Workplace Health and Safety Queensland

Concrete Pumping Campaign 2009

Workplace Health and Safety Queensland
www.worksafe.qld.gov.au

Queensland Government

Purpose

To provide guidance on Workplace Health and Safety Queensland (WHSQ) enforcement issues for concrete pumping equipment in Queensland. This guidance is intended to be used by persons associated with the operation of this type of equipment. The document discusses a selection of issues relating to concrete pumping equipment and its safe operation, but is not intended to discuss all issues. The benchmarks listed are based on the *Concrete Pumping Code of Practice 2005* and Australian Standards AS1418.15 and AS 2550.15.

Boom issues

Six year inspection

Issue

Concrete placement booms are operated under onerous conditions and are subjected to cyclic loading from the pulsing motion of the concrete pump. Annual safety inspections will not include all high stress areas since some of these can only be found following strip down of the boom. The six year major safety inspection is considered to be an industry benchmark to help prevent collapse of concrete placement booms. Both the *Concrete Pumping Code of Practice 2005* and AS 2550.15 specify six year major inspections.

Control measures

All concrete placement booms are to receive a 6 year major safety inspection that is overseen and signed off by an engineer. The inspection is to be comprehensive and include a strip down of all high stress areas, including the boom, slew ring and outriggers. Hydraulic cylinders will require creep testing and will require strip down if they fail this test. The inspection should be overseen and signed off by a professional engineer. Non-destructive testing of pins and critical welds is to be carried out. A comprehensive report is to be prepared for each major inspection that details damage and worn components and work done on the boom. The report is to include a summary of all work done on the boom. A 6 yearly inspection certificate, signed by the engineer, should be kept with the concrete placement boom.
Note: the strip down requirement does not apply to line pumps (i.e. with no boom).

Reference: section 5.6 of the *Concrete Pumping Code of Practice 2005* and section 8.3 of AS 2550.15.

Annual inspection

Issue

Due to the type of plant, the way in which it operates and the high risk in the event of collapse, concrete placement booms require a high level of maintenance and safety checks. The annual safety inspection is an industry standard with high risk plant.

Control measures

All concrete placement booms are to receive an annual safety inspection carried out by a competent person. The inspection documentation will include an inspection checklist and an inspection certificate signed by the competent person. The checklist produced by the boom manufacturer should be used where it exists.

Reference: section 5.5 of the *Concrete Pumping Code of Practice 2005* and section 8.3 of AS 2550.15.

Structural damage, alterations and repairs

Issue

Concrete placement booms are subjected to high levels of cyclic loading and are relatively complex. If they are damaged the repairs need to be undertaken in a safe way with regard to principles of safe design and workmanship. If repairs are not carried out in this way boom failure will occur. Any alterations to the boom should be discouraged.

Control measures

Unless repairs are undertaken in accordance with the placement boom manufacturer's instructions, a professional engineer is to supervise the repair process and provide written certification for the repair or alteration. Where the design is altered, it is preferable for the manufacturer to specify the change in design. All repairs and alterations are to be certified by either an engineer or the boom manufacturer as complying with AS 1418.15.

Example 1: Localised repair to boom – professional engineer required

One section of the placement boom has received severe localised damage and requires either replacement of the steel plate in the damaged area or replacement of the complete boom section. Replacement boom sections are no longer available from the boom manufacturer. The decision is made to cut out and replace a section of the steel plate on the boom. This process also requires welding of the boom. No specific procedures exist from the boom manufacturer for this type of repair. A professional engineer is to be engaged to assess the damage and determine whether it is safe to repair. The engineer will also specify and supervise the repair procedure and provide written certification for the repair of the placement boom. Repairs, including welding procedures, are to undertaken by competent persons. The certification should be to relevant Australian Standards including AS 1418 and AS 2550. Testing of the unit prior to final certification and operation may be required by the professional engineer.

