

Risk management

Mobile cranes overturning on construction sites

A guide to loss prevention



Most incidents are as a result of inadequate planning, unclear responsibilities or unsafe use.

Each year, a number of mobile cranes overturn on construction sites causing serious accidents. This often involves personal injury, significant property damage and potential business interruption claims.

This guidance document aims to provide supporting information to assist in preventing the overturning of mobile cranes. There are different types of mobile crane in which the specific operating instructions for a particular manufacturer and model of crane should be referred to. This guide does not attempt to cover the design of cranes, nor does it cover all aspects of lifting operations.

Further industry best practice guidance is included towards the end of this guidance document and the reader is strongly recommended to refer to BS 7121 and the guide C703 when planning mobile crane operations.

The hazards which increase the risk of an overturning occurrence are due to many various factors. These include;

- Unstable working platforms.
- Subsurface voids.
- High winds.
- Poor level of routine maintenance.
- Inexperienced crane operators and/or supervisors.
- Excessive loads.
- Underrated crane capacity
- Poor crane operation such as use of outriggers and bearing plates.
- Poor management and planning of the lifting operation.

Common terms and definitions

Mobile crane: a self-powered crane with a boom, which may be fitted on a mast (tower). It is capable of travelling laden or unladen, without the need for fixed runways. It relies on gravity for stability, with the chassis of the crane not having any capability to carry goods.

Crawler crane: an off-road mobile crane which travels on site. They are mounted on a tracked chassis. Lifting capacities are typically greater than for mobile cranes and movement around site is possible fully rigged. Crawler cranes are generally employed for longer durations and for undertaking routine lifts and movements over relatively short distances.

Lift plan: The appointed person who is to plan the lift should have adequate practical and theoretical knowledge and experience. The plan will address the risks highlighted within the risk assessment, resources required to complete the lift, and the procedures and responsibilities needed to ensure the safety of the lifting operation.

Permit to Lift: a formal process recording checks and approvals prior to confirming a lift may proceed.

Appointed Person: a key person with the training, practical and theoretical knowledge and experience required to plan and manage a lifting operation.

Crane supervisor: Appointed Person who controls the lifting operation and ensures that it is carried out in accordance with the Appointed Person's safe system of work.

Crane coordinator: person who plans and directs the sequence of operations of cranes to ensure that they do not collide with other cranes, loads and other equipment.

Crane operator: person who is operating the crane for the purpose of positioning loads or erection of the crane.

Slinger: person responsible for attaching and detaching the load to and from the crane and for the correct selection and use of lifting accessories. They are also responsible for initiating the movement of the load.

Signaller: person responsible for directing the crane driver to ensure safe movement of the crane and load.

Working platform: temporary geotechnical structure providing a stable working surface for mobile cranes, piling rigs and other heavy construction equipment.

Working Platform Certificate: a certificate which confirms the working platform has been properly constructed in accordance with the design, and that it will be adequately maintained to ensure its ongoing integrity. The certificate requires the signature of the main contractor on site and must be handed to the Appointed Person before lifting work commences. The certificate introduces a system for defining specific responsibilities, increasing safety awareness and highlighting the importance of maintaining the platform in good condition.

Hirer and contractor responsibilities

Hired Crane (hired and managed)	Contract Lift (fully contracted)
<p>The employing organisation (hirer) is responsible for:</p> <ul style="list-style-type: none">- Carrying out all work in accordance with BS7121 and Lifting Operations and Lifting Equipment Regulations 98 (LOLER).- The safety and welfare of crane operator.- The safe operation of the crane.- Supplying a qualified and competent Appointed Person.- Providing a qualified and competent slinger / signaller and crane supervisor.- Planning the lift and operate a safe system of work.- Producing risk assessment and method statement(s).- Ensuring that the crane hired is of a suitable type and capacity.- Ensuring suitability of working platform.- Verifying the credentials of the crane hire company and certification supplied.	<p>The employing organisation (hirer) is responsible for:</p> <ul style="list-style-type: none">- Allowing access to site to site for a full survey to be carried out for the risk assessment and method statement(s).- Informing crane owner of hazards which are not evident during site visit.- Supplying accurate information of the load to be lifted.- Provide information of the load(s) to be lifted.
<p>The crane owner (contractor) is responsible for:</p> <ul style="list-style-type: none">- Providing a suitable crane that is properly maintained, thoroughly examined, tested and certified.- Providing a CPCS qualified competent operator.	<p>The crane owner (contractor) is responsible for:</p> <ul style="list-style-type: none">- Providing a suitable crane that is properly maintained, thoroughly examined, tested and certified.- Providing a CPCS qualified Appointed Person.- Providing a qualified and competent slinger / signaller and crane supervisor.- Providing a CPCS qualified competent operator.- Providing risk assessment and method statement.- Organising and controlling the lifting operation.- Planning the lift and operation of the safe system of work.- Carry out all work in accordance with BS7121 and Lifting Operations and Lifting Equipment Regulations 98 (LOLER)

