CONSTRUCTION AND ERECTION OF BRIDGE BEAMS

April 2004

INDUSTRY STANDARD
On 18 June 2017, the Occupational Health and Safety Regulations 2017 (OHS Regulations 2017) replaced the Occupational Health and Safety Regulations 2007 (OHS Regulations 2007), which expired on this date. **This publication has not yet been updated to reflect the changes introduced by the OHS Regulations 2017 and should not be relied upon as a substitute for legal advice.**

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INTRODUCTION

THIS DOCUMENT SETS OUT INDUSTRY-WIDE GUIDELINES FOR ESTABLISHING AND MAINTAINING A SAFE WORKING ENVIRONMENT WHEREVER PRECAST CONCRETE OR STEEL BEAMS ARE BEING USED TO CONSTRUCT BRIDGES.

The industry associated with the manufacture and erection of bridge beams needs to be aware of its obligations to protect employees, contractors and members of the public under Victoria’s occupational health and safety legislation.

This Industry Standard provides practical advice about the safe design, manufacture, transportation and erection of bridge beams and associated precast concrete elements. The emphasis is on ensuring a safe working environment whenever these elements are used, particularly over road and rail. It is not intended to be an all encompassing design, manufacture and erection manual.

Advice on the general design, manufacture and erection of bridge beams can be found in the referenced documents.

This Industry Standard is based on current knowledge and construction methods within the industry and is not intended to exclude other methods or processes that can be shown to meet the requirements of providing a safe workplace.
This document was prepared by a committee representing Government agencies, construction contractors, suppliers and construction unions.

The committee comprised:

- Abigroup Contractors Pty Ltd
- Civil Contractors Federation
- Construction, Forestry, Mining & Energy Union - Construction & General Division
- Construction, Forestry, Mining & Energy Union - FEDFA Division
- Conmor Cranes Pty Ltd
- Crisp Consultants Pty Ltd
- GHD Management Engineering Environment
- Highrig Crane Hire
- John Holland Pty Ltd
- Leighton Contractors Pty Ltd
- Master Builders Association of Victoria
- Thiess Pty Ltd
- VicRoads
- VicTrack
- Westkon Precast Concrete Pty Ltd
- WorkSafe Victoria
SECTION 1 - GENERAL

1.1 PURPOSE

This Industry Standard provides practical guidance for the design, manufacture, transportation and erection of bridge beams (refer to Figure 1.1) and associated precast concrete elements to ensure, so far as practicable:

- a safe working environment for those in the industry
- the safety of the public.

![Bridge constructed from precast concrete beams.](image)

Figure 1.1: Bridge constructed from precast concrete beams.

1.2 SCOPE

This Industry Standard provides recommendations on the following:

- the safe design, manufacture, storage, transportation and erection of precast concrete bridge beams and other precast concrete elements used in bridge construction
- the safe erection of steel beams in bridge construction.

The emphasis of this Industry Standard is on the planning required for safe methods of construction and erection of precast concrete beams for bridges over road or rail.

The principles set out in this Industry Standard may also be applied to other bridge construction activities not specifically addressed in this document.
1.3 EXCLUSIONS

This Industry Standard does not cover:

• bridge beams assembled in place from individual segments
• in-situ concrete bridge beams or decks
• launched bridge beams
• the design, manufacture and transportation aspects of steel bridge beams.

Precast and tilt-up elements not associated with bridge construction are also excluded from the scope of this Industry Standard. These are dealt with in the Victorian Industry Standard for Precast and Tilt-up Concrete for Buildings.

1.4 RELATIONSHIP TO AUSTRALIAN STANDARDS AND BRIDGE DESIGN CODE

Bridge beams shall be designed and manufactured in accordance with the relevant Australian Standards and the AustRoads Bridge Design Code.

This Industry Standard is intended to complement the key Australian Standards dealing with the design, construction, handling and erection of precast concrete bridge beams and the erection of steel bridge beams.

Where any technical conflict arises between a provision of either an Australian Standard or the AustRoads Bridge Design Code and this Industry Standard, the provision of the Australian Standard or the AustRoads Bridge Design Code (as amended and reissued from time to time) must prevail.

1.5 REFERENCED DOCUMENTS

Documents referenced in this Industry Standard are listed in Appendix A.

1.6 DEFINITIONS

The definitions of terms used in this Industry Standard are given in Appendix B.
1.7 CLIENT INFORMATION

Specific information from the client may be critical in the design and construction sequence of bridge beams, particularly where erection is to occur over road or rail. To assist in developing a uniform basis for tendering, this information should, wherever possible, be made available to the relevant parties well ahead of the tender stage as part of the tender documentation.

This information should include, but is not limited to:

- the name of all authorities with whom the principal contractor will need to liaise, and seek approval from, in regard to site occupation and construction activities
- the expected timing and duration of construction activity windows in respect of works over or adjacent to existing transport services. The relevant information should include the expected lost time, if any, due to processing and activating site access permit systems
- the location and type of services in the vicinity of the site
- any conditions to be met by the contractor in regard to maintaining specified levels of traffic flow for existing roadways or railways
- any restrictions on hours of general construction activity e.g. start/finish times in residential areas
- any other issues that might affect the design or construction of the bridge.
2.1 GENERAL

A principal objective of the Victorian Occupational Health and Safety Act 1985 (the Act) is to provide a safe working environment and eliminate risks to the health of employees as far as practicable.

One of the employer’s primary obligations under the Act is to provide:

“such information, instruction, training and supervision to employees as are necessary to enable the employees to perform their work in a manner that is safe and without risks to health”. [Section 21(2)(e) of the Act]

Employers owe the same duty of care to independent contractors and their employees working at the workplace. [Section 21(3) of the Act]

In fulfilling this obligation, the industry should maintain a structured system of education and training to enable both employers and employees to:

• identify and manage risks involved in the manufacture, transportation and erection of bridge beams
• keep abreast of the current state of knowledge within the industry on the means of eliminating hazards and controlling risks to health and safety.

2.2 PRE-PLANNING AND CO-ORDINATION

Pre-planning and co-ordination between the relevant parties is essential to maximise the benefits of using precast concrete bridge beams safely.

Erection of bridge beams, particularly over road or rail, requires close liaison between the client, relevant authorities and the principal contractor.

At the tendering and planning stage, the client should clearly define any constraints to construction methods adopted in terms of activity windows available to the principal contractor.

Traffic management arrangements are critical for beams erected over road or rail. Due to their fixed alignment, railways cannot be readily diverted. Consequently, construction activities usually need
to be performed within limited timeframes during line closures. The need to concentrate on key construction operations within short periods of time requires detailed planning and may require specialist techniques.

It is the responsibility of the design engineer to ensure that the bridge is designed and detailed so that it can be constructed as intended. Consideration should be given to the constraints placed by the client, service lines in the vicinity and the need for public safety, access and egress.

Prior to manufacture, the principal contractor, in association with the manufacturer and the erector, should plan the complete construction and erection sequences as intended by the designer. Any variations to the beam design or detailing shall be approved by the designer.

Close collaboration between the design engineer, principal contractor, manufacturer and the erector is necessary to ensure safety during all phases of construction.

2.3 TRAINING

Employees need to work safely. They must be trained and instructed in safe systems of work and work practices.

Employers must ensure an appropriately experienced person maintains a high level of supervision of employees who are not yet deemed competent to carry out their work safely.

Training programs should address the identified occupational health and safety needs for employees and their managers, and should provide opportunities for individuals to have their existing skills recognised and to develop new knowledge and skills.

Education and training programs should be structured to lead to nationally recognised qualifications and should be delivered by a registered training organisation. Such training should be in addition to, and not replace:

- general construction industry occupational health and safety induction training
- site-specific induction.
Training and instruction programs should include:

- induction on this Industry Standard
- occupational health and safety training to the industry competency standard as defined by the National Building and Construction Industry Training Board, Construction Training Australia
- First Aid training to the minimum requirements of WorkSafe’s Code of Practice, First Aid in the Workplace
- supervised practical experience programs specific to the tasks being performed by the employee. Such training should be complementary to, or part of a program leading to, a national qualification
- identification of hazards, and control of risks associated with the work practices carried out by employees
- the selection, care and use of protective clothing and equipment
- work activity briefings.

2.4 HEALTH AND SAFETY

Employers should ensure that all employees have the opportunity to be fully involved in the development of relevant procedures including hazard identification, assessment of risk and control of risk methodology.

Employers have a general duty to take all practicable steps to ensure the safety of employees while at work. In particular, they must take all practicable steps to:

- provide and maintain a safe working environment
- provide and maintain facilities for the safety, health and welfare of employees
- ensure that machinery and equipment is suitable for the task, i.e. designed, made, set up, and maintained to be safe for employees
- ensure that employees are protected from hazards in the course of their work
- provide procedures to deal with emergencies that might arise while employees are at work.
The safety induction process is designed to ensure employees receive and understand all the information and instruction necessary to safely and competently perform the tasks required of them. It is necessary that a record be kept, detailing those items included in safety inductions which have been demonstrated, explained, issued and understood by employees.

Employees should discuss with their employer any occupational health and safety issues that they are unsure of or do not understand.

Before commencing work on projects, all employees, including sub-contractors, must as a minimum, be informed by their employer of:

- emergency procedures
- hazards they might be exposed to while at work
- hazards they might create while at work which could harm other people
- ways to minimise the likelihood of hazards becoming a source of harm to themselves and others
- the need for rail safety awareness training when working adjacent to rail lines
- the location and correct use of safety equipment
- work activity briefing.

Employers must inform employees of the results of any health and safety monitoring.

Employers are also responsible for the health and safety of people who are not their employees.

Employers must take all practicable steps to ensure that employees do not harm any other person while at work, including members of the public or visitors to the place of work.

Depending on the nature and duration of site visits, visitors might need to be given a site safety brief and/or be accompanied by an inducted person.

