  - layout of the precast production facility
  - precast beds
  - access to and protection of the beds and moulds
  - moulds
  - demoulding
  - handling, storage, and transport of the precast elements
  - craneage

- **Design of the site offloading and erection process,** including design of:
    - access
    - lifting
    - storage
    - erection and temporary support of the precast 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 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
- undertake erection design to ensure the precast concrete can resist foreseeable issues with handling, transport, erection, environmental, and construction loads
- provide the precast manufacturer with information showing the necessary lifting and insert locations, orientations and specifications (including any additional reinforcement/strongbacks) required
- produce rigging configuration, erection sequence and drawings (including brace specifications)
- review the completed shop drawings
- issue a certificate confirming erection design complies with relevant codes.

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

ERECTION DESIGN: WHAT TO CHECK
Has erection design addressed:
• the size and shape of the precast concrete elements?
• erection loads?
• design of the supporting members to cater for the erection loads?
• lifting inserts?
• 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?
• minimum dimensions of drilled piles or in-ground mass blocks (if used)? These should allow for the spacing and edge distance requirements for the number and type of cast-in components being used.
• base restraint details to be incorporated? (Where friction alone will not provide base restraint with an appropriate safety factor.)

6.2.1 GENERAL CONSIDERATIONS

All aspects of design should be carried out in accordance with any relevant legislation. If the temporary support system of precast concrete will be in place for six months or less, the design of that system shall 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 shall be based on a 1 in 25 years event.

Competent persons should design the handling, transport, erection and temporary support systems for precast concrete. 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 H of these guidelines.)

6.3 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 may include wall panels, beams, columns, floors and roofs (for example, when constructing buildings, bridges, stadiums and reservoirs).

Temporary works 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 elements (such as deflections and vibration).

The structural designer should also provide information 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 procedure.

6.3.1 DESIGN TO RESIST LOADS

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

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 mass blocks (also known as 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.

6.3.2 TEMPORARY SUPPORT FOUNDATIONS

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

An in-ground or on-ground mass block made of concrete is one method for transferring lateral loads to the ground in conditions where floor slabs are not available to resist the brace loads. The mass block is specifically designed to support brace loads. Lateral loads are resisted by the mass of the concrete block and the friction between the concrete surface and the supporting ground.

Mass blocks should be designed by competent persons who take into account the various design loads and conditions outlined in Section 6.5.10 of these guidelines.

Brace loads can act in tension and compression. The resultant forces on the mass block may reduce the base friction. This needs to be considered in the design.

If piles or mass blocks are used as brace foundations, they 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.

6.4 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 10.6 of these guidelines), considering:
    - the size and capacity of crane(s) required for lifting and erection
    - positioning of a tailing crane on site (if tailing crane required to transport a large panel)
    - the effect of the panel size on lifting restrictions such as wind speed and the rating of the cranes available
    - 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.

6.5 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 of 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 inserts, lifting inserts, 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 (Hiab), 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.

There should be sufficient temporary base restraint to prevent a sliding failure (kick-out) at the base or support of the precast concrete element. Note that the panel weight may not provide base restraint.

6.5.1 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 inserts and stresses within precast concrete 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 10.9 of these guidelines for information about rigging practices and configurations.

6.5.2 CONCRETE WEIGHT AND STRENGTH

Concrete strength increases over time and is affected by curing conditions, environment and temperature. 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 building, 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 the minimum number or days, 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 or bracing inserts, the structural designer should approve the change.

With approval from the structural designer, higher strength concrete can be used:

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

Some lifting inserts 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 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 an 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).

6.5.3 MINIMUM STRENGTH FOR LIFTING FROM MOULDS

The minimum concrete strength for lifting elements from moulds needs to allow the lifting inserts to develop sufficient strength and the element to have sufficient bending strength. The concrete element needs to reach the minimum required concrete strength for lifting and erection.

Calculate the minimum concrete strength needed to lift the elements from the mould using:

- concrete stresses at the lifting points
- stresses caused by the transfer of pre-stressing forces or handling.

Take into account that:

- the flexural stresses may not determine minimum concrete strengths for vertically cast concrete elements, or elements cast on tilting moulds
- transport over rough ground may cause impact loads.

6.5.4 FRICTION AND SUCTION LOADS

Suction loads occur when precast concrete is being lifted off the casting bed or stacks, adding direct loading to crane lifting equipment and lifting inserts. 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 (in the case of mobile cranes). Suction loads can also damage

precast concrete elements. Note that suction loads are based on the surface area rather than the panel weight.

Designers should consider the effects of suction loads to ensure safety and the integrity of the precast 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 inserts, 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 and unpredictable sudden movements. Take particular care if the lifting force applied exceeds the weight of the precast element by more than 10%.

6.5.5 DYNAMIC/ IMPACT LOADS

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

The designer should consider the dynamic factors shown in the following table, along with other general considerations of design (that is, the factor of safety for the construction of concrete elements, the factor of safety for lifting inserts, and the factor of safety for the lifting system).

Means of transportation	**Dynamic factor will be a minimum of:**
A stationary crane, including an overhead gantry crane, a crane standing on outriggers or a tower crane	1.2
Mobile lifting device travelling on an even, prepared surface	2.0
Mobile lifting device (such as a digger, back hoe or ‘pick and carry’ crane) on an uneven surface	5.0

Table 2: Dynamic factors based on means of transportation

6.5.6 REPETITIVE LIFTING

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

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

6.5.7 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 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 element to resist thermal and shrinkage stresses and prevent cracking resulting from handling elements
- when there is a chance of load reversal resulting from handling during transport or erection.

During handling and transportation, 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 concrete element. If required, additional reinforcement or strongbacks (see Section 6.5.8 of these guidelines) should be added to strengthen the element.

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 inserts, 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.

6.5.8 STRONGBACKS

Strongbacks are temporary supports used to:

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

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

Figure 4: Strongbacks supporting a large precast concrete element

Large or awkwardly shaped precast 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.

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

An engineer should consider the size, shape, weight and connection details of elements when designing strongbacks.

Strongbacks should be designed for strength and/or for deflection, depending what is most important. They have to be stiff enough to prevent the concrete cracking due to differential deflection. Strongbacks limit deflection and prevent the concrete exceeding its rupture strength and cracking when it is being lifted.

Design should also take into account:

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

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

Materials to be used for the manufacture of strongbacks should be designed to a relevant standard such as NZS3404 and NZS3603.

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 the Ministry of Business, Innovation and Employment as a Crane Design Verifier. 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 should be:

- designed, marked and tested by a CPEng or Design Verifier, and also
- 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 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.

For more information

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

www.worksafe.govt.nz

AS 4991 – Lifting Devices

6.5.9 LIFTING INSERTS

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

Lifting inserts should be properly embedded in well-compacted uncracked concrete to function effectively.

Every individual item of lifting equipment should be clearly and permanently marked with its WLL and a unique numbering system. This allows the item to be easily identified after the lifting inserts are cast into the element.

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

Inserts or other components that are for permanent fixing in the completed structure should not be used as part of the erection handling or lifting process unless approval has been obtained from the structural designer.

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.

Use a minimum safety factor of 5 for applications requiring repetitive lifting of a concrete element during its service life. For example, concrete road barriers and manhole covers are likely to be lifted multiple times.

Lifting inserts that are used for lifting and handling during all stages of manufacture, delivery and installation should be designed to a minimum safety factor of 3. 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 inserts and systems is a significant hazard and should be considered during the design. As with lifting clutches, lifting inserts should be manufactured and tested in accordance with a valid international standard or technical reference (such as CEN TR 15728 2016 - *Design and use of inserts for lifting and handling of precast concrete elements*).

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

WorkSafe recommends that designers using proprietary lifting inserts 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 inserts to use, designers should refer to the list below. It identifies the key factors to consider.

LIFTING INSERT DESIGN: WHAT TO CHECK
Does lifting insert design include:
• the number, location and placement of fixing inserts, adequate to resist the tension and shear forces (static and cyclic) imposed on the connections?
• reduction of insert capacity when placed near an edge or an opening?
• component reinforcement?
• adequate cover to all inserts?
• ductile behaviour and robustness of the insert?
• concrete strength required to reach the required insert capacity?
Have these factors been considered when selecting the number and size of lifting inserts required:
• lifting insert capacity?
• whether the 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 influence of suction and friction during demoulding?
• possible influence of dynamic factors when lifting on site with non-stationary cranes?

EDGE- OR FACE-LIFTING

Design face-lifted concrete elements that are to be fixed vertically 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 inserts 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 inserts placed in the element face, the geometric centre of the face-lift inserts 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 INSERTS

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

Avoid multiples of three rows or columns of lifting points where equal loading is required, as complex rigging configurations are needed. For example, avoid lifting arrangements involving odd numbers of lifting points.

6.6 IMPOSED ACTIONS

Design for site processes should consider any reasonably foreseeable actions imposed on precast concrete 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 element, position on structure, surface roughness, site subsoil classification, hazard factor, return period, near fault factor and period of vibration.

Seismic assessment of precast 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/NZS1170.5.

For more information

Building Regulations 1992: Schedule 1: The Building Code

www.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.*

SECTION 7: DOCUMENTATION

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 in-ground mass blocks
- 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
- include dimensions, material properties and fixing details
- specify design loads and performance requirements for precast 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 manufacture 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 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 manufacturer, head contractor, crane controller and client.

Shop drawings may include:

- date and issue number
- project name and location
- identification and number of concrete elements
- volume and mass of concrete elements
- concrete element dimensions and centre of gravity
- concrete design strength
- minimum concrete strength required for lifting. To achieve the strength required for lifting, 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 inserts
- erection layout.

There may be temporary works drawings covering bracing, propping, and arrangement of the elements in their final location.

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 on site by the head contractor.

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 craneage
- 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 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
- bracing and propping details for each element:
    - type and angle (as designed and certified by a competent person)
    - configuration and size of erection braces and, where applicable, knee braces and cross-bracing and any other secondary bracing that may be required
- details of levelling shims; see Section 10.5 of these guidelines
- on-site lifting and handling requirements

- any special requirements, such as:
    - non-standard finishes
    - special lifting and handling procedures
    - preferred lifting and handling system to suit available equipment
    - additional reinforcing for handling, transport or for other reasons
- all inserts and other components to be cast-in for lifting, handling or fixing
- type, make and location of all required lifting inserts; if additional reinforcement or tension bars are required for the lifting insert 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 inserts
    - bracing inserts 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 inserts, and the size, configuration and concrete cover of any component reinforcement required. Details for edge-lift inserts and other 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).

7.6 PROJECT-SPECIFIC CHECKLISTS AND FORMS

PCBUs may choose to use other project-specific checklists and forms, such as the examples described below.

