FORMWORK

LEARNING OUTCOME

Describe the requirements under the Work Health and Safety legislation for formwork.

ASSESSMENT CRITERIA

- Describe the statutory requirements relating to formwork.
- List the hazards that are associated with the processes of formwork.
- Describe the control measures that are available to eliminate or minimise the risk associated with these hazards.

REFERENCES

Work Health and Safety Act 2011 - Part 2 Health and Safety Duties

Work Health and Safety Regulations 2011
- Section 225, 306P and 306Q - Duties for scaffolding
- Section 306C and 306D – Risk of falls
- Schedule 3 – High Risk Work
- Section 315H – Falling objects in relation to dismantling formwork
- Section 315I – Perimeter containment screening as a control measure

Formwork Code of Practice 2016

Technical Standards
- AS/NZS 1576.1 – Scaffolding - General Requirements
- AS/NZS 4576 – Guidelines for scaffolding
- AS 3600 - Concrete Structures
- AS 3610.1 – Formwork for Concrete – specifications
- AS 6669 – Plywood – Formwork
- AS/NZS 2269 - Plywood - Structural

ATTACHMENT

Formwork Code of Practice 2016
Concrete Pumping Code of Practice 2005

FORMWORK

Formwork is a temporary structure that supports part or the whole of a permanent structure until it is self-supporting. Individual components of formwork, for example frames, are plant. Once assembled the components form the temporary structure. Some formwork systems are designed to remain with the permanent structure.

Generally work carried out to design, construct, erect, alter, maintain, dismantle or remove formwork will be defined as construction work.

Formwork means the surface used to contain and shape wet concrete until it is self-supporting. This includes the forms on or within which the concrete is poured and the frames and bracing which provide stability. Although commonly referred to as part of the formwork assembly, the joists, bearers, bracing, foundations and footings are technically referred to as falsework.

Hazards associated with work involving the erection, alteration and/or dismantling of formwork include:

- formwork collapse (before, during and after placement of concrete);
- falls from heights;
- slips, trips and falls
- falling objects
- noise
- dust, and
- hazardous manual tasks.

PLANT DESIGN REGISTRATION

Structural components, including formwork frames, specifically intended to support formwork do not require design registration. However, if traditional prefabricated scaffolding is used as part of the supporting structure, these components require design registration. The person with management or control of design registrable plant must ensure the design registration number is kept where it is readily accessible. If you are hiring prefabricated scaffolding, the supplier must provide the design registration number, usually on the supply docket or agreement.

DUTY HOLDERS

Persons conducting a business or undertaking (PCBU)

A PCBU has the primary duty to ensure, so far as is reasonably practicable, workers and other people are not exposed to health and safety risks arising from the business or undertaking.

This duty requires the person to manage risks by eliminating health and safety risks so far as is reasonably practicable, and if it is not reasonably practicable to eliminate the risks, by minimising those risks so far as is reasonably practicable. It also includes ensuring, so far as is reasonably practicable the:

- design, provision and maintenance of safe formwork plant and structures
- safe erection, alteration, dismantling and use of formwork, and
- safe use, handling, storage and transport of formwork plant.

Designers, manufacturers, suppliers and importers of plant or structures, including temporary structures, must ensure, so far as is reasonably practicable, the plant or structure is without risks to health and safety. This duty includes providing information to manufacturers so that plant or structures can be manufactured and erected to the design specifications. For designs that have unusual or atypical features but not for common designs where the risks are already known, designers must give the person who commissioned the design of the temporary structure a written safety report. For example, a design specifying an unusual structure for a specific application may introduce unique hazards requiring specific risk controls.

People installing, constructing or commissioning plant or structures must ensure, so far as is reasonably practicable, all workplace activity relating to the plant or structure including its installation, use, decommissioning or dismantling is without risks to health or safety.

Officers such as company directors, have a duty to exercise due diligence to ensure the business or undertaking complies with the WHS Act and Regulation. This includes taking reasonable steps to ensure the business or undertaking has and uses appropriate resources and processes to eliminate or minimise risks from the formwork activity.

Workers and other people at the workplace must take reasonable care for their own health and safety, co-operate with reasonable policies, procedures and instructions and not adversely affect other people's health and safety.

SAFE FORMWORK DESIGN AND CERTIFICATION

An 'engineer', such as a suitably qualified civil engineer experienced in structural design, is responsible for overseeing the safe design and certification of the complete formwork structure. This includes design of the formwork support structure, the formwork deck and connection details, and certification that the formwork drawings and other formwork documentation have been completed.

