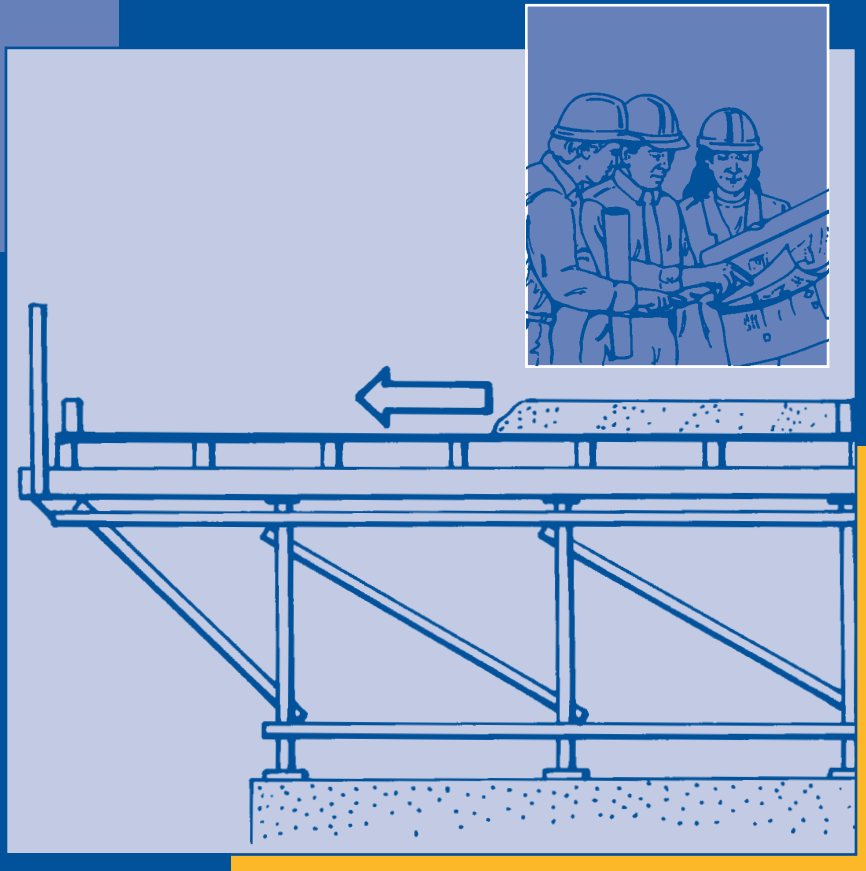
FORMWORK

ADVISORY STANDARD



QUEENSLAND GOVERNMENT

Department of
Employment, Training
and Industrial Relations

WORKPLACE HEALTH & SAFETY

Formwork Advisory Standard 2004

Workplace Health & Safety

Important information about this Standard

1. Was made 7 September 2004.

2. Commences on 10 September 2004.
3. Expires 5 years after its commencement.

What is this Standard about?

The *Formwork Advisory Standard 2004* states ways to plan, erect and strip formwork and place concrete on the formwork to manage exposure to the risk of injury from the collapse of formwork.

What is an advisory standard

An advisory standard is a document that states ways to manage exposure to a risk. If you have a workplace health and safety obligation, and there is an advisory standard about that risk, you can meet your obligation by adopting and following the advice in the standard. Alternatively, you may meet your obligation by choosing another way, providing it gives the same level of protection for the risk.

Workplace health and safety obligations and the Workplace Health and Safety Act 1995

The *Workplace Health and Safety Act 1995* imposes obligations on people at workplaces to ensure workplace health and safety. Workplace health and safety is ensured when persons are free from the risk of death, injury or illness created, by workplaces, workplace activities or specified high risk plant.

How can I meet my obligations?

Under the Act, there are three types of instruments made to help you meet your workplace health and safety obligations, regulations, advisory standards and industry codes of practice.