7.6.1 PANEL DESIGN

During the design phase, some PCBUs use a 'panel design checklist' to specify details such as the location of the pour, the orientation of the panel, sling/rigging height, preferred strengthening methods (eg strongbacks) and the type of threaded inserts preferred. A sample panel design checklist is shown in Appendix I of these guidelines.

7.6.2 LIFT DESIGN REQUEST

Some PCBUs use a 'lift design request form' to enable a lift design to be produced. Although the precast manufacturer knows how to lift and load elements for transport from their own facility, requirements on a construction site may differ.

The form requests details such as unit weight, preferred compressive strength at time of first lift, type and position of lifting inserts, rigging requirements (eg the number of cranes needed during installation) and any design or certification requirements. See Appendix J of these guidelines for an example.

7.6.3 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 panels.

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. See Appendix K of these guidelines for an example.

DOCUMENTATION FOR STRUCTURAL DESIGNER: WHAT TO CHECK Has the head contractor given the following documentation to the structural designer:
• shop drawings?
• 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?
• erection documentation?
• structural and precast concrete element documentation?
• drawings showing the supporting structure of precast units?
• loading information?

• instructions for use, storage and maintenance of plant and equipment (where applicable)?
• a copy of any report, licence or authority required to carry out precast concrete construction work?

7.7 OTHER DOCUMENTATION

Other documentation that should be accessible on site includes site-specific documents and records, including the emergency plan and the items listed in the table in 5.2 of these guidelines.

SECTION 8: MANUFACTURING

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 upstream PCBUs, precast concrete manufacturers must, so far as is reasonably practicable, make sure the precast concrete elements they manufacture are without risks to the health and safety of people using them for the purpose they were manufactured for.

Sections 40–43 of HSWA specify the duties of upstream PCBUs, including PCBUs manufacturing plant, substances, or structures. Upstream PCBUs have specific duties under HSWA around testing, analysis, and information provision. See Section 8.4 of these guidelines for more information.

8.1 WHAT COULD GO WRONG?

WHAT COULD GO WRONG?	POSSIBLE CAUSES
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 inserts. • Incorrect installation of steel reinforcing.
Workers suffering musculoskeletal injuries (eg sprains and strains, back injuries, abdominal hernias) when handling 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	• Not using appropriate control measures to minimise exposure to substances commonly used in precast concrete manufacture (including concrete, curing compounds and release agents).

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.

8.2 THE PRECAST MANUFACTURER

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.

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.

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 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 inserts (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 elements in the precast yard
- provides relevant paperwork to the head contractor before the precast concrete leaves the precast yard/is offloaded at site; this may include a Manufacturer's Statement of Compliance.

Plant and equipment should be well-laid out to ensure efficiency and safety for workers. For example, casting beds should be well-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.

8.3 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 precast manufacturer and the erection sub-contractor should together decide the propping, bracing and any special lifting requirements.

The head contractor should check and approve the drawings before concrete is cast, or 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 concrete is manufactured.

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

8.4 PRECAST MANUFACTURER'S DUTIES

As an upstream PCBU, a precast concrete manufacturer's duties include making sure that the elements they produce are without risks to the health and safety of persons using them for the purpose they were manufactured for, including during transportation to the site. The manufacturer must also provide adequate information about the element's purpose, any testing and examination results (see below), conditions for use, and how the panels will be handled. Consideration should also be given to how the panels will be transported.

The erection crew requires information necessary for handling elements on site, including:

- special rigging requirements
- temporary propping requirements
- limitations or restrictions on handling or storage.

8.4.1 TESTING

The precast manufacturer must undertake, or arrange the undertaking of calculations, analysis, testing or examination that may be necessary to ensure the precast concrete elements are without health and safety risks. They must provide instructions about how the elements should be used and any analysis or test results, or conditions of use, to make sure there are no risks to health and safety.

EXAMPLES OF TESTS AND EXAMINATIONS THAT MAY BE CARRIED OUT

- - visual inspection of a precast element for damage, cracks or other defects
- - measuring to ensure the dimensions are correct
- - visual inspection to confirm that lifting inserts are correctly placed
- - testing whether an element can be lifted without cracking.

8.5 OPTIONAL PRECAST MANUFACTURER'S STATEMENT OF COMPLIANCE

The PCBU who manufactured the element should be satisfied that the element is fit for purpose (built to the engineer's specification) before sending it to the site.

The precast manufacturer may prepare a Statement of Compliance before transporting or erecting precast concrete elements. This may take the form of a Producer Statement, Part 3 (also known as a PS3). This may fulfil the manufacturer's duty to provide health and safety information about their products or designs to other PCBUs.

A Statement of Compliance confirms the elements were manufactured in accordance with the approved shop drawings and to the design/specifications specified by upstream designers. See Appendix L of these guidelines for an example.

Providing a Statement of Compliance is optional. By sending an element to its destination, or allowing a manufactured element to be lifted, the manufacturer is confirming that the element is fit for purpose.

8.6 CURING COMPOUNDS AND RELEASE AGENTS

The strength, water-tightness and durability of concrete will depend on it being sufficiently cured. Check that the release agents or curing compounds used during manufacturing are compatible with each other, and with applied finishes and joint sealants, before using them. Consider:

- solubility
- discolouration
- temperature effects.

Apply curing compounds and release agents in accordance with the manufacturer's instructions. Using release agents incorrectly may lead to high suction loads or panels sticking to the casting surface.

8.6.1 SAFETY DATA SHEETS

The precast concrete manufacturer (and anyone else holding a hazardous substance) must have a safety data sheet (SDS) for every hazardous substance supplied to their workplace for the first time. 'First time' also means:

- when a substance is supplied for the first time in five years
- when a substance is supplied for the first time after a change to the SDS.

The precast concrete manufacturer (and anyone else holding a hazardous substance) needs to make sure that the SDS is available to:

- workers in the areas where they work
- emergency workers who could be exposed to the substance in an emergency
- anyone else who could be exposed to the substance.

8.7 MOULDS AND CASTING BEDS

8.7.1 MOULDS

Formwork or mould design can have a direct bearing on how 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 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 in place to keep workers safe from all risks.

8.7.2 VERTICAL MOULDS AND TILTING MOULDS

Thin, lightly reinforced 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.

8.7.3 SURFACE FINISHES

Surface finish requirements can determine the preferred orientation of a precast 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.

8.7.4 LIFTING FROM CASTING BEDS

When lifting precast elements from a casting bed, allow for suction or demoulding forces. The centre of the lifting inserts should coincide with the centre of gravity of the precast element.

8.7.5 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 an error-proof system for checking all bolts are removed before lifting the element from the mould. Failing to remove bolts is a common cause of lifting insert failures.

8.8 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 inserts cast into precast concrete elements.

Type of unit	**Insert location**
Piles	150 mm along the length
Flooring units	150 mm along the length
Beams	200 mm along the length 50 mm along 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 insert.

Table 3: Recommended tolerances for location of lifting inserts cast into precast concrete elements

SECTION 9: HANDLING, STORING AND TRANSPORTING

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?

WHAT COULD GO WRONG?	POSSIBLE CAUSES
Elements falling or collapsing (eg the uncontrolled collapse of elements or person being caught between an element and another object) causing severe crush injuries	• Poorly stored elements (eg poorly maintained A-frames or other storage equipment, incorrectly stored frames, elements stacked the wrong way). • During transportation having: - uneven, unsecured or overloaded racks or support frames - noncompliant lifting systems - damaged 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 elements (eg 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 harmful levels	• Handling elements 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 elements	• Not using appropriate equipment to reduce the risk of a fall. • Equipment not being inspected or well-maintained.

For information on working at height:

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

9.2 HANDLING, STORING AND TRANSPORTING

Handling, storing and transporting precast concrete includes:

- removing precast concrete from moulds
- transporting precast concrete elements to temporary storage
- moving from temporary storage and loading for transportation
- loading onto the means of transportation (eg a trailer)
- transporting by road, rail or over water
- moving from transportation to temporary site storage
- moving from temporary site storage to final location
- erection at the job site (once concrete reaches the required strength).

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:

- hooking up anchor points
- using any lifting devices (eg gantry cranes)
- moving precast concrete 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 inserts/devices
- lifting method, type of lifting equipment and crane capacity
- support points for storage and transportation.

Handle precast concrete elements appropriately for their shape and size, to avoid excessive stress or damage. Different sets of lifting points and cast-in devices may be used for various handling stages. Minimise the chance of impact between elements.

9.3.1 CONCRETE STRENGTH FOR HANDLING

The precast manufacturer can use the Manufacturer's Statement of Compliance to confirm the concrete strength to the person transporting and/or erecting the tilt panels. The concrete strength may be determined from match cast concrete test cylinders, historical records, or impact hammer tests. Concrete test cylinders have to be stored close to the concrete element to replicate the same conditions as the concrete element.

Letting concrete dry out, or prolonged cold weather, can slow the strength gain of concrete. See also Section 6.5.3 of these guidelines which covers the minimum strength for lifting from moulds.

Precast concrete is at higher risk of damage if it has not reached its full designed strength before handling.

- Remove precast concrete from moulds only after the concrete strength has reached the minimum strength required for lifting.
- A competent person (such as a rigger) should give approval before a precast concrete element is lifted.

Provide temporary bracing or strongbacks for elements where required.

9.3.2 AVOID MULTIPLE HANDLING AND RELOCATION

Precast concrete is prone to damage each time it is handled or moved. The erection sequence should minimise multiple handling.

Careful planning and scheduling will reduce the need to handle and relocate precast concrete elements. WorkSafe recommends lifting precast 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.

Follow a system if multiple handling cannot be avoided. For example, stack units as near as possible to their final fixed 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 elements the wrong way can cause permanent deformation that makes elements unusable. A competent person (such as an engineer) should:

- decide how and where 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 site will influence how high the elements can be safely stacked. Wind zones may affect the stability of stored elements.

Obtain approval from a competent person before storing a precast concrete element on a suspended floor slab or beam. If approval is not received, return the element to ground level.

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 similar length elements 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 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' is the word used to describe timber or other material used under or between precast concrete elements. See Section 9.4.1 of these guidelines for more information.

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

When storing multiple 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 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.

Do not stack units on partially constructed steel frames or structures, or in areas that allow for displacement through accidental contact with the units.

9.4.1 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 and no element is loaded by elements stacked above it. 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 elements.

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.

9.4.2 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 elements so that they retain their correct shape. 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 elements twist, deflect or deform, the greater the permanent creep deformation.

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

Differences in exposure during storage will cause differences to the shape of elements and to their appearance. This can affect the outside panel in a stack against a frame, and the top element when elements are stacked on top of each other.

