



Mobile crane



Crawler crane



Telescopic boom EWP



Concrete placing pump



Excavator with vertical  
mast wick drain stitcher



Vehicle loading crane

# Safe support of mobile plant guide

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# Introduction

This guide provides industry with methods to ensure that ground conditions have been suitably assessed and that risks associated with plant overturning have been managed when operating mobile plant. Assessment should include management of ground conditions prior to the start of operations and ensuring outriggers are set up correctly.

Mobile plant includes:

- elevating work platforms (EWPs)
- mobile cranes:
  - hydraulic slewing cranes
  - lattice boom cranes
  - hydraulic pick-and-carry cranes
  - vehicle loading cranes
- mobile concrete placing booms
- piling rigs
- any other mobile plant where the risk of overturning may be high.

Ensuring there is adequate ground stability to support the load is a fundamental step in planning for mobile plant use. Procedures for ensuring that plant does not collapse into the ground or tip over are well documented in manufacturers' instructions. Plant operators may find additional information contained in industry best practice guides, codes of practice and Australian standards for mobile cranes or concrete pumps.

# Issues

Past incidents in Queensland include two fatalities involving the collapse of heavy mobile plant, where the primary cause was the subsidence of the ground beneath the mobile plant.

In 2012, a worker was killed after being struck by the vertical mast mounted on an excavator when the ground gave way, causing the unit to topple over.

In 2015, a photographer was killed after the EWP he was working from collapsed when one of the outrigger legs sunk into the ground.

Plant stability is reliant on many factors including:

- the stabilising moment of the plant
- applied moments from any load
- ground conditions
- ground slope
- wind.

## Types of mobile plant

Many models of EWPs, mobile cranes, concrete placing booms and telehandlers rely on the safe support of outrigger feet to prevent the plant overturning. Crawler cranes and excavators sometimes apply less pressure to the ground due to their track width and greater surface contact area with the ground.

## Hazards and associated risks

### Ground conditions

Ground conditions can vary dramatically from one workplace to another and from one part of the workplace to another.

Failure to address poor ground conditions to ensure mobile plant stability can lead to the plant overturning, with serious injury or death to the plant operator and others nearby.

Factors that affect the ability of the ground to provide adequate support include:

- the presence of water, including when it is mixed with the soil as mud and when it is under the surface (e.g. underground springs or streams)
- the type of ground (e.g. clay, sand, rock or a mixture of these)
- backfilled ground that was previously an excavation or trench
- cavities or penetrations in the ground that have been covered but still exist
- continued operation of the crane in one location
- rain, prior to and during operation of mobile plant including runoff that could undermine dunnage, outrigger pads or bog mats.

When mobile plant is being set up, the plant operator can only make a decision based on site information available (e.g. diagrams for underground pipework, electrical conduits and the surface of the ground).

Generally, rock provides the most stable supporting surface for the mobile plant. However, although rock may be present on the surface, it may not extend far below the surface. One way to establish how far rock may extend below the surface is to examine nearby excavations or trenches at the workplace. Rock that extends far below the surface provides a good indication of the ground's integrity, as long as the excavation you are examining is not too far from the plant. Bear in mind that additional risks must be managed when outriggers are positioned too close to an excavation.

Care must also be taken with ground that has a crust on its surface. The surface of this type of ground is usually harder than the ground underneath (see photographs 1 and 2). The harder surface may give the perception that the ground is more stable than it actually is. If the ground is punctured by an outrigger, or the end of a crawler track, the softer ground will be exposed, which may cause the plant to overturn.

Be cautious when the ground is made up of fill. Indicators that the ground contains fill include the presence of rubble (i.e. broken concrete, bricks, metal, and timber) and that the ground doesn't appear to be natural. Do not assume that because there are no obvious signs that the ground is soft that it can safely support the plant.

When mobile plant is continuously operated in one location the ground underneath the outriggers will compact. Additional care must be taken to ensure that the plant has not compacted the ground to the extent that the minimum overturning moment of the plant is reduced (i.e. the plant is more likely to overturn).

## Proximity to excavations and trenches

When mobile plant is set up close to excavations or trenches, there may be an increased risk of the sides of the excavation or trench wall collapsing, causing the crane to overturn. This risk increases with softer ground, and the presence of groundwater.

The risk of collapse is greater for vertical cuts in the excavation wall in comparison to walls that have been battered back at an angle. The presence of 'slippery back', where there is a naturally occurring slip plane such as a fracture in the ground, can also increase the risk of excavation or trench collapse.

Generally, the following principles should be applied when setting up mobile plant near excavations:

- Where the ground is compact and not crumbling, the distance of any part of the crane support timbers from the excavation should be at least equal to the depth of the excavation (1:1 rule).

For example, for a three-metre-deep trench in compact ground, the outrigger timbers or pads should be a horizontal distance of at least three metres away from the closest edge of the trench wall.