Example 2: Replacement of a section of the boom with a complete new section – professional engineer not required

One section of the boom has been damaged and the crane owner sends the complete mobile placement boom to the manufacturer's agent in Australia to have the boom repaired. The agent decides that the boom section is to be replaced with a brand new boom section supplied by the original boom manufacturer. The boom section is replaced with new pins and a competent person employed by the boom agent inspects the complete boom after repair and provides a certificate stating that the unit is safe to return to operation. The certificate is on the letterhead of the placement boom agent. In this case a professional engineer is not required.

Note: Wherever a failure or damage occurs to the boom during normal operation, and the design of the boom could be faulty, the manufacturer's agent and Workplace Health and Safety Queensland are to be notified regarding the incident. In the event of a potential fault with the design it will be necessary for the agent to notify other owners of booms with the same design.

Boom used as a crane

Issue
Concrete placement booms are designed to be used with a specific amount of pipeline and concrete. This load is applied to the boom approximately equally along its length. If additional loads are added to the boom, such as those when using the boom to lift freely suspended loads, catastrophic failure of the boom can occur or the design life of the boom can be reduced.

Control measures
Concrete placement booms are not to be used as a crane to lift any freely suspended load. Only pipeline and hoses specified by the manufacturer can be attached to the boom.

Pipeline issues

Pipeline damaged

Issue
Concrete pipelines operate at high pressures and the consequences of a ruptured line can cause serious injuries and fatalities. Concrete pumped at high pressure is very abrasive. When failures of pipe lines occur, parts of the pipe can become projectiles and the concrete will also be released at great pressure. Pipes can be damaged due to rough handling or if the boom inadvertently strikes an obstruction (e.g. boom slewed into a building). Damaged pipes are more likely to fail.

Control measures
Damaged concrete pumping pipe is to be replaced with undamaged pipe of the correct specification.

Identification of pressure piping

Issue
Concrete pipelines operate at high pressures and the consequences of a ruptured line can cause serious injuries and fatalities. The pipe material is to have a technical specification suitable for the characteristics of the concrete pump. A mild steel pipe will require a higher wall thickness to be able to withstand pressure in a concrete pump. Mild steel will also have greater wear rates. Harder steel is often used in concrete pumping pipe lines or twin wall pipe that has a harder inner section. While harder pipe can have lower wall thicknesses, care needs to be exercised because the pipe is more brittle. If the pipe is too brittle failure can be more sudden. For the reasons above it is important that the pipe specification complies with the instructions of the concrete pump manufacturer.

Control measures
Concrete pumping pipe is to be identified with a unique identification number that relates back to documented records on the concrete pump. It is preferable **that the pipe is also marked** with a manufacturer's name (or trademark) and a pressure rating. Documented information on the correct pipe specification, as specified by the concrete pump manufacturer, is to be maintained on the concrete pump. The numbering of the pipe should be sequential from the hopper end (i.e. lowest number at the hopper end increasing along the length of the boom).

Reference: section 5.12(d) of the *Concrete Pumping Code of Practice 2005.*

Pipe thickness records – Single wall pipe

Issue
Concrete pipelines operate at high pressures and the consequences of a ruptured line can cause serious injuries. When failures of pipe line occur, parts of the pipe can become projectiles and the concrete will also be released at high pressure. Pipe bends will generally require higher wall thickness due to more localized wear and the fact that most bends are castings and can be more brittle than pipe.

Control measures
Pipe is to be removed from the pump and discarded when it reaches its minimum thickness allowance as specified by the concrete pump manufacturer for the grade and type of pipe being used. Thickness readings are to be carried out at intervals not exceeding one month and a pipe thickness log book is to be maintained for the pipe with the pump. If wear rates are very rapid, or the pipe is nearing its discard limit, thickness measurements will need to be at frequencies of less than one month. Thickness testing of bends should be measured where the wear is likely to be higher (i.e. on the outer radius). Information on the minimum allowable pipe thickness, specified by the pump manufacturer or another relevant expert, should be kept with the concrete pump.

Reference: section 4.1.3 and 5.12 of the *Concrete Pumping Code of Practice 2005* and section 8.4 of AS 2550.15.