If unplanned storage is needed, PCBUs should agree together on an acceptable storage method and location. If the 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 CHECK
Have PCBUs storing precast concrete 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?

9.4.3 STORAGE RACKS AND 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 adequately secured and designed to withstand any forces applied during loading, transport and unloading.

An engineer should approve design of all static storage racks and frames used to store or transport precast elements, including ‘toast racks’ and A-frames. Figure 5 shows a typical A-frame.

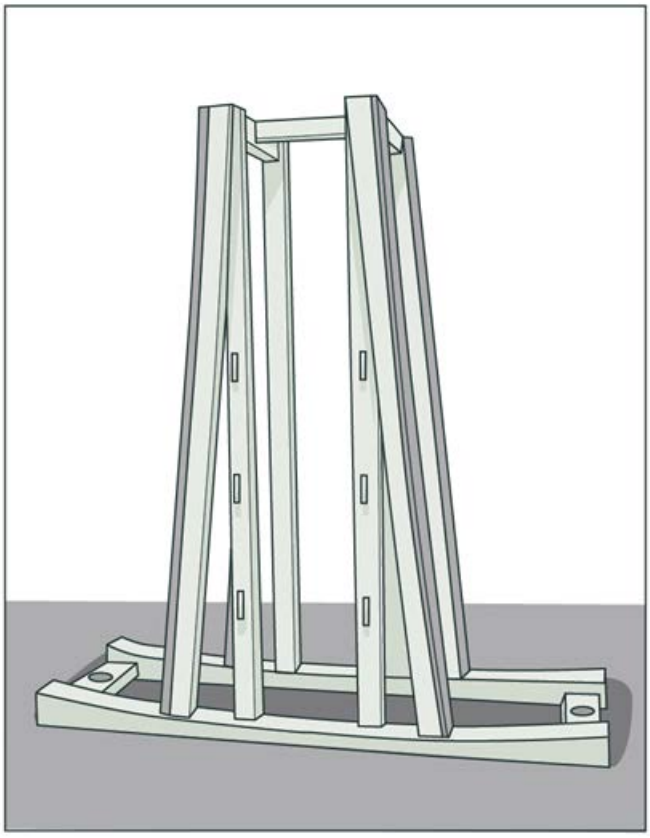


Figure 5: A typical A-frame

A competent person should construct racks and frames, and complete annual certification requirements. They should check racks and frames will remain stable when 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 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.

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 elements into and out of racks and frames.

Only work on precast 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 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

9.5.1 TRANSPORT CONTRACTOR

The transport contractor is responsible for:

- planning the delivery route
- obtaining any permits needed
- safely securing the load for transportation
- transporting the concrete from the precast yard to the installation site.

9.5.2 NEW ZEALAND TRANSPORT AGENCY (NZTA) COMPLIANCE

The transport contractor should be familiar with:

- NZTA's Vehicle Dimensions and Mass (VDAM) Rule. See NZTA for the current version.
- NZTA's *The Official New Zealand Truck Loading Code*: a code of practice for the safety of loads on heavy vehicles. It provides owners, drivers, operators and loading staff with guidance about basic safety principles and precautions that must be taken to ensure that common loads are transported safely.
- NZTA's *Code of Practice for Temporary Traffic Management (CoPTTM)*: this describes best practice for the safe and efficient management and operation of temporary traffic management on all roads in New Zealand.

Check and maintain New Zealand Transport Agency (NZTA) compliance during all transportation phases, including areas where the public has access.

If 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 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.

9.5.3 PLAN AHEAD

Delivering precast concrete elements safely to the workplace requires planning and co-operation between PCBUs, particularly the transport contractor, the head contractor and the erector.

Notify the transport contractor about transportation and delivery requirements, as well as any limitations, so that suitable vehicles and drivers can be scheduled. Mass and height should be considered to ensure stability of the load.

Confirm that the element has reached sufficient strength before transportation. Consider specific design components that may affect transportation, including the stability of long or unusually shaped elements.

A purpose-built trailer should be the first choice for transport, if available. Figure 6 shows a typical step-down trailer with A-frames that may be suitable for carrying concrete panels.

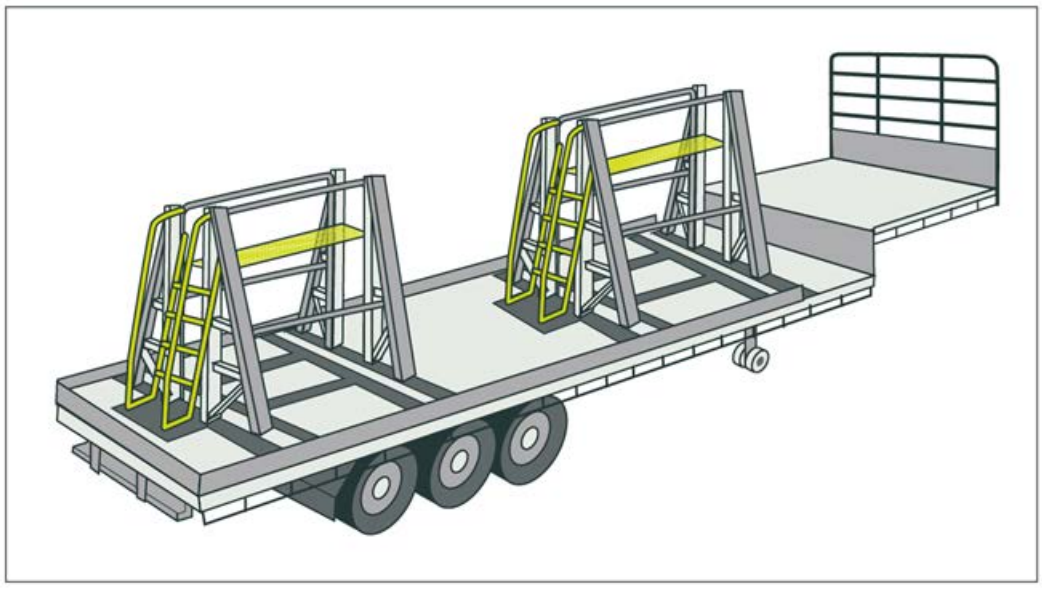


Figure 6: A-frames on a step-down trailer

Precast concrete elements should be adequately fixed and secured to the vehicle to prevent movement or spills during transport. Careful planning will reduce the need to transport elements around the site. To minimise risk, try to avoid multiple loading and unloading.

Have a traffic management plan in place when transporting precast concrete elements to the workplace. Section 8.5.5 of these guidelines recommends what a traffic management plan should include. The transport route should be checked for restrictions, and permits obtained if required.

The transport contractor should ensure drivers have clear instructions, are aware of risks and hazards, and are adequately trained to safely transport precast concrete elements.

9.5.4 PLANT AND EQUIPMENT

Plant and equipment used during transport includes:

- trucks, trailers, fork hoists, cranes and other lifting devices
- storage racks, frames and supports (including A-frames and vertical storage racks)
- dunnage
- load restraints (such as chains, slings, lifting clutches)

A competent person should inspect all plant and equipment to ensure that it is safe to use and fit for purpose. Any bent, worn, corroded, or damaged plant and equipment should be removed from service, repaired or replaced and re-inspected by a competent person (such as an equipment inspector or rigger) before it is used again.

TRANSPORTATION: WHAT TO CHECK Has the transport contractor considered:
• equipment needed?
• truck requirements and availability?
• permits required?
• transport routes, taking account of: o bridges? o winding roads? o power lines – on the way to the site, as well as on the site itself?
• 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 elements to prevent movement during transportation?
• how to avoid high impact loads on elements?
• recognised routes for over-dimensional loads?
• differential road cambers (bends, rises etc.) that may cause instability through leaning, or distortion in long concrete elements?
• site access limitations?
• site-specific traffic management plan? (See 9.5.5 below.)
• delivery sequence and timing?

Are drivers:
• trained to transport precast concrete elements?
• aware of hazards 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?

9.5.5 SITE-SPECIFIC TRAFFIC MANAGEMENT PLAN

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

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

TRAFFIC MANAGEMENT: WHAT TO CHECK
Does the 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 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?

For more information

WorkSafe's fact sheet *Workplace Traffic Management.*

www.worksafe.govt.nz

NZTA's *Code of practice for temporary traffic management* (CoPTTM).

www.nzta.govt.nz

9.5.6 LOADING AND UNLOADING

Vehicle loading must comply with NZTA's *The Official New Zealand Truck Loading Code.* www.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 ground that is as level as possible. 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.

Unusual or irregular shapes

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

Secure and restrain elements well

Restrain elements on transport vehicles so:

- each element is individually secured to prevent it falling from the vehicle
- elements do not move during transport
- elements do not become unstable when the restraint system is released on site.

The restraint (eg chains, webbing straps) used should suit:

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

Consider whether special restraints or packing are needed:

- for long elements, especially when transporting over large distances
- to protect corners, sharp edges, or other details.

Workers should not detach any securing ropes, chains or tarpaulins until the vehicle has stopped in the area agreed for unloading.

Unloading

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

Elements should be unloaded in a way that does not cause instability of the delivery vehicle or its load.

Check whether there is:

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

Keep elements transported on A-frames restrained until their weight can safely be taken by the crane. Do not release an individual element until the crane has taken the initial load of that element.

Check for damage

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

9.5.7 DRIVER'S RESPONSIBILITIES

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

Transporting precast concrete elements by road, rail or water may create dynamic loads that cause the elements to shift. Once the precast concrete 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 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 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.

9.6 SITE ACCESS, CONDITIONS AND LIMITATIONS

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

The driver should refer to the traffic management plan before driving off a public road and onto the site.

It is the driver who decides whether it is safe to enter the site. The driver should be confident that their vehicle can travel safely on the access provided.

ON-SITE ACCESS: WHAT TO CHECK
Have the relevant PCBU/s:
• ordered appropriate cranes?
• confirmed crane access?
• confirmed suitable access for the delivery vehicle(s)?
• identified hazards (eg trees, power lines)?
Have the relevant PCBU/s:
• 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: o soil strengths? o adequacy of site concrete to resist loads? o adequacy of concrete for attaching props and braces, including in- or on-ground mass blocks, floor slabs and other structural items?
• made sure all relevant workers know the erection sequence?
• made sure temporary propping and bracing requirements are in place according to plans? • provided a copy of the plans?
• 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?

DRIVERS: WHAT TO CHECK
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, such as the optional Manufacturer's Statement of Compliance?

SECTION 10: ERECTING

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 serious harm 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. This is the primary duty of care.

10.1 WHAT COULD GO WRONG?

WHAT COULD GO WRONG?	POSSIBLE CAUSES
Elements falling or collapsing (eg the uncontrolled collapse of elements or person being caught between an element and another object) causing severe crush injuries	• Structural collapse • Failure of temporary works • Inadequate structural capacity of foundations • 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)
Underground and overhead services and structures (eg underground cables, water, gas or sewage pipes, overhead powerlines) 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 powerlines when moving a precast concrete element. • Referring to outdated service mark-outs.

