EDITION: 2020/2021

# PUMPING handbook

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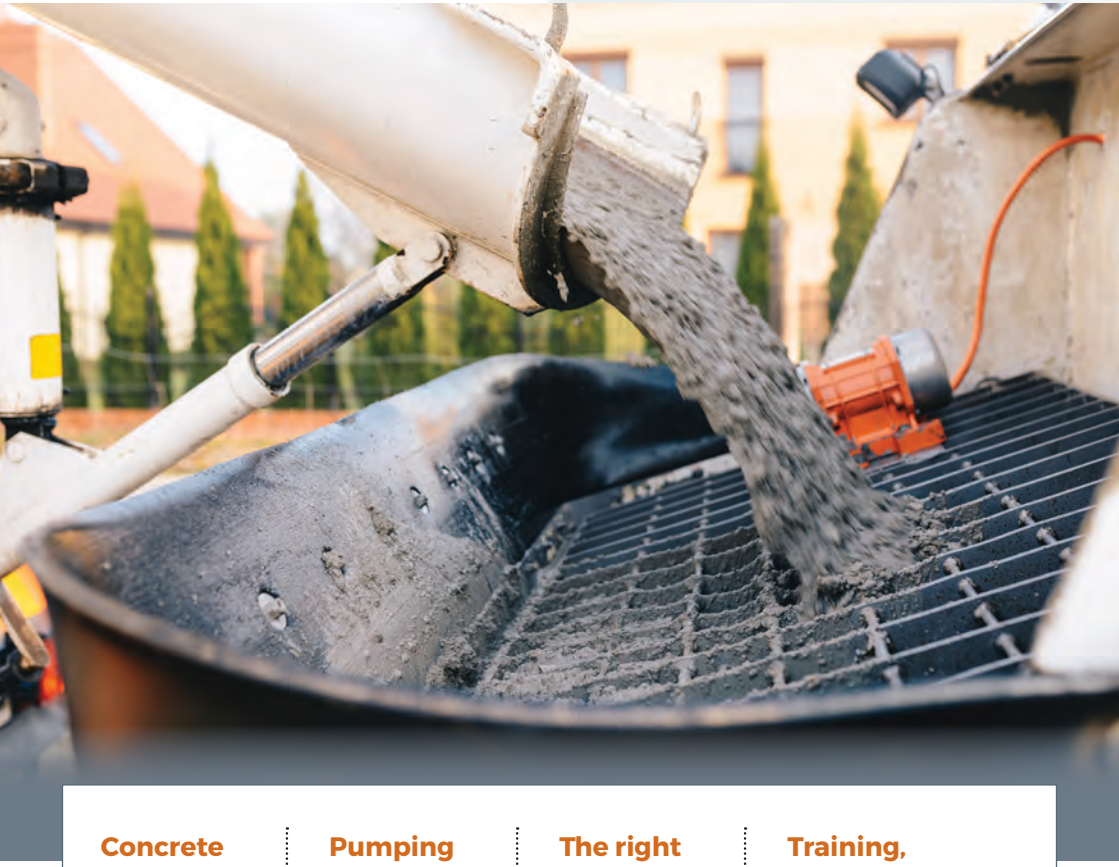

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# PMSA

## Built to last – the company | the equipment

***PMSA is South Africa's complete solution provider for concrete equipment. Quintin Booysen is the company's highly visible sales and marketing manager, with a keen finger on the pulse of the industry and a steady hand on the tiller of PMSA. Booysen began this interview with these words: "The recovery has been stronger than anticipated, and the demand for concrete products are very healthy at the moment, from both public and private sectors."***

**CT** **PMSA has a strong presence in the Southern African construction market and beyond; what are the key elements people should know about the company?**

**PM** "PMSA celebrates its 45th years in 2021 and from the very beginning, our focus has always been to provide complete solutions for concrete equipment, catering to all sectors using concrete in their business. This includes the civil sector and building trades needing ready mix concrete trucks, concrete pumping solutions, concrete batch plant solutions and all forms of pan mixers and precast concrete equipment.

As a concrete equipment provider, PMSA in its own right has been supplying traditional

concrete pumps for just on 12 years, and our acquisition of Concrete Pumps in Durban over ten years ago added their collective skills and expertise to PMSA capacity, knowledge base and collective skill-base. As the original suppliers of SEM pumps in South Africa, Concrete Pumps led the way in high pressure system pumps, before piston pumps became the industry gold standard. Since the early 90's, they have specialised in piston pumps."

High-pressure pumps were surpassed by piston pumps in sheer volume of concrete pumped per hour, typically between 10 and 30 cubic metres per hour. The compressed air system pump – also known as the pressure pot pump – typically comes in three capacities: 100, 250 and 500 litres. An important application for high-pressure pumps today is in underground scenarios like mining, in which weight of equipment and simplicity of operation must be balanced against a typically lower need in volume of concrete.

Piston pumps simply provide more power and are more suitable for mobile trailer and boom pumps. Piston pumps can pump concrete to over 100 metres in height.

**CT** **What are some of the special capacities PMSA can provide in pumping technology?**

**PM** PMSA acquired the Southern African dealership in 2018 from CIFA, the Italian company, which was an early adopter of S valve technology – the gold standard today. CIFA is part of Zoomlion and was established in the early 1960s. This mean PMSA is able to supply boom and portable trailer pumps range from 30 to 140 cubic metres per hour, with boom pumps reaching 20 to 80 metre heights.

Our CARBOTECH Series features the last number of boom sections fabricated from carbon fibre. This significantly provides extra strength and height at much lower weights. This is especially important when working in South Africa's rather strict road limitations. It allows us to put a bigger pump on a smaller chassis; we can legally mount a 47 metre boom pump on an 8X4 truck

Another very important technology we offer through CIFA is the ASC Advanced


**If you are thinking about concrete … think PMSA**

Stability Control System. This is an incredible solution for challenging construction sites. A frequent challenge is the struggle to deploy all the outriggers to their complete extension. This results in major risks for safety and potential damage and destruction. The ASC Advanced Stability Control System monitors the mounted truck in real time, and in this way ensures that the rig will never topple. This allows you to position the pump without fully extending the outriggers, allowing the operator to work within entirely safe margins.

Our CEM placer pumps are used extensively underground, and are well-suited due to their minimal moving parts. We also provide shotcrete machines and Agicars – which are low-height ready-mix trucks for underground use.

**CT PMSA is a leading supplier of a complete bouquet to the concrete sector including all types of batching plants from pre-cast through to ready-mix batch plants both dry and wet concrete batching plants. What are some defining features of PMSA's range, both in terms of what your produce and what you distribute for your partners?**

PM PMSA has successfully been supplying ready mix batching plants for decades, used in all sectors – from civil works – to built environment – to precast. We produce purpose-built ready mix plants and distribute mobile ready mix plants produced by the IMER Group. PMSA is the IMER Southern African partner for the wet batching and ready mix trucks. PMSA can supply anything from 15 cubic metres per hour to over 120 cubic metres per hour, as well as large plants up to 300 cubic metres per hour for enormous build projects.

Annually PMSA supply approximately 15 to 20 wet batching plants into the precast and ready-mix sectors, which make us a leading supplier of batching plants in the region.

Over the last couple of years, PMSA has sold several wet batching plants into windfarm projects for the very demanding concrete work on both the tower bases and the pre-cast elements of the towers themselves.