1. **If there is a regulation about a risk** – you must do what the regulation says.
2. **If there is an advisory standard or an industry code of practice about a risk** – you must either
    - do what the standard or code says; or
    - adopt another way that identifies and manages exposure to the risk and take reasonable precautions and exercise proper diligence about the risk;

If there is no regulation, advisory standard or industry code of practice about a risk - you must choose any appropriate way and take reasonable precautions and exercise proper diligence to ensure you meet the obligation.

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1. Introduction

DANGERS OF FORMWORK

The collapse of formwork in the building and construction industry has the potential for severe injury and can also result in death of a person.

This standard provides practical advice about ways to identify and manage the risk of a person being injured when formwork collapses.

WHAT IS FORMWORK?

Formwork is the surface, supports and framing used to define the shape of concrete until the concrete is self-supporting. This term includes the forms on which the concrete is poured, the supports to withstand the loads imposed by the forms and the concrete, the bracing which may be added to ensure stability, and the footings. The formwork structure is called the formwork assembly. Parts of the formwork assembly are also known as falsework. Examples of formwork include prefabricated systems such as slip form, table form and jump form.

USING CONTROL MEASURES

Control measures eliminate or reduce the potential for events such as the collapse of formwork. When implementing control measures for erecting and dismantling formwork so that it does not collapse, consideration should be given to:

(a) keeping the formwork documentation at the workplace;

(b) following the formwork documentation;

(c) erecting the formwork on foundations which will support the loads to be imposed on the formwork;

(d) not erecting formwork near excavations;

(e) ensuring materials used in the erection of formwork are not defective;

(f) securing loose material which may be dislodged as a result of inclement weather;

(g) inspecting the formwork assembly before and during the placement of concrete;

(h) not attaching equipment to the formwork assembly unless specifically designed for this purpose;

(i) not using a stripping process, which may cause damage to the permanent structure or the formwork.

2. Construction Workplace Plans

PLANNING FORMWORK ACTIVITIES

Planning for erecting and dismantling formwork is important. A construction workplace plan is one of the tools used to manage erecting and dismantling formwork.

WORKPLACE HEALTH AND SAFETY PLANS

Part 8 of the *Workplace Health and Safety Regulation 1997* describes the requirements for preparing a construction workplace plan. The required contents of a construction workplace plan are listed in Section 56 of the regulation.

A principal contractor for a construction workplace must ensure a construction workplace plan for the workplace is prepared before construction work starts at the workplace.

The construction workplace plan must be -

(a) written in a way so that it can be understood by the persons doing the construction work; and
(b) signed and sated by the principal contractor

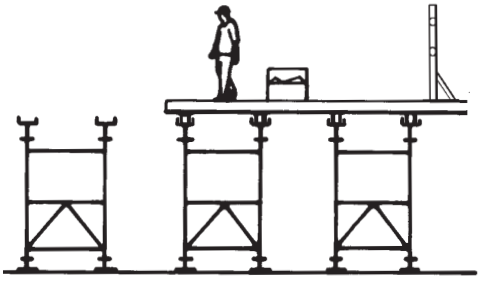
3. Control measures

CONTROL MEASURES ESSENTIAL

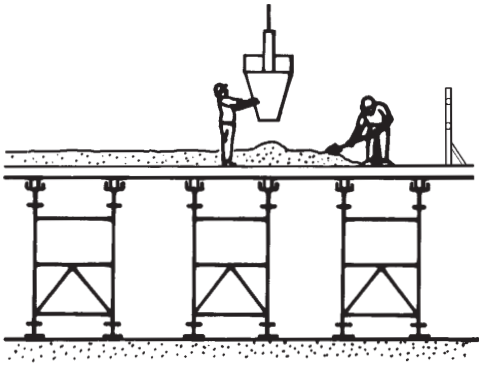
Formwork operations should not start unless control measures are in place.

Control measures to prevent the risk of injury resulting from formwork collapse can be organised under four areas according to the stage of formwork operations. A checklist for each stage of the formwork operation is included in Appendix 1.