- Where the ground is loose or backfilled (i.e. crumbling), the distance of any part of the crane support timbers from the excavation should be at least twice the depth of the excavation (2:1 rule).



*Photograph 1: Outrigger pad on fill with no visual signs that the ground is soft.*



*Photograph 2: Outrigger pushed into soft ground after breaking through crust.*



*Photograph 3: Bog mat used to spread the applied load.*

## Short legging of outriggers

Mobile plant may overturn when the boom or counterweight are positioned towards the short-legged outrigger or stabilisers (see photograph 4).

Short legging is a practice that is often carried out due to one or more of the following factors:

- Restrictive set up areas for the mobile plant (i.e. presence of underground services and obstructions such as barriers, roads, and structures). A risk assessment and pre-planning of the job will significantly reduce the risk of mobile plant overturning.
- Unsuitable ground conditions for safe support of the outrigger feet (i.e. the ground is sloping, uneven or too soft).
- The mobile plant operator has a poor understanding of the safe work practices.

Operators and/or the person who conducts a business or undertaking (PCBUs) should not be pressured into setting the mobile plant up unless it is safe to do so. The hirer and/or principal contractor also have a duty to ensure that the mobile plant can be safely set up.



*Photograph 4: Concrete placement boom overturned when the boom slewed over short legged outriggers on one side of the vehicle.*

## Risk management

Work health and safety laws require a PCBU to manage all work health and safety risks, so that the health and safety of workers and other people are not affected by an organisation's conduct.

Risk management principles should be applied to the planning, pre-start and duration of works phases for the use of mobile plant at a workplace.

### Planning

- At the design and construction stages of the building, designers and specialist contractors should consider that adequate space must be available so that mobile plant required as part of the building process, can be safely set up and packed up.

- Ensure an assessment of ground conditions has been made in relation to the:
  - ground support required for the mobile plant
  - expected applied load.

Operators who make this assessment must be provided with suitable training, instruction and supervision to be deemed a competent person to make this assessment.

- Where work is to be carried out as part of a construction project and/or where a principal contractor (PC) is appointed, it is the PC's duty to ensure the workplace has been adequately prepared for the incoming mobile plant. This would include ensuring that a suitable assessment of the ground conditions has been carried out prior to the start of works. Section 13.1 of the Mobile Crane Code of Practice 2006 provides detailed information on the roles and responsibilities associated with mobile crane operation on a worksite. This information applies across all forms of mobile plant.
- Ensure that a safe work method statement (SWMS) has been prepared that shows the operating conditions under which the mobile plant can be used, including short legging. For concrete placement booms and truck mounted elevating work platforms, the SWMS is to include a diagram showing the permissible operating zone of the boom. For mobile cranes the load chart is to show lifting capacities of the crane with outriggers, including when outriggers are only partially extended. This load chart is to be complied with for all positions of the boom.
- Mobile plant owners should ensure that adequate timbers and/or pads are provided with the plant when it leaves the yard so that it can be set up safely on the ground type that exists on site. This may require sending another vehicle to site with the plant, if the additional timbers and pads cause the mass of the mobile plant to exceed allowable axle loadings specified by the relevant authority (i.e. Department of Transport and Main Roads). If the ground is particularly poor the PC may need to have the ground improved under the guidance of a geotechnical engineer.
- For operation of a mobile crane, following assessment of the ground conditions, the crane operator must select suitable support for the use of the outriggers. The crane operator must be competent to use calculation formulas provided by the manufacturer of the plant to determine the ground pressure that will be applied when the mobile plant is at maximum capacity. A reasonable approximation for maximum ground pressure applied by the outriggers can be determined by using calculations available in section 10.2.6 of the Mobile Crane Code of Practice 2006.
- Risk of plant overturning becomes greater as the size of the plant increases and/or the ground condition is poor. The best outcome is that a geotechnical engineer assesses the ground condition before the mobile plant is set up or travels over the ground. Sometimes a geotechnical engineer is required as part of the building process to assess the ground. If this is the case, the geotechnical engineer should be engaged to make an assessment of the ground in the location where the mobile plant is to be set up and the bearing capacity of the ground is to be provided to both the supplier of the mobile plant and the plant operator. Even if the geotechnical engineer assessment is not required as part of the building activity it is advisable to engage a geotechnical engineer wherever the bearing capacity of the ground is unsure. Further guidance on this topic is provided in the Mobile Crane Code of Practice 2006.



- In certain circumstances, such as the use of crawler cranes or heavy mobile plant, it may be necessary to pre-load the ground in addition to geotechnical testing, to test the ground conditions for mobile plant before work begins. This is often achieved by loading the affected area and observing any deformation in the ground prior to the start of operations.
- Ensure that timbers are set up correctly and are of sufficient bearing area to support the mobile plant (see photographs 6 and 7).