Employees have a responsibility to take reasonable care for their own safety and health while at work. Employees must also ensure that their actions do not harm or place others at risk.
SECTION 2 - EMPLOYER RESPONSIBILITIES

Employees must co-operate with their employer on health and safety matters and must not interfere with or misuse anything provided by their employer to protect health and safety. [Section 25 of the Act]

### 2.5 HAZARD MANAGEMENT

Employers must have an effective method in place to identify hazards and to determine whether there are significant hazards that require further action. A hazard means an existing, new or potential situation or event that could jeopardise the safe working environment.

The most serious hazards that could lead to death or serious immediate injury are often well recognised. However, the injuries that develop gradually over longer periods of time, such as manual handling injuries, skin cancers from exposure to ultraviolet sunlight and noise induced hearing loss, are often not recognised.

Risk is always present when handling, transporting and erecting precast concrete elements.

To ensure appropriate hazard management, an assessment of the risks, referred to as a Job Safety Analysis (JSA) shall be carried out by the principal contractor in conjunction with health and safety representatives of the contractors and/or workers involved in the work.

A JSA lists the hazards and control measures, including safety procedures, which should be implemented. The minimum content requirements of a JSA include:

- an identification of the hazards
- an assessment of the risks from the hazards identified
- control measures required to minimise the risks from the hazards
- identification of the person(s) responsible for implementing and monitoring the control measures.

Where possible, the hazard should be eliminated or the risk reduced by changing or modifying the proposed work method, construction method, or by the use of alternative equipment.

Where the hazard cannot be eliminated, control measures must be implemented to isolate the hazard and to minimise risk to
employees. In these circumstances, measures such as barricading areas of danger, provision of specific safety training and work instructions, use of protective equipment, and posting of warning signs should be implemented. Such measures should be discussed with employees and evaluated to ensure that they are effective and do not create additional hazards.

The accepted means of planning to prevent injury is to identify, assess and then control the risk. At the control stage there is a recognised hierarchy of hazard control measures that should be applied. These processes for managing risk are included in various occupational health and safety regulations and should be followed as part of the hazard management process.

For rail projects, a separate rail safety risk assessment is required by the rail authority, where the contract work is deemed to present a risk to rail operations.

### 2.6 INCIDENT NOTIFICATION

Under the *Occupational Health and Safety (Incident Notification) Regulations 1997*, WorkSafe Victoria must be immediately notified by an employer, self-employed person or person in charge of a workplace, in the event of a workplace fatality, prescribed injuries requiring immediate medical treatment, or a dangerous occurrence that exposes a person to an immediate risk to the person’s health and safety. This includes, for example, the fall of a load during lifting, the collapse of a crane or the collapse of any part of a structure.

Further information is given in the WorkSafe booklet, *Incident Notification – At a Glance*.

### 2.7 SPRAINS AND STRAINS

Many injuries that occur in bridge construction are sprain and strain injuries.

The largest number of sprain and strain injuries arise from people lifting, carrying or otherwise applying force to an object. This is known as manual handling. Other sprain and strain injuries result from falls or from being struck by an object.

While injury to the back and neck is the most common, many injuries occur to the arm, including the shoulder, and to the leg. Many of these injuries will be the result of positioning items (such
as bearing blocks), or guiding large objects (such as beams) that are being moved by cranes.

Although some manual handling injuries can be caused by a single action, such as lifting or moving a heavy object, more often they are the result of a number of actions over a longer time. Reducing the risk arising from a number of individual manual handling tasks will produce a significant reduction in the overall risk to which workers are exposed.

The *Occupational Health and Safety (Manual Handling) Regulations 1999* require employers to eliminate risk arising from manual handling or, where elimination is not practicable, to reduce the risk as far as is practicable. The Regulations also set out the obligations to identify, assess and control any risk from manual handling. Addressing risk at design, purchasing and planning stages of the project is always the best option, as changes can be made at these stages with minimum impact.

Work planning should consider the manual tasks individuals are expected to do and, where possible, it should revise or improve those methods to reduce the risk of injury.

For example, the task of cutting pile heads with a jackhammer should be assessed. The designer and contractor should consider alternative construction techniques that avoid the need for the pile head to be cut. Where this is not possible, then other methods, such as using machinery that will expose the workers to lower levels of manual handling risks, should be considered. Where such alternatives are deemed impracticable, then a method of independently supporting the weight of the tool should be adopted.

WorkSafe’s *Code of Practice for Manual Handling* provides guidance on the necessary steps for identification of hazardous manual handling, assessment of the level of injury risk, and the control of injury risk. Guidance on those features or tasks that produce risk of manual handling injury can be obtained from the Code. Recognising and analysing those risk features are the first steps towards the development of better work practices.
SECTION 3 - DESIGN FOR CONSTRUCTION

3.1 STRUCTURAL DESIGN CONSIDERATIONS

3.1.1 General
This section covers the general safety aspects that need to be considered in the design of bridge beams to ensure safe handling, storage and erection. The relevant Australian Standards and the AustRoads Bridge Design Code should be referred to for design issues.

For beams to be erected over road or rail, the design should take into account the time available for the erection process.

3.1.2 Structural Configuration
Beams should be designed to be placed directly onto piers or other supports that are permanent or parts of the permanent structure. Where beams are designed to be placed onto a temporary support structure, the support structure shall be designed and documented by an erection design engineer, in accordance with the requirements of Section 7 and the following:

- The structural configuration shall be checked at all stages of construction for stability and safety.
- Provisions for lifting, access walkways, fall prevention systems, or other provisions to facilitate safe work practices, should be incorporated into the design documentation.

It should be noted that the rail industry prefers that piers between railway tracks are avoided.

3.1.3 Dimensional Tolerances
Construction and manufacturing tolerances for the physical dimensions of bridge elements should be taken into account by the designer.

Combinations of skew, slopes and curvature can become complex, and special attention should be paid to detailing, to provide clarity of dimensions and layout on the drawings.

Proper consideration should be given to prescribed gaps between beams and at the ends of beams. No arbitrary upper limit should be placed on the accumulation of tolerances.
Design tolerances for beams and support structures should be specified in the project specification and drawings.

Bearing systems should be designed for the nominated tolerances, taking into account the three dimensional geometry of the structure.

### 3.1.4 Pre-stressing

Pre-stressing of beams is achieved by either the pre-tensioning or post-tensioning of tendons.

Pre-stress forces shall be specified as the jacking force before and after all losses. The assumptions applied to calculate the jacking values should be shown on the drawings.

Details to be nominated on the drawings should include:

- the post-tensioning sequence – i.e. the order in which tendons are to be stressed
- whether post-tensioning tendons are single or double-end tensioned. If double-end tensioned, whether stressing is to be sequential or concurrent
- the de-stressing sequence, i.e. the order in which pre-tensioned strands are to be released
- design jacking force for stressing
- allowance for losses in the jack
- allowance for pull-in at anchorage
- total elongation per tendon (measured behind the jack before lock-off)
- tolerance assumed on elongation for the required jacking force
- for pre-tensioned concrete components, the force per strand given as a force at the end of the pre-tensioning process, i.e. after allowances for shortening in the bed and losses in couplers, jacks and anchorages.

In accordance with Clause 5.16.3.5 of the AustRoads *Bridge Design Code*, pre-tensioned tendons and post-tensioned tendons shall not be stressed beyond 0.8 and 0.85 respectively of their minimum breaking load during the stressing operations.
3.1.5 Reinforcement
Reinforcement projecting from the top of a beam should be detailed in such a way as to provide the minimum possible tripping risk, without compromising the structural integrity of the design, e.g. use closed loops and not open hooks which can trap the foot.

Designers should check that every reinforcement detail actually works in respect to cover and congestion. This is particularly important for pre-tensioning strands, which tend to occur in a fixed grid. Flexibility and adequate tolerances must be provided. Prescribed bend radii of bars should be taken into account in all applicable details by drawing accurately to scale, with real bar thicknesses, including deformations. Three dimensional views should be used where necessary.

3.1.6 Calculation of Mass
Designers should make every endeavour to calculate accurately (to the nearest tonne – upper bound value) the mass of each beam or beam element. Beam mass is usually critical to craneage, transportation and erection.

Knowledge of materials used is vital in calculating unit mass of concrete, as aggregate densities can vary. The density used in the calculation of beam masses shall be given on the drawings, and should not be less than 2,700 kg/m³ for reinforced and prestressed concrete beams. Differences between actual and theoretical masses are generally related to changes in cross-sectional dimensions and voids.

In the case of steel beams, particular care should be taken to include the mass of all stiffeners, bracing and welds as these can represent 15% or more of the total mass. Both temporary and permanent bracing should be included in the calculation.

3.1.7 Revisions to Drawings
At the time of any revision to a construction detail or specified procedure, the appropriate drawing or other document should be updated and the revision clearly indicated. Provisional updating by marking up or preparing a hand drawn detail, and signing and dating the mark-up or new detail, is acceptable, if approved and countersigned by the designer, and where applicable, the proof engineer.
Irrespective of how the revision procedure is implemented, the drawing or other document should be updated and the revision clearly indicated.

### 3.2 DESIGN FOR CONSTRUCTION

A construction method and sequencing should be incorporated into all design processes from the earliest stages of a project.

#### 3.2.1 Construction Sequence

The construction sequence used in the design should be shown on the design drawings. When subsequent changes are made to the construction sequence, these changes should be documented in accordance with Section 3.1.7.

#### 3.2.2 Lifting

All components should be designed to allow for installation using a method that is both safe, practical and in accordance with occupational health and safety requirements. This might necessitate consultation with all relevant parties to achieve both a safe and efficient outcome.

Beams should be analysed by the design engineer for the compressive forces applied by a one-crane lift. The design should allow for an included sling angle of up to 90°. The maximum included sling angle should be clearly stated on the drawings, as it controls the size and capacity of the crane required and dictates the tension in the lifting gear and lifting inserts.

If more than one lifting point (e.g. insert or loop) is required at each end of the beam, they should be installed in pairs at right angles to the beam centre line and at equal distance from the centre of gravity line (refer to Figure 3.1). Due to the complexity of the associated rigging, a combination of three lifting points at each end should not be used.

If a beam cannot structurally withstand a one-crane lift, then this should be clearly stated on the drawings.

Lifting inserts shall be designed to take all possible load combinations during lifting, both in the precast yard and on the construction site.