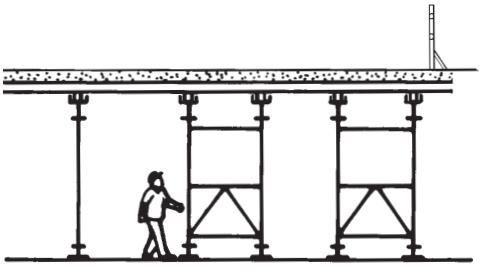
Planning



Erection of formwork



Placement of concrete



Stripping of formwork

PLANNING

(a) Erection, adjustment of formwork, placement of concrete and dismantling of formwork should be carried out according to the formwork documentation. Formwork documentation includes all drawings, specifications, brochures and associated documents that describe the formwork assembly to be erected. The details about what should be included in project and formwork documentation is shown in Appendix 2.

(b) The formwork documentation should be available for inspection at the workplace by anybody involved in the formwork process and should be presented in a way that is easily understood by persons erecting the formwork assembly.

(c) The erection of the formwork should not be altered from the formwork documentation unless the formwork designer has been consulted and has approved the changes and an amended formwork documentation has been prepared.

(d) Formwork should be designed by a qualified person in accordance with *AS 3610 - Formwork for Concrete.* An example of a qualified person is a person who holds a Degree in Engineering or a person who has successfully completed the formwork design component of an Associate Diploma Applied Science (Building) or a Degree in Building or equivalent.

(e) Formwork should be erected and dismantled by persons who have received training in the particular system of formwork being used.

(f) If a crane or hoist is required to lift formwork materials, operators of this plant must be certified to work in a prescribed occupation.

(g) Any person in the area where formwork operations are being carried out should wear suitable personal protective equipment, such as safety footwear, industrial safety helmets, and hearing protection.

(h) Lighting should be provided where natural light is insufficient to allow work to proceed safely. When relying on artificial lighting, multiple light sources should be used to prevent glare or shadow problems.

(i) Control measures should be put in place to prevent mobile plant and vehicles from coming in contact with the erected formwork by using measures such as barricades, signs, posts and buffer rails, concrete or timber kerbs.

(j) The project should be planned so as to avoid the necessity of excavating service trenches under, through or adjacent to any formwork system.

ERECTION OF FORMWORK

(a) Formwork should be assembled in accordance with *AS 3610 - Formwork for Concrete* and the formwork documentation.

(b) Any defects to formwork components and materials such as joist, bearers, plywood, support frames, and jacks should be reported to the formwork contractor.

(c) Precautions should be taken to prevent dislodgment of any part of formwork (eg sole boards) due to water causeway or run off that could affect ground conditions.

(d) All loose material that can be dislodged by wind, storms etc should be made secure before leaving the work area.

(e) The area where formwork is to be erected should be free of any obstructions. Ground conditions should be checked and made stable (eg. checking of previously filled trenches).

PLACEMENT OF CONCRETE

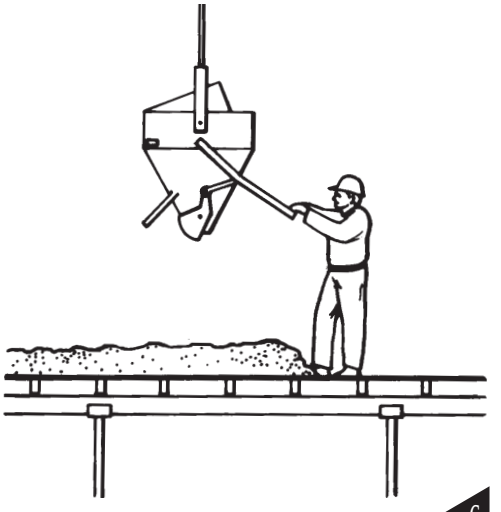
(a) An inspection should be carried out prior to the placement of concrete to ensure the formwork assembly complies with the formwork documentation.