Key components in preventing the overturning of mobile cranes include:

Management and planning

The root cause of many overturning occurrences is due to poor management and planning of the lift. The following elements are vital to ensuring a lift is carried out safely and without incident.

1. Safe system of work

A safe system of work should be established and maintained for every crane installation operation and lifting operation. A safe system of work should include:

- Planning of the lifting operation including preparation of the lift plan. Selection, provision and use of a suitable crane(s) and work equipment.
- Any necessary preparation of a site for the lifting operation which may include entry / exit routes for the crane(s).
- Any rigging / derigging or setting up of crane, inspection, maintenance, thorough examination and testing of the crane(s) equipment ensuring reports are available.
- The provision of properly trained and competent personnel who have been made aware of their responsibilities under the Health and Safety at Work etc. Act 1974.
- Adequate supervision by properly trained competent personnel having the necessary authority.
- Prevention of unauthorised movement or use at all times.
- Coordination of crane movements to avoid collisions between cranes and other type of plant or structures.
- The safety of persons not involved in the installation or lifting operation and the need for the operator, unless in imminent danger, to remain in control of the crane throughout the lifting operation.

2. Selection and duties of personnel

All those involved in a lifting operation must be competent, adequately trained and aware of their duties which is detailed in BS7121-1. All crane

operators should hold a valid CPC card.

3. Appointed Person

The Appointed Person has overall

control of the lifting operation. Their responsibilities include:

- Planning of the lifting operation (including approval of risk assessments, lift categorisations and method statements), crane and lifting accessory selection, instruction, supervision and consulting with responsible bodies.
- Ensuring the outcomes of planning process are recorded in the lift plan.
- Ensuring adequate pre-operational checks, intermediate inspections, maintenance and thorough examination of equipment is completed.
- Taking responsibility for the organisation and control of the lifting operation.
- Ensuring the crane supervisor and other members of the lifting team are fully briefed on the contents, scope and limits of the method statement.

Being familiar with the relevant parts of the project health and safety plan where the lifting operation is being carried out on a site where the Construction (Design and Management) Regulations 2015 apply. Some of the duties, but not the responsibilities, may be delegated for simple lifts. The Appointed Person should consult with other experts including temporary works engineers and crane suppliers.

4. Crane maintenance

The crane(s) should be in a satisfactory condition and operating order at all times. Planned maintenance should be undertaken in line with manufacturers instructions and thorough examinations completed. The report of thorough examination, test certificates and documentation in place should be available for review. Detailed requirements are included in BS7121

and within Lifting Operations and Lifting Equipment Regulations and Provision and Use of Work Equipment Regulations.

5. Contract lift vs crane hire

An organisation that requires a load to be moved, and does not have its own craneage, has two options. These are; crane hire or the employment of a contractor to carry out the lifting operation (Contract lift). If an individual or organisation does not have expertise in lifting operations, they should not hire cranes but should opt for the contract lift option. Insurance arrangements should be clarified. A summary of the options can be found in the table on page 3.

6. Complexity of lift

The duties and extent of planning involved for a lift will vary depending on the complexity.

Lifts are categorised as follows;

- Basic,
- Intermediate or
- Complex

The categorisation is a function of the level of hazards present within the area of the crane operation, which are established through the risk assessment process. Detailed guidance is further provided within BS 7121-1.