We have a full range of mixers from 25 litres to over 4,500 litre mixing capacity which can be used in batching and mixing as well as other industrial sectors in need of quality batching and mixing solutions.

**CT What distinguishes PMSA's ready mix drums for ready mix trucks?**

PM We supply imported ready mix drums for a full range of trucks; we generally supply 6 and 8 cubic metre ready mix trucks. All of our

drums are manufactured with wear-resistant steel, which extends lifespan, and has the added advantage of reducing drum thickness to 4mm, significantly reducing the overall weight of the truck. The drums are specially designed to accommodate the extra blades, which allow for slow mixing speeds and a better quality mix. We offer both steel and plastic chutes, which are lighter and reduce operator fatigue.

Providing equipment that is built-to-last is matched by PMSA's built-to-last customer relationships. Key to this is customer support. PMSA has offices in Johannesburg, Cape Town and Durban, and has an established dealer network outside of South Africa. With over 250 staff across their regions, PMSA provides both on-site support as well as service on customers' premises, and construction site, with a fleet of Service Vehicles.

**CT What other ways do you support the industry, and what suggestions do you have that would strengthen the industry?**

PM PMSA have appointed Flowmaster as a CIFA agent for the inland regions of South Africa. Since the early 2000s Flowmaster was the official and original CIFA dealer in South Africa. Carlo Gobini, the current Managing Director of Flowmaster, is the son of the founders of the first concrete pumping professionals in South Africa, who set up the original large concrete pumping brands in South Africa. He draws on literally the most experience anyone in South Africa can have, when it comes to concrete pumping. PMSA holds this experience in very high regard and has made sure it can draw from it.

Like CIFA, PMSA does not believe in supplying cheap equipment that needs to be replaced often. We believe our customers can only be enriched with top quality, durable equipment which can be added to. Thus expanding a

customer's offering, not merely keeping its head above water. We believe in generational relationships with customers, passing traditions down in parallel with them. CIFA share this philosophy, which makes them an ideal supply partner for PMSA as well.

**CT What specific thing would you like to see developed in the concrete construction industry?**

Customers invest millions in their equipment but often neglect to do the same with their personnel. Training is a non-negotiable to get the best out of your equipment and as a direct co-investment into that equipment. Too often equipment is damaged purely due to poor training. And you cannot blame the operators for this. It comes down to valuing the human capital, with proper remuneration, and contact skills management.

The industry is in sore need of a professional body for concrete pumping professionals. This will do many things, but importantly will start to address the damaging price wars we tend to tend to see nowadays. Sacrificing expertise for price does not benefit anybody. Not the equipment owner, not the client, not the contractor. Everyone pays in the end, and a tradition of excellence get destroyed in the process. This needs to be addressed urgently. ■

# **The right pump** for the job

Decisions, decisions. A concrete contractor's success comes down to more than hard work. It involves the decisions he or she makes including equipment choices to deliver a positive return-on-investment.

For dry shotcrete processes, use a rotary gunite machine. These machines offer precise control of material flow at low or high outputs.

Selecting the right concrete pump for the job ensures success and eliminates the need for frequent maintenance and repairs.

This guide will help with the decision-making process.

## HYDRAULIC SWING TUBE PUMPS

Use a swing tube pump for projects involving harsh materials and long-distance pumping. These pumps come in sizes with 8 cm and 10 cm outlets. The 8-cm pump works great for jobs from 2-8 cubic metres per hour, while the 10-cm pump tackles jobs that require 9-20 cubic metres per hour. The output or material pressure at pump discharge from a swing tube pump varies from 51 bar up to 145 bar.

Clean the pumping system properly after each use to avoid premature wear on the cup seals and material pumping tubes. A swing-out or hydraulic lift hopper offers easy and quick access for cleaning and maintenance.

For best results, generously grease the outgoing housing, swing tube shaft and swing tube cylinders during each hour of operation, and ensure it's always operated by a well-trained, and experienced worker.

## SQUEEZE TUBE OR PERISTALTIC PUMPS

Squeeze pumps provide the lowest output pressure when compared to swing tube, rotor stator or ball seat pumps. The maximum output pressure at pump discharge is 35 bar. As a result, squeeze pumps don't work well for pumping larger than half-inch aggregate, exceeding

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15 metres vertically or moving material more than 75 metres horizontally. The slump of the material should not be less than 8 cm. Squeeze pumps are preferred for cellular concrete because the lower pressure does not damage the bubbles in this material. Squeeze pumps have also been used successfully to pump shotcrete with steel and synthetic fibres.

The lower pumping pressure makes a squeeze pump the safest to operate and, in many cases, customers with no concrete pumping experience can operate a squeeze pump.

Not only that, but squeeze pumps offer the easiest maintenance. They contain only one wear part, the rubber pumping tube, which is replaceable in about 30 minutes. Operators also clean them quickly by simply pushing a sponge ball through the pump.

## HYDRAULIC BALL VALVE PUMP

The ball valve pump delivers as much as 75 bar pumping pressure, however it is limited to 8/20-cm aggregate and a slump that is 8 cm or larger. The ball valve pump will not run in reverse, therefore extreme caution must be taken to relieve the pressure on the delivery line should the line plug. There is a small ball valve on the discharge pipe of the manifold to manually relieve this pressure. Materials such as gypsum flooring materials, which are very plastic in nature, tend to build up over time in the receiving hopper and manifold. Shotcrete materials do not have these same characteristics and will work well provided the aggregate does not exceed 8/20-cm in diameter. These pumps offer the advantage of a low purchase price and easy maintenance.

## ROTOR STATOR, SCREW, PROGRESSIVE CAVITY OR WORM PUMPS

Most applications for rotor stator pumps use the low-velocity or spray-up method. A rotor stator pump generates as much as 41 bar of pumping pressure. These pumps are commonly used for pumping highly flowable materials, but they also tolerate small aggregate.

Aggregate that is too sharp may result in premature stator wear, and rotor stator pumps typically wear fast when used for material with aggregate that's larger than 2-cm. They cannot be run dry of material without causing damage to the stator. Rotor stator pumps offer about 30 percent more pumping pressure than a squeeze pump.

Look into the mechanical seal maintenance requirements manufacturers offer for rotor stator pumps. It's important to select a model that gives operators the ability to perform mechanical seal maintenance without taking apart the rotor and stator. This drastically reduces labour expenses, keeping equipment where it's profitable: on the jobsite. Rotor stator manufacturers recommend cleaning the machine by flushing the pump and delivery system with water.

## ROTARY GUNITE MACHINE

Use a rotary gunite machine for dry shotcrete processes. These machines offer precise control of material flow for low or high outputs. The speed the rotor turns is directly related to the amount of material that will pass through the rotor section.

These can be powered with an electric motor, air motor, gas or diesel engine or hydraulics. The rotary gun is also available as a skidsteer work tool. The dry shotcrete process means the material remains dry until it is properly hydrated at the nozzle. Best results occur if the material has 3 to 5 percent moisture when loaded into the hopper of the gunite machine. Pre-dampen the material, if needed, to accomplish this. These machines offer easy stop and start with no cleanup. However, they generate more dust and waste, particularly if not properly hydrated.