Discard procedure – Twin wall pipe

Issue
Concrete pipelines operate at high pressures and the consequences of a ruptured line can cause serious injuries and fatalities. When failures of pipe line occur, parts of the pipe can become projectiles and the concrete will also be released at great pressure.

Control measures
Pipe is to be removed from the pump and discarded when it reaches its minimum thickness allowance as specified by the concrete pump manufacturer for the grade and type of pipe being used. Thickness measurements, with the pipe on the boom, cannot be easily carried out for twin walled pipe as the ultrasonic instrument will only measure the wall thickness of the outside section of pipe. At pre-determined intervals the pipe thickness should be checked by removing clamps and checking thickness with calipers or another measuring instrument. A documented system needs to be prepared and implemented that ensures catastrophic pipe failure (i.e. failure of the outside pipe section) should not occur. When the pipe is nearing its minimum thickness the procedure for checking should be more frequent. The procedure should include a record of the volume of concrete pumped and pipe thickness reading(s).

Reference: section 5.12(b) of the *Concrete Pumping Code of Practice 2005*.

Damaged or incorrect pipe clamps

Issue
Concrete pipelines operate at high pressures and the consequences of a ruptured line can cause serious injuries and fatalities. Damaged pins, arms or locking systems can result in clamp failure and subsequent pipeline failure.

Control measures
Clamps connecting concrete piping need to be of the correct size, appropriate for the pressure rating of the concrete pump and maintained in good condition.

No identification or pressure rating on clamps

Issue
Concrete pipelines operate at high pressures and the consequences of a ruptured line can cause serious injuries. Clamps connecting concrete piping need to have adequate strength and correctly fit the pipes they join.

Control measures
Clamps are to be permanently marked with the manufacturer's name (or trademark), and the maximum permissible operating pressure. The clamps are to be rated at a working pressure equal to or greater than the maximum working pressure of the concrete pump.

No safety pins on quick release clamps

Issue
Concrete pipelines operate at high pressures and the consequences of a ruptured line can cause serious injuries. Quick release clamps can open when knocked or if they are not properly closed.

Control measures
Quick release clamps are to be fitted with locking pins (R-clips or similar) to prevent inadvertent opening of the clamp.

Reference: section 4.1.3 of the *Concrete Pumping Code of Practice 2005* and section 9.6.5 of AS 1418.15.

Excess hose on boom

Issue
Concrete placement booms are designed to be used with a maximum amount of hose suspended from the boom tip. If the amount of suspended hose specified by the manufacturer is exceeded this can result in catastrophic failure of the boom or reduce the design life of the boom.

Control measures
Concrete placement booms are not to be used with a length of hose suspended from the boom tip exceeding that specified by the boom manufacturer. This applies to both operation of the boom in pumping mode and when the pump is not in operation (i.e. with the end of the hose folded over and the boom moved from one location to the other). The manufacturer's operating instructions are to specify both the hose diameter and the maximum hose length that can be suspended from the boom. This will often be four metres of 125 mm diameter hose, although greater lengths of smaller diameter hose are sometimes specified by the boom manufacturer.
Note: this does not apply to hose that is lying on the ground or floor, provided the excess hose is disconnected when the boom is moved.

Reference: section 4.3.3(f) of the *Concrete Pumping Code of Practice 2005*.

Hopper issues

Hopper grate interlocks/restraint

Issue

The hoppers on most concrete placement pumps are fitted with agitator paddles and a switching valve mechanism that swings from side to side as concrete is pumped through alternate cylinders. The switching mechanism can also be known as an "S – tube" or "rock valve". The switching mechanism will move rapidly and can still move after the on/off switch has been turned off due to residual hydraulic pressure stored in the accumulator. If hands or feet are placed around the switching mechanism amputation can occur. The rotating paddles can also cause fatal injuries. Sometimes interlocks are over-ridden so that persons can lift the grate and access the hopper particularly during cleaning. In other situations an interlock system may only stop either the paddles or the switching valve mechanism and not both. **Note:** this issue applies to both boom and line pumps although the older "squeeze-crete" pumps will only be fitted with paddles.