Although pre-stressing strands are still widely used as cast-in lifting inserts, the AustRoads *Guide to Bridge Construction Practice* discourages their use.
Where there is no practicable alternative to strands being used as lifting inserts, they should:

- be designed with a load factor of 4, including allowances for impact
- be placed on the exact angle of lift, i.e. vertically for a two-crane or spreader beam lift, and at the relevant angle for a single crane lift (Note that in some cases, two sets of lifting strands may be necessary; one vertical and one inclined.)
- have the projecting loop protected by steel ducting, which should stop at 40-50 mm above the concrete surface
- have their embedment checked prior to the casting of each individual beam.

Guidance on the use of pre-stressing strand lifting loops can be obtained from the *Precast Concrete Handbook*, published by the National Precast Concrete Association Australia and the Concrete Institute of Australia, and the *PCI Design Handbook*, published by the American Precast and Prestressed Concrete Institute.

Where non-proprietary lifting equipment, attachments or brackets are used (refer to Figure 3.2, overleaf), they should be designed in accordance with the relevant Australian Standards by a person qualified for membership of the Institution of Engineers Australia and who is competent in that field of engineering.
Non-proprietary lifting components should be proof loaded. Where this is impractical, due to the extreme dimensions or load capacity of the components, a quality assurance system should be established, incorporating:

- third-party design analysis
- material identification
- non-destructive examination of welds and castings
- other appropriate non-destructive examination.

The use of high capacity fixed or adjustable spreader beams is not preferred. These beams are not available as standard items and generally require design, manufacture and testing for specific projects.

Lifting attachments should be clearly and permanently marked in accordance with AS 1418.1.

### 3.2.3 Fall Prevention

The contractor must ensure that fall protection is provided to all employees involved in the erection. Where possible, the erection design engineer should liaise with the erector to ensure the beam design includes specific design details, cast-in ferrules or other provisions for the connection of temporary fall prevention systems. Such systems may include the provision of temporary guardrails,
supports for temporary work platforms or anchorage points for travel restraint or fall arrest systems.

Note: Where an erector has not been appointed at the time of initial design, the client should ensure that the above consultation and appropriate design modifications are made following the appointment of an erector. This should occur before shop drawings are completed and before beam manufacture commences.

AS/NZS 1891.4, *Industrial fall arrest systems and devices*, Part 4: *Selection, use and maintenance*, provides advice on appropriate anchorage capacities for anchorage systems.

Erection design engineers should clearly indicate on the shop drawings the location, capacity and allowable use of any anchorages that are suitable for safety lines.

### 3.2.4 Bearings

Bearing design should take into account the beam erection phases and the associated fixing and stability requirements. For example, bearings should be generally placed horizontally, but if they are on a slope, then temporary or permanent restraints should be designed to prevent beam and/or bearing movement during construction operations. Note: VicRoads specifies all bearings to be horizontal.

Particular attention should be paid to the bearing fixings, so that adequate tolerances are provided for the placing of beams on the bearings. The bearing supports should be of suitable size to allow for ample tolerance in placing and adjusting the position of the beams (refer to Figure 3.3). Bearing keepers should also be sized to allow for similar tolerances.

Wherever possible, preference should be given to the use of bearings that can be fixed to the beam prior to transport to the site.

*Figure 3.3 Elastomeric bearing pad placed on adequately sized pedestal.*
3.2.5 Transport
Beam design should take into account the effect of load dynamics from transportation. The geometry of the beam should be such that it can be safely moved with readily available equipment.

A clear understanding of local road restrictions and readily available equipment is vital. The designer and/or contractor should establish any height, width or mass restrictions on the proposed transport route.

Impact loads and load effects due to eccentricities applied to the beams in transport shall be incorporated into the design.

Lateral stability during transport should be assessed, and where necessary, temporary bracing should be provided.

Support points to be used during transport should be shown on the design drawings, together with tolerance limits of these locations. The tolerance limits on the locations of the beam support points must provide adequate clearance to bearing plates.

A method for restraining beams on transport vehicles should be incorporated into the beam design. The design of the restraints should ensure that the beam can be rigged and that its initial weight can be taken by the crane prior to the release of the restraints.

The designer’s approval should be obtained for the beam support system to be used during transport.

3.2.6 Design of Steel Beams for Erection
The following specific points should be noted when designing steel beams for erection over road or rail:

- The lifting arrangement used to erect beams should be discussed with the erector, and lifting cleats or other attachments should be designed to suit.
- Beams may need to have special bracing designed to prevent buckling due to compressive forces generated by a one-crane lift.
- Where beams are to be assembled or lifted in pairs, suitable vertical and horizontal (in plan) bracing shall be designed to provide stability during handling.
- Provision should be made for jacking of the beams at the supports, to permit placement or adjustment of bearings.
• For site locations over or in the vicinity of electrified railway lines or other powerlines, the design of the beam erection methodology should minimise the likelihood of crane or beam contact with live powerlines.

3.3 DESIGN FOR TEMPORARY WORKS AND SPECIAL CONSTRUCTION EQUIPMENT

All temporary works and special equipment required for construction on-site should be designed and documented by the erection design engineer, and certified by the proof engineer.

3.3.1 General

The temporary works designs should include, but are not limited to, the following:

• Detailed engineering designs and drawings for the temporary support system.
  
  Note: Off-the-shelf support systems are not generally suited to complex support arrangements unless used as part of a designed and documented system.

• Consideration of the stability of the temporary and permanent structure during all stages of erection and dismantling.

• Details of methods to provide safe access to all working zones of temporary and permanent structures.

• Fixings for temporary works cast into the beam during manufacture.

• Methods to protect the temporary and permanent structures against road and rail traffic impacts. Loadings for barriers should be specified on a site-by-site basis and should be referred to the relevant authority, such as VicRoads or VicTrack, for review.

• Consideration of the traffic management systems implemented on the site. Temporary works designers should make themselves aware of traffic management arrangements and design the temporary works accordingly. For example, space required for traffic management signs or barriers might need to be provided within or around the temporary works.
3.3.2 Footings for Temporary Works

Site preparation should be part of the temporary works design package, and geological assessments should be carried out for all storage and handling areas. Crane siting areas should be specifically targeted for geotechnical assessment.

The use of timber footing pads is not recommended, and timber should not be used if there is any possibility of the pads being under water for even a short period.

Where the use of timber footings is allowed, they should be checked for the ability of the timber to withstand the applied crushing and other stresses. The erection design engineer and proof engineer should check and certify that the timber used is of the type and grade specified in the design.

3.3.3 Construction Method

The construction method and associated temporary works should be subject to a formal Work Method Statement prepared in accordance with the requirements of Sections 2 and 7 of this document.
4.1 PRE-PLANNING

Prior to manufacturing the precast elements, the parties involved in the design, manufacture, transport and erection process should have liaised and planned the complete construction and erection sequences. Factors that need to be taken into account in this process include:

- site limitations and local street access
- component size
- crane size, configuration, mobility and access
- delivery sequence
- transport requirements
- overhead obstructions, particularly tram or train wires, overhead powerlines and construction-site overhead power
- occupancy arrangements for contractors operating on or over roadways or railways
- underground obstructions (pits, etc.)
- timing (night or day).

4.2 DRAWINGS

The shop drawings for each precast concrete element should be prepared and reviewed by the relevant parties prior to commencing manufacture. This review should be in accordance with the requirements of Section 3 - Design for Construction.

The effects of bridge cross-fall on the dimensions, grade and skew of the individual components are important considerations for bridge beam detailing.

To minimise multiple handling, the casting sequence, storage, delivery sequence and erection requirements need to be considered before commencing manufacture.

4.3 FORMWORK

Formwork must be designed and constructed in accordance with AS 3610, Formwork for Concrete.
Precast concrete construction usually requires multiple uses and early stripping of formwork, and these requirements should be taken into account in the design of the formwork.

Formwork or mould design for precast concrete elements can have a direct bearing on how elements are cast and handled, and on the loads imposed during manufacture. In particular, the following should be noted:

- Surface finish requirements can influence the preferred orientation of a precast element in the mould. The quality of the finish of vertical mould faces may differ from that cast against a horizontal surface. Two-stage casting can be used to avoid this problem.
- Moulds for elements such as beams may require special provisions to accommodate pre-stressing. Generally, the side forms should be released or removed prior to releasing stressing strands. Stop-ends should be detailed to accommodate sliding of the component during release.
- Both suction and friction can be reduced by the use of high quality mould release compounds.
- 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. Friction forces are increased by vertical or near vertical sides on a mould. To reduce friction, mould sides should be detailed with adequate draw, or should be released to allow them to spring back.
- To avoid overloading lifting inserts, the mould can be vibrated while gently lifting one end of the precast element.

Where void formers are used within a beam section, they should be securely fixed in position to prevent movement during placement of the concrete. Note that buoyancy forces can be significant.

4.4 TOLERANCES

Unless otherwise specified, tolerances should be in accordance with the appropriate Australian Standards.

In Victoria, the appropriate Standard for precast bridge beams is the VicRoads *Standard Specifications*. For other precast concrete elements, the appropriate Standard is AS 3610 or VicRoads *Standard Specifications*. 
The tolerance on deviation from planeness of the casting bed should be such that the as-cast element meets the specified requirements.

The effects of cumulative tolerances on the overall dimensions of a series of elements should be considered. Where necessary, appropriate allowance should be made in formwork dimensions to ensure that the overall dimensions fall within the specified tolerances.

The visual impact of element misalignment might be reduced by the use of various details such as chamfers and arises.

As noted in Section 3, the tolerance on the unit mass is an important consideration for handling and erection purposes. Checks should be undertaken to verify and denote the mass of elements as manufactured. Where appropriate, the calculated mass shall include fixtures such as guardrails and crash barriers.

4.5 RELEASE AGENTS

Before a release agent is chosen for use in the manufacture of the precast element, it should be checked for compatibility with the curing compound and other applied finishes and joint sealants. A proven proprietary combination curing compound or release agent should be used. Consideration should be given to the following factors:

- Solubility – the products should not be washed off by rain.
- Discolouration – if it is a pigmented product, the pigmentation should weather off within a reasonable time.
- Temperature effects – extreme temperatures might blister the product and cause it to lose its properties.
- Compatibility with finishes – the adherence of applied finishes, including joint sealants, should not be affected.