WHAT COULD GO WRONG?	POSSIBLE CAUSES
Workers suffering musculoskeletal injuries (eg sprains and strains, back injuries, abdominal hernias) when handling elements (eg 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 elements 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 erecting elements	• 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 injure 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

10.2 ERECTOR/ERECTION TEAM (INSTALLER)

The erector:

- works with the precast manufacturer, the head contractor and the competent person responsible for erection design (see Section 6.2 of these guidelines) to decide on the erection sequence and safe work practices
- produces and briefs erection crews on the HSMS
- inspects precast concrete, reviews the Manufacturer's Statement of Compliance (if provided), and reviews erection plans/rigging drawings
- confirms clutches are compatible with inserts and inspects all rigging gear prior to use (for example, face-lift clutches should be used on face-lift inserts)
- erects concrete elements and installs temporary bracing
- checks torque on brace lifting inserts where applicable
- checks lifting inserts and surrounding concrete for wear and damage, and suitability for lifting

- ensures the precast elements are secured in accordance with the erection plan before handing over to the head contractor.

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

10.3 ERECTION PLANNING

10.3.1 ERECTION CREW

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

- an erection crew supervisor responsible for safety, rigging, placement, propping, 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 element 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.

10.3.2 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.

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 construction 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)
- specification of correct lifting inserts/cast-in components
- transport requirements

ERECTION PLANNING: WHAT TO CHECK Does the erection plan address all aspects of the erection procedure?
• Is the site clear and safe for all trucks (including counterweight trucks) and crane/s access and assembly?
• Is there a compacted hard-fill ramp at a suitable gradient?
• Has the crane operating area been cleared to provide enough room for: o crane outriggers? o counterweight tail swing? o slew path and under hook height? o overhead obstructions, including overhead powerlines?
• Can the crane platform support the loads imposed by the crane during operation?
• Are support methods, including falsework: o adequate? o in the correct location?
• Have the locating dowels or other horizontal restraints been fitted before lowering the precast concrete elements?
• Is there enough clear space for safely propping and bracing precast concrete elements?

ERECTION PLANNING: WHAT TO CHECK *(continued)*
• Are the recommended braces fitted to the elements?
• Have brace foundations reached their required strength before elements are erected?
• If strongbacks are required, are they available and correctly installed?
• Are control measures in place for safely working at height?
• Are there enough properly trained erection crew members?
• Has an exclusion zone been set up for the working area?
• Are the weather conditions suitable for erection?
• Is a Manufacturer's Statement of Compliance required?
• Is a traffic management plan in place?

10.4 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 climate 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.

10.4.1 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 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 element to the correct level while freeing the crane quickly 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 support points requires care and supervision to ensure that the requirements for strength and durability are met.

10.4.2 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.

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
- generally are not vertical
- prevent overturning and resist horizontal movement.

Braces are commonly used when erecting wall panels to resist wind and other loads until panels are permanently fixed. (Props are another form of support, typically used to support beams and floors; see Section 10.4.1. of these guidelines.)

Brace connections should be designed with a safety factor of 2.5 against failure. When post-installed inserts are used to attach a brace, they should be designed with a safety factor of 3.

Do not use deformation-controlled lifting inserts 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 lifting inserts that rely solely on chemical adhesion unless each fixing is individually proof-tested to the working load limit.

Adjustable braces should have:

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

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

Unless deliberately designed and specified, bracing inserts should not be closer than 300mm 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 inserts should allow the braces to hang vertically during lifting without interfering with the lifting rigging. For the bracing insert, a minimum horizontal displacement of 200mm from the vertical line of the lifting inserts is acceptable.

Precast concrete manufacturers should not substitute lifting insert types without written approval from a competent person.

Bracing insert requirements and precast concrete element details should be shown on the shop drawings.

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

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.

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.

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 design documentation. Where elements can be coupled together, one central restraint to resist rotation or toppling may be sufficient (subject to the competent person's approval).

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

Check that there is sufficient temporary base restraint to prevent a sliding failure (kick-out) at the base or support of the precast concrete element. The panel weight may not provide base restraint.

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

10.4.3 CHECK BRACING REGULARLY

Check bracing regularly – and immediately after an event such as an earthquake or storm – to 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 inserts.

10.4.4 BRACE CONFIGURATION

As noted above, WorkSafe recommends using a minimum of two restraints to support each precast element, unless clearly specified and detailed in the design documentation.

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. Columns are usually braced with one brace in two orthogonal directions – that is, two braces in all. 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 67% of the height of the panel from its base. 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.

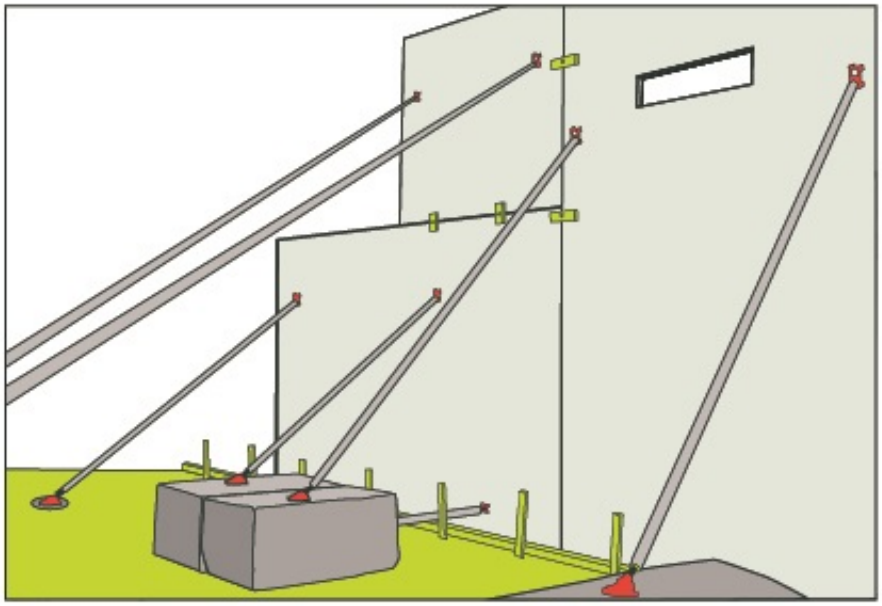


Figure 7: Panels, mass blocks and braces

10.4.5 BRACING INSERTS

Bracing inserts are used to connect the brace to the braced element and the brace footing. They should be designed with a safety factor 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 inserts. Post-installed mechanical lifting inserts can also be used.

Alternative inserts include:

- mechanical fixings, such as undercut inserts and post-installed fixings, used in accordance with the manufacturer's recommendations by the manufacturer of the bracing insert
- load-controlled (torque-controlled) expansion inserts with a permissible load limited to 0.65 of the 'first slip load'.

Figure 8 shows examples of expansion inserts acceptable for anchoring braces.

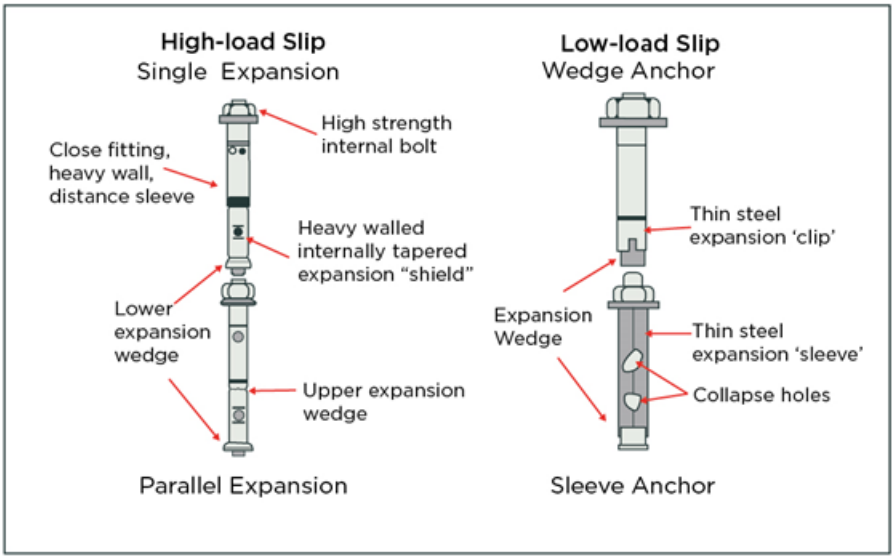


Figure 8: Examples of expansion inserts

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

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

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

Bracing inserts 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 insert capacities are sensitive to the:

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

10.4.6 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 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 concrete element. Using a fixing with higher capacities may avoid this.

10.5 LEVELLING SHIMS

Levelling shims carry the full load of the precast element and any loads applied to it prior to permanent fixing of the precast element. Shims should be manufactured from a suitable durable material and be used on solid foundations. Shims should not be placed on thin layers of site concrete.

A levelling pad (concrete footing) or a level bearing area is used to provide a level seating for the shims, as shown in Figure 9. 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 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 re shims.

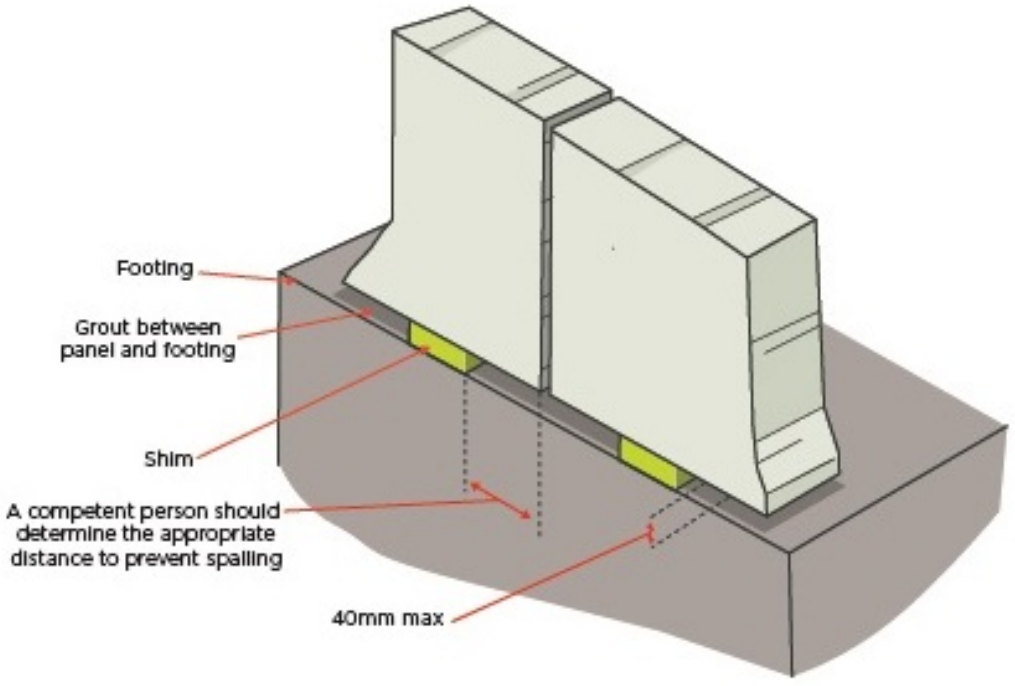


Figure 9: Levelling shims

The total height of each levelling shim (that is, the distance between the panel and the footing) should be a maximum of 40mm, 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.