With these guidelines as a reference, concrete contractors set themselves up to make the best decision for their jobs. ■

PUMPING handbook

WORKING ON SITE



**Pumps and** chassis

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# Site establishment and securing equipment

## SITE ESTABLISHMENT

While the concrete pumping equipment does not change much from day to day, setting up on a job site presents a number of hazards and every situation is different, presenting a variety of different challenges. It is important that the pump is set up in good time well in advance of the arrival of the concrete to ensure that everything is in good order and final checks are done to avoid undue pressure on the pump crew.

## PRE-JOB SITE INSPECTION

A pre-job site inspection should be carried out making use of templates as a checklist to establish that all the preparation, contact persons, equipment, material and administration is in place. The inspection should evaluate access to the job site as well as the space required to properly establish the pump with fully extended outriggers. Deviations and exceptions need to be recorded and forwarded to the operator's supervisor or managers for resolution.

## SECURING THE BOOM AND OUTRIGGERS

While traveling to site or repositioning the pump on site, the boom must be fully folded and secured in the transport mode. Outriggers must also be fully retracted and secured.

## VEHICLE AND PUMP ACCESS

When accessing or getting down from a pump, the same "3 point rule" applies as when the cab of the vehicle is accessed. As is the case with RMX and tipper trucks, slips and trips are significant causes of injury and lost time in pumping operations.

Where heights being accessed exceed 1.8m, the requirements of FPE 1: Working at heights applies.

## WIND

It is important to have an awareness of the weather conditions for the day when establishing on site. Concrete mobile pumps can have a vertical reach of 17 meters to 70 meters. The

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limits to operating in wind needs to be known for each pump as per the manufacturer's recommendations.

## SETTING UP NEAR POWER LINES

Pumping establishment regularly involves setting up in the proximity of power lines. Electricity is a major hazard as a result of the action of unfolding the boom from transport mode or moving the boom during pumping. There is the potential for electric current to pass down the boom through a person to the ground. Note that the boom does not need to be in direct contact with the power lines for such a possibility. When setting up near power lines, national legislation and regulations apply. Consult the person in charge of the site and request evidence of any lines that are de-energised. Establish a minimum clearance distance from live lines, relative to the voltage of the power line, to establish the 'exclusion zone'.

Many countries have different network voltages and have regulations that require different exclusion zones, most of them are freely available to download via the internet. For South Africa, visit www.nersa.org.za.

## USE OF A SPOTTER NEAR POWER LINES

Due to multidirectional movements of the pump boom and the need to concentrate on the delivery point, a concrete pump operator may lose perspective of the position of the boom relative to power lines. A further difficulty would be judgement of depth of field based on the position of the pump operator. It is unlikely that a pump operator can accurately judge the boom proximity to the exclusion zone, therefore where there is a risk that the pump boom could enter the exclusion zone, a safety observer should to be designated to alert the pump operator. Effectively earth the pump as a precaution when working near power lines. ■

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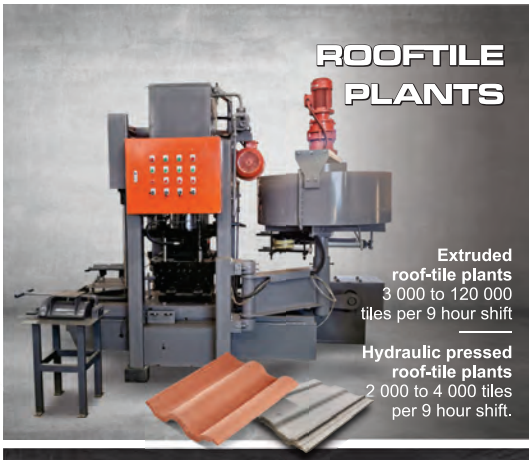

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# Pre-job checklist for concrete pumping

(Use this checklist to manage general details, top-line mix notes, and safety accreditations.)

Project: ..... Date:.....

Location:.....

Directions: .....

| 1. Contacts | | | | | |
|---|---|---|---|---|---|
| **Who** | **Name** | **Phone** | **Mobile** | **Fax** | **E-Mail** |
| C. Contractor | | | | | |
| Plant(s) | | | | | |
| Pump Contractor | | | | | |

| 2. General Conditions | | | | |
|---|---|---|---|---|
| **Start Time** | **Pump:** | **am/pm** | **Concrete:** | **am/pm** |
| Placement Location | • Slabs | • Walls | • Footings | Other |
| Placement Rate ($m^3$/hr.) | | Volume ($m^3$) | | |
| Type of Pump | • Regular | • Z-Boom | • Telescoping | • Trailer |
| Size of Pump (m) | | Pipeline dia, mm | | |
| Pumping Distance (m) | Vertical | | Horizontal | |
| Slump/Air Spec | • Point of Discharge | | • Point of Placement | |
| Testing | • Point of Discharge | | • Point of Placement | |
| Priming Agent | • Grout | | • Slick Pack | |

| 3. Concrete Mixture (see Concrete Mix Submission form) | | |
|---|---|---|
| Class of Concrete | CSA A23.1 | Mix ID |
| Strength MPa | 28 day | Other |
| Ordered Slump (mm) | Air Range % | |
| Special Requirements | | |

| 4. Pump | | |
|---|---|---|
| Pump Equipment Safety Certified | Yes | No |
| Pump Operator ACPA Certified | Yes | No |

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# Secure installation and safe operations:
## From pump to pipeline

### PUMP OUTRIGGER POSITION
Trenches and embankments are a common feature of construction sites and usually occur between the pump position and discharge point.

### OUTRIGGER PADS AND BLOCKS
Undisturbed ground or ground disturbed on construction sites for the installation of services are unlikely to have sufficient bearing pressure to support the outrigger pads that are supplied with the pump. Additional timber blocks or beams placed under the sole pads help to further distribute the load applied through the outriggers. The length of the timber beams depends on the type of ground support. They also prevent local damage to pavement surfaces. Refer to Appendix L for a guide to the length of timber blocks for different ground conditions.

### RAISING AND LEVELLING OF THE PUMP
Once the pump has been safely positioned, it needs to be raised to a position that allows for a stable working platform. The pump action introduces harmonic loads which will be aggravated by the pumps tyres if the pump is not raised and stabilised by the outriggers, leading to metal fatigue and potentially failure of boom components and collapse of the boom.

### ATTACHING PIPES TO THE END OF A BOOM
Ideally a pump should be selected with sufficient reach to deliver concrete to the required position. This may not always be possible resulting in the addition of further pipes to the end of the boom. Where the reach of a pump needs to be extended, there needs to be a section of flexible hose between the boom and the pipeline. The weight of the pipeline needs to be supported independently of the boom. Examples of such support could be in the form of trestles. Note that this type of flexible hose has a metal collar at both ends and must not be used on its own hanging from the end of a boom as it can represent an additional hazard. There should also only be one section of flexible hose hanging from the end of a boom.

### PIPELINE SAFETY CABLE
Where a discharge or placing hose is attached to the end of a boom, this hose shall also be secured with a safety chain/cable. Flexible hoses are frequently added and removed from boom pipelines. In the event that the hose is not properly secured it may result in the hose falling from considerable height. A safety Chain/cable would prevent the hose from falling should it become detached from the boom pipe line.

### SNAP CLAMPS
Snap clamps are used to build steel pipelines and while the clamps speed up the process, it is possible for them snap open under pressure.

### RUBBER SEALS
Clamps for joining steel pipes are designed to work with rubber seals. If different seals are used

or other materials in the place of seals, there is a likelihood of concrete paste leaking from the join. This will result in the concrete being less pumpable, leading to increasing pump pressure and potential blockage of the pipeline.