The curing compound and release agent should be applied in accordance with the manufacturer’s specifications.

4.6 PRE-STRESSING

Manufacturers of pre-stressed elements should be aware of the inherent hazards and risks of the stressing operation and should have adequate control measures in place to safeguard workers from all such risks.
The pre-stressing details, and where applicable the post-tensioning sequence, should be in accordance with the design drawings.

Pre-stress forces should be as specified on the design drawings. Allowance should be made for losses in the jack and pull-in at anchorage.

The jacking force and strand elongation should be recorded in accordance with the requirements of the design drawings.

### 4.7 REINFORCEMENT

Reinforcement shall comply with the requirements of the appropriate Australian Standards. Unless otherwise specified, reinforcement shall be securely fixed in accordance with AS 3600, *Concrete structures*, and supported in the correct position to prevent displacement during concrete placement.

Where plastic-tipped metal bar chairs are used to support reinforcement in external faces, care should be taken to ensure that the plastic tips are not damaged during or after manufacture.

Note: VicRoads specifications do not permit the use of these chairs.

### 4.8 LIFTING INSERTS

Lifting inserts should be cast-in proprietary products that comply with the requirements of Section 3. They should be of the type and capacity specified in the drawings.

Where non-proprietary products are used, they should be specifically designed for the project (in accordance with Section 3) by a person qualified for membership of the Institution of Engineers Australia and who is competent in that field.

Factors affecting the load capacity of the inserts include:

- the concrete strength of the element at the time of lifting
- embedment lengths of the insert
- direction of loading; shear or tension.

No variations shall be made to the specified lifting insert locations on the approved drawings without the written approval of the design engineer and/or erection design engineer. If changes are made, the drawings should be amended accordingly and certified by the design engineer.
Lifting inserts should be accurately positioned and securely tied in accordance with the supplier’s recommendations and as detailed on the drawings. Inserts must never be welded.

To ensure compatibility, wherever possible, all insert types should be of the same manufacture and the same size. Lifting clutches compatible with lifting inserts must be available and used.

### 4.9 CONCRETE PLACEMENT

Prior to placing concrete, the arrangement should be inspected for compliance with the drawings. In particular, this should include checks on:

- formwork dimensions
- formwork stability
- edge details and penetrations
- connection details
- insert locations, types and fixing to reinforcement
- reinforcement sizes, locations, cover and fixing
- form oil effectiveness.

The inspection should be carried out by a trained and competent person who was not involved in the original set-up.

Records should be kept to substantiate the manufacturer’s certificate of compliance.

When ordering concrete, the supplier should be advised of:

- the specified characteristic concrete compressive strength
- any specific VicRoads requirements
- the concrete compressive strength required at time of lifting
- the maximum aggregate size
- the required slump
- special design requirements, if any, e.g. colour, cement content and water-to-cement ratio
- the site access, required rate of supply and the method of placement, e.g. type of pump.
Vibrators should be used to compact the concrete. Particular attention and care should be paid to vibrating the concrete around the stressing anchors, inserts and adjacent to the corners and edges.

Concrete should be placed in a uniform manner and properly spread over the area before commencing vibration.

### 4.10 MINIMUM CONCRETE STRENGTH

The minimum concrete strength at which the pre-stressing force can be transferred to the element (strand release) or at which the precast concrete elements can be lifted from the mould, depends on:

- the stresses caused by the transfer of pre-stressing forces
- the flexural and shear stresses caused by handling
- the concrete stresses in the concrete element at the time of lifting.

The strength of the concrete at initial lift should not be less than the value specified on the drawings.

The minimum strength of the concrete at initial lift should be determined by a method that is representative of the concrete strength in the element.

Concrete grades higher than those specified by the design engineer might be required to enable early release and lifting.

### 4.11 CURING

The strength, water tightness and durability of concrete depend on the concrete being adequately cured.

Release agents used in the manufacture of precast concrete elements should be checked for compatibility with the curing compound and other applied finishes and joint sealants.

Formwork should be carefully stripped to prevent damage.

If the precast element is damaged, the proposed repair system should be submitted to, and approved by, the design engineer before the repair is attempted.
4.12 BEARINGS

Wherever possible, bearing plates (refer to Figure 4.1) should be fixed to the underside of the beam before transporting to site. An appropriate work procedure should be established that will allow the items to be fixed to the underside of the beam in a safe manner. This will require the beam to be supported on temporary shoring, sufficiently clear of the ground to allow adequate access and workspace.

![Steel bearing plate fitted to the beam prior to transportation.](image)

4.13 TEMPORARY BRACING, STRONGBACKS AND TIEDOWNS

Precast concrete elements that are odd shaped, or inherently slender, may require strengthening for lifting, transport and erection. Strengthening techniques might include the addition of strongbacks, temporary bracing or the use of a lifting beam. The design engineer and/or erection design engineer should advise on the type of temporary strengthening/special lifting requirements needed for lifting, transport and erection of the element. This is to ensure that loads applied to the element by the lifting system are within its designed capacity.

Provision should be made, where appropriate, to cast fixings into the element for any tie-downs or braces required for either transportation or for temporary support during erection.
SECTION 4 - MANUFACTURE

4.14 SPECIAL PROVISIONS FOR ON-SITE CASTING

For elements cast on-site, concrete base slabs are commonly used as the casting bed. The likely construction loads shall be taken into account when designing temporary casting beds.

The overall stability of the element during and after casting needs to be considered, and temporary bracing might be necessary to provide stability.

Precast bridge elements are likely to be very heavy, and special consideration should be given to lifting requirements. This includes access and loads imparted by the crane onto the supporting base.

4.15 ELEMENT IDENTIFICATION

During or immediately after manufacture, all precast concrete elements should be permanently marked with a unique identification designation that shows at least the:

- project name
- client name
- unique identification designation
- date of casting/manufacture
- truck loading direction
- orientation in the structure
- mass of the unit, and where appropriate, fixtures such as guardrails and crash barriers should be included in the mass.

These identification requirements are intended to improve safety, not only on the construction site, but also in the precasting yard.

Unit masses are usually critical to constructability (cranage, transport, support structure, etc.). For this reason, all beams should be physically weighed prior to delivery. Load cells should be installed in all cranes in precasting yards to eliminate the risk of overloading both cranes and rigging during the initial lifting of beams.
4.16 MANUFACTURER’S CERTIFICATE OF COMPLIANCE

Prior to the transportation or erection of precast concrete elements, the contractor or manufacturer should prepare a manufacturer’s certificate of compliance stating that the manufacture of the elements was carried out in accordance with the approved drawings.

The manufacturer’s certificate of compliance should be supplied to the erector and be available on-site at the time of lifting the elements listed on the certificate.

As a minimum, the certificate should include the following details of each element:

- concrete strength (refer to Section 6.2)
- date of manufacture
- identification number
- mass
- confirmation of number, type and capacity of lifting inserts
- quality assurance sign-off.
5.1 GENERAL

This section deals with:

- the handling and storage of precast concrete elements in the factory or casting yard
- the storage of precast elements on the construction site.

As well as providing a safe workplace and protecting the concrete element, the objective of a handling and storage system is to ensure safe transfer of the element.

There is no standard method of handling and storage for precast concrete elements. Methods will vary depending on the type and shape of element and whether the element is in the factory or on-site. The important criteria are:

- safety of the personnel
- protection of the concrete element.

At no time should a precast element be placed in position without a positive restraint unless it is inherently stable. Inherently stable elements are those elements that, due to their geometry, cannot tip or rotate when stored and subjected to wind loads, construction loads and impact loads generated during placement and removal of the element and, where applicable, accidental impact from vehicles.

5.2 HANDLING

The general requirements for rigging and lifting systems are specified in documents referenced in Appendix A.

Prior to lifting, there should be an induction process for all personnel involved.

Handling methods may vary, depending on the facilities available and the types of elements being manufactured.

Pre-planning between manufacturer, principal contractor and erector is vital, so as to minimise multiple handling.

Where elements require multiple handling for processing or finishing, the rigging systems and lifting insert configurations should be agreed upon by the manufacturer, principal contractor and erector, and designed and detailed by a competent professional engineer.
The rigging system to be used and the method of handling for each element should be shown on the drawings.

No element should be lifted without appropriate methods being documented within the Work Method Statement, including:

- crane location for each lift
- rigging configuration
- types of lifting clutches
- fall prevention systems
- access systems.

### 5.3 CONCRETE STRENGTH FOR HANDLING

Precast concrete elements should not be removed from the moulds and placed into storage until the concrete has attained the minimum strength specified for lifting.

The minimum strength of the concrete at initial lift should be determined by a method that is representative of the concrete strength in the element.

### 5.4 STORAGE

The storage area should be large enough for elements to be stored properly, with adequate room for lifting equipment and for manoeuvring trucks and cranes.

The area should be reasonably level and hard surfaced with adequate drainage to ensure that a safe workplace can be maintained.

Elements should not be stored directly on the ground. Generally, two discrete support points should be provided unless specifically noted otherwise by the project design engineer.

It is recommended that geotechnical advice be obtained to assess the ground conditions and advise on the suitability of the bearing capacity of the foundation material.

Where elements are stacked on top of each other, the following should apply:

- Support points should be directly above each other unless specifically documented otherwise.
• The stacked height of elements should be limited to ensure that the ground bearers and lower elements can support the loads from above.

• The stability of the stack should be checked by a person competent for that task. This check should be specific to each type of element, and each type of stack should be considered on its own merits.

• An overall hazard and risk review shall be conducted and included in the Work Method Statement.

Special consideration should be given to pre-stressed elements to ensure that they are supported only at the designated bearing points. Pre-stressed elements should never be supported, even temporarily, at any other points. Equally, they should never be tipped sideways or stored directly on the ground.

5.5 STORAGE SYSTEMS

Storage systems for elements that are not inherently stable shall be designed to resist the loads and forces applied to them. This includes wind loads, construction loads and impact loads generated during placement and removal of the element and, where appropriate, accidental impact from vehicles.

