

I.S. 361 : 2010 – Draft Code of Practice for the Safe use of Tower Cranes & Self Erecting Cranes

In response to requests from industry, the Cranes Sub-Committee of the N.S.A.I. HSSCC has drafted a Code of Practice for the Safe Use of Tower Cranes & Self Erecting Cranes.

This Code of Practice gives recommendations for the safe use of tower cranes, including self erecting tower cranes. Subjects covered include: selection of tower cranes, planning the installation, erection, extension, maintenance, operation, and dismantling. It also covers the appropriate selection and training of personnel involved in the safe installation and use of tower cranes.

The Committee has completed the first phase of its work and the draft is now undergoing a public enquiry. **The enquiry period will run from 29th July 2010 to the 1st October 2010.** All comments received by the NSAI during that period will then be considered by the Cranes Subcommittee.

Submissions using the NSAI comments template (available from NSAI website www.nsai.ie) should be returned to NSAI no later than 5pm on Friday 1st October 2010 to:

therese.clarke@nsai.ie

Finally, NSAI wishes to acknowledge and thank the members of the Cranes Sub-Committee and its Chairman, Mr. John Colreavy, for the commitment and input made to date.

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Draft for Public Comment

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Enquiry period: 29th July 2010 to 1st October 2010

Please send your comments on the comments sheet available on www.NSAI.ie to:

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Technical Secretariat

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Foreword

The code was drafted by Subcommittee 2 of the NSAI Committee on the Safety of Cranes in consultation with various organizations.

SCHEDULE

Code of Practice: Tower Cranes and Self Erecting Cranes

1 Scope

This Code of Practice gives recommendations for the safe use of tower cranes, including self-erecting tower cranes.

Subjects covered include selection of tower cranes, planning the installation (including site specific design work, e.g. base and ties), erection, extension (including climbing), maintenance, operation, and dismantling,. It also covers the appropriate selection and training of personnel involved in the safe installation and use of tower cranes.

2 References

This Code of Practice incorporates by dated or undated reference, provisions from other publications. These references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies (including amendments).

Safety Health and Welfare at Work Act 2005

Safety Health and Welfare at Work (General Applications) Regulations (S.I. No. 299 of 2007)

Safety Health and Welfare at Work (General Applications) Amendment (S.I.No 732 of 2007)

Safety Health and Welfare at Work (Construction) Regulations (S.I.No. 504 2006)

Railway Safety Act 2005

I.S.EN 471, *High-Visibility Warning Clothing*.

I.S.EN 61000-6-2, *Electromagnetic compatibility (EMC)*.

I.S. E.N. 12077-2, *Crane Safety – Requirements for health and safety – Part 2- Limiting and indicating devices*

I.S. E.N. ISO 13857, *Safety Of Machinery - Safety Distances To Prevent Hazard Zones Being Reached By Upper And Lower Limbs*

I.S. EN 13586, *Cranes – Access*.

I.S. EN 1991-1-4, *Eurocode 1:Actions on Structures: Part 1-4: Wind Actions*.

I.S. EN 14439 2006, *Cranes – Safety- Tower Cranes*.

I.S. E. N. 62305-2, *Protection Against Lightning - Part 2: Risk Management*

I.S. E. N. 62305-3 *Protection Against Lightning - Part 3: Physical Damage To Structures And Life Hazard*

I.S. E. N. 62305-4, *Protection Against Lightning - Part 4: Electrical And Electronic Systems Within Structures*

ISO 12480 – 1, *Cranes – Safe use – Part 1: General.*

ISO 12482 – 1, *Cranes – Condition monitoring – Part 1: General.*

ISO 7296-1, *Cranes graphic symbols - part 1: general*

ISO 3056, *Non-calibrated round steel link lifting chain and chain slings — Use and maintenance.*

ISO 4301, *(all parts), Cranes — Classification.*

BS 7121-1, *Code of practice for Safe use of cranes, Part 1. General.*

BS 7121-3, *Code of practice for Safe use of cranes, Part 3. Mobile cranes.*

BS 1757, *Specification for power-driven mobile cranes.*

BS 449-2, *Specification for the use of structural steel in buildings — Part 2: Metric units.*

BS 5950-1, *Structural use of steelwork in building — Part 1: Code of practice for design — Rolled and welded sections.*

BS 6968, *Guide for use and maintenance of non-calibrated round steel lifting chain and chain slings.*

I.S. EN 473, *Non-destructive testing — Qualification and certification of NDT personnel — General principles.*

I.S. EN 45004, *General criteria for the operation of various types of bodies performing inspection.*

BS 7430 , *Code of Practice for Earthing*

CIRIA publication C703 - *Crane Stability on Site.*

CIRIA publication C654 - *Tower Crane Stability FEM (The European Federation of Materials Handling) 1.004 Recommendations for the calculation of wind loads on crane structures.*

FEM (The European Federation of Materials Handling) 1.005, *Recommendation for the calculation of tower crane structures in out of service conditions.*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply

appointed person

Competent person who has overall control of the crane operation(s) and acts on behalf of the employing organisation requiring the load to be moved

approved form

a form approved by statute or under contract

climbing

increasing or decreasing the tower height of a crane using a means other than another crane

competent engineer

person who has such theoretical knowledge and experience of the design of the lifting equipment as enables them to assess the design of tower crane bases, ties and supporting structure connections, together with the adequacy of supporting structures to take the loads imposed by the crane

competent person

person who has such practical and theoretical knowledge and experience of the crane and the equipment used in the lifting operation as is necessary to carry out the function to which the term relates in each particular context

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 (e.g. concrete placing booms, tele-handlers, piling rigs)

crane operator

person who is operating the crane for the purpose of positioning loads or erection of the crane

NOTE Sometimes referred to as “crane driver”.

crane supervisor

person who controls the lifting operation, and ensures that it is carried out in accordance with the appointed person’s safe system of work

employing organization

person or organization who requires a lifting operation to be carried out and is responsible for safe use of the crane

NOTE In the case of a hired crane the degree of the employing organization’s responsibility for the safe use of the crane depends on whether the crane is being supplied under a crane hire contract or a part of a contract lift.

erector

person who erects, modifies or dismantles a conventional tower crane

erection supervisor

person in control of a team of tower crane erectors on site

indicator

device which provides warnings and/or data to facilitate the competent control of the crane within its design parameters

inspection body

employer of the competent person(s) who provide examination and testing services

NOTE Where the person is self employed, the term may also apply to that person

installation

group of activities associated with the erection, alteration and dismantling of a tower crane

lifting

any movement of loads or persons that includes a change of height

basic lift

lifting operation where the weight of the load(s) can be simply established, and there are no hazards or obstructions within the area of the operation

standard lift

lifting operation where there are hazards, either within the working area of the crane or on the access route to the working area

complex lift

lifting operation which includes cranes using load enhancement equipment, lifting of persons or when the lifting operation is at a location with exceptional hazards

lifting equipment

work equipment (crane) for lifting or lowering loads, including attachments used for anchoring, fixing or supporting the load

load

weight which is lifted by the crane

NOTE If cranes are used to lift loads from water, the load could also include forces due to water flow or suction.