Besides using the rubber seals specifically designed for the clamp, seals need to be cleaned immediately after each use to prevent concrete build up and difficulties in building the next pipeline.

## LIFTING AND FIXING OF PIPES

Particular care needs to be taken in the carrying, lifting and fixing of pipes to a structure, for which there shall be a safe work procedure. Where pipelines are attached to a building, the pipeline attachment should be designed, detailed and signed off by a professional engineer. Particular care should be taken when accessing a structure via staircases or temporary platforms without adequate edge protection.

## THRUST BLOCK

Due to the high pressure produced while pumping, vertical pipelines need to be effectively supported where they change direction. Where the pipe bend cannot be secured in position, a thrust block cast from concrete is an effective way to secure the base elbow of a vertical concrete pipeline.

## INSPECTION OF TOOLS

Any interruption to concrete pumping can have a significant knock on effect. For example there is potential for air to enter the delivery pipe which could result in a whipping action upon resumption of pumping. Delays are also likely to affect subsequent planning for deliveries of concrete. Having the tools necessary to keep the pump operational and in good condition contributes to a safe operation.

Particular attention should be paid to tools and materials used for effective clean-up of the pipe line and pump after the completion of a pump job to ensure that pumping services are not delayed at the next job.

## BUILDING A PIPELINE

Longer pipelines require adequate time to build and secure. Where the pipeline is of significant length or where the site conditions are not straight forward, it is recommended that the pipe line is established well ahead of the pump establishment.

## SUPPORTING PIPELINES

Both vertical and horizontal pipelines need to be properly supported at regular intervals and must adhere to manufacturer's requirements. For horizontal lines, the support may be in the form of trestles while vertical lines need to be firmly bracketed onto the structure.

## SHUT OFF VALVE

The installation of a shut off or switching valve allows for further options and contingencies on larger projects. This would allow for the switching between pumps without emptying a pipeline and would also allow for the discharge of concrete from a vertical pipeline into a receiving hopper or ready-mix truck. ■

# Concrete pumping equipment

## MAINTENANCE PROCEDURE

Maintenance of the equipment shall be completed to an high standard carried out as per manufacturers specifications and conducted by competent technicians within a planned maintenance schedule designed in consultation with the equipment supplier for the vehicle, pump and boom.

## PUMP PRE START-UP CHECK SHEET

An operator pre start-up check sheet is common for the operation of most key items of equipment. This is particularly important for a concrete pump to ensure that items that require attention are scheduled for maintenance or repairs.

## COMPLIANCE WITH VEHICLE AND TRAFFIC SAFETY

Vehicle, traffic and pedestrian hazards are responsible for the highest number of incidents and fatalities at Holcim. Concrete pumps typically travel through built up areas and are vehicles that are permanently carrying a full load consisting of the pump and boom. The vehicles are usually close to the limits of height width and axle mass distribution. The rear overhang of the boom is a further area of risk to other road users. Vehicles that tow pump trailers also require care to ensure control under braking. The drivers of these vehicles require high levels of competence and need to be alert at all times. The pumping operation needs to be managed in accordance with the Fatality Prevention Element (FPE3): Vehicle, Traffic and Pedestrian Safety as well as the Road Safety Program (RSP) that deals specifically with the risks presented by vehicles and traffic. The requirements of these directives apply equally to the management of outsourced pumping services.

## OPERATING PARAMETERS

When operating the pump, the operator should be aware of the operating parameters of the pump and boom. This would include pump hydraulic pressure and temperature as well as engine revolutions and temperature. Further information would be the pump reach and output. This information should be easily available to the operator on the job site. All information should be as per the manufacturer's specification and should be included in the Group Company standard operating procedures and training material.

## BOOM INSPECTION

Due to the pulsating action of the concrete pump, the placement boom is subject to dynamic loads which results in the potential for metal fatigue or components being stressed beyond their design limits over time. The boom can be further stressed due to the way it is operated and connected to pipelines to extend the effective reach of the pump. Other than visual inspection, magnetic particle and dye penetration techniques are more effective at showing up cracks in critical areas of the boom. The CPMA (Concrete Pump Manufacturers Association: USA) recommends an annual inspection of pumps less than 5 years old, every 6 months for pumps between 5 and 10 years old and thereafter every 500 operating hours. Manufacturers' requirements for boom maintenance in particular must be strictly adhered to. All inspections should be done by competent persons with a proven track record in the use of advanced inspection techniques. The protocols of the Design Safety and Construction Quality Program (DSCQP) directive are also recommended for boom maintenance.

## VISUAL PIPE INSPECTION

There are many factors involved in pipeline management for concrete pumping, such as the grade of steel, wall thickness, wear patterns along the length of a pipe, abrasiveness of the aggregates, effectiveness of the concrete mix design etc. Bends and reducers are particularly susceptible to wear and need to be more closely and individually inspected. Pipes operate under pressure and can cause injury and damage to property should they rupture. As a result, a visual inspection of pipes, reducers, hoses and bends shall be carried out by a competent person at least monthly.

## PIPE SPECIFICATIONS

The pipe parameters such as grade of steel, maximum pressure, wall thickness, minimum wall thickness and expected life should be established and form a part of the purchasing decision and design of maintenance procedures such as pipe wall thickness testing. Specifications should also be included in the pumping safety operating procedures and training material. The type or grade of pipe should be visibly displayed on the pipe, preferably indelibly marked to resist obscuring by contamination.

## PIPE THICKNESS

In conjunction with the pipe specifications, there should be a system for routine measurement of pipe thickness by using ultrasonic testing or physical callipers as way of identifying which pipes are nearing the end of their life cycle. Different pressure class and composition of pipe relating to grade of steel would have a different wall thickness and as a result a different minimum thickness which should be established in conjunction with the pipe manufacturer or supplier. As a result, these differences need to be visible to the pumping crew and different class of pipes stored separately and systematically in the yard to facilitate use and measurement.

The wear rate for pipes is higher around the joins and the bottom section of pipes for horizontal lines. As a result pipe thickness checks should focus on the ends of pipes and there should be a practical and visible system for managing the end of cycle use. For example, pipes that are nearing their minimum wall thickness can be painted orange at their ends indicating one more cycle. Pipes with less than the required minimum wall thickness should be immediately removed from service. Horizontal pipes that wear more around the bottom segment should have an orientation mark and should be given a quarter rotation to extend their useful life.

## CONCRETE QUALITY ASSURANCE

An effective concrete pump mix needs to be accurately and consistently batched and managed via a concrete testing and recording regime. Concrete consistency testing such as the slump test is one of the most common tests and is particularly relevant for concrete pumping.

## RECORDS

It is important to retain records relating to key concrete pumping activities as evidence of procedures having been carried out but also for proactive maintenance and decision making. For example, the choice of pipes should be on the basis of the volume of concrete pumped and wear rate records. Records would also be required should there be a need to investigation an incident such as a boom failure.

## MAINTENANCE AND REPAIR RECORDS

Records shall be kept of repairs and maintenance for the lifetime of the equipment, including inspections carried out before the pump unit re-entered service. This is of particular importance for the maintenance of structural components such as booms where the risk of failure increases with time and use. ■

# Pumping concrete operation plan

(Use this checklist to sign off plans and track all revisions and copies.)

Project Name: .....