10.6 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.

10.6.1 WHAT COULD GO WRONG?

WHAT COULD GO WRONG?	POSSIBLE CAUSES
The crane could tip 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 used as directed in the crane manufacturer's instructions. • Insufficient counterweights are used. • Wind effects on the load or crane during extreme events. • The weight of the load is calculated incorrectly.
The structure of the crane could fail.	• 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 could hit 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.

WHAT COULD GO WRONG?	POSSIBLE CAUSES
The dogman/rigger, ground workers and/or crane operator could be electrocuted.	• The crane comes in contact with overhead or underground power sources. • There is an arcing of electrical current when the crane comes close to power lines. • Minimum approach distances (MADs) not followed.
Objects could 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 inserts or connectors. • Exclusion zones are not maintained and unauthorised people enter the lift area.
The load could be dropped.	• The lifting equipment has not been maintained. • The lifting equipment is not fit for purpose.

The PCBU 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 and operators and dogmen/riggers have the appropriate skills and training.

10.6.2 CRANE CONTROLLER, CRANE OPERATOR AND DOGMAN/RIGGER

A **controller** is the owner, lessee, sub-lessee, or bailee of a crane in a workplace. 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:

- cranes are in a safe condition and are operated safely
- cranes are inspected regularly and properly maintained (as advised by the crane manufacturer)
- all operational cranes have a current certificate of inspection issued by a recognised inspection body
- operators are competent and have appropriate training and experience.

The **crane operator** needs to have the knowledge and skills to operate the particular type of crane they are using. They can pick up the 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 workplace 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.

10.6.3 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 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 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 elements. Some elements may not be able to be lifted until the wind speed reduces.

A tag line (see Figure 10) is ideal for guiding 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.

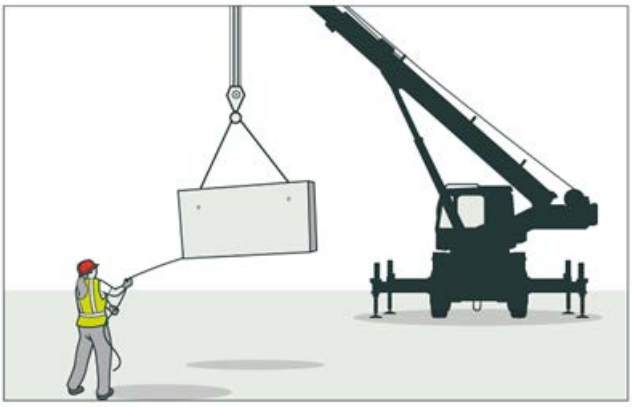


Figure 10: Worker guiding panel using tag line

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 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 11 for more information.

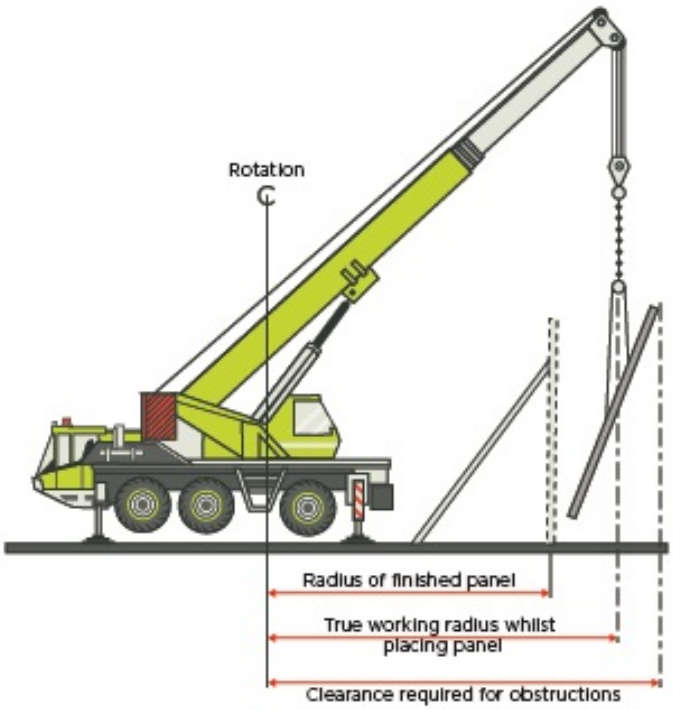


Figure 11: Crane working radius

10.6.4 TILT PANELS

Wherever practicable:

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

A competent person (such as a manufacturer or supplier) should provide an insert 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.

10.7 LIFTING OPERATIONS

Lifting operations should be planned, supervised and carried out by competent people. Objects falling from height can injure or kill workers or others.

The PCBU must take all practicable steps to ensure that equipment:

- is maintained in a safe condition
- is operated safely
- is operated within the limits that 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 www.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. 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.
- manage the health and safety risks from falling 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 props when authorised
- securing props to the 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; see Section 10.8 of these guidelines.

If it is not reasonably practicable to prevent an object from falling freely or to use a system to arrest the fall, WorkSafe recommends the creation of an exclusion zone. This is a defined area where people are not allowed to go when particular work is being done.

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*

www.worksafe.govt.nz

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

10.7.1 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.

10.7.2 LIFTING PRECAST CONCRETE ELEMENTS

One or more cranes may be used to lift and place precast concrete elements. Figure 12 shows two cranes moving an element.

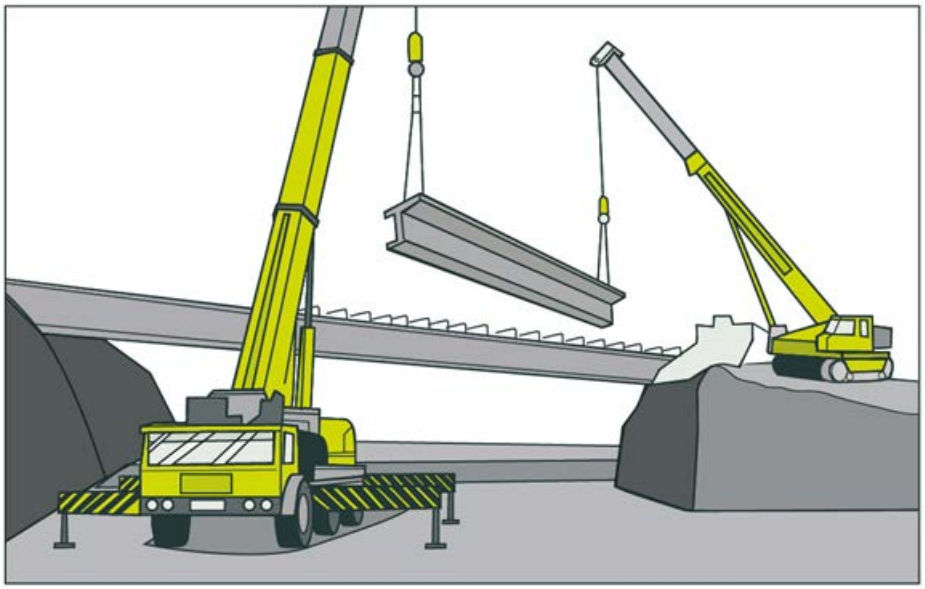


Figure 12: Two-crane lift

When lifting a tilt panel, the lifting inserts 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.

Do not use hoops of reinforcing steel for lifting.

Lower loads gently to avoid sudden impact.

10.7.3 LOAD RESTRAINTS AND LIFTING

Any load carried on a vehicle must be sufficiently restrained to prevent movement caused by the forces as described in NZTA's *The Official New Zealand Truck Loading Code*, see www.nzta.govt.nz. Load restraints must prevent movement of a load under certain conditions (eg during cornering).

10.7.4 LIFTING ELEMENTS FROM DELIVERY VEHICLE

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

Before attaching lifting equipment to precast concrete, check the lifting inserts to ensure they are undamaged and compatible with the proposed lifting equipment. Figure 13 shows a typical rigging system (lifting clutch and lifting anchor) for a precast concrete element.

A suitable system should be in place to prevent workers falling from vehicles while loads are being rigged.

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

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.

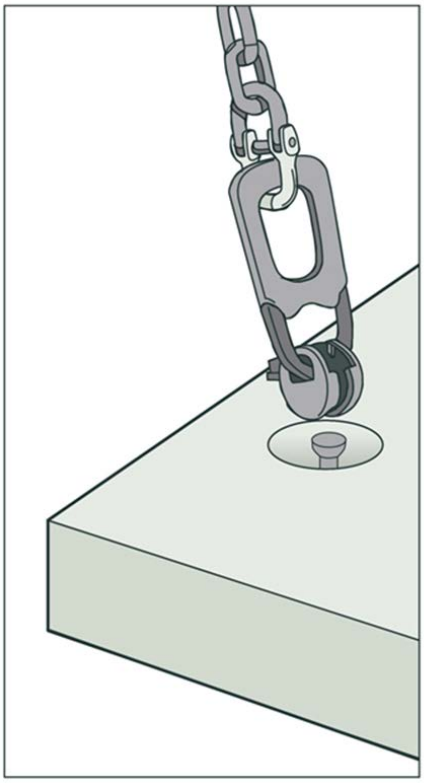


Figure 13: Typical rigging system for a precast concrete element

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 on rigging and lifting

WorkSafe's *Approved code of practice for load-lifting rigging*

www.worksafe.govt.nz

10.8 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 to establish an exclusion zone, depending on ease of access and the likely presence of workers or others. Perimeter fencing around the site will help.

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 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 issue should be addressed in the planning stage.

10.9 RIGGING

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

The precast 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 for erecting tilt panels and other precast concrete elements requires careful pre-planning. The erector and the dogman/rigger should work together to select the rigging system that will connect the element to the crane. They have to ensure that the system can handle the forces it may be exposed to.

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.

This means that 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.