lifting accessory

equipment from which the load can be suspended

NOTE Also known as accessories for lifting.

method statement

document produced by the appointed person to describe how the crane installation or lifting operation is to be carried out

project supervisor construction stage/project supervisor design stage

NOTE see Safety, Health and Welfare at Work (Construction) Regulations (S.I. No. 504 2006).

radius

horizontal distance between the point at which the axis of rotation meets the ground and the vertical centreline passing through the hook

NOTE For non-slewing cranes, the horizontal distance from the centreline of the hook to the centreline of the nearest bogie or axle, bogie or track, measured at ground level, can be assumed to be the radius.

radius indicator

device that shows the radius at which the crane is operating

rated capacity

load that the crane is designed to lift for a given operating condition (e.g. configuration, position of the load)

NOTE The rated capacity was formerly known as "safe working load"

rated capacity limiter (RCL)

device that prevents the crane from being overloaded

senior erector

erector with sufficient experience and additional skills to enable them to work with and directly oversee a trainee erector

service conditions

in service or out of service

in-service

condition where the crane is handling loads not exceeding the rated capacities within permissible wind speeds and other conditions as specified by the manufacturer

out-of-service

condition where the crane is either not required for use or is out of use, without a load on the hook and in conditions as specified by the manufacturer

NOTE These conditions may include a higher wind speed than that permitted for the in-service conditions.

signaller

person responsible for directing the crane operator to ensure safe movement of the crane and load

slinger

person responsible for attaching and detaching the load to and from the crane, for correct selection and use of lifting accessories in accordance with the specifications of the appointed person and for initiating the movement of the load

trainee erector

person undergoing training in the erection of cranes and working at all times under the direct supervision of a senior erector

testing - functional testing

operation of each motion of the appliance without a load applied in order to determine whether the equipment performs as the manufacturer intended

testing - performance testing

operation of each motion of the appliance with the rated load applied in order to determine whether the equipment performs to the manufacturer's specification

testing - overload testing - static

operation of the appliance with a load exceeding the rated load applied but without operating the full range of motions of the appliance in order to determine whether the appliance is stable, structurally sound and fit for the use for which it was designed

testing - overload testing - dynamic

operation of each motion of the appliance with a load that exceeds the rated load applied in order to determine whether the appliance is stable, structurally sound and fit for the use for which it was designed

testing - non-destructive testing (NDT)

testing carried out on the structure of the appliance to establish the presence, location and extent of any defects that can affect the integrity of that structure

NOTE The techniques employed for non-destructive testing are such that they do not damage or alter the material under test. NDT is also known as non-destructive examination (NDE)

thorough examination

examination by a competent person in such depth and detail as the competent person considers necessary to enable them to determine whether the equipment being examined is safe to continue in use

NOTE The thorough examination is not part of the maintenance regime for the equipment but provides owners with information which could be used to determine the effectiveness of the regime. The competent person may require supplementary tests as part of thorough examination

tower crane - conventional

slewing jib type crane with jib located at the top of a vertical tower which is assembled on site from components

tower crane - self-erecting (SETC)

jib type crane with jib located at the top of a vertical slewing tower which is a pre-assembled unit transported to site and deployed from its travelling configuration for use

use

of work equipment activity of any kind involving work equipment

NOTE This includes starting, stopping, programming, setting, transporting, repairing, modifying, servicing and cleaning.

user organisation / user

competent person or organisation which has direct control over the lifting operation

weight

vertical force exerted by a mass as a result of gravity

zoning device

electromechanical/electronic device to control the area in which a tower crane works

4 Safe system of work

A safe system of work shall be established and followed for each of these phases. The safe system of work shall include the following:

- (a) A risk assessment

The Risk Assessments for the different phases should include the following issues, some of which may be common to a number of phases :

Erection phase

Delivery to site:

- traffic management,
- pedestrians,
- load security /stability,
- lifting from trailers,
- people on trailers (work at height),
- mobile crane deployment,
- lifts over people and property,
- overground and underground services,
- ground conditions,
- weather,
- certification of lifting equipment.

Erection Stage:

- falls from heights,
- competency/training/supervision,
- base design & strength,
- permit to erect,
- materials falling from a height,

- striking objects/people,
- exclusion zones,
- wind,
- daylight (sufficient),
- fatigue,

Use of Cranes

- people lifting,
- exceeding the rated capacity,
- instability – crane,
- weather – load constraints,
- failure of lifting accessories,
- striking – proximity hazards,
- work at height,
- unauthorised access,
- inspection and maintenance,
- competency,
- noise,
- fire – electrical,
- refuelling generators,
- electrocution,
- machinery – entanglement,
- slinging and signalling,
- fatigue.

Dismantling

- see Erection Phase but note that requirements may have changed,
- seized components,
- ease of access.

(b) Planning of the operation

All crane operations, including crane erection and dismantling, shall be planned to ensure that they are carried out safely and that all foreseeable risks have been taken into account. Planning shall be carried out by personnel who have the necessary expertise and are subject to appropriate supervision. In cases of repetitive or routine operations, this planning may only be necessary in the first instance, with periodic reviews to ensure that no factors have changed.

As part of the planning process, due consideration shall be given to the characteristics of the load, site conditions and other structures (including cranes) in the vicinity and the method of lifting.

- (c) preparation of a Method Statement for erection, dismantling and handling of complex loads.
- (d) selection, provision and use of suitable crane(s) and equipment, including lifting gear (with tag ropes where necessary) appropriate to the operation .
- (e) maintenance, examination and, where necessary, testing of the crane(s), checks, inspections etc. of crane(s) and equipment including completion of any approved forms.
- (f) provision of competent personnel who have been made aware of their relevant responsibilities and the responsibilities of other persons involved in the crane operation.
- (g) adequate supervision by properly trained and competent personnel having the necessary authority.
- (h) ensuring that all necessary certificates and other documents, in particular all approved forms, are available.
- (i) prohibiting unauthorised movement or use of the crane at all times.
- (j) ensuring the safety of persons not involved in the crane operation.
- (k) coordination with other applicable parties for appropriate approval compliance or cooperation in avoiding hazards or guarding against hazards.
- (l) establishing a system of communication which is understood by the persons involved in the actual lifting operation, including use of hand signals and two-way radio.
- (m) taking account of the hazards that may affect the safe movement of the load.
- (n) prohibition of the use of mobile phones by the driver when controlling a load while operating the crane.

The safe system of work shall be effectively communicated to all parties concerned.

National legislation for construction safety places duties on clients, designers and project supervisors to give proper consideration to the use of cranes.

5 Crane and bases

5.1 Types of tower cranes & self erecting cranes

5.1.1 General

Tower cranes have either a non-slewing or slewing tower. With a non-slewing tower, the slewing ring is situated at or near the top of the tower and the jib slews about the vertical axis of the tower, which itself remains stationary. With a slewing tower, the slewing ring is situated at the bottom of the tower and the whole of the tower and jib assembly slews relative to the base of the crane e.g. a "Self Erecting Tower Crane".