7. Risk assessment and method statement

An essential element of any crane operation is the production of a risk assessment and method statement. The risk assessment should be carried out by the Appointed Person and identify the hazards and risks associated with the lifting operation. Reference should be made to the overall site risk assessments included in the CDM Construction Phase Plan CIC80. The Appointed Person should ensure that a full method statement is prepared, detailing the safe system of work and control measures for the lifting operation. A 'Permit to Lift' is a useful

mechanism to ensure all pre-lift checks are undertaken.

8. Crane selection and access

The choice of a suitable mobile crane is governed by a number of factors including the characteristics of the load to be lifted (weight and dimensions), radii, heights of lifts, areas of movement, frequency and types of lifting operations, length of time on site, ground conditions and space available for access, erection, travelling, operation and dismantling.

9. Crane Siting

The siting of the crane should take into account the crane standing and support conditions, the effect of wind and the adequacy of access to allow the placing or erection of the crane in its working position. This will also include dismantling and removing from site.

Particular care needs to be taken when siting mobile cranes in or near the high risk areas, for instance at the edge of open trenches and excavations as these are likely to collapse without warning (see C703). An engineering assessment by a competent

geotechnical engineer is required before setting up in such a location.

10. Checklists

The management, planning and execution of a crane lift has to take into account many aspects. It is recommended that the use of checklists and pro-formas are employed to ensure all aspects are addressed. These may include (but not limited to) key elements of the safe system of work, the load and the lift, the location, specifying and operating teams, the crane, the lifting gear and any temporary works. Sample checklists are included in C703.

The mechanism of overturning is often as a result of a failure of the ground or supporting structure beneath the crane or the crane outriggers. The following aspects are key to ensuring an adequate foundation is provided.

11. Site categories and underground hazards

Sites can be split into a number of categories to highlight the most likely hazards that need to be considered and risk assessed. More attention is required to establish

the strength of the ground where ground conditions are poor or where there is a lack of data on the nature of the subsoil.

Typical categories include:

- Greenfield sites - particular problem areas are adjacent to rivers, estuaries and floodplains where soft alluvial deposits and high groundwater tables can be expected.
- Beaches - low sand density and a variable groundwater level can create difficult conditions.
- Brownfield sites - unknown previous use including basements, storage tanks, poorly-filled open pits and poorly-compacted fill, etc.
- Paved areas - tarmacked or paved areas can appear deceptively strong but lead to outriggers perforating through weak surfacing. Lightly-trafficked car parks, estate roads and footpaths should be scrutinised.
- Town centre sites - consider underground hazards including services, drainage pipes, buried cables, basements and tunnels beneath paved areas. This can lead to outriggers perforating in to the void below.



12. Ground investigation

Before a crane arrives on site, existing information on the nature of the soils should have been investigated. Reference should be made to any existing site ground reports, and particular attention paid to the character of the ground at shallow depths where the mobile crane(s) will be sited.

13. Ground bearing capacity

An assessment of the ground bearing capacity is required to determine the size and type of crane foundation required. This can be calculated with reference to the ground investigation reports and should be carried out by a competent geotechnical engineer. It should be noted that the presence of water tends to reduce the strength of soils and can lead to a reduced capacity, since the initial bearing capacity assessment.

14. Settlement

Settlement must be kept to a minimum to avoid the slew ring being out of the horizontal resulting in the jib not being in a vertical plane. This can result in side loads on the jib and possible failure of the jib.

Excessive settlement can also attract additional loading onto the outriggers or tracks that is settling. Level indicators and inclinometers should be utilised. If settlement occurs, then the foundation will need to be reassessed.

15. Working platforms and design

A working platform may be required to provide a designated area of the site over which mobile and crawler cranes can travel during their delivery and movement around the site, lifting operations and removal. The design, installation, maintenance and repair of the working platform should be the responsibility of the main contractor.

The appointed person should consult with a temporary works engineer on the detailed requirements. The platform should be free-draining to prevent the build-up of water. In certain cases, separation/filter membranes may be required beneath the platform. Appropriate factors of safety should be employed in the design and regular checks undertaken to ensure the platform is not disturbed by other construction activity.