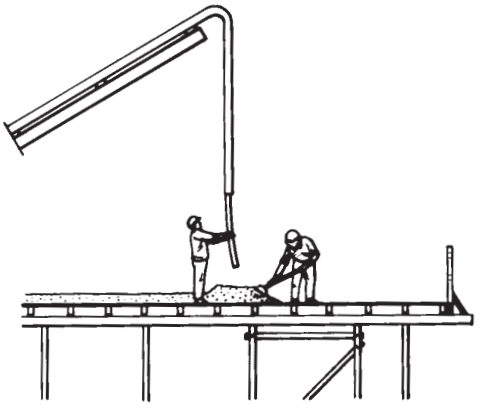
(b) There should be continuous supervision of the formwork assembly by a spotter. Examples of where spotters could be placed include:

- at the bottom of wall forms;
- in the vicinity below a deck being poured; or
- on walls forms (eg lift and stair shafts, dams, silos).

(c) A system of communication should be put in place between the formwork supervising personnel and the concrete placing crews in case an emergency should arise.

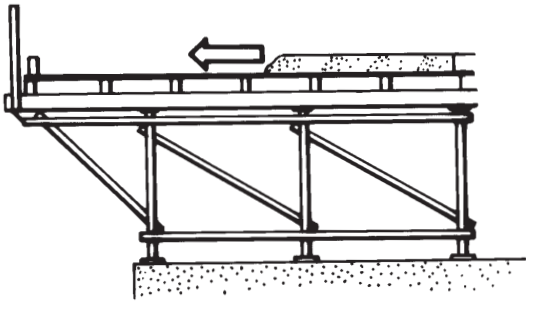
(d) Only persons who have received training in this work should do placement of concrete. This is to ensure uniform placement of concrete and overloading does not occur.





(e) The placement of concrete should be on the inboard part of any formwork before proceeding to a cantilever section to maintain stability of the forms.

(f) Hoisting, pumping and other equipment should not be attached to the formwork assembly unless specifically designed for the purpose.



STRIPPING OF FORMWORK

(a) Persons who have received training in the work being done should carry out stripping of formwork, in accordance with *AS 3610 - Formwork for Concrete.*

(b) Stripping of formwork should comply with the formwork documentation and be carried out in a manner that ensures the gradual transfer of the load from the formwork or the supports to the permanent structure.

(c) Drop stripping should not be carried out as it may result in injury to persons in the formwork area and damage to the permanent structure or the formwork.

(d) Any back propping used should be checked after post-tensioning has been carried out. This is because post-tensioning may loosen props and also cause them to be overloaded.

4. Risk management process

WHAT IS RISK MANAGEMENT?

Risk management is the process of **finding out** what can cause an injury (formwork collapse) **deciding** what could happen as a result (injury to persons at or near a workplace), and **doing something about it.**

The steps of risk management are:

(a) identify the hazards to workplace health and safety arising from formwork activities;

(b) assess the risks;

(c) determine and implement control measures to eliminate or reduce the risks; and

(d) monitor and review the effectiveness of the control measures.

HAZARD IDENTIFICATION

Prior to commencing work, all hazards related to the collapse of formwork should be identified. There are a number of ways to identify potential sources of injury. The selection of the appropriate procedure(s) will depend on the type of work processes and hazards involved. Methods of identifying hazards include:

- **Consultation with worker/s** is one of the easiest and most effective means of identifying hazards. Workers are usually aware of what can go wrong and why, based on their experience with a job.
- **Specialist practitioners and representatives** of industry associations, unions and government bodies may be of assistance in gathering health and safety information relevant to formwork collapse.
- **Workplace injury and incident records** should be used to identify hazards.

Examples of construction activities and situations which may contribute to the risk of injury from formwork collapse include:

(a) building formwork on inadequate foundations;

(b) failure to install or failure to correctly install formwork components;

(c) using defective formwork components;

(d) inadequate bracing and ties;

(e) mobile plant and vehicles coming in contact with formwork;

(f) overloading of formwork;

(g) poor on-site training and supervision;

(h) unsafe work practices (eg drop stripping); and

(i) incorrect or too rapid placement of concrete.