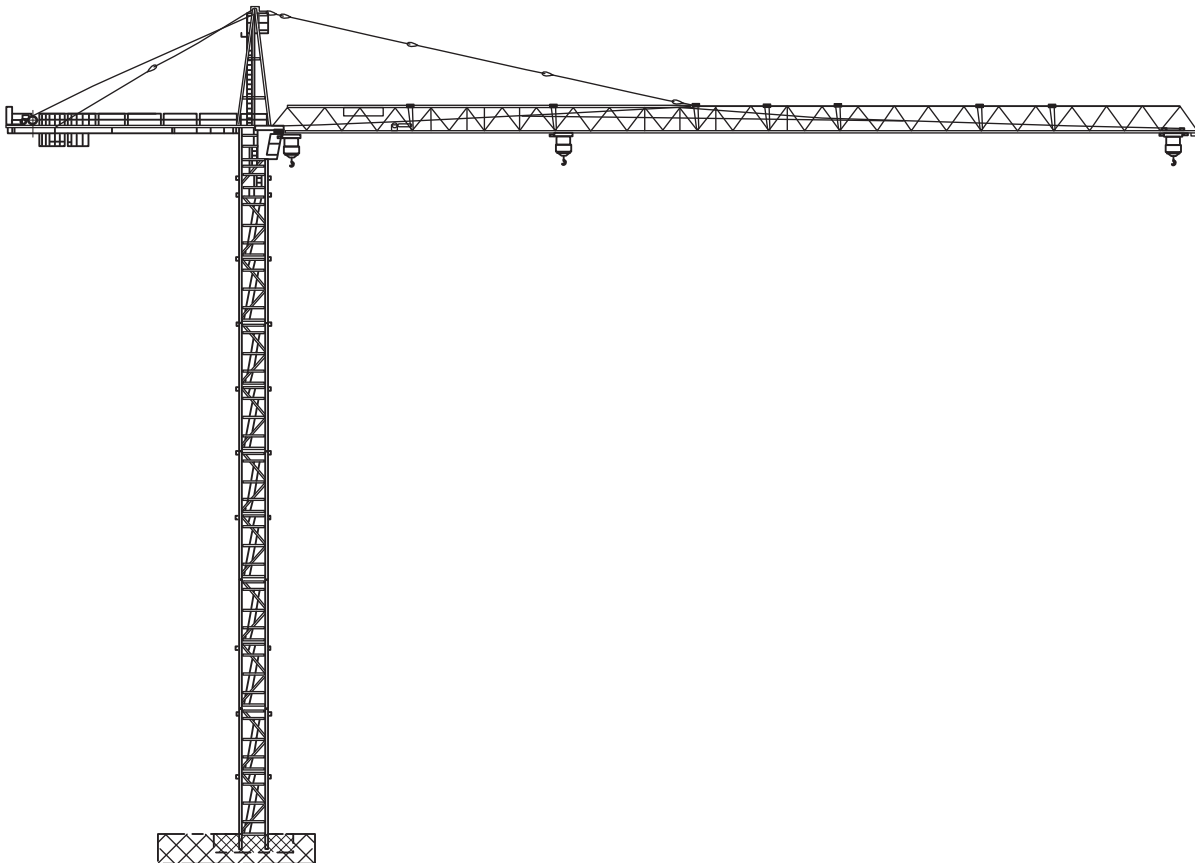


Figure 1 — Non-slewing tower - slewing ring at top of tower

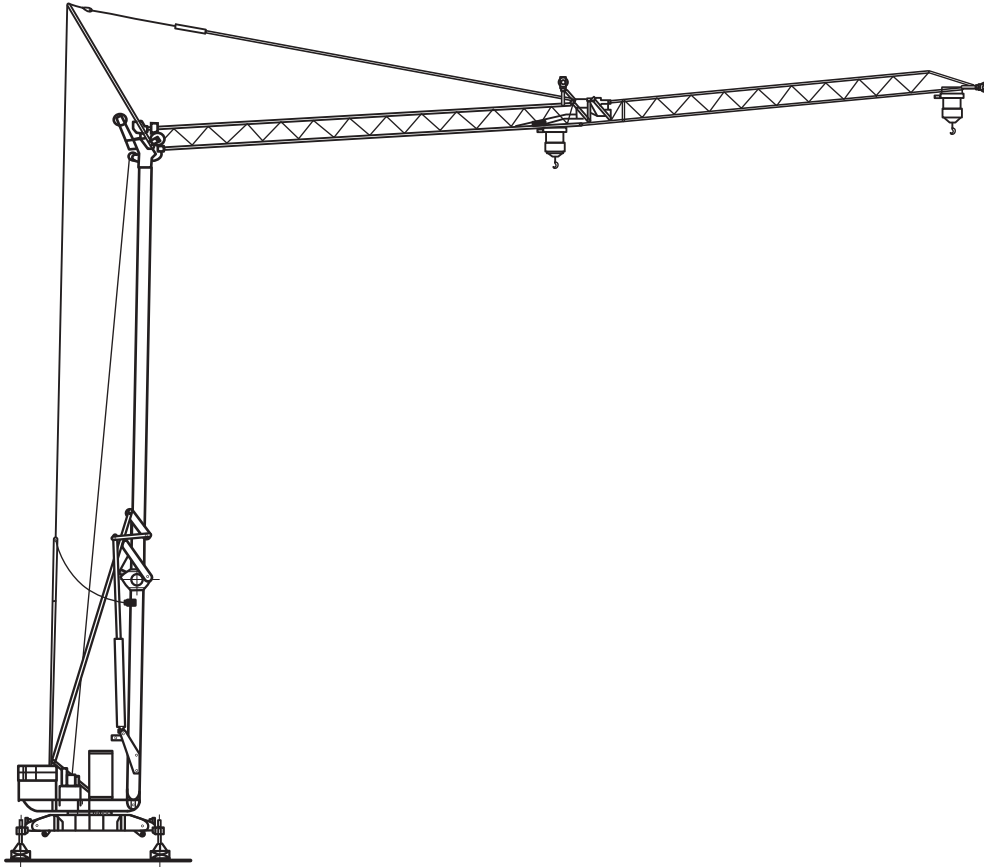


Figure 2 — Slewing tower - slewing ring at base of tower

5.1.2 Climbing crane

A climbing crane is a top slewing tower crane that can be altered at height after initial erection. Where the crane remains on its original base this can be achieved by the use of internal telescoping equipment or external climbing frames.