Excavations, trenches, or other holes should be suitably backfilled to avoid creating soft spots. The edge of the platform needs to be clearly defined and ground preparation should extend beyond the working area required.

16. Working Platform Certificate

Consideration should be given to using a 'Working Platform Certificate' to ensure that the correct procedures have been followed, the ground is adequate to support crane activity and that there are no irregularities that could result in local subsidence or toppling. Further detailed guidance on working platforms for tracked plant and a sample working platform certificate is available from the Federation of Piling Specialists.

The issue of a 'Working Platform Certificate' should be an aspect of the 'Permit to Lift'.

17. Outrigger foundations

The crane outriggers should be extended and the tyres lifted clear of the ground.

The outrigger feet are relatively small and transfer high pressures on the ground. The pressure can be reduced by the provision of suitable spreader mats which, depending on the allowable bearing pressure of the subsoil, could consist of timber mats, timber and ply plates, proprietary mats, steel grillages, concrete pads or piles (for high loads in weak soil conditions). Calculations will be required and the Appointed Person should consult with the temporary works design engineer and crane supplier. Outriggers should always be positioned central to the spreader mats, which should be in contact with the ground over its entire surface area.

A useful best practice guide and pro-formas on producing a risk assessment and method statement for a contract lift is available from the CPA Crane Interest Group (www.cpa.uk.net).

References and guidance:

- BS 7121-1:2016 - Code of practice for safe use of cranes (www.bsigroup.com)
- BS 7121-3:2017+A1:2019 - Mobile cranes
- CIRIA Publication C703:2003 - Crane stability on site (www.ciria.org)
- BRE Report 470 - Working platforms for tracked plant (www.brebookshop.com)
- CPA/Crane Interest Group - Best Practice Guide for Risk Assessment and Method Statement for a Contract Lift: 2018 (www.cpa.uk.net)
- Working Platform Certificate (www.fps.org.uk)

Disclaimer: The guidance in this document refers to industry best practice loss control advice. Adoption of the advice contained within this document does not imply compliance with industry, statutory or HSBEI guidelines, nor does it guarantee that related losses will not occur.

Case studies

Case study 1

Two construction companies were prosecuted by the HSE following the overturning of a 35-tonne truck-mounted telescopic crane on site. The collapse occurred after one of the outriggers, which supported the crane, sank into the ground.

The crane driver was forced to leap to safety and the 5.7-tonne beam that was being lifted into place narrowly missed two employees as it fell. The principal contractor and crane operator were both fined and ordered to pay substantial costs.

The incident could have been avoided had the planning and supervision of the lifting operation not been so deficient. The crane overturned because it was being operated, with the knowledge of both companies, in a part of the site that had not been prepared for such activities. The roadway was not wide enough to accommodate the outrigger



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spread of the crane. Clear warnings were ignored in the run-up to the incident about the ground bearing capacity for the use of cranes on the

site. The risk assessments which had been produced were inadequate as they only considered use at a completely different part of the site.

Case study 2

The principal contractor and crane hire company were ordered to pay a substantial fine and costs after a serious communications failure led to a mobile crane toppling over on site.

The extended 50-metre jib fell across the site, narrowly missing workers and a nearby busy road.