Control measures

Hopper grates designed for opening are to be fitted with an interlock switching system that de-activates **both** the paddles and the s-tube when the hopper grate is lifted. This system is to ensure that there is no energy in the system that can cause movement of the paddles or s-tube after the interlock switch is activated (i.e. from remaining hydraulic pressure in the accumulator).

Reference: section 4.3.1 of the *Concrete Pumping Code of Practice 2005* and section 10.2 of AS 1418.15.

Hopper grate provision and gap size

Issue

Body parts are being crushed or amputated by the agitator paddle and the s-tube in the hopper on concrete pumps. A grate is provided by pump manufacturers and this helps to prevent such injuries. On some pumps, the gap size has been increased to help the concrete pass through the grate, particularly in the case of stiff mixes. The grate also needs to be frequently cleaned otherwise concrete will build up and restrict concrete flow.

Control measures

A grate is to be provided on the hopper of every concrete pump. The grate is to cover the complete hopper and the gap between bars is not to exceed 75 mm. The distance from the top of the grill to any moving part is to be at least 100 mm.

Reference: section 4.3.1 of the *Concrete Pumping Code of Practice 2005* and section 10.2 of AS 1418.15.

Support of mobile concrete boom pumps

Short legging of outrigger legs

Issue

"Short legging" describes the action of only partially extending outrigger legs on the mobile concrete placement boom and can lead to the unit falling over. Short legging is often used due to factors such as inadequate set up area, poor planning, pressure from clients and a lack of understanding of safe work practices. The unit may inadvertently fall over when the operator forgets that some of the outriggers are short legged and slews the boom into the wrong area. Short legging is prohibited by some mobile boom manufacturers.

Control measures

Short legging is a practice that should be avoided wherever possible, due to the increased risk of overturning of the mobile plant.

Persons in control of workplaces and principal contractors should ensure that adequate room is available to enable a concrete placement boom to be set up safely. This includes both operation of the mobile plant and ancillary activities such as cleaning out the concrete placement boom. It may also include obtaining road or footpath closures from the relevant authority. The company supplying the mobile plant should provide the hirer with the **actual area required** to set up the plant with outriggers fully extended, expressed as a length by width dimension in metres.

Short legging may only be permitted where either option (1) or option (2) is implemented:

1. **Option 1** - the mobile plant is fitted with a slew limiting device that prevents the boom slewing into the zone where the outriggers are not extended, to stop the plant overturning. Note: these devices may not totally prevent the risk of overturning and the operator should be trained in the operation and limitations of the device.

2. **Option 2** – All of the following actions take place:
   a. The manufacturer's operating manual for the mobile plant permits short legging (i.e. partial extension of outriggers) and states the operating conditions that must be complied with when this practice takes place. A copy of the manual is kept with the mobile plant.

   b. The outriggers are marked with an indicator that shows the extent of the short legging (i.e. marks on the outriggers) or the operator's manual shows how far the outriggers are to be extended (i.e. by diagrams).

   c. A work method statement has been prepared that shows the operating conditions under which the short legging can be used. For concrete placement booms, the work method statement is to include a diagram showing the permissible operating zone of the boom operating. The work method statement should be signed by both the plant operator and the principal contractor's representative (or the person in control if no principal contractor is required for the job).

Reference: AS 2550.15 – 1994 clause 4.2 (j)

Support of outrigger feet on mobile placement boom

Issue
Safe operation of mobile concrete placement booms relies on the outrigger feet being safely supported. Where the feet sink there is a likelihood that the unit will overturn.

Control measures
Outrigger feet are to be supported so that there is no risk of the feet sinking into the supporting surface. This will require that support pads or timbers are provided underneath the outrigger feet. Where the unit is set up on poor ground the size of the pad or timbers will need to be increased. As a general indicator any sinking of an outrigger foot or pad is a strong indicator that the area of the pad will need to be increased.