Contract No:.....

| Document Reference No: | Document Status | Tick Applicable Box |
|---|---|---|
| | | Draft |
| | | Live |
| **Contacts** | **Name:** | **Signature:** |
| Pumping Operation Manager | | |
| Batching Plant Manager | | |
| Project Manager | | |
| Pump Supervisor / Site Manager | | |
| Health & Safety Manager | | |

| Issued to: (name & company) | | |
|---|---|---|
| Response required by (date): | Plan Approved/Agreed by: | |
| **Plan Approved/Agreed Status:** *(Indicate by circling relevant option)* | **Yes** *(Accepted, ready for implementation.)* | **No** *(Rejected, must be amended & resubmitted.)* |

| Revision Records | | | | |
|---|---|---|---|---|
| Version No | Issue Date | Pages / Section Amended | Prepared by | Approved/Agreed by |
| 1 | | | | |
| 2 | | | | |
| 3 | | | | |
| 4 | | | | |
| 5 | | | | |

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# Safe pumping and equipment handling

## CONCRETE PUMPING

Once established, the pumping process should become a lot more controlled and repetitive. Consistency and continuity of supply as well as quality of concrete become key to a successful and stress free pump job. However, there are specific areas of risk, such as ready mix trucks backing up to the pump hopper, the area around the boom and the area around the discharge hose, particularly when working at height. A particular problem regarding working at height is the extent of edge protection provided and safety relating to the stability of the support to the formwork. While these aspects fall outside of the scope of the pumping service, the pump crew needs to have some basic knowledge in order to raise the alarm should they not feel safe. A further activity that requires attention is the clean-up process.

## PUMP REMOTE CONTROL

To take advantage of a better viewing point, it is common to use a remote control or radio remote control for concrete pumping. Where this is the case, the controls on the pump need to be effectively isolated. The remote control shall be on the person of the pump operator. Should it become necessary to put the remote control down, the emergency shut-down must be activated and the remote control shall be locked up to ensure that it is not otherwise activated.

## BOOM DANGER ZONE

The area under the boom is a high-risk area due to the continuous adjustment of the boom, an error in the control of the boom and even sudden boom collapse due to component or hydraulic failure.

It may seem obvious to avoid the area immediately under the boom, it also happens to be

the area where concrete needs to be compacted and finished off, often under some time pressure. There are generally too many workers in the area under the boom.

## DELIVERY HOSE DANGER-ZONE

The rubber delivery hose usually hangs in a vertical position from the end of a mobile pump boom. If the concrete pump ingests air, the resulting compression can result in a whipping action when exiting the delivery hose. Under no circumstances can a discharge hose be a rubber connecting hose with a metal collar.

## UNSIGHTED DISCHARGE POINT

Under certain circumstances, the pump operator will not have visibility of the concrete discharge point. It is also important that the signaller and pump operator have radio contact or at least a clear understanding of signals used to direct the positioning of the discharge point.

## MISUSE OF THE BOOM

The concrete boom has been purpose built for the pumping of concrete only. The design of the boom uses its weight to optimise the reach of the boom. It is tempting for an operator to

assist the pumping crew in lifting and moving a pipeline attached to a mobile pump as pumping progresses. Avoid all lifting actions not intended for in the design of pump, as it not only risks failure, but also weakens the boom, contributing to boom failure at a later stage.

## RESTING THE BOOM ON AN OBJECT

The boom self-supporting. If rested on any object, it will be subjected to forces it was not designed for. Dynamic loads during pumping would further aggravate the problem and put the support work or structure at risk.

## PUMP CLEANING

It is essential to clean pipelines immediately after pumping before slurry from the concrete sets in the pipes and becomes hard. Follow manufacturer's instructions at all times. Manufacturers often supply various cleaning devices, like sponges, rubber cleaning plugs or 'pigs', adaptors and sponge baskets. Take particular care in retrieving cleaning devices from the pipeline, ensuring to switch off the engine and pump, and in the emergency shutdown mode. Mobile pumps should also never travel with concrete in the pipe, as the segregation of concrete in the pipe will lead to blockage even after a short distance of travel.

## PIPELINE CLEANING USING WATER OR COMPRESSED AIR

For long pipelines, it may be necessary to use water or compressed air to clean out pipelines. This highly specialised activity that requires special attention due to the pressures involved and the potential for ejecting concrete and cleaning devices under pressure.

Where water or compressed air is required to clean out pipelines, competent people specifically trained for this method, using the required equipment, should only carry this out. Equipment includes an air compressor of the specified capacity, air to concrete pipeline adaptors, valves and a sponge ball catching basket where required. Draw up a standard operating procedure, incorporating manufacturer's specifications and shall be followed at all times.

## PIPELINE BLOCKAGES

Blockages in the concrete pipelines do occasionally happen and must be promptly but safely dealt with to avoid the consequence of concrete setting in the pipeline. A blockage is the result of a combination of a number of failures in the process and is a sure indication that not all is fully under control. Due to the added pressure that the stoppage causes to personnel on the job site and further queuing of mixer trucks, the situation can compound itself and increase the likelihood of a hazardous event. As a result, a competent person must remove the blockage. Notify the despatch office immediately to hold back further deliveries until the blockage has been cleared. It is also important for the root cause to be established and steps taken to avoid the situation repeating itself.

## ADDITION OF WATER TO THE CONCRETE

Avoid adding water to the concrete at the delivery point. The addition of water to concrete both reduces the concrete strength and to segregation of concrete, which could lead

to a blockage in the pipeline. Concrete consistency changes with time, particularly in transit, commonly referred to as slump loss. Should the properties be sub-optimal for pumping, the consistency should not be altered through the addition of water. Where there is a risk of slump loss due to distance travelled or elevated temperatures, ensure that admixtures are on hand and are added with the customer's knowledge and under the direction of a competent concrete technologist. Always notify the concrete technologist when there is a greater than expected change in the property of concrete at the delivery point. It is good practice to do a slump test on each truckload of concrete to be pumped and it is a requirement of the specification for many projects.

## SAFE WORKING LOADS

Operate the concrete pump well within its working loads or 'green zone'. Safe working loads include limits of hydraulic pressure and temperature. Length, height and bends in concrete pump pipelines as well as concrete properties can all have a significant impact on pump pressure and pump operating temperatures. Elevated hydraulic temperature results in reduced hydraulic oil viscosity and increases the likelihood of hydraulic failure.

## PUMP OPERATOR LINE-OF-SIGHT

The pump operator should position himself so that he has visibility of the concrete discharge hopper as well as the discharge point of the delivery hose. Where this is not possible, the operator should have effective communication with a designated single point of contact at the concrete delivery point. This should at least include established hand signals and should include radio contact.

## DANGER ZONE AROUND THE PUMP

The area around the pump is dangerous due to the trucks backing up to the pump hopper and the positioning of the discharge chute. No one should be in the area between a truck and a pump, particularly when backing up. Anyone guiding the truck back should be off to the side of the truck and visible to the driver at all times. Only competent personnel carrying out planned and routine tasks should be in this area. Always maintain a distance of 600mm or more between all vehicles and the pump.