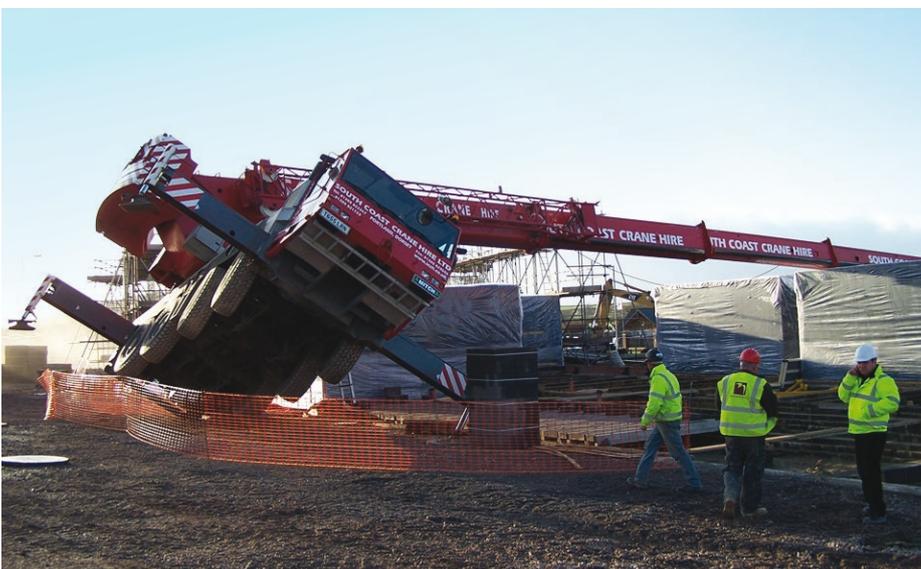
The 80-tonne crane was supplied and operated by the crane hire company

but confusion arose as to whether the job had been set up on a 'crane-hire' only or 'contract-lift' basis (where planning of the lifting operation is included).

This meant both firms neglected the planning of the lift and led to vital roles for the job not being assigned.

A competent person should have been appointed to plan the lift, either provided by the crane hire company if it was a contract hire arrangement or by the hirer if it was a hire-only agreement. The crane hire company should have ensured this happened when it set up the contract.

Important information — including the weights being lifted and ground conditions — were not passed on to the workers involved. The crane was overloaded and was being operated on poor ground. A larger crane and ground mats to spread the load of the crane's outriggers should have been used.



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Hazards and mitigation

Overturning hazard

Controls to mitigate the risk

Failure of the ground

Unstable/uncompacted working surface

Undertake a suitable and sufficient site investigation to determine the nature of the ground conditions. Ensure a suitably designed and compacted working platform is installed and maintained.

Underground hazards including services, drainage pipes, buried cables, basements and tunnels, etc. beneath paved areas

Obtain existing services drawings and undertake trial pits, probing and cable detection to identify all buried services and voids.

Open excavations and slopes

Ensure crane is set up a suitable distance from the edge of open excavations and slopes.

Poor ground conditions – adjacent to rivers, estuaries, marshes, floodplains, beaches, landfill sites and areas with a high groundwater level

Undertake a suitable and sufficient site investigation to determine the nature of the ground conditions. Monitor groundwater and soil saturation levels. Ensure a suitably designed and compacted working platform is installed and maintained. Use suitable bearing plates beneath outriggers.

Management and planning failures

Inexperienced supervisors and crane operators

Ensure only competent, trained persons are employed (see BS 7121-1). Consider a Contract Lift if competence of supervisors is in doubt.

Unclear roles and responsibilities

Ensure key positions are established and individuals appointed detailing their roles and responsibilities.

Movement or set-up in unauthorised locations

Provide a sketch illustrating the permissible set-up location(s) and allowable access route(s). Prevent access to unsafe areas with barriers.

Uncontrolled lifting operations

Ensure all lifting operations are included within a Lift Plan, including a risk assessment, a method statement and a 'Permit to Lift'.

Incorrect factor of safety in design of working platform

Ensure a competent designer is employed and suitable Factor of Safety (FoS) used. Clarify if the design criterion refers to ultimate bearing capacity (ground failure) or allowable bearing pressure (including an FoS). See C703 for guidance.

Overloading

Load too heavy

Ensure the load to be lifted is not greater than permitted in the lift plan. The rated capacity indicator/limiter should be maintained in good working order.

High wind loading

Establish site wind speed limits (red/amber/green). Use an anemometer to monitor in-service wind speeds. Monitor weather forecasts. Adhere to manufacturers tolerances for wind speed.

Lifting radius too far

Stay within the agreed lifting location and radius. Avoid swinging of loads or travelling with high loads.

Mechanical failure

Poorly maintained crane

Ensure crane is regularly maintained in accordance with manufacturers instructions and in line with the Lifting Operations and Lifting Equipment Regulations (LOLER) and Provision and Use of Work Equipment Regulations (PUWER) requirements

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HSBEI-1307-0622-3

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