Reference: section 4.2.1(d) of the *Concrete Pumping Code of Practice 2005*

Vehicle movement – Concrete trucks

Reversing concrete trucks

Issue
Concrete pumps are supplied with concrete by concrete trucks that reverse up to the pump hopper. Visibility is difficult for the concrete truck driver and there is risk of persons between the truck and concrete pump being run over or crushed. The risk is greater when two concrete trucks are used to supply a single pump (i.e. two trucks backed up to a hopper).

Control measures
A documented work method statement for the movement of concrete trucks to and from the concrete pump needs to be prepared. The following factors should be part of the work method statement:

- The exclusion of persons, not directly involved in the operation, from the working zone.
- A nominated spotter to be responsible for directing and observing both vehicle and personnel movement within the working zone.
- When workers behind the reversing vehicle go out of the driver's view and into the path of the vehicle, the driver should stop the vehicle or sound the horn.
- The concrete chute on the concrete truck is not to be moved when the truck is reversing.
- Persons working in the area are to wear high visibility vests.
- Concrete trucks are to be provided with audible reversing alarms and flashing lights.

Reference: section 4.3.1 of the *Concrete Pumping Code of Practice 2005*

Powerlines

Issue
Electrocution of pump operators, line hands, concrete truck drivers and others can occur when a concrete placement boom or hose contacts overhead powerlines.

Control measures
It is always best to eliminate the risk by setting the boom up where contact cannot occur (i.e. powerlines are outside of the operating radius or range of the boom). To eliminate the risk of electrocution, powerlines can also be de-energised by the power supply authority, but if this is done

signed documentation is to be provided. Exclusion zones stipulate the minimum safe distance from live powerlines for people and machinery. Exclusion zone distances are three metres for up to 132 kV and six or eight metres for higher voltages – exceeding these distances is a simple way to minimise risk. Where live powerlines are within the operating range of the concrete placement boom, a safety observer is to be provided. The safety observer is required to signal the pump operator to stop the boom when it approaches the exclusion zone distances mentioned above. Adequate time is to be allowed, when signaling the pump operator, to allow movement of the boom to stop so that the exclusion zone distances are complied with (i.e. the safety observer may need to signal the operator to stop the boom when it is at a much greater distance than three metres from the132 kV powerlines to comply with the three metre distance).

Tiger tails on lines serve as a visual aid to help stay away from powerlines, but do not insulate the lines. The exclusion zone mentioned above must still be complied with even though tiger tails are fitted.

Reference: *Code of Practice for Working Near Exposed Live Parts.*

Pump cleaning

Cleaning with air

Issue

When using air to clean out concrete lines the cleaning plug (i.e. rubber plug or sponge) can be ejected from the end of the pipeline at speed and cause injury to persons. Concrete and water can also be a hazard when it is ejected from the pipeline. If the end of the pipeline is not adequately secured during blow out the pipe can move violently.

Control measures

A work system is to be developed that prevents injury to persons when cleaning out the concrete line with air. Rubber hose must always be removed from the end of the boom before the line can be cleaned out with air. Where there is any likelihood of the pipe line recoiling during the cleanout process the end of the pipeline must be secured by mechanical means so that this cannot occur. The recoil hazard is more likely when the end of the pipe is not anchored to a boom or wall brackets. Material in the pipeline should be discharged into a solid bin or vessel that adequately contains any ejected materials.

Sometimes a purpose built attachment (sometimes called a “ball catcher” or “cage”) is fitted to the end of the steel pipe to catch the rubber plug. This device should be designed to prevent air escaping from the end of the pipe. This is achieved by designing the ball catcher so that it is shorter than the compressed length of the rubber plug. When the plug has contacted the ball catcher, the compressed air must be exhausted (dumped) from the pipeline before the ball catcher can be removed otherwise injury to the operator is likely to occur.

Reference: section 4.3.5 of the *Concrete Pumping Code of Practice 2005*

Other issues

Number of personnel

Issue
Two key locations on a concrete pump require input from competent persons – the hose at the end of the concrete pump and the concrete delivery hopper. In the event of malfunction of the unit or when unauthorized persons enter the work zone, the pump may need to be shut down to minimize the likelihood of injury.