While this Code requires that overseeing the safe design and certification of formwork systems may only be performed by an engineer, it is recognised that some design work may be performed by appropriate personnel such as a 'competent person' experienced in formwork design and documentation. Design documentation may only be prepared by a competent person in the circumstances listed in Table 1 if the competent person is using brochures, charts, tables and information which has previously been verified for compliance with *AS3610 - Formwork for concrete* by a suitably qualified engineer.

Formwork design and certification	
Vertical formwork (Columns and walls)	
Less than 2.4 m high	Competent person
2.4 to 3.5 m high	Engineer
More than 3.5 m high (single arrangement)	Engineer
More than 3.5 m high (repetitive arrangement)	Engineer
Single-sided less than 2.4 m	Competent person
Single-sided more than 2.4 m	Engineer
Self-climbing or crane assisted formwork systems	Engineer
Soffit formwork	
Less than 3 m high and less than 250 mm thick	Competent person
More than 3 m high **or** more than 250 mm thick	Engineer
Infill slabs less than 4.5 m high, 20 m^2 and 300 mm thick	Competent person
Stair and landing formwork more than 3 m high **or** more than 200 mm thick	Engineer
Multistorey formwork and backpropping	Engineer

Table 1 Exceptions to the requirement to be an engineer for formwork design and certification

VERIFICATION OF THE STRUCTURE WITH THE DESIGN

Verification that the formwork structure complies with the design of the formwork system must be documented and provided. A construction check list can be used to assist in this process. Relying solely upon such a checklist will not be sufficient to verify compliance with relevant Australian Standards. The verification and documentation that a design has been complied with may be delegated to a 'competent person' on site. Table 2 provides a list of circumstances where a competent person may perform an inspection.

	Inspection	
	Access for trades	**Pre-pour**
Vertical formwork (columns and walls)		
Less than 2.4 m high	Competent person	Competent person
2.4 to 3.5 m high	Competent person	Competent person
More than 3.5 m high (single arrangement)	Competent person	Engineer
More than 3.5 m high (repetitive arrangement)	Initial pre-pour inspection by engineer on first arrangement only and then competent person thereafter	
Single-sided less than 2.4 m	Competent person	Competent person
Single-sided more than 2.4 m	Competent person	Engineer
Self-climbing or crane assisted formwork systems	Initial pre-pour inspection by engineer and then competent person thereafter	
Soffit formwork		
Less than 3m high and less than 250mm thick	Competent person	Competent person
More than 3m high **or** more than 250mm thick	Competent person	Engineer
Infill slabs more than 4.5m high, 20m^2 and 300mm thick	Competent person	Engineer
Stair and landing formwork more than 3m high **or** more than 200mm thick	Initial pre-pour inspection by engineer and then competent person thereafter	
Multistorey formwork and backpropping	Competent person	Engineer

Table 2 Circumstances where a competent person may perform an inspection

An effective quality control system must be implemented for the construction of formwork. A pre-pour inspection is a check to assist in ensuring the specifications of the engineer have been complied with. A pre-pour inspection should be a part of any quality control system. Sign-off by an engineer or competent person as specified in Table 2 is required following the final pre-pour inspection.

FALLS FROM HEIGHTS

PCBU's who intend to do construction work where the risk of falling is at least two metres must, before work starts, use control measures to prevent a person falling any distance or arrest a person's fall.

During formwork construction the structure is constantly changing. Hence, continual modification of fall protection measures is also necessary. One of the biggest challenges is to provide adequate fall protection on the leading edge of the formwork deck. Where there is only one leading edge (i.e. the other edges are provided with two metre high edge protection), the provision of fall protection on the leading edge is relatively straightforward. However, where there are multiple leading edges and/or the deck is not at one consistent level the provision of fall protection can be very difficult to implement.

Control measures to prevent or minimise the risk of falls from any height include:

- Design floor slabs that are one consistent thickness
- Provide fall protection on the leading edge of the formwork deck
- Where it may be impractical to provide edge protection on leading edges, provide perimeter edge protection on edges of the formwork deck
- Perimeter scaffolding or proprietary screen systems completed formwork decks
- Progressively lay formply for the formwork deck
- Securely cover all penetrations where a person or object could fall through

SLIPS, TRIPS AND FALLS

Formwork construction, because of its constantly changing work environment, restricted access through frames and formwork supports and a large volume of material and waste, requires ongoing monitoring of housekeeping practices to eliminate slips, trips and falls hazards.

Control measures to prevent or minimise injuries due to slips, trips and falls include:

- Ensure there is clear access for the safe movement of materials, equipment and persons on site.
- Materials stored or stacked in a location so as to minimise slip, trips and falls hazards.
- Rubbish storage and removal that can be moved as work progresses
- Sufficient access lighting and task lighting to allow workers to safely move around the workplace and perform their job.