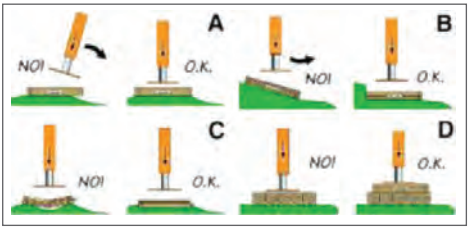
## PUMP HOPPER CONCRETE LEVEL

When the concrete level in the pump hopper become too low, the concrete pump could ingest air. This can lead to air compressing in the pipe and discharging with explosive force from the flexible hose, resulting in a dangerous whipping action. At start up and when the pump ingests air, all persons must be clear of the exclusion zone, which is twice the length of the flexible discharge or placing hose. ■

# Boom pump outriggers
## safe setup

**TIPPING ACCIDENTS WITH CONCRETE BOOM PUMPS MOST OFTEN RESULT FROM:**

- Inadequate cribbing
- Misjudging the soil
- Poorly compacted soil
- Setting up too close to excavations or back-filled areas
- Hidden voids
- Washouts
- Natural or man-made voids




*Do's and Don'ts of outrigger stabilisation*

Setting the outriggers of a concrete pump with a placing boom is one of the most critical jobs of the concrete pump operator and should always be done in accordance with the manufacturer's recommended procedure. If not done properly, it can lead to a serious accident. Tip-over accidents can be avoided if people take precautions when the unit is set up. Both operators and contractors must be aware of the potential danger that exists when a large boom is unfolded and extended over outriggers. If the contractor remembers to offer additional cribbing and if the operator remembers to ask for it when it isn't offered, the problem can be minimized before the boom is even extended.

**HERE ARE SOME RULES TO FOLLOW WHEN SETTING OUTRIGGERS:**

- Do not set the outrigger on uneven soil. If necessary, reposition the unit or level the soil
- Do not set the outrigger on a hill. The force of the machine weight must be transmitted straight down, otherwise the outrigger load would be partially down and partially sideways, putting undue strain on the outrigger leg
- Do not bridge a hole with outrigger cribbing. If there is no soil contact over the hole, the pressure on the ends of the pad is much greater. The soil could give way or the cribbing could break
- If you determine that you need five pieces of cribbing to support the load but the foot only touches three of them, the outrigger will sink into the soil. To avoid this problem,

sapsda

*Southern African Pump Systems DEVELOPMENT Association*

# Sustainable development of the pump and related industries including all participants by:

## Providing skills and training

Provide training for people involved in the industry
Provide a platform where the "experienced" can hand over their skills and knowledge to the "young".

## Providing networking opportunities

Provide a platform for Suppliers, manufacturers, end users, employers and labour to meet informally and develop an understanding of each other's challenges within the industry and create symbiotic relationships.

## Encouraging transformation and local content

Encouraging transformation and local content through the creation of a peer-regulated certification process encouraging local content and transformation development without the sacrifice of sustainability.

**Contact us:**
Lizanne Rennie (Association Administrator)
Mobile: +27(0)81 752 8629

E-mail: info@sapsda.co.za
Website: www.sapsda.co.za

lay dunnage the opposite direction on top of the first layer. The top layer of dunnage must contact all pieces that are supporting it
- When jacking, put the full weight of the truck on each outrigger, one at a time, and if the pad starts to sink, retract the foot and supply more cribbing. Continue this process until the outrigger appears stable and the pad shows no sign of sinking. Only then are you ready to unfold the boom
- If you can't get the outriggers to stabilize, do not unfold the boom. Relocate the pump to a location that will support the weight of the outriggers.


*The one-to-one rule*

## CRIBBING: MORE OR LESS?

- More is better
- The stronger the material, the better
- Pay close attention to the type of soil the unit will be set up.

## TRAINING

Every person in the chain of a pumping job has a responsibility to help protect the hose person and other nearby personnel. Education is the key, followed closely by diligent watchfulness and personal protective equipment. Educational materials are available from the American Concrete Pumping Association, and everyone involved in the concrete pumping process should be trained, including:

- Job superintendents
- Labour foremen
- Labourers
- Pump operators

## RESPONSIBILITIES

### Contractors

- One of the things a contractor can do to help is to order the right size boom. If the boom is too small, the operator may have to set up too close to an excavation to reach the pour; if the boom is too large, it will require much more cribbing than a smaller unit
- Have a place prepared for the pump before it arrives on the job
- Inform the pump operator of backfilled areas, soft or muddy areas, or underground obstructions
- Have cribbing near the setup area prior to the pump's arrival (including steel sheets if the soil is known to be bad)
- Monitor the setup; don't let the operator cut corners or take chances.

### Dispatcher

When the contractor calls to order the pump the dispatcher should:

- Learn the size of pump that is needed and send that size if possible
- If availability means that a unit that is larger or smaller than necessary will be sent, warn of possible complications
- Ask about soil conditions or underground obstructions.

### Operator

The operator is ultimately in charge and must make good decisions regarding setup, including:

- Use as much cribbing as practical; too much is better than too little
- Watch for all warning signs prior to setup
- Watch for sinking outriggers while unfolding the boom, and continue to recheck them throughout the day
- Keep people out from under the boom whenever practical.

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# Balancing the mix for the pump

'Pumpable' concrete is the predominant concrete used for large-scale projects, and has many advantages over conventional concrete.

Pumpable concrete simply refers to concrete which can easily pass through a pipeline without causing segregation or bleeding. One of the key advantages of building this way is the ease of transferring concrete directly from the mix site via the pump and into place. Other methods of placing concrete have inherent transport delays, and higher labour demands. Concrete pumps are designed in such a way as to minimise friction at the inner walls.

Ensuring the concrete is suitable for pumped application turns on the right balance of water to concrete: enough to ensure good flow, but no so much as to accelerate the water from the pump at a faster pace than the concrete. There should be sufficient water content available in the concrete for achieving good flow of concrete through the pipeline. If the water content is too high, the water is forced to move faster than the aggregates in concrete. This leads to the expulsion of water from concrete faster and creates clogging of aggregates of concrete.

## WHAT ARE THE REQUIREMENTS OF PUMPED CONCRETE?

1. The slump value recommended for good pumpable concrete ranges from 50mm to 150mm.

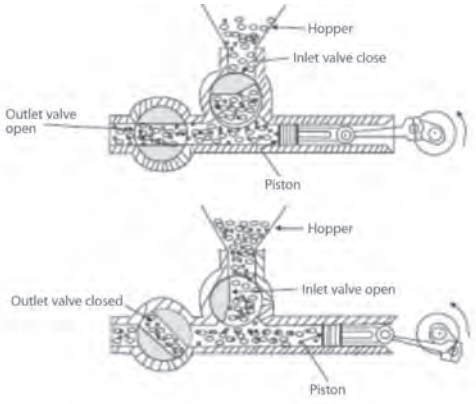
2. The water-cement ratio should not be too high. If the water content is too high, then the water alone will move faster along the pipe results in blocking of aggregates of concrete in the pipe.
3. The concrete should not be too wet or too dry.
4. The pumped concrete should not be sticky.
5. Air entrainment admixture is also helpful for the transmission of concrete.

## WHAT ARE THE TYPES OF CONCRETE PUMPS USED FOR CONCRETE PUMPING?

There are two types of pumps used for pumping of concrete: direct acting pump and squeeze pump.

## DIRECT ACTING PUMPS

Direct acting pumps are the commonly used types of pumps for pumping of concrete. They have a horizontal piston as shown in the below figure.




The concrete is fed into the hopper of the direct acting pump. The working of this type of pump is purely by reciprocal motion of the piston. From this motion, a suction pressure is created inside the pump.