The design of the storage system should be fully documented.

To minimise the effects of vehicle and other uncontrolled impact, the element support systems (racks, frames, etc.) should be robust and designed so that failure at one point does not result in a progressive total failure.

5.6 SITE STORAGE

Generally, the sequence of erection should be such that storage and multiple handling of elements on-site is minimised.

When site storage and multiple handling are unavoidable, the required work method should be clearly documented and included in the Work Method Statement.
Storage of elements on-site should be in accordance with the general requirements for storage and handling, and the following:

- Elements should be stored only in a position approved by the design engineer.
- Ground conditions should be checked to ensure that the mass of the element can be supported.
- Where an element is to be stored on an already erected span, approval and written instructions must be obtained from the design engineer before proceeding.

### 5.7 IMPACT PROTECTION

For precast elements stored in areas of vehicular movement, additional protection might be required to maintain a safe workplace. This could include the use of bollards or other physical barriers.

During handling and storage, care should be taken to minimise the likelihood of impact between elements.
6.1 GENERAL

To prevent accidents and injuries, loads on vehicles should be adequately restrained. It is the responsibility of the transporter to ensure that the vehicle used is suitable to transport the elements and that they are properly secured.

The transporter is responsible for obtaining the necessary permits for all over-dimensional loads. Drivers must be able to produce the permits upon request.

6.2 BASIC PRINCIPLES

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

The feasibility of transporting a crane of the required type and capacity to the site (to lift the elements) also needs to be taken into account.

Elements should be loaded in a sequence compatible with the sequence required by the erector.

Elements should be loaded so that the identification marks are visible during transport and unloading.

Placement of the elements should evenly spread the load along the vehicle’s centreline.

The manufacturer should ensure that the concrete strength of the precast elements has reached the specified design strength for transport and erection.

Precast elements should not be transported within seven days of casting, unless concrete in the specific elements is tested to confirm that the design strength for transport and erection has been attained.

Prior to transportation of beams, consideration should be given to:
- fixing of bearing assemblies to the beams (refer to Section 4.12)
- location of transport support points as designed (refer to Section 3.2.5)
installation of ferules in the beams for fixing of temporary beam supports (refer to Section 4.13)

fixing of fall-prevention systems, so far as is possible, to the beams (refer to Sections 7.6 and 3.2.3)

decking out of the open-top beams.

6.3 TRAFFIC MANAGEMENT

Consideration of traffic management requirements should be planned well in advance of falsework erection or beam erection. The level of traffic management should be addressed on a case-by-case basis depending on the volume of traffic, speed limit of vehicles, proximity of works to traffic, and the construction methods applied.

The level of detail required for the traffic management plan should be pre-determined by the client through the appropriate section of the contract specification. A traffic management plan should include the following:


- Traffic control details around the work site and precast yards including detours where necessary, for work site protection, falsework protection, access or egress to the site.

- Protection of falsework, where required, from traffic damage.

- Timing and staging of the works.

- Approval of other authorities, such as rail and utilities service providers that might be affected by the works.

The traffic management plan should be distributed to all relevant parties. All involved personnel should be inducted into the requirements of the traffic management plan.
6.4 ELEMENT RESTRAINT

Methods of restraint should comply with the Department of Transport Federal Office of Road Safety’s *Load Restraint Guide* and VicRoads’ *A Guide to Restraining Concrete Panels*. These guides describe the performance standards for restraints, and provide information on the principles of restraining, requirements for positioning, and advice on securing loads.

Restraint equipment and anchor points must be strong enough to hold the load. The equipment should be inspected before use to ensure that it is serviceable.

The particular method of restraint is dependent on the type of element being transported and the type of vehicle being used. The beam should be:

- placed in a manner that does not make the vehicle unsafe or unstable
- secured so that it is unlikely to fall or be dislodged from the vehicle (refer to Figure 6.1)
- restrained using an appropriate method
- supported only at the specified bearing positions.

The vehicle must never be moved without the load being secured in the appropriate manner.

Drivers should stop and check the load and the restraints shortly after commencing the journey and periodically thereafter to ensure that the load has not moved or settled.

Where precast elements are carried on a flat top trailer, a safety chain must be placed around the front edge of the elements to prevent forward movement. The rated capacity of a safety chain must be at least half the mass of the load it is restraining.

When a trailer and jinker are used to transport long elements, the elements should be securely seated in a bolster, and double-chained to both trailer and jinker.
Drivers should be adequately instructed in the safe transportation of precast elements, with particular attention given to:

- overhead powerlines (including those for tram and train)
- OD routes (recognised truck routes for over dimensional loads)
- checking with VicRoads’ control room for details of lane closures en-route for wide loads
- roundabouts and reverse camber in the road
- turning circle
- jinker trailer control.

Figure 6.1: Typical beam secured on truck for transportation.
SECTION 6 - TRANSPORTATION

6.5 ELEMENT PROTECTION

Points of contact between elements, supports and restraints should be provided with protective material to prevent breakage and staining. Corner protectors should be used under all restraints to prevent movement and damage to the element.

Where elements are transported horizontally, they should be stacked so that each element can support the loads from above. The support points should be directly above each other unless specifically designed otherwise.

The stacked height of elements should be limited to ensure that the bearers and lower elements can support the loads from above, and so that the stack remains stable during transportation.

Special attention should be given to pre-stressed elements to ensure that they are supported only at designated bearing points and that restraint systems do not impose excessive loads. Pre-stressed elements should never be supported, even temporarily, at points other than where designated.

Pre-stressed elements should never be tipped sideways or rotated in a manner that could result in load reversal.

6.6 DELIVERY

Delivery of the precast elements onto the site requires co-operation between the principal contractor, the transporter and the erector.

The principal contractor should provide a recognised traffic control management plan that includes, where necessary, traffic controllers (flagmen), barricades and road closure permits to allow unimpeded access to the site.

The manufacturer should ensure that the transporter has detailed instruction on how to enter the site.

The transporter should inspect the site prior to entry to verify that there are no dangers such as backfilled excavations or overhead services.
The area to receive the delivery vehicle should be firm and level, and preferably proof checked for load capacity.

Where elements are delivered for direct placement on the structure, the transporter should position the vehicle as directed by the erector and should stabilise the vehicle prior to releasing the element restraints. Where necessary, semi-trailers should be stabilised by lowering their support legs onto a firm base.

The transporter should be aware of the beam orientation and know which elements are to be unloaded first.

If the unloading sequence can lead to instability of loads:

- elements should be individually restrained and the loading configuration checked to ensure that removing individual elements does not result in instability of the load or the vehicle
- restraints should not be removed until the crane takes the initial weight of the element.

Under no circumstances should a vehicle be moved without the load being secured in the appropriate manner.

The transporter is responsible for ensuring that the load is secured in the appropriate manner at all times, even during the unloading operation.
7.1 GENERAL

Thorough pre-planning is vital to the safe erection of bridge structures. All personnel should be aware that erection of any element is hazardous and that the purpose of the pre-planning process is to identify hazards and to eliminate or adequately control any risk in the erection process.

7.2 PLANNING THE CONSTRUCTION AND ERECTION SEQUENCE

Prior to manufacture, the erector, in association with the design engineer and the principal contractor, should have planned the complete construction and erection sequences.

The planning process should be documented as part of a Work Method Statement and take into account:

- site limitations
- local street access
- element sizes
- crane size, mobility and access
- casting sequence
- overhead obstructions, including overhead powerlines
- proximity to railway and roadway infrastructure
- temporary works
- applicable authorities’ regulations
- traffic management planning
- lay-down areas for crane rigging and beam storage
- no person to work under a suspended load
- height access and safe working platforms
- requirements for road and railway occupation or use
- occupational health and safety requirements and industrial requirements for maximum work and rest periods
- adequate lighting for work at night
• contingency plans for worst-case scenarios
• erection stages providing flexibility to promptly discontinue works should the need arise
• site emergency planning, and notification to relevant local authorities
• working near or over water.

The planning process should ensure the on-site provision of:

• amenities for the erection crew in accordance with WorkSafe’s Code of Practice for Building and Construction Workplaces or WorkSafe’s Guidance Note, Provision of Amenities on Mobile and Short Term Civil Construction Sites, as appropriate
• adequate site access for the proposed construction method
• adequate access for the size of the cranes and other plant to be used
• adequate access for all forms of transport required for the project, including semi-trailers, extendable trailers, transport dollies and cranes
• regular maintenance and suitability checks for height access equipment to ensure its serviceability and appropriateness for the construction methods.

Elements should be erected in accordance with the pre-planned sequence referred to in Section 3.2.1.

An element should not be erected on-site within seven days of casting unless its concrete has been specifically tested to confirm that the design strength for erection, as shown on the shop drawings, has been attained. Test results should be readily available on-site prior to transporting or erecting the element.

Where applicable, the principal contractor should provide the erector with verification that the concrete in temporary supports has attained its required strength before elements are erected.

The lifting and placement method should ensure that a sudden failure of the element or rigging will not endanger the riggers, the crane operator or the crane.
Whenever possible, fall prevention systems should be fixed to the element before it is lifted (refer to Figure 7.1).

Where work is occurring over operational railways or roadways, measures should be taken to ensure that:

- no erection of beams or elements occurs above traffic below
- protection is in place at all times to prevent objects from falling onto traffic or persons below
- temporary fencing that is at least 1.8 metres high is provided on each side of the erected bridge deck. Such fencing should be clad with shade-cloth or similar material to retain any windblown items. Due to its flammability, hessian should not be used.

7.3 CRANAGE REQUIREMENTS

Cranage planning should start as early as possible in the development of the work or project. In the case of new bridges, the designers should, at the initial design stage, give consideration to crane loadings and access. This is important where methods such as supporting from temporary falsework or off existing structures is contemplated.
The planning of crane activities should be divided into various stages including:

- the initial design
- the site set-out
- immediately prior to the use of the crane(s) on-site.

Wherever feasible, the planning process should include consultation with the erector.