RISK ASSESSMENT

Risk assessment allows appropriate control measures to be developed. Once hazards have been identified, they should be assessed in terms of their potential to do harm. To assess risk, consideration should be given to:

(a) **probability** (the likelihood that harm will occur); and

(b) **consequence** (how severe the injury could be).

Various techniques can be used to carry out a risk assessment. The Risk Assessment Calculator is an example of one technique, which can be used to assess risk. Additional information on how to use the Risk Assessment Calculator is included in Appendix 3.

Factors to consider when assessing the probability and consequence of the risk include:

(a) method of erecting and dismantling the formwork;

(b) competency of employees;

(c) weather conditions;

(d) materials to be manually handled;

(e) materials to be mechanically handled;

(f) specific site instructions to employees;

(g) extent of supervision available;

(h) loading of the formwork deck with other than formwork materials;

(i) number of people who may be exposed;

(j) type of work to be carried out;

(k) work practices in use;

(l) scheduling of work; and

(m) type of plant, machinery and equipment to be used.

RISK CONTROL

Risk control is the process of eliminating or reducing the risk factors. Control measures should be chosen and implemented to eliminate or reduce the risks as far as possible. When deciding on the most appropriate measures to use, practicability and acceptance of the control measures should be considered.

The following control measures are listed in order of the most effective way of managing the risk of injury from formwork collapse:

(a) **Eliminate the hazard** for example discontinue the activity or not use the plant

(b) **Minimise the risk,** for example by:

- substituting the system of work or plant
- modifying the system of work or plant
- isolating the hazard
- introducing engineering control

(c) **Provide 'back-up' controls,** for example by:

- adopting administrative controls and safe work practices
- using personal protective equipment

MONITOR AND REVIEW CONTROL MEASURES

The risk identification, assessment and control process requires regular monitoring to ensure the implemented control measures perform as originally intended and continue to prevent or adequately control the risk of injury from formwork collapse. Control measures should also be checked carefully to ensure that they do not create new hazards, directly or indirectly. A written record, which details when control measures were reviewed, should be kept.

Do the following:

(a) When the work situation changes from what you had planned, repeat the risk assessment for that part of the work which has changed, ie. go back to and reassess the risk.

(b) Tell the workers about how the work should be done to effectively manage the risk.

(c) Consider the potential for fatal or serious injury and where this potential exists, control these risks as a priority.

Control measures should also be checked carefully to ensure that they do not create new hazards, directly or indirectly. A written record, which details when control measures were reviewed, should be kept.

CASE STUDY

Formwork for beams and suspended floors is erected on compacted sloping ground. Rain is predicted prior to the pouring of the concrete.

Hazard Identification (Case Study)

The hazard arises from unstable foundations as a result of washouts at the location of the sole plates.

Risk Assessment (Case Study)

The Risk Assessment Calculator has been used to assess the risk. Consideration was given to the following factors:

(a) It is **very likely** that formwork collapse will result from rainwater running down the sloped ground and destabilising the sole plates.

(b) The **possible consequence** from collapse of formwork may be a serious injury if a worker falls from the formwork or is struck by formwork components.

The Risk Assessment Calculator indicates that this hazard should be given a high priority.

Further information on how to use the Risk Assessment Calculator is shown in Appendix 3.

Risk Controls (Case Study)

The control measure to be implemented is digging shallow drains on the upper slope to divert any likely watercourse.

Appendix 1: Formwork Assembly Checklist

PLANNING

- When planning formwork assembly, ask the following questions:
  - (a) Is the formwork documentation provided in an easily understood format?
  - (b) Has the formwork designer approved the changes and has the formwork documentation been amended?
  - (c) Have workers received proper instruction and training in work methods?
  - (d) Are plant operators certificated to work in a prescribed occupation?
  - (e) Are workers correctly attired/dressed?
  - (f) Is lighting of the work area adequate?
  - (g) Has external protection been considered (ie. screens/scaffolding)?
  - (h) Have measures been taken to prevent mobile plant from hitting formwork?