FALLING OBJECTS

Falling objects are significant hazards, creating risks to workers and others during formwork erection, alteration and stripping, when slipping and jumping forms, and whenever loads are lifted over work areas.

The control measures that are implemented should firstly aim to prevent objects from falling, but equally prevent injury if an object has fallen. Small objects, such as bolts and concrete aggregate, falling from a height can cause serious injury.

Control measures to prevent or minimise the risk of falling objects include:

- Perimeter containment screens that extend above the formwork
- Good housekeeping practices – ensure items are cleaned up and kept away from edges, voids and penetrations

NOISE

The Work Health and Safety Regulation 2011 (WHS Regulation) describes what must be done to prevent the risk to a person from exposure to excessive noise at work.

Persons must be protected from the risk of noise induced hearing loss during their work.

Activities, such as the erection or dismantling of formwork, the clanging and banging of metal on metal, or the use of hammers, create impact noise which can damage hearing immediately. This type of noise is particularly damaging to hearing because of its high impulsive noise levels.

Other loud noise, such as that created when using a circular saw, will gradually damage a persons hearing after regular exposures.

For formwork activities, often the only way to protect against noise induced hearing loss is by wearing appropriate hearing protectors whenever noise is produced. The selection of hearing protection is appropriate when the wearer can hear what goes on in the immediate environment.

For most formwork activities a hearing protector with an SLC80 between 15 and 20, or a Class 2 or 3 rating, should be adequate, provided the hearing protector is worn correctly during noisy activities.

Where a risk assessment shows the use of hearing protectors is the preferred option to control the risk of exposure to excessive noise, the use of the hearing protectors must be enforced when persons in the immediate vicinity are exposed to noise during various formwork activities.

Refer to the Managing noise and preventing hearing loss at work Code of Practice 2011 for further information about managing noise exposure as a risk to workplace health and safety.

DUST

The WHS Regulation details requirements in relation to managing the workplace health and safety risk associated with hazardous substances.

The WHS Regulation describes a number of obligations that must be met about silica dust. While concrete itself is not a hazardous substance, high levels of silica dust can be produced during formwork processes.

A hazardous chemical is generated when power tools cut, grind, chip, scrape, crush or blast materials such as concrete. Silica dust may be created to a lesser degree, by sweeping, cleaning, dismantling building equipment and demolition.

Highly visible dust caused by earthmoving equipment on building sites or other earthworks sites is unlikely to contain hazardous levels of respirable silica dust. On the other hand, hazardous silica dust levels produced by other activities may be barely visible. Appropriate steps to minimise person’s exposure to silica dust must be taken.

Dust that is generated during formwork can be controlled by:

- using engineering controls such as dust extraction or a wet process; and
- providing respirators (as a last resort) where dust is likely to exceed permissible levels.

HAZARDOUS MANUAL TASKS

Hazardous Manual tasks means a task that requires a person to lift, lower, push, pull, carry or otherwise move, hold or restrain any person, animal or thing involving one or more of the following:

- repetitive or sustained force;
- high or sudden force;
- repetitive movement
- sustained or awkward posture
- exposure to vibration

Nearly all work done during the erection, altering and/or dismantling of formwork involves manual tasks (e.g. erecting formwork frames, handling sheets of ply, unloading vehicles or using hand tools such as hammers or saws).

The Hazardous Manual Tasks Code of Practice provides information about how to prevent or minimise exposure to risks that contribute to/or aggravate work related musculoskeletal disorders.

Control measures for manual tasks fall into two major categories – design and administrative controls.

DESIGN CONTROLS

Design controls make changes to the work area, tools or equipment or, the way a job is done and/or the provision of mechanical aids to reduce the effort required to do the job. Design controls are preferred as they are permanent and do not rely on worker behaviour.

Examples of design controls include:

Job design and redesign

- Use more modern formwork systems which incorporate newer technologies;
- Use alternative formwork techniques, such as, table forms or if using traditional formwork systems use materials such as shorter length bearers, joists and smaller sheets of ply which are easier to handle; and
- Store materials and equipment as close as practical to the work area and in a manner that facilitates ease of handling.

Provide mechanical aids

- Use mechanical aids such as cranes, hoists, pallet jacks and trolleys to move materials, tools and equipment around the site and when loading and unloading vehicles wherever possible.

Administrative controls

Administrative controls are achieved by modifying work practices, policies and procedures to reduce exposure to the risk of a musculoskeletal injury due to the performance of manual tasks. Administrative controls are less preferred as they only reduce exposure to the risk factors, they rely on ongoing supervision to ensure they are implemented, and they may be forgotten under stressful conditions (e.g. when trying to meet deadlines).