10.9.1 LOAD EQUALISATION

Take special care with rigging arrangements where load equalisation measures are required. Decide whether to equalise loads between lifting points on precast 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 14.[2]

[2] Figures 14 and 15 reproduced with permission from Ancon.

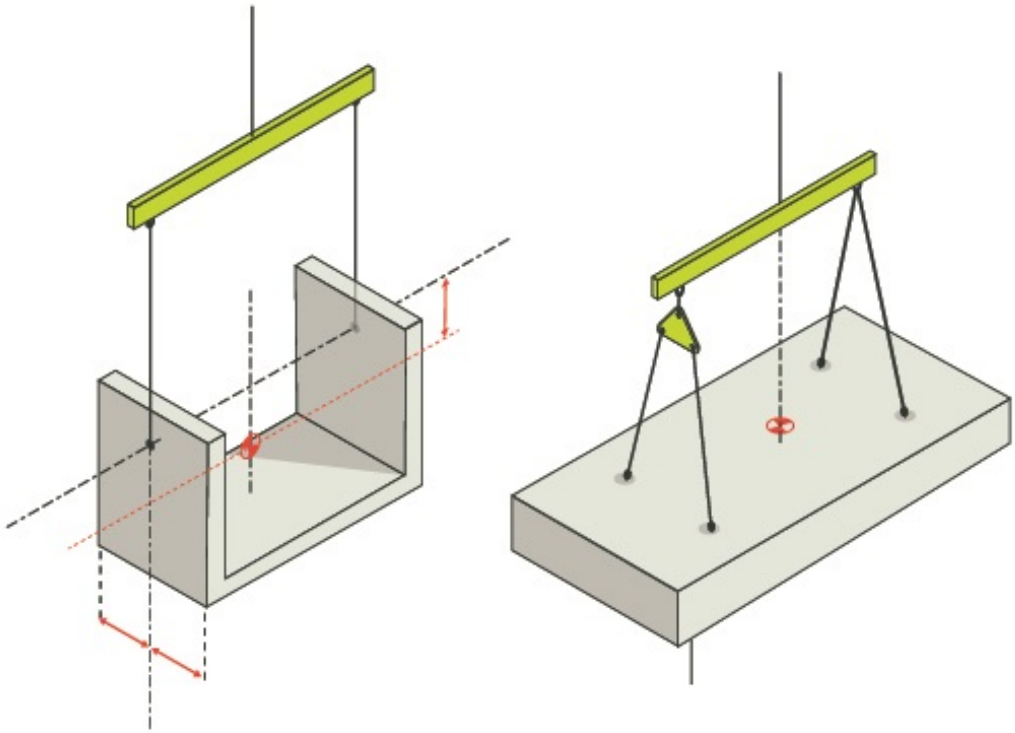


Figure 14: Precast concrete elements with centre of gravity below centre of lift

Common lifting designs with fixed length slings require 3 or 4 lifting points for stability. However, when using multi-leg (3 or more) fixed length slings connected to a common point, the full load should be taken by only 2 of the lifting points, as shown in Figure 15 below.

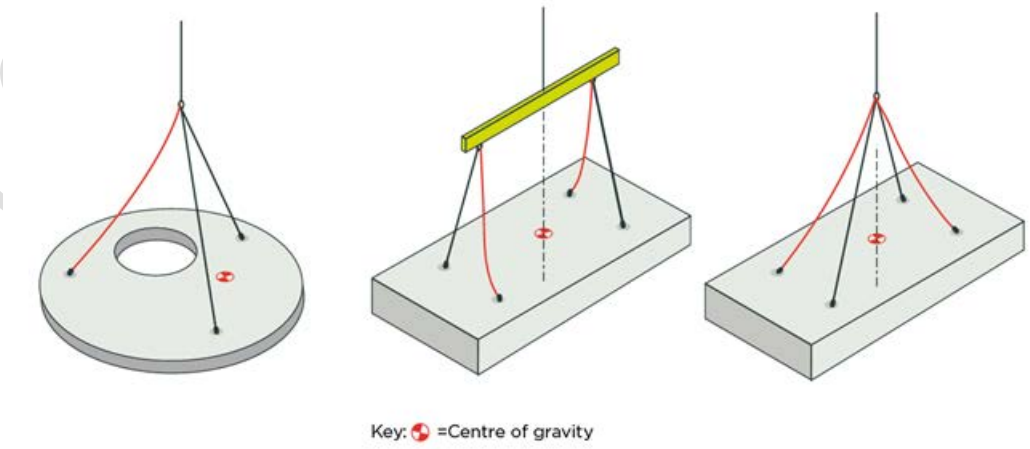


Figure 15: Influence of non-equalised rigging systems on distribution of lifting loads

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 element relative to the centroid of the lifting points.

Avoid designs with multiples of 3 lifting points because it is difficult to rig the system correctly to guarantee equal load distribution.

Figure 16 shows other possible configurations for lifting precast concrete elements.[3] The rigging system should be designed to distribute equal loads to all lifting points. Sometimes the design may require unequal loading on lifting points, causing an increased load to be applied to particular lifting inserts. This should be considered when selecting the insert capacity, and the requirements should be clearly specified on the shop drawings.

[3] *Precast New Zealand* and *Crane Association of New Zealand* have additional information and examples. www.precastnz.org.nz www.cranes.org.nz

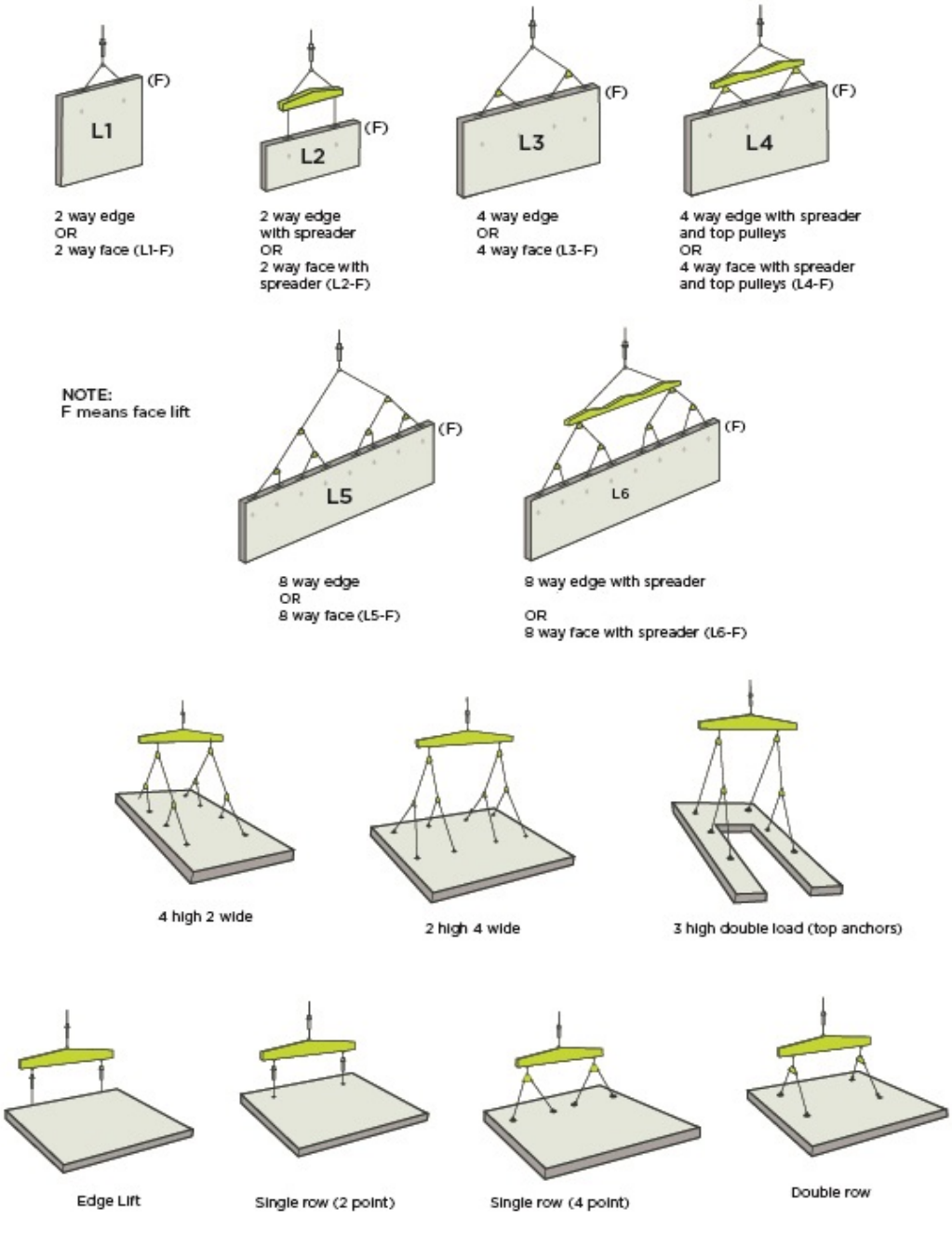


Figure 16: Examples of possible rigging configurations for lifting precast concrete elements [4]

[4] Figure 16 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 for erection into the structure.

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

Contact a competent person immediately if inserts are incorrectly located, faulty or missing, or if concrete is poorly compacted or cracked close to lifting inserts.

10.9.2 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 17.

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

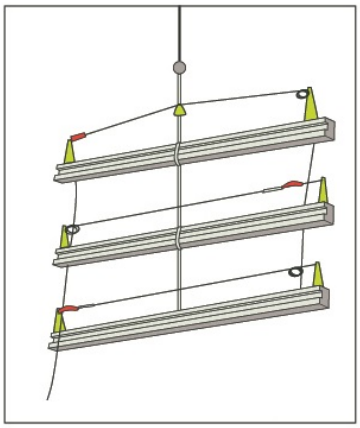


Figure 17: Christmas tree lifting

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

- The objects lifted need to be uniform (of similar dimensions and weight).
- The combined load must not exceed the capacity of the crane.
- Each object has to be rigged independently of the others.
- Each object should be spaced approximately 0.5m above the one below.

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. To avoid or reduce exposure, 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.

10.9.3 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 CHECK
Is the rigging system designed to suit the spacing and layout of the lifting inserts for preferred rigging configurations?
• Will lifting occur in the direction specified for the placement of the lifting inserts?
• Is the appropriate rigging equipment available and serviceable, with a current inspection tag?
• Do braces interfere with the rigging?
• Are lifting inserts in the correct location?
• Have recesses been cleaned out in preparation for lifting, so that lifting clutches can correctly engage?
• Is the rigging system for each precast concrete element generally as set out in the erection documentation?
• Is the lifting equipment compatible with the inserts cast in to the precast concrete element?
• If the lifting clutches and the lifting inserts are from different suppliers, has someone confirmed with the supplier of the lifting clutches and the supplier of the lifting inserts that the clutches and inserts are compatible?
• Are the lifting inserts clearly identified, to assist during loading and unloading?
• Are strongbacks required? o If required, are they available?
• Is load equalisation required?
• Is any special handling required?
• Is appropriate equipment available?
• Are loads and reach within the capacity of the crane? o 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).