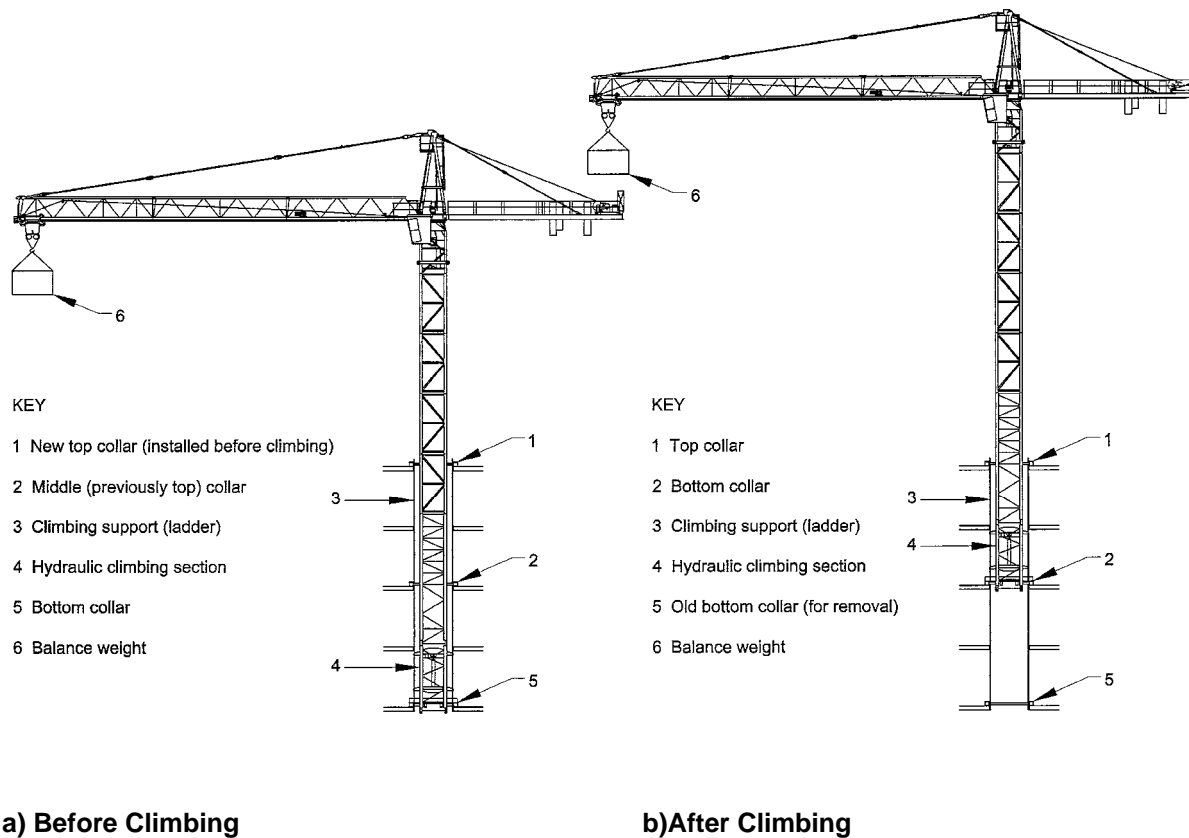


Figure 3 — Typical internal climbing sequence

5.1.3 Truck mounted self erecting tower crane

A truck mounted self erecting tower crane is a self erecting crane permanently fitted onto a truck /lorry chassis. These are particularly suitable when considerable inter-site mobility is required. Extra care should be taken in ensuring that outriggers, jacks, etc., are adequately supported for their imposed loads.

(See Figure 4. below)

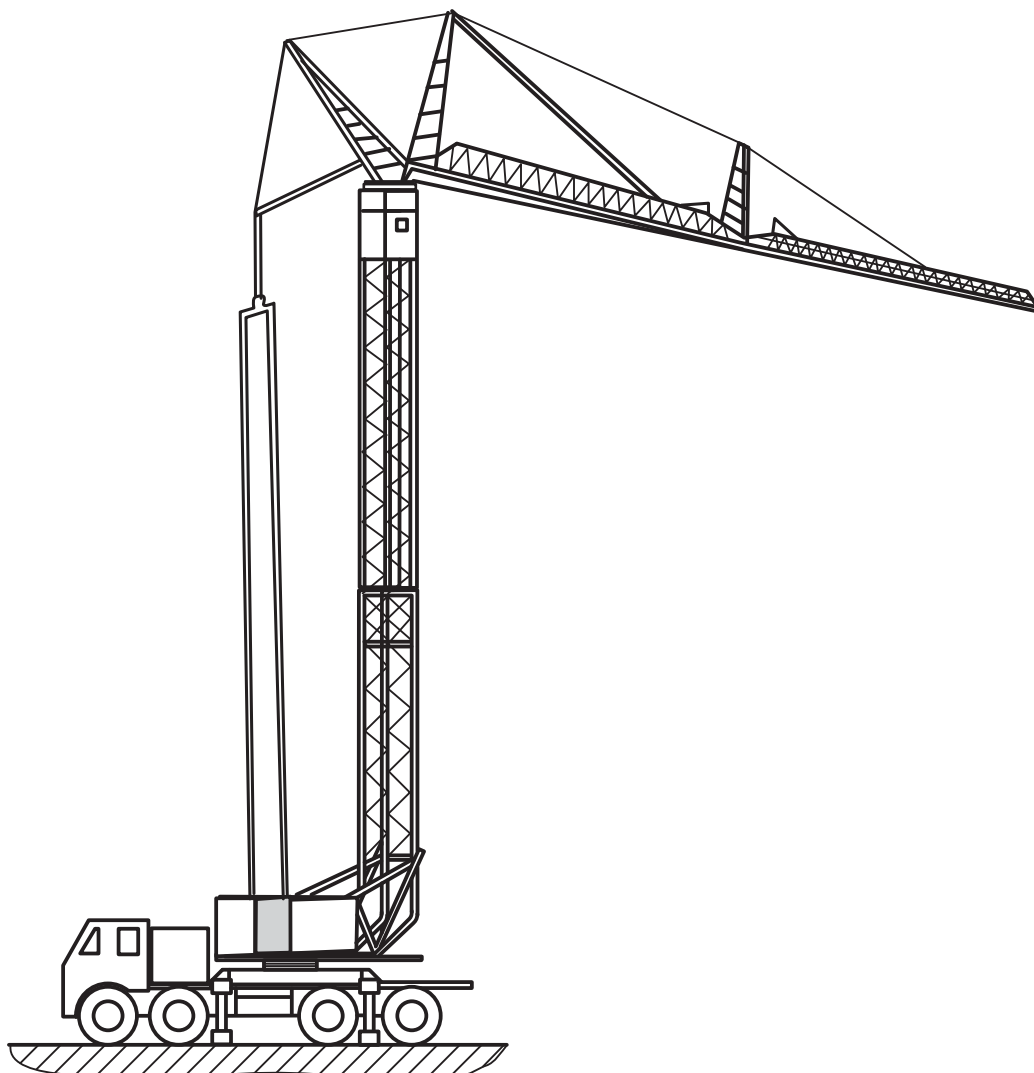


Figure 4 — Truck mounted tower crane

5.1.4 Wheel/Trailer mounted self erecting tower crane

Some self erecting tower cranes are available on trailer mounted assemblies with pneumatic tyres. These machines need to be towed into position and must be properly mounted on their outriggers or jacks before erection or use.