ERECTION

- Is the formwork assembly free from defects? If so consider:
  - (a) excessive wear to materials;
  - (b) defects in timber (excessive knots, cracks, grain defects, saw cuts);
  - (c) deformed, bent or dented equipment, square cuts to props, cracked welds;
  - (d) identifying and regrading of timbers.
- Have any defects in the formwork assembly been reported to the formwork contractor?
- Is the area free of obstructions?
- Have ground conditions been checked?

- Is the formwork assembly erected in accordance with formwork documentation? If so consider:
  - (a) formwork components consistent with specifications;
  - (b) adequate foundations;
  - (c) spacing of formwork components such as frames, bearers, joists, props, ties, braces etc;
  - (d) correct assembly of frames;
  - (e) frames should be plumb unless otherwise indicated;
  - (f) ensuring frames are sitting in the base jack and 'U' head nut recess;
  - (g) diagonal braces are installed to frames;
  - (h) plan bracing;
  - (i) tying of frames when greater than 2 frames in height;
  - (j) using base jacks or base plates;
  - (k) provision of sole plates;
  - (l) ensuring base plates have full bearing on sole plate/foundation;
  - (m) inclined or unbraced props are securely tied (eg to a secured and stable structure);
  - (n) props are not joined prop-on-prop;
  - (o) bearers are positioned over centre of 'U' heads;
  - (p) using wedges for sloping surfaces;
  - (q) edges of ply are supported;
  - (r) correct pins used in props and frames;
  - (s) check formwork assembly has been levelled and is within tolerances specified in the formwork documentation; and
  - (t) the need for anchor points at the base of the formwork assembly.
- Have precautions been taken against water erosion, eg. the installation of drains or trenches?
- Have precautions been taken to prevent dislodgment of formwork assembly in high winds?

PLACEMENT OF CONCRETE

(a) Has the formwork been inspected prior to placement of concrete? In particular, are fittings tight and unlikely to become loose when concrete is vibrated?

(b) Have spotters been positioned?

(c) Is there a system of communication in place?

(d) Are workers trained in the placement of concrete?

(e) Are all workers aware of maximum pour rates (especially vertical pour rates)?

STRIPPING

- Have workers been trained in formwork stripping?
- Are stripping procedures in place? If so consider:

(a) are barricades/warning signs erected to create an exclusion zone;

(b) the minimum stripping times to be observed;

(c) is stripping carried out in a systematic manner;

(d) housekeeping (removal of nails from timber, rubbish removal etc);

(e) stacking of stripped formwork assembly prior to relocation;

(f) is reshoring/backpropping installed as per formwork documentation. Input must be provided by the engineer to the formwork designer; and

(g) has back-propping been checked after post-tensioning?

Appendix 2: Formwork documentation and project documentation

THE FOLLOWING INFORMATION SHOULD BE PROVIDED IN THE FORMWORK DOCUMENTATION:

(a) plans, elevations and sections to show the general arrangement of the formwork and to identify and locate all members and components including bracing;

(b) details sufficient to fully describe important or unusual features of the design;

(c) reference to documentation for proprietary items;

(d) the areas of the forms designed to carry stacked loads;

(e) requirements of the project documentation relating to formwork;

(f) method of provision for field adjustment of the forms prior to and during concrete placement;

(g) where required, location of weep holes, vibrator holes, clean-out holes and inspection openings;

(h) sequence of concrete placement and minimum elapsed time between adjacent placements;

(i) wrecking strips and other details relating to stripping of the forms;

(j) design assumptions including those related to strength, stability and stiffness;

(k) footing design assumptions such as foundation material description, safe bearing value, limitations on settlement during erection of formwork, placement of concrete and dismantling of formwork. Reference to information sources such as geotechnical reports should also be included;

(l) preparation of the foundation, such as filling, compaction and drainage;

(m) footing details, such as type and size of footings, level of soffit, concrete strength, reinforcement, specification and details of site filling or compaction, and precautions against washouts;

(n) engineer certification of non-proprietary equipment; and

(o) vertical pour rates.