Will elements need to be re-aligned/repositioned after lifting from the delivery vehicle? If yes: o Is there enough room available? o Is the right equipment available?
Are the erection crew familiar with methods and restrictions applying to precast concrete elements lifted without cast-in inserts?
If precast concrete elements are being lifted without cast-in inserts, is appropriate equipment available?
Has the concrete reached the required concrete strength as defined for the lifting procedure?

For more information

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

www.worksafe.govt.nz

10.10 LIFTING INSERTS 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 element are to be used for lifting or handling, or any other use, care must be taken to 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.

10.10.1 LIFTING INSERTS

Lifting inserts are referred to by their working load limit. Their actual safe load may be less, depending on conditions. The load capacity of lifting inserts 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 insert 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)
- tension stresses in the concrete around the insert
- length of chains and chain angle

Steel reinforcement 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 insert.

Pre-stressing strand, while not recommended, may be used in a controlled manner if in compliance with recognised standards.

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

Some types of lifting inserts 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 insert manufacturer.

The design of the reinforcing is to ensure that the lifting insert system will give the required factor of safety.

Put in place a site procedure to follow if panels arrive on site with different lifting inserts or lifting inserts 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 provide remedial works.

10.10.2 LIFTING CLUTCHES

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

Lifting clutches are to be:

- designed with a factor of safety of 5
- initially tested by the supplier to a factor of safety of 2
- visually inspected for damage or wear each day prior to use
- used only with the type and size of inserts that they are compatible with
- made in accordance with a valid international standard or technical reference (such as CEN TR 15728 2016 - Design and use of inserts for lifting and handling of precast concrete elements)
- 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.

LIFTING INSERTS AND CLUTCHES: WHAT TO CHECK
Is all lifting equipment certified and in good condition?
• Are the lifting clutches correctly engaged before lifting?
• Has the precast concrete element reached the specified strength for lifting, as per the shop drawings? (This may already have been done if the element was manufactured off-site.)
• Is the appropriate rigging equipment available? o This includes lifting beams and correct attachments for cast-in lifting inserts.
• Are recesses cleaned out ready for lifting?
• Are the lifting inserts in their correct location? o Contact the designer immediately if the location isn't correct or there are faulty or missing lifting inserts. The designer should fix the problem and/or provide a solution.

10.11 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 is significant risk if only one crane is used.

When a precast concrete element is lifted flat and then tilted to a vertical position in one operation, it should be lifted using two crane hooks with suitable lifting eyes, as positioned by a competent person responsible for the erection design.

One or more competent person/s need to be involved to ensure that the following requirements are met:

- The crane should be fitted with multiple hoist drums that have automatically applied brakes and independent winch controls.
- The crane should have a Load Moment Indicator (LMI) system that can indicate the load on each hook being used.

- The lifting and ‘tailing’ winch and hooks should have sufficient capacity to rotate the panel; often the ‘tailing’ load can be up to 80% of the panel weight.
- The boom head on the crane should be suitable for the two hook operation.
- The panels to be rotated should be in line with the crane to prevent:
    - panels swinging (like a gate) when being lifted from the panel 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 panel either sliding forward or back towards the crane when it is being lifted.
- The boom has to be placed directly over the centre of gravity of the panel and boom angle needs to be adjust
- ted to compensate for boom deflection.
- The included angle between the main hoist rope and the auxiliary hoist rope should not exceed 30 degrees.

APPENDICES

APPENDIX A: STANDARDS AND OTHER TECHNICAL REFERENCES THAT MAY BE APPLICABLE TO PRECAST CONCRETE WORK

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

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	Tilt-up concrete construction
AS 4991	Lifting devices

Technical References

VDI/BV-6205 series: 2012	Lifting Anchor and Lifting Anchor Systems for Concrete Components (Koblenz, Germany: Bundesverband Bausysteme e.V)
CEN TR 15728 2016	Design and use of inserts for lifting and handling of precast concrete elements

APPENDIX B: GLOSSARY

A-frame An A-frame trailer is designed to carry precast concrete panels in an upright position. Panels usually lean and are secured to an A-shaped frame.

Anchor A proprietary cast-in item or post-installed fixing for temporary use in the handling, transport or erection process; 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 panel kicking in, or out, during the erection process.

Brace A structural member, normally placed diagonally and firmly attached to resist horizontal movement and provide stability. Commonly used as temporary members to resist lateral loads on elements.

In these guidelines, 'brace' refers to a diagonal or non-vertical member and 'prop' refers to a vertical member resisting a vertical load.

Chartered Professional Engineer

A person is a Chartered Professional Engineer (CPEng) if they are registered and hold a current registration certificate. See www.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
- their employer has evidence (such as training records) demonstrating 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 element and a solid object.
Cyclic load	A recurring load, or a recurring reversing load.
Deadman	see *In-ground mass blocks*
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 elementary slinging or lifting tasks and direct position loads. (See also *Rigger.*)
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 owner and the head contractor, including structural drawings, architectural drawings, and other drawings. c) **Structural drawings**: drawings supplied by an 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, amongst other items, things such as bracing, propping, location and arrangement of the 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 element would land following an uncontrolled fall. For example, during lifting or placing by a crane.
Dunnage	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.
Element	see *Precast concrete element*

Engineer who is a CPEng A Chartered Professional Engineer registered under the Chartered Professional Engineers of New Zealand Act 2002 and holding a current registration certificate.

Engineered Lift Plan A plan for complex lifts. May follow a similar format to a Lift Plan, but will generally have more detailed/technical content. Usually developed by an engineer or similarly competent person.

Exclusion Zone A defined area where people are not allowed to go when particular work is being done.

Expansion anchors Post-installed anchors, known as heavy duty high load slip expansion anchors or 'load-controlled' anchors, where an increase in load results in increased wedging force.

Factor of Safety The ratio between the minimum breaking load and the working load limit.

Falsework The temporary structures and/or systems used to support a permanent structure during erection and until it becomes self-supporting. Falsework is a part of temporary works. See *Temporary Works*

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 Behaviour that has the potential to cause death, injury or illness - whether or not that behaviour results from physical or mental fatigue, drugs, alcohol, traumatic shock or another temporary condition that affects behaviour.

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	A specifically designed concrete block that supports the base of the brace. Lateral loads are resisted by the mass of the concrete block and the friction between the concrete surface and the supporting ground.
In situ concrete	Concrete that is cast in its final position (rather thanbeing cast in one place and then later moved to another position).
Lateral bracing	see *Base restraint*
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.
Lift plan	A document that details how to carry out simple or regular crane lifts. Usually developed by the lift team or similarly competent people. May be used as an addition to, or as an alternative to, Job Safety Analysis (JSA). See also *Engineered Lift Plan.*
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 insert to enable attachment to and transfer of load to a crane, or other lifting or handling equipment.
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	A component cast into a precast concrete element to provide a point of attachment for the lifting equipment.
Lifting spreader	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 inserts.
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 points. Any lift requiring attachment to more than two lifting points in a beam, or three lifting points for a face-lifted element, will normally be a non-standard lift.
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 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. Within 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'.)
Rebar	see *Reinforcing steel*
Reinforcing steel	Steel with a circular or practically circular cross-section, suitable for reinforcing concrete. Also known as reo or 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.
Reo	see *Reinforcing steel*
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 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 inserts). Normally due to a concentration of load or to sliding.
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 face-lifted 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*
SWL	see *Safe working load*
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.
Working load / Working load limit	see *Safe working load*

APPENDIX C: HEALTH AND SAFETY MANAGEMENT SYSTEM (HSMS)

An effective health and safety management system (HSMS) will help a construction site operate safely, by ensuring efficient ways of dealing with risks that can cause harm to workers or others, and by identifying and controlling those risks.

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 a 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 CHECK
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: HEALTH AND SAFETY REPRESENTATIVES, AND HEALTH AND SAFETY COMMITTEES

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 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.

Figure 18 summarises a PCBU's worker engagement and participation duties. 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 health and safety in the workplace. HSRs have these functions and powers after they have been elected (or are regarded as having been elected) by fellow workers in their work group.

After completing initial training, trained HSRs 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 health and safety policies and practices for the workplace
- make it easier for the business and workers to co-operate on ways to ensure workers' health and safety.

For more information

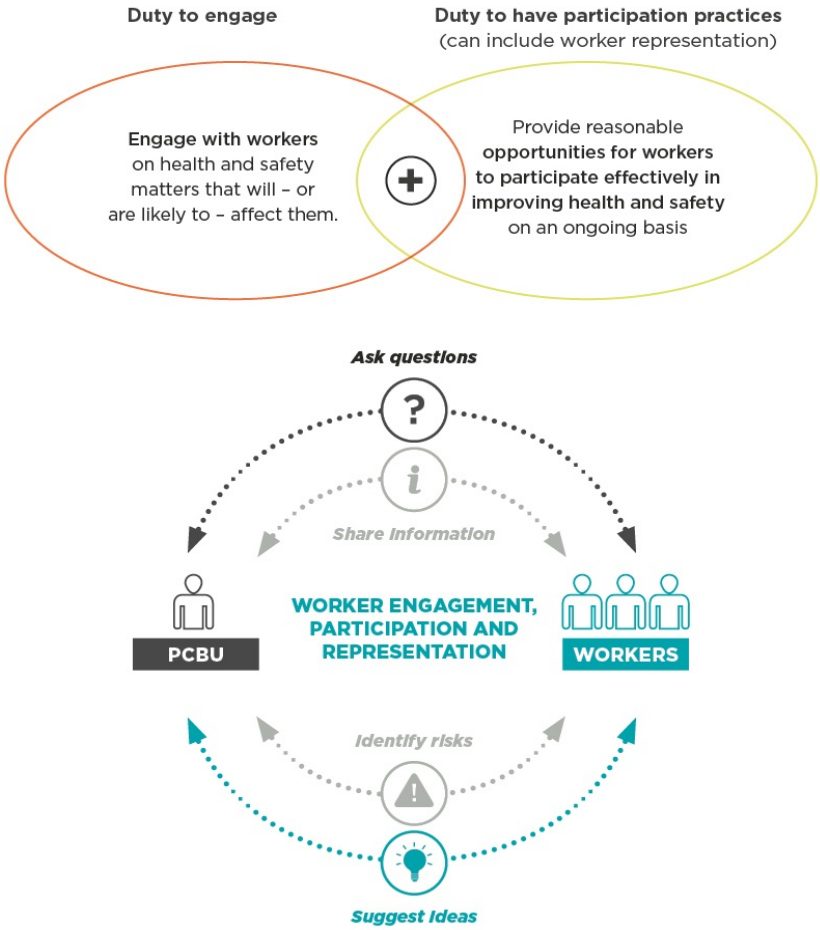
WorkSafe's interpretive guidelines *Worker Representation through Health and Safety Representatives and Health and Safety Committees*

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

WorkSafe's pamphlets:

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

www.worksafe.govt.nz



…effective worker participation is vital to managing health and safety issues successfully in the workplace.[5]

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.