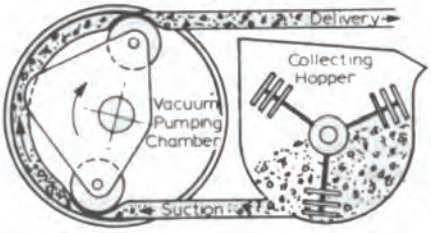
The working of the direct acting pump is such a way that, during the suction stroke the inlet valve opens while the outlet valve remains closed. During this process, the concrete will enter into the suction pipe from the hopper.

After the suction stroke, the inlet valves close and outlet valve open like in the above figure. During this process, the piston will push the concrete toward the pipe and this process continues.

The maximum size of aggregate used in the concrete for direct acting pump should less than 1/3 rd of the diameter of the pipe to avoid clogging. The motion of concrete always in the form of impulse. However, the output of the pipe should maintain a constant flow.

## SQUEEZE CONCRETE PUMPS

The second type of pump is squeezed concrete pumps. The squeeze concrete pumps convey concrete by squeezing its pumping tube installed in the cylindrical drum as shown in the below figure.




## DEALING WITH BLOCKAGES IN PUMPABLE CONCRETE?

The primary cause of blockage in pumps is due to the action of friction due to the aggregates and ingredients in the concrete on the pipe wall is very high.

The other cause is water is being forced out of the mix and causing accumulation of large particles inside the pipe. When choosing a right pump, you should take care of its length, the number of bents, the diameter of the pipeline, length of flexible hose etc. ■

### WATER TO CONCRETE RATIO CALCUTOR

Normally, the water cement ratio being between 0.4 to 0.6 as per IS standard.

We take 0.42 as a ratio of W/C.

Quantity of water = 0.42 x 50 = 21 Liters (1 bag cement = 50 Kg)

So the required quantity of water is 21 Liters per cement bag.

Thumb Rule?

**M15 Ratio 1:2:4**

Cement = 317 Kg (unit weight = 1440 kg/cum)

Sand = 638 Kg (unit weight = 1450 Kg/cum)

Blue Metal = 1478 Kg (unit weight = 1680 Kg/Cum)

Total = 316.8+638+1478 = 2433 Kg

Unit weight of Water = 1000 Kg

Water ratio = 1000/2433 = 0.41

By this method you can calculate the water-cement ratio for concrete.

# Checklist for concrete pumping

(Use this checklist to manage contact details, general site conditions, safety and equipment conditions and special concrete mixture notes.)

Project: .....

Location:.....

| 1. Contacts | | | | | |
|---|---|---|---|---|---|
| **Who** | **Name** | **Phone** | **Mobile** | **Fax** | **E-Mail** |
| C. Contractor | | | | | |
| RMC Supplier | | | | | |
| Pump Contractor | | | | | |

| 2. General Conditions | | | | |
|---|---|---|---|---|
| **Start Time** | **Pump:** | **am/pm** | **Concrete:** | **am/pm** |
| Placement Location | • Slabs | • Walls | • Footings | Other |
| Placement Rate ($m^3$/hr.) | | Volume ($m^3$) | | |
| Type of Pump | • Regular | • Z-Boom | • Telescoping | • Trailer |
| Size of Pump (m) | | Pipeline dia, mm | | |
| Pumping Distance (m) | Vertical | | Horizontal | |
| Slump/Air Spec | • Point of Discharge | | • Point of Placement | |
| Testing | • Point of Discharge | | • Point of Placement | |
| Priming Agent | • Grout | | • Slick Pack | |

| 3. Concrete Mixture | | | | |
|---|---|---|---|---|
| Strength (MPa) | 28 days: | | Other | |
| Max Size of Aggregate (mm) | (no larger than 1/3 pipeline diameter) | | | |
| Density (kg/$m^3$) | | Lightweight | Yes | No |
| Slump (mm) | | Air (%) | | |
| Water Reducer | Regular | MRWR | HRWR | |
| Fibres | Yes | No | | |
| Special Requirements | | | | |
| Set Time Requirements (hr.) | Initial: | | Final: | |
| Water Addition | Yes | No | | |
| Permitted | | | | |

| 4. Jobsite/Safety | | | |
|---|---|---|---|
| Wash Out Area | Yes | No | Location: |

PUMPING handbook

# HAZARDS, RISKS AND SAFETY



**Hazard** profiles

**Safe** pumping

**Personal protective** equipment

# Hazard profiles for concrete pumping


The major hazards relating to equipment and facilities as identified in the hazard profile for concrete pumping shall be adequately controlled. However, hazard identification and risk assessments shall always be completed to ensure that all local conditions are considered.

Ensuring safety in pumping begins with the identification of hazards and managing risks.

- A hazard is something that has the potential to cause harm to persons or the environment, damage to property or other loss
- The risk arising from a pumping activity is a combination of the potential consequence (harm etc.) and the likelihood that the consequence is realised
- Events are incidents that either a) could have resulted in realization but did not due to one or more factors (also known as a 'near-miss') or, b) consequences were realized and are known as accidents.

A typical example of a major hazard profile for pumping has been presented in Table1 below. However this hazard profile will differ from one operation to another due to changes in workplace design, equipment, physical conditions, project types and locations as well as other local factors. Therefore, the Group Company shall identify a hazard profile for pumping applicable to their operating conditions. It is recommended that a hazard profile for pumping activities be grouped under the OSHA categories of:

- Safety Hazards
- Work & Organizational Hazards
- Chemical Hazards
- Physical Hazards
- Ergonomic Hazards
- Biological Hazards

Once the hazard profile for the local concrete pumping operation has been established, the hazards shall be mitigated using a risk based approach. The concrete pumping process has been divided into the following three categories which also reflects the recommended management priority for a safe pumping operation:

1. Organisation and culture
2. Systems and processes
3. Equipment and facilities

## SYSTEMS AND PROCESSES

A safe concrete pumping business consists of a safe workplace, solid processes and competent people. While the previous section dealt with organisation and culture, this section deals with solid processes, via minimum standards and also recommended best practice. Systems and processes form the foundation of compliance. This aspect allows for sustainable continuous improvement by systems and processes that direct and guide actions in a systematic manner. This requires various forms of documentation. At best, a quality management system such as ISO 9000 would provide a suitable structure for the processes.

## RISK MANAGEMENT

Due to the nature of pumping activities, there are a number of hazards that need to be identified

in order to best mitigate the risks. While a number of these hazards are in common with other Holcim operations, the processes and activities associated with these risks need to be identified at the various stages of the operation. The minimum standards in this section are aimed at mitigating the risks presented by more significant hazards prevalent in concrete pumping.

## RISK ASSESSMENT

The challenges on a construction site vary from one job site to another requiring a basic risk assessment for each site to identify the hazards and their potential impact. Hazards of high significance highlighted by past incidents include vehicle and traffic movements, working at heights and working in the proximity of power lines. This makes it important for a basic risk assessment to be carried out by a competent person at each site where a pump is to be established for the first time. The risk assessment would identify the risk presented by any site specific hazards to be added to the pre-start-up check.

## HAZARD IDENTIFICATION AT ORDER TAKING

Potential hazards should be covered as a part of routine order taking involving concrete pumping and any potential hazard should be recorded on documentation that is visible to the supervisor and pump operator. The hazard should receive particular attention in the risk assessment for the first pump establishment on the site and subsequent observations and toolbox talks.