5.1.5 Crawler mounted self erecting tower crane

These machines are similar in design to the wheel/trailer mounted tower crane in that they can be both erected / dismantled within a very short time. They usually do not have any pick & carry duties and care needs to be taken if manoeuvring the machine on undulating ground conditions when the tower & jib are in their working positions.

5.1.6 Micro tower crane

Micro tower cranes are tower crane units complete for mounting on the top of either a special mast or a mast climber. They usually have a radius of approximately 6 m, a rated capacity under 1 000 kg and are remote

controlled. Micro tower cranes are generally used for offloading materials and placing within a limited area of a building.

5.2 Types of jib

5.2.1 "A" frame type

The jib is held in a horizontal or slightly raised position by tie bars or ropes connected to an "A" frame on the top of the crane tower. The hook is suspended from a trolley which moves along the jib to alter the hook radius

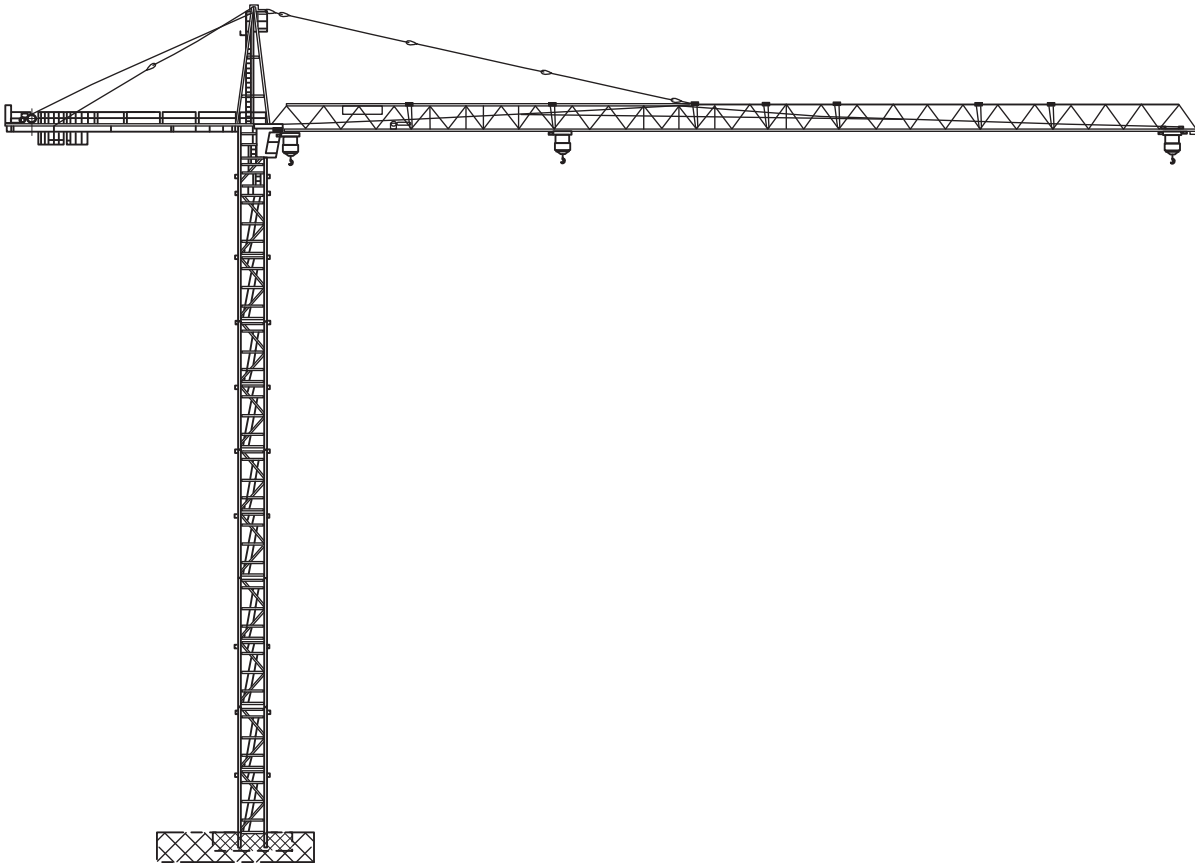


Figure 5 — "A" Frame type of jib

5.2.2 Flat top type

A flat top horizontal trolley jib is connected directly to the tower top and does not require tie bars or ropes connected to an "A" frame. This reduces the overall height of the crane which can be important on congested sites and where adjacent cranes oversail. The hook is suspended from a trolley which moves along the jib to alter the hook radius. Compared to its equivalent "A" frame type it can handle a higher weight at a given radius.

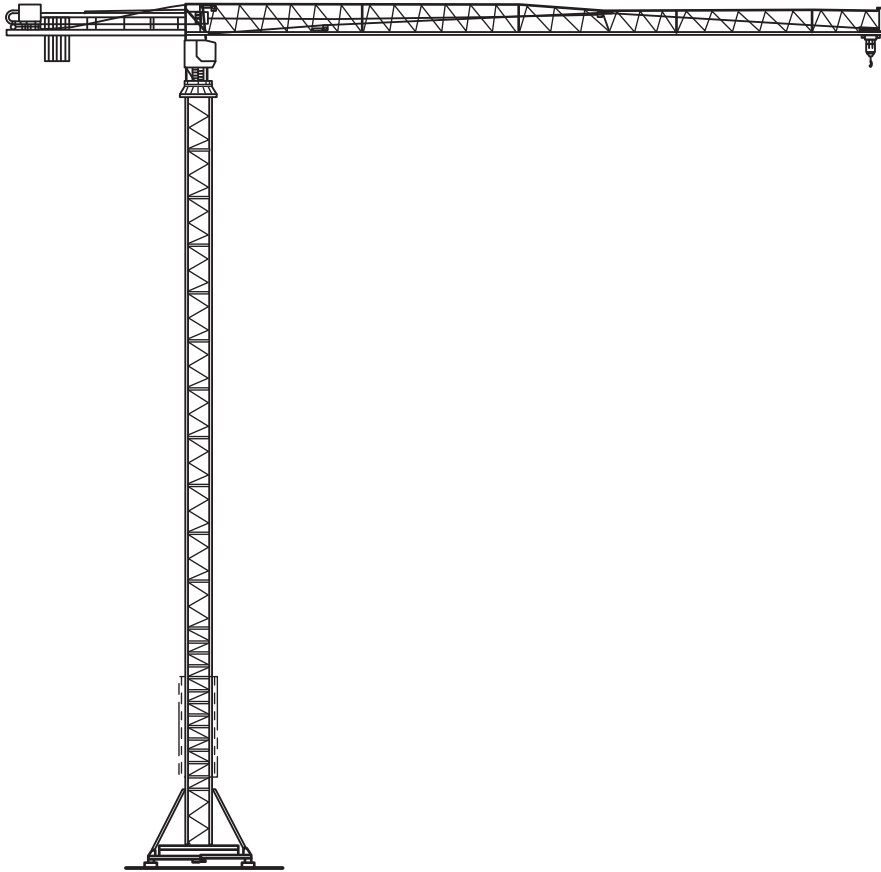


Figure 6 — Flat top type jib

5.2.3 Luffing jib

The jib angle can be changed to reposition the load at various radii. The jib may be single- or multi-component, and if multi-component, may be articulated (goose necked) or telescopic. Due to the varying out of service conditions for these cranes, particular care should be taken to observe the manufacturer's instructions regarding jib angle because if the jib is set too high, the crane may not weathervane in these conditions and high wind speeds can blow the jib over backwards.