*Photograph 7: Poor ‘pigstyng’ of timber supports.*

- Fiber blocks**

Block	Length	Width	Height	Material
1	200	100	100	Concrete
2	200	100	100	Concrete
3	200	100	100	Concrete
4	200	100	100	Concrete
5	200	100	100	Concrete
6	200	100	100	Concrete
7	200	100	100	Concrete
8	200	100	100	Concrete
9	200	100	100	Concrete
10	200	100	100	Concrete
11	200	100	100	Concrete
12	200	100	100	Concrete
13	200	100	100	Concrete
14	200	100	100	Concrete
15	200	100	100	Concrete
16	200	100	100	Concrete
17	200	100	100	Concrete
18	200	100	100	Concrete
19	200	100	100	Concrete
20	200	100	100	Concrete
21	200	100	100	Concrete
22	200	100	100	Concrete
23	200	100	100	Concrete
24	200	100	100	Concrete
25	200	100	100	Concrete
26	200	100	100	Concrete
27	200	100	100	Concrete
28	200	100	100	Concrete
29	200	100	100	Concrete
30	200	100	100	Concrete
31	200	100	100	Concrete
32	200	100	100	Concrete
33	200	100	100	Concrete
34	200	100	100	Concrete
35	200	100	100	Concrete
36	200	100	100	Concrete
37	200	100	100	Concrete
38	200	100	100	Concrete
39	200	100	100	Concrete
40	200	100	100	Concrete
41	200	100	100	Concrete
42	200	100	100	Concrete
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72	200	100	100	Concrete
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74	200	100	100	Concrete
75	200	100	100	Concrete
76	200	100	100	Concrete
77	200	100	100	Concrete
78	200	100	100	Concrete
79	200	100	100	Concrete
80	200	100	100	Concrete
81	200	100	100	

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- Crawler type mobile plant is sometimes assumed to apply an even pressure at any point where the tracks are in contact with the ground, this is rarely the case. When a load is being carried by a crawler crane, the weight distribution will be biased towards the front of the crane. When there is no load, the bias will be at the back of the crane due to its counterweights. Load bias will also be greatly affected by the working radius of the crawler crane.



*Photograph 8: Load biased over the front of the crawler crane has caused the ground to subside.*

## Duration of works

- Ensure exclusion zones are maintained and that unauthorised personnel are kept away from the plant and associated equipment. Exclusion zones should include the maximum radius envelope of the plant (i.e. the maximum extension of a boom from any tipping point on the plant).
- Regularly inspect the ground to ensure that continuous operation of the crane has not compressed the ground to the extent that further operation of the crane will be unsafe.
- Continuously monitor the site to ensure changes in ground conditions are managed.

Operators of mobile plant must ensure the crane is operated in accordance with the plant manufacturer's instructions.

## Training and supervision

All operators of mobile plant must receive training in the use of the specific equipment they are required to operate. When the mobile plant is used as a mobile crane, the operator of the mobile plant may require additional training and competencies. In some circumstances, the operator of the mobile plant may also need to hold the appropriate high risk work licence class.

Information, training and instruction for mobile crane operations should include:

- documented work procedures to be used in the setting up and safe operation of mobile crane activities
- method for inspection and maintenance of mobile cranes
- knowledge of the crane manufacturer's operation and service manuals
- correct use, care and storage of personal protective equipment
- correct use, care and storage of tools and equipment
- compliance with electrical safety practices
- procedures to be adopted in the event of accident or injury.

Mobile plant operators should also be assessed on their ability to determine adequate ground conditions to support the setup of mobile plant to prevent the risk of plant overturning or collapsing.

Mobile plant operators must also attend familiarisation and refresher training. Refresher training should include a demonstration of competency and be conducted at intervals not exceeding three years.

Supervisor and management training must also be provided to help ensure that the supervision and management of the health and safety issues are appropriately carried out in the workplace.

# Further Information

## Legislation and codes of practice

- *Work Health and Safety Act 2011*
- *Work Health and Safety Regulation 2011*
- *Mobile Crane Code of Practice 2006*
- *Concrete Pumping Code of Practice 2005*
- *Managing Risks of Plant in the Workplace Code of Practice 2013*

## Australian Standards

- AS 2550.1 – 2011 Cranes, Hoists and Winches – Safe Use – General Requirements
- AS 2550.10 – 2006 Cranes, Hoists and Winches – Safe Use – Mobile Elevating Work Platforms
- AS 2550.15 – 1994 Cranes – Safe Use – Concrete Placing Equipment
- AS 2550.10 – 2016 Cranes – Safe Use – Mobile Cranes

## Safe Work Australia

- *Guide to mobile cranes*

## Safety alerts

- *Support of mobile plant on outriggers*
- *Risks of short legging when using mobile plant*

Further information is available at [\*\*worksafe.qld.gov.au\*\*](http://worksafe.qld.gov.au).