Figure 18: Worker engagement, participation and representation at a glance

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

APPENDIX E: JOB SAFETY ANALYSIS TEMPLATE

Job Safety Analysis worksheet (JSA)

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

Job No		Date		Prepared by (name and title)		Approved by (name and title)	
Job description							
All 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		Name			Name		
Signature		Signature			Signature		
Name		Name			Name		
Signature		Signature			Signature		
Are work permits required? __Y/__N **If yes, provide details.**							
Notes							

Job Safety Analysis worksheet (JSA)

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

Job step	**Job step hazard**	**Identify risks you need to deal with (potential harm from hazard)**	**Priority/Urgency** ***Pay close attention to your high priority risks***	**CONTROL MEASURE** First try to **eliminate risk**	**CONTROL MEASURE** *If elimination not possible:* **Substitution, Isolation, Engineering** – if possible	**CONTROL MEASURE** *Then if any risk still remains:* **Administrative controls, 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 Codes of Practice and guidelines (see www.worksafe.govt.nz)
4. Industry-specific guidance
5. Permit attachments

APPENDIX F: NOTIFICATIONS TO WORKSAFE

Notification of particular hazardous work

PCBUs (including persons who control the workplace) must notify WorkSafe at least 24 hours before doing any hazardous work (as defined below).

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 at www.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 as:

- any commercial logging or tree-felling
- any construction work where:
    - workers could fall 5 m or more (excluding work on a house up to two storeys high, a power or telephone line, or carried out from a ladder only, or minor or routine maintenance or repair work)
    - scaffolding from which someone could fall 5 m or more while the scaffolding is being put up or dismantled
    - an appliance (other than a self-propelled mobile crane, excavator or forklift) has to lift weights of half a tonne (500 kg) or more higher than 5 m
    - workers have to work in a pit, shaft, trench or other excavation that is more than 1.5 m deep and which is deeper than it is wide at the top
    - workers need to work underground in any kind of excavation, heading or drive, where there is ground cover overhead
    - in any excavation in which any face has a vertical height of more than 5 m and an average slope steeper than a ratio of 1 horizontal to 2 vertical
    - explosives are used, or stored on site for this purpose
    - workers need to breathe air that is or has been compressed or breathe a respiratory medium other than air. (There is an exception in regulation 26(4), HSE Regulations).

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 when notifiable events occur. These events trigger requirements such as preserving the site and keeping records.

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
- damage to or collapsing, overturning, failing or malfunctioning of 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

Section 23 of HSWA www.legislation.govt.nz

WorkSafe's fact sheet *What events need to be notified?*

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

APPENDIX G: DUTIES OF DESIGNERS, MANUFACTURERS, IMPORTERS, SUPPLIERS, INSTALLERS, CONSTRUCTORS AND COMMISSIONERS

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.

Importers must 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 the people listed in Table 4, below.

The table summarises the duties of these PCBUs, based on Sections 39 – 43 of HSWA.

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

APPENDIX H: EXTRACT FROM SECTION B1.3.3 (PERFORMANCE) OF SCHEDULE 1 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.

APPENDIX I: PANEL DESIGN FORM EXAMPLE

Please send all drawings to [*email address here*].

Typical turnaround for drawings is [*specify*] working days after receiving the drawings and this completed form.

Designs will be based on the information on this form.

Customer Name								
Project Name								
Project Address								
Date Submitted								
Customer Name				**Telephone**				
Customer Email								
Region Category	A		B		C		D	
Terrain Category	1		2		3		4	
Location of Pour	On-site	Factory	Civil		Tilt-up		Precast	
Orientation of Panel	Edge-lift		Face-lift		Spin up			
Spreader Beams Available	Yes		No					
Sling /rigging height restriction?					Max sling angle is 60 degrees Y/N			
Concrete strength at first lift		MPa	Concrete Strength at site		MPa			
Casting bed type	Floor Slab		Steel forms		Tilt tables			
Preferred strengthening method	Strongbacks			Extra reinforcement				
Strongback Supplier		Recommended strongback type if it is not RMD						
Brace Supplier		Recommended brace type if there is any, **OR** if the bracing angle cannot be 60 degrees						
Design required for footing?	Con.Blocks	Deadman	Pad footing	Strip footing	Is geotechnical report required?			
Type of threaded Inserts preferred (please tick) [Manufacturer to specify product reference details]:								
[XXX]		[XXX]		[XXX]		[XXX]		[XXX]	
Footing/deadman inserts								
Other information								

APPENDIX J: LIFT DESIGN REQUEST FORM EXAMPLE

This form would usually be filled out and sent in together with the drawings of the element to be lifted.

Project Name/Job Ref.		
Date design required by		
Drawing or Design No./Ref.		
Contact details of person requesting design	Name: Phone: Email:	
Customer details	Name: Phone: Email:	
PRECAST OR PRESTRESS DETAILS		
NOTE: *Additional reinforcing may be added to support the lifting inserts*	**PRECAST __**	**PRESTRESS __**
Unit weight		
Preferred compressive strength of concrete at time of first lift		
Concrete cover required for lifting inserts (if different to drawing)		
Type of lift (edge, face, both)		
Type of lifting inserts (threaded, lifting hoop, foot or eye)		
Prestress force (kiloNewtons)		
Position of lifting inserts (as shown on shop drawings/construction drawings/design drawings)		

Can lifting inserts be moved to allow a more practical design to be completed?		
Number of **load-bearing lifting inserts**		

RIGGING REQUIREMENTS	
Number of cranes to demould	
Dynamic factor required	
Preferred sling angle	
Number of cranes to install	
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)*	

SPECIFY ANY DESIGN AND / OR CERTIFICATION REQUIREMENTS

ADDITIONAL REQUESTS

NOTE: Drawings for non-symmetrical elements should include the location of the centre of gravity.

APPENDIX K: TILT-UP AND PRECAST CONCRETE CHECKLIST EXAMPLE[6]

Project:	**Sub-contractor:**	**Engineering Co.:**	**Date:**	**Panel Number/s:**
Site supervisor:	**Sub-contractor site supervisor:**	**Engineer:**		
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 must be given to [INSERT NAME/TITLE] when all items are completed. 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.				

[6] Adapted with permission from Laing O'Rourke. Copyright © Laing O'Rourke 2011. All rights reserved.

Item Number and Description	Acceptance Criteria a) include approved drawings, relevant standards, engineer's instructions, client specifications & manufacturer's instructions b) attach any item-specific checklists to this form	Inspection/Action by		
		NAME / ROLE	NAME / ROLE	NAME / ROLE
1. Drawings required	Drawings certified by a competent person exist for the following: - panel design: location of lifting inserts and bracing points, steel content, panel weight, panel dimensions, panel number, location of strongbacks (where applicable), concrete strength - 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			

Item Number and Description	Acceptance Criteria a) include approved drawings, relevant standards, engineer's instructions, client specifications & manufacturer's instructions b) attach any item-specific checklists to this form	Inspection/Action by		
		NAME / ROLE	NAME / ROLE	NAME / ROLE

2. 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:_____			

3. 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 insert and clutch design - pre-pour inspection of panels by competent person in accordance with design specifications			

Item Number and Description	Acceptance Criteria a) include approved drawings, relevant standards, engineer's instructions, client specifications & manufacturer's instructions b) attach any item-specific checklists to this form	Inspection/Action by		
		NAME / ROLE	NAME / ROLE	NAME / ROLE
4. Qualifications	Crane operator and dogmen/riggers have appropriate training and qualifications			
5. 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 safe working load (SWL) and current inspection tags displayed - Lifting inserts 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			

Item Number and Description	Acceptance Criteria a) include approved drawings, relevant standards, engineer's instructions, client specifications & manufacturer's instructions b) attach any item-specific checklists to this form	Inspection/Action by		
		NAME / ROLE	NAME / ROLE	NAME / ROLE
6. 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			

Item Number and Description	Acceptance Criteria a) include approved drawings, relevant standards, engineer's instructions, client specifications & manufacturer's instructions b) attach any item-specific checklists to this form	Inspection/Action by		
		NAME / ROLE	NAME / ROLE	NAME / ROLE
7. 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 5º from perpendicular and is approximately 50-60º 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			

Item Number and Description	Acceptance Criteria a) include approved drawings, relevant standards, engineer's instructions, client specifications & manufacturer's instructions b) attach any item-specific checklists to this form	Inspection/Action by		
		NAME / ROLE	NAME / ROLE	NAME / ROLE
8. 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			
9. 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			
10. Grouting	- Grouting undertaken using specified product and within required timeframe			
11. 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			
	- 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			

Item Number and Description	Acceptance Criteria a) include approved drawings, relevant standards, engineer's instructions, client specifications & manufacturer's instructions b) attach any item-specific checklists to this form	Inspection/Action by		
		NAME / ROLE	NAME / ROLE	NAME / ROLE
12. Specify any additional requirements				

APPENDIX L: 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.

ITEM	DESCRIPTION	MANUFACTURER TO COMPLETE
1	Project name	
2	Construction site address	
3	Shop drawing number	
4	Precast manufacturer's name	
5	Concrete element identification marks	
6	Date of transport to site	
7	Product type	
8	Concrete grade used	
8	Weight of elements	
9	Elements have reached adequate strength for lifting and transportation	
9	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.	
9	Signature	
10	Title	
11	Date	
NOTE: The precast manufacturer is not responsible for the on-site rigging, handling or slinging of the precast concrete elements listed above.		

SOURCE: Adapted with permission from Precast NZ's industry guide *Handling Transportation and Erection of Precast Concrete* (2015)

APPENDIX M: 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 risk in a workplace. 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 supervision, training, information and instruction provided are 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 fact sheet *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.*

8.1 All workplaces need an emergency plan that must be implemented in the event of an emergency.

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 the workplace 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.

REGULATION 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
- the 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 (fire, 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 with the relevant people in the workplace to identify areas for improvement or where the plan needs 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 Procedures Template

See the WorkSafe website for an emergency procedures template that could be used at most workplaces.

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.

DISCLAIMER

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