This type is sometimes used where sites are extremely restricted or there are issues relating to the oversailing of adjoining property. They are more costly to run and more difficult to erect compared to similar capacity horizontal jib cranes.

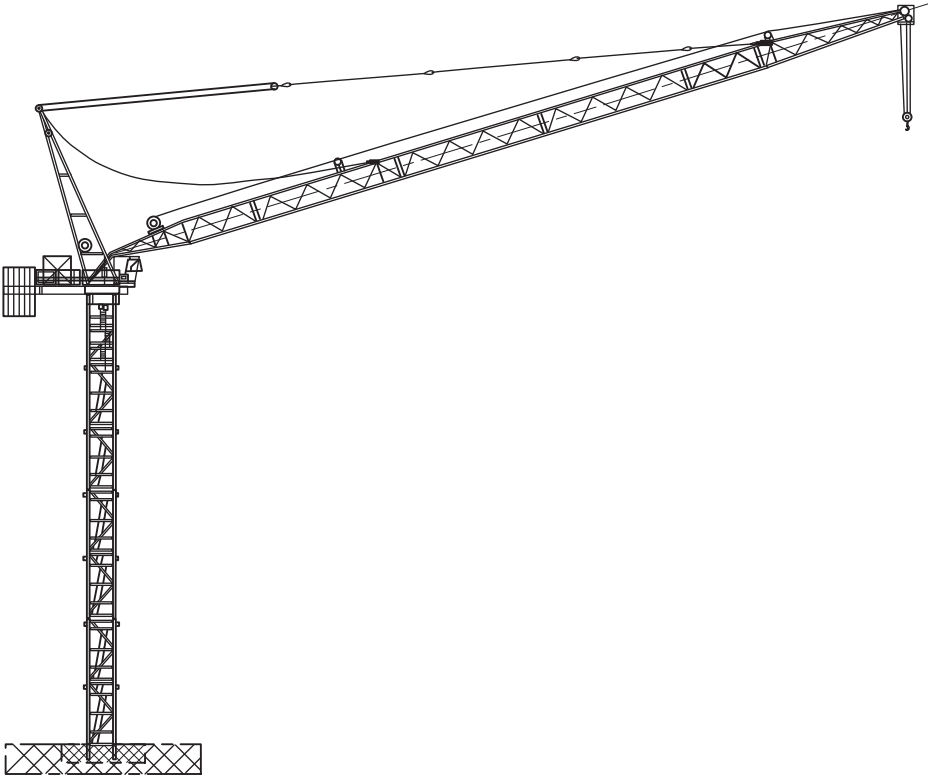


Figure 7 — Luffing jib

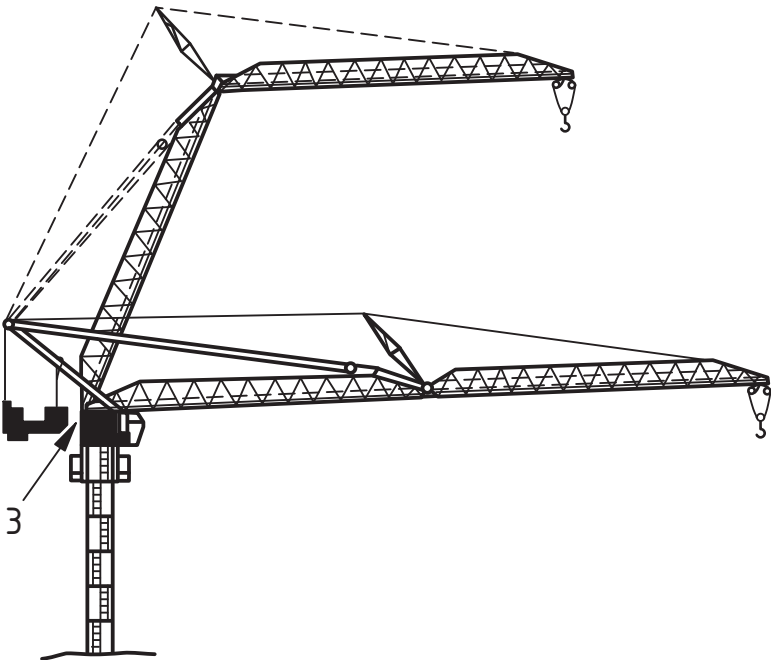


Figure 8 — Rear pivoted jib

Key

3 Pivot

5.3 Types of base

This section deals with the different types of bases used for tower cranes.

It is vitally important that accurate information about the characteristics of the intended crane is provided to the base designer and that a check is carried out prior to erection to ensure that the installed crane meets the criteria for the base design.

If a need arises to change from the intended crane configuration, a design review shall be required and used to check that prior to erection the base design is suitable for the supplied crane.

Generally their use will be for relatively short periods but where tower cranes are permanently installed e.g. factory locations, the condition of the bases will need to be periodically determined by a competent person.

Tower bases should be included on a daily inspection regime to detect any signs of damage, loosening of connections or cracking in the structure.

A suitable regime should also apply for the detection of any differential settlement.

5.3.1 Rail type base

A crane with a travelling rail type base has a tower mounted on a steel structure, similar to a cruciform base, which is supported on bogies that run on rail tracks. The travelling base is ballasted to ensure stability and may also be used, in accordance with the manufacturer's instructions, statically in a similar manner to a cruciform base.

A rail mounted tower crane is mounted on a chassis frame which is supported on rail wheels which are usually double flanged. There can be four single wheels on smaller machines or more usually four double wheel bogeys. The wheels or bogeys can have special mountings to enable the crane to negotiate bends.

The design of rail installations shall be in compliance with the crane manufacturers' instructions. Rail track requires expertise in its design, layout and installation, particularly if it is to be curved.

Rail track should be made of suitable materials and strict control should be exercised to ensure that it is not in any way abused. The area between the tracks should never be used for the storage of materials or for access to, from or across the site. The total area of the rail tracks in use should be fenced off to prevent access by unauthorized persons.

If there needs to be a point at which vehicles cross the rail track, this should be carefully controlled to prevent accidental collision, and precautions should be taken to ensure that the track is not overloaded by the vehicles crossing it. The gauge of rail tracks should be maintained by suitable means, for example tie bars. Rail tracks should not be welded or subjected to heating.