Examples of administrative controls include:

Work organisation

- Incorporate rest breaks or task variety into the job where the risk can not be prevented or minimised; and
- Ensure adequate numbers of persons to meet deadlines.

Task specific training

- Provide education and training in relation to the performance of manual tasks. This includes training in the correct use of mechanical devices, tools and equipment, as well as safe performance of the specific manual tasks and handling methods (e.g. team lifting). Team lifting is not a preferred method for load handling and should only be used as a last resort when mechanical aids cannot be used or the work cannot be redesigned. Persons must be trained in team lifting techniques and adequate numbers of workers must be provided.

Preventative maintenance program

- Clean and maintain tools, equipment and formwork components regularly.

When developing controls, it is critical to consider formwork as part of the overall construction process as each stage can have an impact on the level of musculoskeletal risk a person is exposed to. As such, controls should be implemented at all stages, from design and planning through to construction and all obligation holders, including manufacturers and suppliers, should consider the manual tasks risks.

STEEL FIXING

Steel fixing is the positioning and assembly of steel bars and mesh sheeting with ligatures to form reinforcement for concrete structures such as concrete slabs, columns, drainage and communication pits, walls and concrete barrier structures. It is the mould created prior to pouring the concrete.

STEEL POSITIONING

Steel must be placed correctly or the strength of a structure may be greatly weakened.

COVER

Cover is the distance from the outside face of the concrete to the nearest surface of reinforcing steel.

If this distance is insufficient, the steel will rust. As the steel changes to rust, the diameter of the actual steel decreases and the strength provided by the steel decreases. This can seriously shorten the life of a building or structure.

Furthermore, when steel rusts, it expands to 2.2 times its original volume. This expansion bursts the concrete open thus exposing the steel to attack by the weather which increases the corrosion.

The actual value depends on the concrete strength and on the location of the concrete such as below the ground or inside a building.

COATINGS

Bars may be coated with zinc or epoxy coatings to improve corrosion resistance. Galvanised steel may react with alkaline concrete and make the steel brittle. To counteract this effect, galvanised steel may be treated with **sodium dichromate**. Gloves must then be worn when handling the steel to prevent chromate induced illness.

Cover is also very important in maintaining the strength of reinforced concrete during a fire. Depending on the length of time the reinforced concrete must withstand the fire, the type of concrete, and the location of the concrete (floor, column etc.) the minimum cover varies from 20 to 70 mm.

The designers must allow for the effect of deformations on bars. If they increase the diameter of bars and if not allowed for, reinforcing steel often cannot be placed properly. Usually it is the cover that suffers

SPACERS

Spacers are used to maintain cover. They keep the steel the required distance away from the edge of the concrete.

FIXING

Fixing is fastening the steel reinforcing bars so that they stay in the correct place between the spacers and relative to each other.

The steel must stay in place:

- while workers walk on it,
- while concrete is being placed,
- and during compaction.

Tie-wire is used at the junctions of bars to hold them together and it must be tied tightly.

Free ends must not protrude into the cover space.

All pieces of tie-wire must be removed from the formwork before concreting otherwise rust-stains soon occur on the finished product.

CONCRETE PUMPING

A concrete pump is a machine used for transferring liquid concrete by pumping.
Boom pumps are used on most of the larger construction projects as they are capable of pumping at very high volumes and because of the labour saving nature of the placing boom. They are a revolutionary alternative to line-concrete pumps.

Concrete pumps are an effective and efficient means for moving and placing concrete. Concrete pumping is a process that is widely used to deliver pre mixed concrete and is also utilised in the manufacture of pre cast and tilt up panels, concrete formwork, slab construction, concrete paving and concrete spraying.

ASSOCIATED HAZARDS

- Unlicensed operators
- Setup
- Manual tasks
- Blockages
- Cleaning

CONTROL MEASURES

- Servicing
- Inspection and supervision

INSTALLATION OF SATELLITE CONCRETE PLACING BOOM

Rigging work includes the use of mechanical load-shifting equipment and associated gear to move, place or secure a load using plant, equipment or members of a structure to ensure the stability of those members. The licence class of basic rigging includes rigging work involving structural steel erection.

The initial placement or installation of the satellite concrete boom would require the installers to have a basic rigging (RB) licence if it involves rigging work as described above.

When undertaking the ‘jump up’ process, where the lift is done by hydraulic equipment, no licence would be required. However, the persons involved would need to be competent in the procedure.

If the ‘jump up’ involved the use of a crane where slings/chains are attached to any part of the structure, persons involved would require a RB licence.

For additional information refer to the *Concrete Pumping Code of Practice 2005.*

Version	Date	Author
1	30/06/2018	WHSQ