The selection and use of cranes and elevating work platforms must comply with all relevant occupational health and safety regulations and, in particular:

- the Occupational Health and Safety (Plant) Regulations 1995

Advice on the recommended ways of complying with these Regulations can be found in WorkSafe’s *Code of Practice for Plant* and in the AS 2550 series of Australian Standards, which are incorporated by reference into the Code of Practice.

### 7.3.1 Crane Selection

The selection of the right crane(s) is an important part of any successful project.

At appropriate stages, the planning process should deal with:

- crane selection, access and siting in accordance with AS 2550
- protection of the public
- ground support conditions and the location of any excavations or underground services likely to be affected by imposed crane loads
- proximity of overhead powerlines
- written procedures for crane set-up and dismantling
- a Work Method Statement detailing the lifting method
- proximity to railways and road infrastructure
- the make-up of the rigging crew
- the communication system
SECTION 7 - ERECTION

• selection of lifting gear
• personal protective equipment for the rigging crew
• emergency procedures.

Erection of precast elements might involve single or multiple cranes, including a combination of cranes of differing types. The feasibility of a particular lifting method will be determined by the method of delivery or access at the site.

Consideration should be given to how the use of specialised lifting equipment will affect crane capacity. This should take into account the mass of the equipment and/or stresses imposed by the configuration of the slings.

Dual crane lifts (refer to Figure 7.2) are the preferred method for lifting long heavy elements. The advantages of dual crane lifts are:

• greater control over the element
• the ability to independently position either end of the element
• the ease of working with lighter rigging gear.

Figure 7.2: Dual crane lift.
In some cases, dual crane lifts might not be practical due to:

- site limitations (crane positions)
- erecting elements over water or obstructions
- transporting elements to required lifting positions.

When a single crane is used for the erection of elements, an auxiliary crane might be required to assist in the safe handling of heavy rigging gear. Equalising triangles, compensating plates and different lengths of rigging gear might also be required.

Taglines fixed at each end of the element should be used to control its movement. In these cases, tagline movement should be monitored to avoid snagging on obstructions.

Elements should not be erected in windy conditions. The JSA should identify whether the element can be safely controlled by taglines. Large elements can generate high loads on taglines and this should not be underestimated.

Crane operation is permissible only up to the wind speed stated in the operator’s manual (corresponding to the boom length being used). The surface area and configuration of the element and rigging should be taken into account in calculating the effects of wind.

The erector should, prior to commencing operations, contact the local meteorological office for information on the expected wind speeds. If unacceptable wind speeds are expected during the time of the proposed lift, the element should not be lifted.

Track-mounted (crawler) cranes might be required to ‘walk’ elements into position. This is permitted only if:

- the crane is designed for this application and has a rated capacity chart to ‘walk’ with suspended loads
- the ground support is suitable for the crane’s track loadings. (Bog-mats might be required to achieve adequate ground support.)
- a geotechnical engineer or other professional engineer has checked and provided written verification of ground support conditions.
7.3.2 Crane capacity and operating radius

The required crane capacity is determined by several factors including:

- the distance from the crane’s centre of rotation to the element’s centre of gravity
- the length of the boom required to handle the element.

The capacity of a crane decreases as the distance of the load from the crane’s centre of rotation increases or as the boom length is increased.

The rated capacity or working load limit of a crane refers to its maximum load capacity at the minimum radius. This should not be confused with its actual capacity when lifting at working radius.

Elements are usually lifted at extended radii and this will determine the required crane capacity. Crane charts should be referred to for the correct selection and configuration of cranes.

Where two cranes are to be used to ‘dual lift’ elements, the required crane capacities should be carefully assessed. Where one end of the element is heavier than the other, particular consideration should be given to each crane’s capacity.

Prior to lifting, the lifting capacity of cast-in lifting inserts or lugs should also be checked against the anticipated loading.

7.4 OPERATING NEAR OVERHEAD POWERLINES

7.4.1 General

When working near overhead powerlines, the procedures and requirements set out in the Office of the Chief Electrical Inspector’s following publications should be followed:

- Rules for Operating Near Powerlines for Cranes, Concrete Placing Booms and Excavating Equipment (refer to Figure 7.3).
- Rules for Operating Elevating Work Platforms Near Overhead Powerlines.
- Rules for Erecting Scaffolding Near Overhead Powerlines.

Similar issues arise when cranes are required to operate within six metres of rail overhead wiring. In this case, a separate overhead access permit is required from the relevant rail authority.
Where a rail authority or an electricity distribution authority’s access permit is required, it should be made available to the supervising rigger and the crane operator prior to the operation.

### 7.4.2 Operational Requirements

Where it is necessary to operate the crane within the specified clearance zone, a dedicated and qualified spotter should be used throughout these phases of the erection. **Approval from the relevant Power Authority is still required**, and safe working procedures should be developed in consultation with all participants. Note that this type of work can be extremely dangerous, and is a common cause of erection incidents.

![Figure 7.3: Clearance of cranes from overhead powerlines.](image-url)
Where working within the specified clearance zone, the erector should implement the following measures:

- Slow down the normal operating cycle of the crane to increase the available reaction time for assessing distances.
- Keep persons not authorised by the erector away from the area.
- Clearly instruct all ground staff to stand clear of the crane and load at all times.
- Install warning notices in a prominent position in the crane cabin to alert operators to check for the presence of powerlines. Typical wording should be ‘DANGER - WATCH OUT FOR OVERHEAD POWERLINES’.
- Use dry taglines (tail ropes) made of natural fibre such as hemp, sisal or other non-conductive material to control the load. Due to their conductive properties, synthetic ropes should not be used. The tagline should be prevented from approaching or being blown into contact with any powerline.
- Provide mobile cranes with an earthing chain with links of at least 10mm in diameter. The chain should be bolted or welded to the carrier chassis and be of sufficient length to allow at least one metre of chain to be in contact with the ground when the crane is set up on outriggers. It is important to note that the earthing chain should not be used when the crane is set up with the carrier within six metres of the rails of an electric train system.
- When operating or travelling in an unfamiliar area, the crane operator should check for the presence of overhead powerlines.

In the event that the crane does contact live powerlines, the crane operator should:

- remain inside the cabin
- warn all other personnel to keep away from the crane and not to touch any part of the crane, rope or load
- try, unaided, and without anyone approaching the machine, to move the crane until clear of the powerline
- if the machine cannot be moved away, remain inside the cabin, notify the electricity distribution authority at once, take no
action until the distribution authority has confirmed that the conditions are safe.

- If it is essential to leave the cabin because of fire or other life-threatening emergency, jump clear as far away from the crane as possible. **Do not touch the crane and the ground at the same time.**

- When moving away from the crane, shuffle or hop slowly across the affected area. Large steps should be avoided, as one foot could be in a higher voltage area and the other in a lower voltage area. Under some circumstances the voltage difference between the two areas could kill.

- Inform the electricity distribution authority of the situation immediately. Until assistance arrives, someone should remain near the crane, but at a safe distance, to warn others of the danger of approaching the crane.

Following any contact with live powerlines, a competent person shall inspect the crane before further use for possible damage caused by the contact. Any damaged components should be repaired or replaced prior to further use of the crane.

Wire rope should be replaced if it touches the powerline, as the arc will usually weld, melt or badly pit the rope.

Proximity warning devices, insulating boom guards and similar devices all have limitations and should not be relied upon to protect from electric shock.

### 7.5 ERECTION PREPARATION

Before erection commences, the principal contractor and erector should:

- confirm that the Risk Assessment and Work Method Statements are appropriate and have dealt with all aspects of the erection procedure
- inspect crane access to the site and the erection platform, and confirm that it is safe
- confirm the method to be used to ascertain the correct location of each beam
- check beams, spaces and supports to ensure that beams will fit
• obtain verification that the erection platform (existing structures, hardstand area, etc.) can safely carry the construction and erection loads

• make sure the immediate area for truck and crane access has been cleared to provide adequate room for crane outriggers, counterweight tail swing, boom swing, and underhook and overhead obstructions

• ensure all traffic management requirements are arranged and approved

• check plinth (pedestal) and bearing locations

• make sure that bearings and tapered packers are correctly located

• confirm that the means of support, including falsework, is adequate for the intended purpose and is correctly located, including levels and crossfall

• verify that the concrete in the element has attained the specified strength for lifting

• verify that the concrete support structure has obtained the specified strength

• determine if it is necessary to equalise loads on lifting points

• ensure that the appropriate rigging equipment is available and is certified

• check that the lifting inserts are in their correct location and that recesses are cleaned out in preparation for lifting

• verify dimensions in accordance with the design drawings.

Where backfilled excavations and trenches are identified, additional measures such as the provision of timber mats or crushed rock may be needed to ensure that any backfilling can support the construction and erection loads. These conditions should all be checked for bearing capacity by either a geotechnical or other professional engineer.

If an existing structure is used to support the crane, the design of the structure shall be checked for the crane loads. A suitable propping system may be required and, if so, it shall be designed in accordance with the appropriate Australian Standards.
If incorrectly located, faulty or missing lifting inserts are identified, immediate contact should be made with the design engineer to establish an appropriate solution.

Prior to any element being lifted, a trial run should be performed to ensure the crane radius is correct and there is sufficient tail swing clearance.

7.6 FALL PREVENTION

The Work Method Statement for the erection of the bridge beams should ensure that persons involved in the erection of, and subsequent work on, the bridge beams are at minimal risk of falling. Where possible, fall prevention should be provided by ‘passive’ control measures such as the provision of guardrails (refer to Figure 7.4), rather than relying on ‘active’ control measures such as the use of fall injury protection devices.

Where it is feasible to install guardrailing on only one side of the beam but not the other, controlling the risk of workers falling over the other edge of the beam may require the use of a series of anchorages, a safety line or static line for the attachment of protective devices worn by workers.

Figure 7.4: Access platform, fixed to the abutment, provides fall protection during the placement of beams.
Restraint systems that restrict the horizontal movement of the wearer so that they are prevented from falling are preferable to fall arrest systems that seek to arrest a person after they have fallen. AS/NZS 1891.4 provides further advice. It should be noted that anchorage capacities of safety lines for restraint systems are much less than those required for arrest systems.