End stops or buffers should be positively fixed (bolted or pinned) to the rail and precisely adjusted to ensure that the crane would make contact with both sides simultaneously. There is a risk of overturning if a crane hits the buffers with sufficient momentum and the installation of automatic brake trippers can reduce this risk. These end stops should be shock absorbing or sprung, and should be moved hard against the crane chassis if the machine is to be used in a static position for any period of time. Rail stops should not be taken into account when calculating the stability of the machine. Where two or more tower cranes run on the same track physical stops should be provided to segregate the track and prevent adjacent crane structures or loads colliding. Rail clamps which the crane manufacturer might provide to prevent the crane from rolling along the track in storm conditions should be fitted whenever the machine is out-of-service. If clamps are not supplied, adequate means should be adopted to achieve the same result.

Rail tracks of all types require periodic inspection, and if any defect or out-of-level becomes apparent, corrective action should be instigated immediately.

Attention should be paid to the design and layout of the power supply (trailing cable) for travelling tower cranes to ensure that it is protected from damage.

Tracks should be earthed in accordance with the National Rules for Electrical Installations (ET 101:2008) produced by the Electro-Technical Council of Ireland (ETCI)

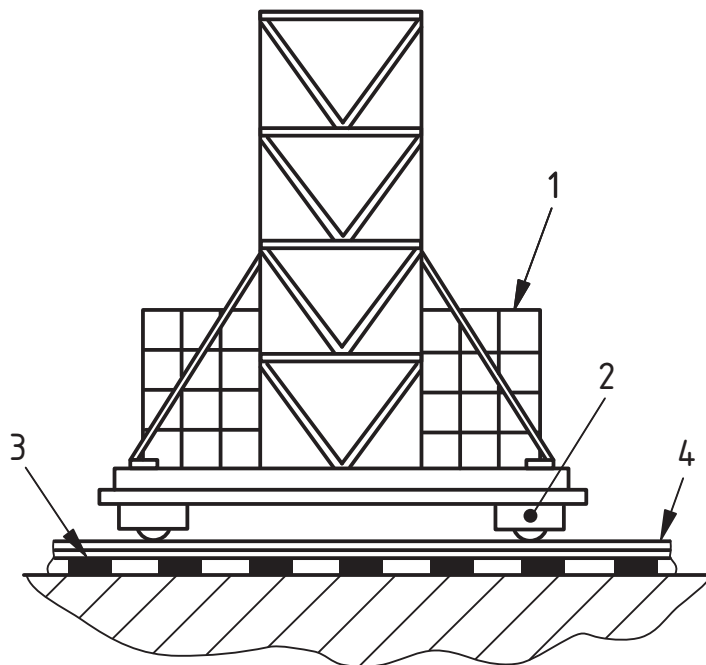


Figure 9 — Travelling base (rail type)

Key

- 1 Base Ballast
- 2 Bogies
- 3 Sleepers
- 4 Rail

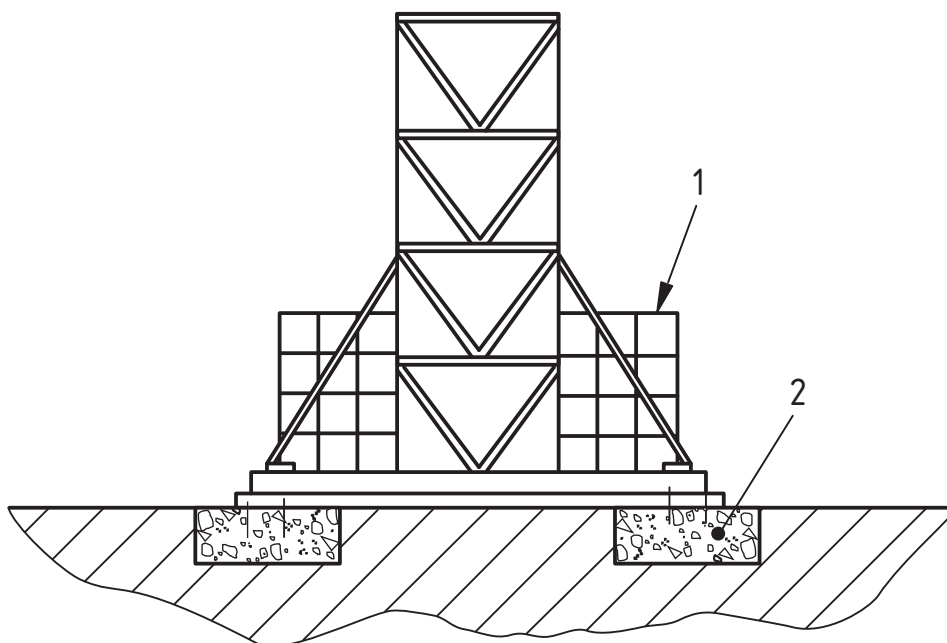


Figure 10 — Static base (rail type)

Key

1 Base Ballast

2 Means to prevent movement

5.3.2 Cruciform type base - static

A crane with a cruciform base stands on its own base of steel sections in the form of a cross. Overturning moments are resisted by either placing ballast on the top of the base or fastening the corners of the cruciform to the supporting structure. The design of the supporting structure and any connections to the cruciform base should be carried out by a competent engineer. Where ballast blocks are used there should be a notice attached detailing the position and weight of the blocks, and that the blocks should be adequately secured as per manufacturers instructions to prevent accidental displacement. The ballast arrangement should not be altered after the crane has been tested, for constructional or any other reasons. Cruciform bases cover a larger area than cast-in bases and therefore might not be suitable for congested sites.

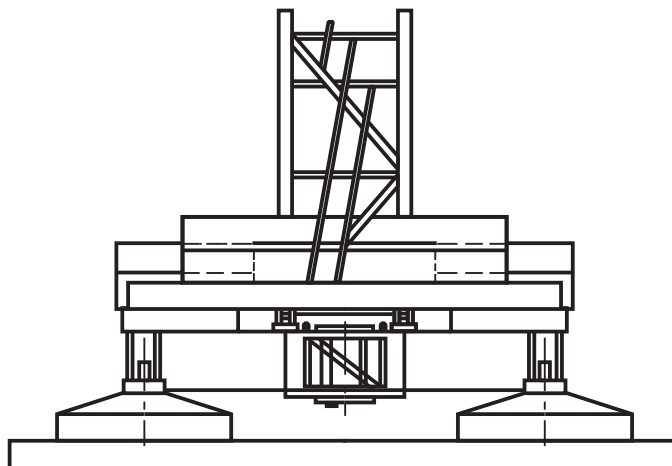


Figure 11 — Cruciform type base

5.3.3 Cast-in base

A crane with a cast-in type base is mounted on special foundation anchors or an expendable element (fixing angle) section which are cast into a concrete foundation block. (See Figure 14 below).

Minimum dimensions for any expendable base block together with the overturning moment and other loadings during operation and out-of-service conditions should be as specified by the crane manufacturer. Having obtained from the crane manufacturer the loads imposed by the crane (noting that these could be net and exclusive of any impact or safety factors), the foundation should be designed by a competent engineer so that the ground bearing capacity is not exceeded.