## OPERATOR OR SUPERVISOR SITE CHECK

Before establishing the pump on site, the supervisor or pump operator should be familiar with the risk assessment for the site. They should walk the relevant area on the job site and follow up with a toolbox talk. This should include making contact with the responsible person on site for the concrete placement and also involve aspects such as:

- Location and building of pipe lines
- Access to the structure/working at height
- Edge protection (or lack of) and openings when working at height
- Stability of working platform (scaffolding and formwork)
- Handling of the discharge hose
- Exclusion and danger zones
- Communication between the operator, drivers and placing team leader

## SAFETY OBSERVATION TOURS

In order to keep in touch with the conditions on site as well as the challenges facing the pump operators, managers and supervisors should conduct safety observation tours (SOT) and record observations of good practices and opportunities for improvement. This should include discussions with the responsible person for concrete placement on site and the pump operator as they are best placed to understand the potential risks involved. The observations should also include a basic assessment of the quality of scaffolding and support work to the formwork on the job site. Lack of cross-bracing, over extended jack screws and eccentric support loads on scaffolding that could lead to instability and potential collapse of a concrete deck during placing and put the lives of the pump operator and crew at risk. The SOTs should form part of the pump managers OH&S KPIs.

## RESOLUTION OF UNSAFE SITE CONDITIONS

Where a risk assessment or site observation has assessed that it is unsafe to proceed with work, a manager or competent supervisor shall stop the pumping operation, assess the situation and resolve the problem by implementing safe interim controls to reduce the risk to an acceptable level, or escalate the issue to their line manager for further instruction. ■


# Safe concrete pumping

A safe concrete pumping business consists of a safe workplace, solid processes and competent people. While the previous sections dealt with organisation and culture as well as systems and processes, this section deals with equipment and facilities fundamental to a safe working environment. In terms of the evolution of safety maturity, equipment and facilities are actions usually implemented ahead of organisation, systems and process activities. This is likely as a result of safety of equipment and facilities being more tangible and visible. However, while this section is generally not as effective in terms of the hierarchy of controls, it represents the foundation for continuous improvement, compliance and cultural change

## CONCRETE PUMPING EQUIPMENT

This section focuses on hazards relating to pumping equipment rather than the tasks related to the pumping activity. Moving and rotating pumping machinery are some of the major hazards that must be controlled in concrete pumping. In addition to the hazards related to trucks on the road, a truck mounted concrete pump has outriggers and a boom that unfolds in various configurations and rotates about its mounting point. The pump and pipes operate at high pressure to enable the concrete to be pumped through the pipeline. The pumping process and dynamic loads imposed on the boom and other components result in the potential for serious injury and even fatalities to operators and associated work teams.

The pump is usually in close proximity to Ready-mix truck drivers, construction workers and members of the public. As a result, operators shall be certified to be competent in the control of their equipment, including the use of remote controls and in the associated safety controls required to ensure safety in the operation of pumping equipment.

## MOBILE PUMP

Most concrete pumps are mounted on a standard truck chassis and the weight imposed by the pump is usually close to the maximum carrying capacity of the vehicle. The choice of vehicle shall comply with the Gross Vehicle Mass (GVM or in some states, the Gross Vehicle Weight

rating GVWR) and maximum allowable axle loads stipulated by the applicable legislation. The specification of the truck including the mounted pump and boom shall comply with applicable road traffic and vehicle legislation. The legality of all vehicles shall be verified before first being put into service, especially where they have been imported or are pre-used.

The declaration of conformity shall be a requirement of the conditions of purchase or where the vehicle is not new or belongs to a third party, shall be obtained from a competent service provider before the vehicle is put into service. The associated risks could include brake failure, steering failure, suspension failure, tire failure, impact from protruding equipment, pipe and boom failure.

Planned inspections and preventative maintenance are important for the safe operation of mobile pumps and should be carried out at the intervals and using the methods as recommended by the manufacturer. An example of advanced inspection methods is crack detection using the die penetration or magnetic particle tests associated with the age of the pump and volume of concrete pumped or hours worked. The competent service provider should be the pump equipment supplier (or suppliers approved agent or service provider) and should be a Holcim vendor. The boom inspection should include all structural aspects of the boom, including its mounting point, hinges and hydraulic ram connection points.

## CONCRETE HOPPER

The concrete receiving hopper has moving parts that agitate and guide the concrete into the two pump cylinders. Hopper grates (recommended max 70mm spacing and min 150mm above moving parts) act as a machine guard but also prevent large pieces of material from entering the concrete pump. The interlock must ensure that any opening of the grate for whatever reason would result in the pump machinery stopping and being isolated to prevent injury from contact with moving parts.

## MOVING PARTS AND OPENINGS

Piston action concrete pumps are fitted with various configurations of valve systems such as the Putzmeister S-valve. These valves have a guillotine like action when alternating between piston chambers. While pumping concrete, these valves are not accessible. However, when the discharge elbow is hinged open for cleaning or maintenance, the valves are within reach and present an extreme hazard when activated, particularly the earlier gate valve systems. The insertion of any article or reaching into the pipe is prohibited. For cleaning of the pump after use, manufacturer's recommendations need to be followed rigorously, including the retrieval of the sponge-ball. Due to the routine nature of this activity, there should be a documented safe operating procedure for pump cleaning.

## EMERGENCY SHUT-DOWN

In the event that something goes wrong such as a concrete pipe or hydraulic pipe burst, it is important for the pump to be shut down fast. The emergency stop needs to be visible and reachable at all times.

## TRAILER PUMP

It is important to ensure that trailer pumps are road legal and are fitted with suitable tow bars,

an effective braking system and road legal trailer lights. Tow bars, air or electronically activated braking and or lighting systems need to be compatible and matched with the tow vehicle. A double safety chain is required between the trailer and tow vehicle and the chains should be cross over each other when connected.

## TOW VEHICLE FOR A TRAILER PUMP

Trailer pumps could weigh between 2000 kg and 11000 kg with high pressure pumps in the 4000kg to 11000kg range. It is important to ensure that the tow vehicle used has sufficient towing capacity such as GVM, stability, power, traction and braking, suitable for the trailer it is towing, particularly for on road use. It is also important to ensure that the tow vehicle has a braking and lighting system that is compatible with the trailer pump, such as air or electrically activated systems. The tow vehicle and pump combination shall be certified to be road legal with the appropriate tow speed limitation which should be visible on the vehicle and trailer.

## PIPELINES

Various grades of steel and designs of pipes are manufactured for concrete pumping. For high pressure applications, particularly vertical pipelines, it is important to ensure that the pipes are designed for the pressures involved. For maintenance purposes, the minimum thickness for pipes will depend on the type of pipe (single or double skin), grade of steel, pipe diameter and maximum pumping pressure of the pump. The wear rate of the pipe is also higher near the ends of pipes, the bottom segment of a horizontal pipe as well as being far higher at the outside of pipe bends. Due to these variables, it is not feasible to provide a standard minimum pipe wall thickness and these need to be determined in conjunction with the pipe supplier for the type of pipe and application.

## SUPPLEMENTARY PPE

Additional PPE shall be supplied to the pump crew based on local risk assessments and the need for further risk control measures. Examples include non-slip soles for safety boots for icy underfoot conditions. A further example would be safety harnesses and restraints where there is no edge protection on job sites and where access cannot be avoided by the operator or crew. While this measure may be the least effective on the hierarchy of controls, it nevertheless has the potential to save lives. ■

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