Erection designers should, in the shop drawings, clearly indicate the location of the anchorages and the purposes for which they are suitable.

7.7 ERECTION CREW

The erector should nominate one person in the erection crew to be directly responsible for the direction and co-ordination of the erection sequence. This person must hold a rigging certificate of competency in either the Intermediate Rigging or Advanced Rigging certificate classes (class codes RI or RA).

The crane operator shall hold, or be under the direct supervision of the holder of a certificate of competency appropriate to the type of crane and, in the case of a slewing mobile crane, appropriate to the crane’s rated capacity.

The size and make-up of the remainder of the erection crew will vary depending upon the nature of the site and the particular circumstances. As a general rule, it should also include at least one additional rigger, holding at least the Basic Rigging certificate class (class code RB), and additional appropriately skilled persons as required.

At least one of the erection crew, preferably the rigger in charge of the crew, should have been trained in this Industry Standard.

At least one of the erection crew, or another person who remains on site throughout erection, should hold a current qualification as a Level 2 First Aider.

7.8 WORKER FATIGUE

Fatigue of individual workers can significantly increase the risk to workers undertaking construction activities. Response times, decision making ability, physical strength and dexterity are all compromised when a person is fatigued.
To recognise and minimise the possibility of fatigue affecting workers, the employer must consider workload and organisational factors that may lead to higher levels of worker fatigue.

Some of the factors to consider are:

- the time of day that work is to be performed
- elapsed time since workers last period of effective sleep (not just the opportunity to sleep)
- the degree of mental workload that is required – both high and low workload
- the level of physical workload
- facilities available for the workers to take in fluids to prevent dehydration, and food to restore energy
- the effect of recent illness and the lingering effect of outside work activities such as working a second job, alcohol consumption and sporting activities
- working and rest periods.

Where tasks demand sustained vigilance, consideration should be given to the length of working periods, so that the risk of accidents is not increased through fatigue of the operators.

The employer should also encourage workers to inform the employer of non-work related factors which might impact on their fatigue levels.

7.9 RIGGING

Setting up a rigging system requires careful and thorough pre-planning. The lifting configuration should be documented and should not be altered without the approval of the erection design engineer.

The method of connecting the rigging system to the element should be agreed to by the manufacturer, contractor and the erector.

The rigging system should distribute equal loads to all lifting points unless specifically designated otherwise in the shop drawings. To ensure equal distribution of loads when lifting precast elements with multi-legged slings, consideration should be given to the provision of load equalising gear as a part of the rigging system.
Where offset lifting arrangements are used, the increase in load applied to particular lifting inserts shall be taken into account when selecting the capacity of the lifting insert.

Sling lengths are critical where the rigging system includes the use of spreader beams or lifting beams with slings running through sheaves. The rigging system shall be designed to suit the spacing and layout of the lifting inserts.

Single, double and four-legged slings are commonly used in the handling of precast elements. In selecting the sling capacity, the increased force due to inclination of the sling and the change of direction at reeving points shall be considered. The included angle between sling legs should not exceed 90°.

Where it is necessary for an included angle to be more than 90°, the capacities of all components of the rigging system, including the crane hook, need to be verified.

In some cases, it is necessary to use sling assemblies that are not of equal length. In this situation, the load in each leg of the sling assembly will be different and all components need to be checked for capacity.

The rigging system should be arranged to allow the element to lie in or near its correct angle for erection into the structure. This can be accomplished through one or more of the following means:

- use of appropriate length lifting gear, including shackles and slings
- appropriate location of the lifting inserts
- use of a compensator plate
- configuration of beams on trucks.

General rigging practices not dealt with specifically in this Industry Standard should be consistent with the advice provided in A Guide to Rigging, jointly published by WorkCover New South Wales and the Victorian WorkCover Authority (WorkSafe).

### 7.10 PLACEMENT OF BEAMS

Under no circumstances should anyone position themselves underneath a beam during erection.
The masses of all elements should be verified prior to the commencement of erection. This information should be shown on the shop drawings, which are to be available to the erection crew. The manufacturer’s certificate of compliance should be available on-site for the erector.

During lifting and placing of beams (refer to Figure 7.5), the following rules should be observed:

- Whenever possible, beams should be lifted with the rigging equipment in view of the crane operator.
- Personnel should not be positioned where they could be trapped or crushed between the suspended beam and any other object.
- When taglines (tail ropes) are used to control the swing of the beam, personnel should position themselves clear of the beam.
- No attempt should be made to lift and erect beams in strong winds, where control of the beam may be lost. It is the responsibility of the rigger in charge, in consultation with the erection crew, to determine that conditions are suitable for erection to proceed.

Unless otherwise specified by the erection design engineer, the beam should be provided with temporary support to ensure stability.

Figure 7.5: Beam being placed onto the pier-falsework and abutment.
Where it is necessary to attach supports to the beam after it has been positioned, the beam must be held firmly and safely by the crane while the supports are attached. Unless otherwise specified on the shop drawings, a minimum of four braces should be connected before releasing the lifting equipment. Four braces may not be necessary where beams are provided with erection brackets or suitable connections to other beams, forming a stable ‘box’ structure. Under no circumstances should there be less than two connections providing support to each precast element.

No brace should be connected to another beam for support unless this has been clearly and specifically documented on the shop drawings.

**7.11 PLACEMENT OF STEEL BEAMS**

The following additional factors should be considered during the erection of steel beams:

- Where steel beams cantilever past a pier, a safe work platform will be needed if there is a bolted splice connection at the end of the beam.

- Changes of temperature may affect the length of a steel beam. This should be assessed to ensure correct fit during erection.

- Where beams are spliced or welded together on-site prior to erection, the designer should ensure that the lifting lugs used for erection are within capacity for the additional mass.

- Bracing may be required between beams during erection to prevent the beams twisting and distorting under their own weight.

- The lifting configuration should be taken into consideration at an early stage of planning. For example, a single crane lift may need different sized lifting lugs and positions compared with a dual crane lift.

**7.12 PLACEMENT OF OTHER ELEMENTS**

These additional factors apply to the erection of other elements such as parapets, bridge railings, crash barriers, etc.:
The mass of all elements should be verified prior to the start of erection. This information should be shown on the shop drawings, which are to be available to the erection crew.

The configuration of the rigging and lifting equipment should be determined in consultation with the erector.

A competent person should attach the lifting equipment to the precast elements and ensure that the immediate area is cleared in preparation for lifting.

Taglines (tail ropes) may be required in some circumstances.

The erection method should ensure that the elements are not suspended over any persons. A nominated spotter or lookout may be required.

The effect of wind should be taken into account in assessing the safe handling and erection of elements.

### 7.13 TEMPORARY FALSEWORK AND PROPPING

Falsework is any type of structural system required to support permanent elements, formwork, plant, equipment and personnel, and includes all associated foundations and structural members (refer to Figure 7.6.).

![Falsework supported directly on pier concrete footing.](image)
Falsework should:

- be erected in accordance with the specification and design drawings. It should be independently proof-checked prior to beam erection (refer Section 3.3 for details)
- have an allowance for uneven loading during beam erection and for incidental loadings, such as vibrations from passing vehicles, trains or other heavy equipment
- be regularly inspected for its ongoing structural adequacy.

The principal contractor must ensure that no section of falsework is removed without written instructions from the erection design engineer.

Where beams are post-tensioned after erection, the stressing process will change the shape of the element, thereby reducing the load on some props and increasing the load on others. This particularly applies where the stressing induces a camber into the beam, which can lift the beam off props at mid-span, transferring the entire load to the props at the ends. Similar effects might occur due to a temperature gradient over the depth of the beam.

Propping systems should allow for possible changes to the distribution of loads during the construction process. Props should be of certified capacity and correctly specified for the purpose intended.

### 7.14 MODIFICATIONS

Modifications to elements should be carried out only with the approval of the design engineer, and following certification by the proof engineer. Any such modifications should be recorded, and drawings should be revised and re-issued.

### 7.15 COMPLIANCE REQUIREMENTS

Prior to lifting any element, the erector should be provided with:

- the Manufacturer’s Certificate of Compliance
- the Work Method Statement
- the component schedule.
The component schedule should be provided by the manufacturer and should include:

- project name and address
- element designation
- element mass
- concrete strength required at the time of erection for the element and, where applicable, the bracing footing
- type, capacity and length of the lifting inserts.

The information required for the component schedule may be included as part of the shop drawings or layout drawings. The shop drawings may be used to form the component schedule.

### 7.16 CONTINGENCY PLAN

Part of the Work Method Statement should include a contingency plan and should take into account:

- staging, based on small parcels of work that can be stopped to make the workplace safe, if the allocated occupation time has expired
- extension of road and rail occupation, if unable to safely secure site
- notifying local authorities of delays
- inclement weather conditions
- standby equipment (e.g. lighting towers, cranes, etc.)
- storage area for elements still on transport
- emergency procedures, and contact details for specialists and emergency services personnel
- cranage to unload elements
- laydown area.
APPENDIX A – REFERENCED DOCUMENTS

REFERENCED DOCUMENTS

Victorian Health & Safety Legislation:
- Occupational Health and Safety Act 1985
- OHS (Certification of Plant Users and Operators) Regulations 1994
- OHS (Plant) Regulations 1995
- OHS (Incident Notification) Regulations 1997
- OHS (Manual Handling) Regulations 1999

WorkSafe Codes of Practice:
- Code of Practice for Building and Construction Workplaces
- Code of Practice for First Aid in the Workplace
- Code of Practice for Plant
- Code of Practice for Manual Handling

Other WorkSafe Publications:
- A Guide to Rigging
- Industry Standard for Precast and Tilt-up Concrete for Buildings
- Incident Notification – At a Glance
- Provision of Amenities on Mobile and Short Term Civil Construction Sites (Guidance Note)

Australian Standards:
- AS 1742.3, Manual of uniform traffic control devices, Part 3: Traffic control devices for works on roads
- AS 1418.1, Cranes, hoists and winches, Part 1: General requirements
- AS/NZS 1891.4, Industrial fall arrest systems and devices, Part 4: Selection, use and maintenance
- AS 2550, Cranes - Safe use
  - Part 1: General requirements
  - Part 5: Mobile and vehicle loading cranes
  - Part 7: Builders hoists
  - Part 10: Elevating work platforms
- AS 3600, Concrete structures
- AS 3610, Formwork for concrete
- AS 3850, Tilt-up concrete construction
- HB 77 Australian Bridge Design Code (set)
- HB 81 Parts 1 to 9 Field Guide for Traffic Control at Works on Roads

AustRoads Publications:
- Bridge Design Code (complete set)
- Guide to Bridge Construction Practice

Office of the Chief Electrical Inspector Publications:
- Rules for Operating Near Powerlines for Cranes, Concrete Placing Booms and Excavating Equipment
- Rules for Operating Elevating Work Platforms Near Overhead Powerlines
- Rules for Erecting Scaffolding Near Overhead Powerlines

VicRoads Publications:
- Standard Specification
- A Guide to Restraining Concrete Panels
- Worksite Traffic Management Code of Practice
- Bridge Technical Notes

Department of Transport, Federal Office of Road Safety:
- Load Restraint Guide

National Precast Concrete Association Australia and Concrete Institute of Australia:
- Precast Concrete Handbook

American Precast and Prestressed Concrete Institute:
- PCI Design Handbook
DEFINITIONS

General Definition:

Contractor: The company or person responsible for the construction of all or part of the project. The contractor will usually be responsible to the principal contractor.