THE FOLLOWING INFORMATION SHOULD BE PROVIDED IN THE PROJECT DOCUMENTATION:

(a) minimum stripping times and stripping procedures;

(b) any limitations on the magnitude and location of stacked materials and minimum strength of concrete to be achieved prior to materials being stacked;

(c) requirements for the minimum number of levels of supports relative to the type of formwork, timing and sequence of its use, the anticipated time between construction of subsequent floors and the expected ambient temperature for multistorey structures;

(d) limitations on the use of the permanent structure for the restraint of formwork;

(e) details of and information on the effect of post-tensioning procedures on the formwork and any special procedures to be adopted in the stripping of formwork;

(f) location of any mandatory joints and any special procedures for locating other joints;

(g) sequence of placement of concrete;

(h) requirements for propping of any composite construction;

(i) details of the cambering of any slabs or beams;

(j) design loads for the permanent structure;

(k) details of any inserts, waterstops, specially formed shapes or penetrations to be constructed, the location and details of which are critical to the serviceability of the permanent structure;

(l) any known information about the foundation which is relevant to the design of the footings for the formwork assembly;

(m) information about any permanent formwork systems, together with any limitations on deflections and any special requirements for their erection and concreting;

(n) information on any architectural details to be cast into the structural concrete.

Appendix 3: Risk Assessment Calculator

HOW TO USE THE RISK ASSESSMENT CALCULATOR

The Risk Assessment Calculator is one technique, which can be used to undertake a risk assessment. The Risk Assessment Calculator is intended as a rapid guide to identify the level of risk.

To use the Risk Assessment Calculator:

(a) Select the appropriate point on the **probability** scale.

(b) Select the appropriate point on the **exposure** scale.

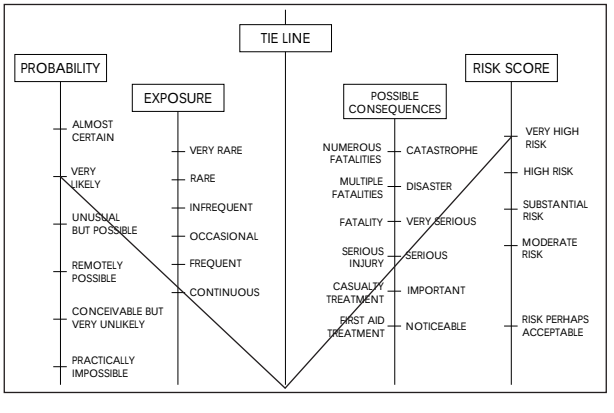
(c) Draw a line between the points chosen on the **probability** and **exposure** scales. Extend the line so that it intersects with the tie line.

(d) Select the appropriate point on the **possible consequences** scale.

(e) Draw a line from the point on the tie line to the point on the **possible consequences** line. Extend the line to the **risk score** scale.

The risk score obtained can then be used to make a judgement about whether the level of risk is acceptable or not. However, the risk score should only be used as a basis for reasoned judgement about a risk. It should be interpreted with caution, as it has certain limitations, for example, it is not possible to describe complex human behaviour by numerical means.

If the score falls between **very high risk** and **risk perhaps acceptable,** the risk should be reduced to the lowest level that is possible.



Appendix 4: Published Technical Standards

Australian Standards

AS 1170	Minimum design loads on structures (known as the SAA Loading Code)
AS/NZS 1576	Scaffolding
AS/NZS 1664	Aluminium structures
AS 1720	Timber structures
AS 2082	Visually stress-graded hardwood for structural purposes
AS/NZS 2269	Plywood-Structural
AS 2858	Timber-Softwood-Visually stress-graded for structural purposes
AS 3610	Formwork for Concrete
AS 4100	Steel structures
AS/NZS 4576	Guidelines for scaffolding