Control measures
A line hand will be required to correctly position concrete at the end of the hose. The pump operator should be located at the pump or, if using a remote control, have a clear view of both the line hand and the hopper. If unable to view both then an additional competent person, other than the delivery truck driver, should be located at the hopper and be responsible for stopping the pump.
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Operator's manual

Issue
Concrete pumps are complex items of plant that require high levels of skill to operate safely. Detailed operating instructions prepared by the pump manufacturer need to be followed.

Control measures
All concrete pumps are to be provided with an operator's manual written in English.

Operator controls

Issue
Concrete pumps are complex items of plant that can cause significant incidents if operated in the wrong way. Operating controls need to have clear, unambiguous instructions otherwise serious incidents can occur.

Control measures
All controls are to be marked in English or International symbols that clearly show the control function.

Emergency stop and warning devices

Issue
Concrete pumps are complex items of plant and there can be potential scope for malfunction or for persons to be injured – particularly persons that should be excluded from the equipment.

Control measures
An emergency stop device and warning device is to be provided at each control bank on the pump including the remote control and at the hopper area. The emergency stop device should be of the mushroom type that is pushed to activate and will require twisting to de-activate.

Operator licence

Issue
Concrete placing booms are complex items of plant that require high levels of skill to operate safely. The potential for injury and death is high if these units are operated in an unsafe manner.

Control measures
All operators of mobile truck-mounted concrete placement booms are required to hold a licence in high risk work to operate this plant (i.e. hold a concrete placing boom licence). This licence is also a reasonable way of helping to show competence to operate a satellite (fixed) concrete placement boom.

First aid kit

Issue
Concrete pumping can be a hazardous operation. Cuts, abrasions and eye injuries can occur.

Control measures
All mobile concrete placement booms should be provided with a stocked first aid kit. Operators and line hands on satellite booms should have rapid access to a first aid kit. The first aid kit is to include a sterilized eye wash kit.

Reference: section 6.2 of the *Concrete Pumping Code of Practice 2005.*

Personal protective equipment

Issue
Concrete pumping can be a hazardous operation. Eye and hearing damage and injury can occur if appropriate personal protective equipment (PPE) is not provided.

Control measures
Pump operators and line hands are to use necessary PPE, including safety boots for operators, safety gum boots for line hands, eye protection, safety helmets and usually hearing protection for pump operators. Rubber gloves are required where there is hand contact with concrete.

Reference: sections 4.4.1 and 6.1 of the *Concrete Pumping Code of Practice 2005*.

Annual plant registration – Mobile booms

Schedule 3 of the *Workplace Health and Safety Regulation 2008* requires annual plant registration for all mobile concrete placement booms. This is to be obtained from Workplace Health and Safety Queensland and evidence of payment maintained on the mobile concrete placement boom.

Collision risk – other plant

Issue
Concrete placement booms can be damaged or damage other plant where they are used within close proximity of other plant. Serious injury can also result from such collision. The risk of collision is increased when the other plant can also move, as in the case of other concrete placement booms or

cranes. The risk will be increased when different crews control the separate items of plant and communication between the crews is poor.

Control measures

Where two items of slewing plant are located within one another's operating radius a work method statement should be prepared that discusses methods to help prevent collision. If work system relies on a safety spotter to instruct the plant operator(s) to stop movement of the plant to prevent collision the spotter needs to have a clear means of communication with the plant operator(s). This could be by means of a two-way radio. The spotter should also be clearly instructed on how close the boom may come to the other plant and when he or she needs to tell the plant operator to stop motion.

When one of the items of plant is stationary the primary responsibility for action to prevent collision rests with the crew controlling the moving plant.

Some factors to consider when developing the work method statement include the following:

- How long is potential exposure time of the risk of collision (i.e. for a fixed satellite boom the need for a more comprehensive procedure may be greater)?
- Does the crew on the two types of plant have different employers? If so, the risk of collision may be greater and the principal contractor will have a greater role to monitor the safe work system.
- Can operation of the two different items of plant be staggered so that they do not have to operate at the same time?
- If the two items of plant do have to operate at the same time, can they operate in different zones of the work site and not have to cross under or over one another?