Client: The owner of the project or the Government body, company or person responsible for developing the project.

Design Engineer: The engineer responsible for the engineering design of the project. The design engineer should be a person qualified for membership of the Institution of Engineers Australia, who is competent to practise in the structural engineering field. The design engineer will usually be responsible to the client.

Designer: The engineer responsible for the design of the section of the works in question.

Erector: The company or person responsible for erecting the precast elements. The erector might be responsible either to the principal contractor, contractor or manufacturer.

Erection Design Engineer: The engineer or engineers responsible for the design of:
• the temporary works associated with the construction of the project
• the method and documentation required for the erection of the precast elements.

The erection design engineer should be a person qualified for membership of the Institution of Engineers Australia, who is competent to practise in the structural engineering field.

The erection design engineer will usually be responsible to the principal contractor, contractor or the manufacturer. The erection design engineer might also be the design engineer.

Manufacturer: The company or person responsible for manufacturing the precast concrete elements. The manufacturer will usually be sub-contracting to (and be responsible to) the principal contractor or contractor.

The manufacturer might sometimes be referred to as the precaster.

Principal Contractor: The company or person in charge of, and responsible for, the construction of the complete project and who has control of the construction site. The principal contractor will be responsible to the client, but might also be the client.

Proof Engineer: The engineer responsible for checking and certification of the design and documentation produced by the design engineer and/or the erection design engineer.

The proof engineer should be a person qualified for membership of the Institution of Engineers Australia, who is competent to practise in the structural engineering field.

The proof engineer will usually be responsible to the client, principal contractor or contractor.

The proof engineer must be independent from the designer whose work is being proof-checked.

Shop Detailer: The person responsible for preparing the shop drawings of the elements. The shop detailer might also be the manufacturer (or a company or person) responsible to the manufacturer.

The shop detailer should be a person who, through training or experience, is qualified to undertake the work as described in this document.
**Transporter** The company or person responsible for transportation of the element. The transporter might also be the manufacturer (or a company or person) responsible either to the principal contractor, contractor, manufacturer or erector.

**Window (as in 'construction activity window')** The timeframe in which construction activity can occur on or over roadways or railways.

**Technical Definitions:**

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brace</td>
<td>A temporary element providing stability to prevent a precast concrete element overturning. Both ends may be fitted with a pinned foot, allowing a degree of freedom for variable fixing angles. They are intended to resist horizontal construction and wind loads.</td>
</tr>
<tr>
<td>Bracing Insert</td>
<td>A component or system cast into, or fixed to, the element or into an element supporting member, for later attachment of a temporary brace.</td>
</tr>
<tr>
<td>Connections</td>
<td>A method by which one or more elements are joined together. (The purpose of connections is to transfer load and/or provide stability.)</td>
</tr>
<tr>
<td>Design Drawings</td>
<td>Drawings prepared by the design engineer showing the overall project and assembled elements and details that reflect the design requirements. They form the basis for preparation of the shop drawings.</td>
</tr>
<tr>
<td>Design Factor</td>
<td>The number by which the failure load is divided to give the working load limit. This was previously known as the safety factor.</td>
</tr>
<tr>
<td>Erection Platform</td>
<td>The base on which the crane is supported during erection of the elements.</td>
</tr>
<tr>
<td>Fixing Insert</td>
<td>A component or system cast into, or fixed to, the element and used to tie the element into the structure, or support other structural members.</td>
</tr>
<tr>
<td>Fixings</td>
<td>The hardware component of connections. Fixings provide for load transfer between the members being connected.</td>
</tr>
<tr>
<td>Joint</td>
<td>The gap between adjoining elements or between an element and some other portion of the structure. Joints might be horizontal, vertical or inclined.</td>
</tr>
<tr>
<td>Levelling Shim[s]</td>
<td>A single or series of thin strips of appropriate material used under elements to support the element in its correct position until the final connection is made.</td>
</tr>
<tr>
<td>Lifting Beam</td>
<td>A device within the rigging system that spreads the load evenly for a given lift.</td>
</tr>
<tr>
<td>Lifting Clutch</td>
<td>A quick-release device used to connect the crane rigging to the lifting insert.</td>
</tr>
<tr>
<td>Lifting Insert</td>
<td>A component or system cast into, or fixed to, the element for lifting the element during erection.</td>
</tr>
<tr>
<td>Precast Concrete Element</td>
<td>A concrete element manufactured under controlled conditions in a factory or casting yard and subsequently transported and erected on a construction site. The casting yard might or might not be on-site.</td>
</tr>
<tr>
<td>Proprietary Components</td>
<td>Components manufactured in a factory environment and carrying a trademark or registered name.</td>
</tr>
<tr>
<td>Props</td>
<td>Temporary elements supporting loads, which produce compression forces. Both ends of the prop are fitted with rigid foot plates that provide support between two parallel surfaces.</td>
</tr>
</tbody>
</table>
**APPENDIX B – DEFINITIONS**

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
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</thead>
<tbody>
<tr>
<td>Rated Capacity</td>
<td>The maximum gross load that may be applied to the crane or hoist of the lifting attachment while in a particular working configuration and under a particular condition of use.</td>
</tr>
<tr>
<td>Reinforcement:</td>
<td></td>
</tr>
<tr>
<td>Structural Reinforcement</td>
<td>Reinforcement, including reinforcing steel and pre-stressing tendons provided for crack control or to resist forces caused by applied loads and thermal/shrinkage movements.</td>
</tr>
<tr>
<td>Additional Reinforcement</td>
<td>Reinforcement additional to the structural reinforcement, provided to resist forces caused by transport or erection loads.</td>
</tr>
<tr>
<td>Component Reinforcement</td>
<td>Reinforcement placed in conjunction with lifting, bracing and fixing inserts so that they can attain their design capacities. Note: Component reinforcement is normally specified by the insert supplier and might not always be shown on the shop drawings.</td>
</tr>
<tr>
<td>Rigging System</td>
<td>A mechanism that might include a series of slings, pulleys, lifting or spreader beams or other mechanical devices to connect the crane to the element being lifted.</td>
</tr>
<tr>
<td>Re-usable Lifting Equipment</td>
<td>The lifting device which is directly connected to the lifting insert, e.g. lifting clutch, bolt-on bracket.</td>
</tr>
<tr>
<td>Shop Drawing</td>
<td>Detailed drawing of an element used in the manufacturing process. Note: The preparation of separate shop drawings might not be required where all necessary details are included on design drawings.</td>
</tr>
<tr>
<td>Strongback</td>
<td>A temporary member fixed to an element to provide localised strengthening of the element during lifting, transport or erection.</td>
</tr>
<tr>
<td>Tag Line [Tail Rope]</td>
<td>A rope attached to the element being erected to help control the element during placement.</td>
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MANUFACTURER’S CERTIFICATE OF COMPLIANCE

PRECAST CONCRETE BRIDGE BEAMS
Manufacturer:
Project name:
Client name:
Beam type: Beam No:
Beam mass: tonnes Cast date:
Concrete strength at delivery: MPa Lifter type:
Delivery address:

Delivery date: Contact name:
Load No: Orientation on truck:
Special instructions:

QA SIGN-OFF
This is to certify that the above precast concrete beam has been manufactured in accordance with the approved design drawings and/or client approved variations.

Name:

Signature:
Position:
Date:
Foundations for Safety is Victoria’s primary forum for dealing with occupational health and safety issues in the construction industry. Foundations for Safety has brought together State Government regulatory agencies, accident research expertise, construction worker unions and employer associations representing principle contractors and specialist trade sub-contractors.

It meets in full session every three months and establishes working parties to progress various health and safety initiatives.

At the time of printing, the organisations represented on Foundations for Safety are:

- Air Conditioning and Mechanical Contractors Association
- Australian Industry Group
- Australian Manufacturing Workers’ Union
- Australian Master Bricklayers Association
- Australian Workers’ Union
- Building Commission Victoria
- CEPU Electrical Trades Union
- CEPU Plumbing Division
- CFMEU Construction and General Division
- CFMEU FEDFA Division
- Civil Contractors Federation
- Finishing Trades Association of Australia
- Master Plumbers & Mechanical Services Association of Australia
- National Electrical and Communications Association
- National Federation of Bricklayers & Masonry Employers
- Office of the Chief Electrical Inspector
- Plumbing Industry Commission
- Royal Australian Institute of Architects
- Victorian Construction Safety Alliance
- Victorian Crane Association
- Victorian Employers Chamber of Commerce and Industry
- Victorian Trades Hall Council
- WorkSafe Victoria

You can help improve health and safety in the construction industry by providing your feedback on this Industry Standard or on other health and safety issues to any member organisation of Foundations for Safety.
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