Where the base design limits the free standing height of the crane, the maximum permitted free standing height should be marked at the base of the crane and entered into the documentation.

Where anchor bolts are used they should be heavily greased or sleeved so as to prevent bonding to the concrete. Whilst such bonding would break down, it could lead to spalling of the concrete around a bolt with a consequent loosening of the bolt.

It is important that the foundation anchors or an expendable element(fixing angle) are installed within the maker's tolerance of accuracy to ensure that the erected crane is within operational limits.

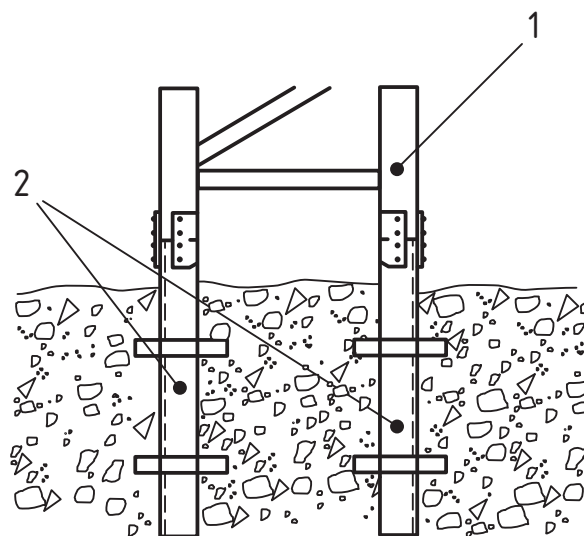


Figure 12 — Embedded element type base

Key

1 Base of crane tower

2 Fixed angle

5.3.4 Grillage base

A grillage base is a steel structure to which the tower of the crane is connected and which in turn is connected to the supporting structure. Grillages are generally designed specifically for each location. The design of grillages and their connections to the supporting structure should be carried out by a competent engineer.

5.3.5 Non-crane structure

A non-crane base structure is a base provided by a structure which is not a normal part of the crane, for example part of a bridge, a building or structure provided specifically for such a purpose. The design of a non-crane base structure should be carried out by a competent engineer.

5.3.6 Self erecting tower crane bases

Self-erecting tower cranes generally use outriggers and jacks, rather than the bases of conventional tower cranes, to transfer loads from the crane structure onto the ground. Attention should therefore be paid to the assessment of ground conditions and the arrangements for load spreading to reduce ground pressure to an acceptable level

5.3.7 Base ballast

When concrete ballast needs to be provided, it should either:

a) have been constructed in accordance with the crane manufacturer's design and specification; or

b) be of a design which has been approved by the crane manufacturer;

Only ballast blocks having markings showing their correct weight should be used. The lifting points on ballast blocks should be visually inspected regularly to ensure that they have not deteriorated and are fit for use.

6 Planning prior to siting & installation of tower cranes

6.1 Selection of cranes

Tower cranes are available in a number of forms and the characteristics of the various machines should be considered in relation to the job requirements. Having decided upon the type of crane and knowing the overall requirements involved, a crane that can carry out the planned lifts safely should be selected. Points to be taken into account in making the selection of the tower crane include the following:

(a) characteristics of loads;

The weights, dimensions and characteristics of the load, as well as any potential for abnormal loading (e.g. additional wind loads), will determine the requirements for rated capacity of the crane. While cranes have rated capacity indicator/limiters, preventing the lifting of items heavier than the crane and equipment can carry, these must not be used to routinely limit the loads. Loads close to the capacity of the crane at the required radius should be identified before lifting is attempted. Some loads may cause non-vertical loading on the crane if lifted incorrectly.

(b) operational speeds, radii, heights of lifts and areas of movement;

The operational rate and area covered by the crane needs to be checked against the construction schedule and plans. Proximity hazards, oversailing and height under hook need also to be considered.

(c) number, frequency and types of lifting operations;

The number and frequency of lifts need to be evaluated to ensure that the requirements of the construction programme can be met. If the loads need to be held for a period of time while being fixed, as with steel work, it will restrict availability of the crane. Similarly where a crane will be required to operate with high load cycle such as with skipping concrete, it will not be available for other tasks during these periods.

(d) length of time for which the crane is required and the maintenance requirements that may arise during that period;

(e) results of previous thorough examinations for any particular machine;

(f) site, ground and environmental conditions, or restrictions arising from the use of existing buildings;

The ground conditions may determine the type of crane base that can be constructed and may restrict the crane capacity. The loads that must be carried by the ground, whether during erection, use or dismantling, need to be considered. The designer of the tower crane support should take into account any additional loading applied to the ground and whether this may affect the foundations of existing buildings or other construction. The ground conditions should also be considered if a mobile crane is needed for erection or dismantling – these cranes need support beneath their wheels and outriggers.

(g) space available for crane access, erection, travelling, operation, out-of-service condition and dismantling;

Tower crane components may be carried to site on articulated trucks, or may be towed as a complete unit in the case of a self-erector. In either case, suitable access to the crane location is needed. In some cases space will be needed for parts of the crane before erection. Space around the crane location is required for erection, raising and dismantling operations. This may need a mobile crane and the working area for this should be identified. Self-erecting cranes will also need space for the erection process. Where a crane is required to travel with a load, for example on a rail base, the space on site needed for the rails may be an

issue within the construction schedule. Sufficient clearance must be retained around the base of bottom slew self-erecting tower cranes.

(h) any special operational requirements or limitations imposed;

The use of a tower cranes near airports, railways, highways, power lines, or over other buildings that are not part of the construction site, requires particular care. Particular guidelines also apply to the use of cranes near railways / airports and the rail operators' safety requirements must be taken into account.

(i) prevailing wind-speeds, which can restrict the use of tower cranes in certain locations;

The location of the site, if positioned on an escarpment or other area of high wind speeds, may reduce the physical dimensions of loads that can be carried. The likelihood of high in-service wind speeds may reduce the availability of the crane. High wind speeds may require the crane to be designed against additional wind loading.

NOTE Further guidance can be found in FEM 1.004,1.005 and IS.EN 1991-1-4.

(j) crane operating Systems;

Consideration should be given to the conditions on site and the tasks to be carried out with the crane prior to selecting the operating type Top slewing tower cranes can be operated from a cabin positioned at the top of the tower/mast adjacent to the slewing ring or from a radio control on the ground. Self erecting cranes are usually operated using radio or cable control.

6.2 Site surveys

The delivery to site, erection, alteration and dismantling of a tower crane requires a site survey to be carried out by a representative of the crane erectors. This involves visiting the location where the task is to be carried out, with a representative of the user, so that both the task and any hazards involved can be identified, enabling a risk assessment & method statement for the task to be prepared prior to the commencement of any works on site.

6.3 Safe access to and from tower cranes

Safe access to and from the base and cab of a tower crane is of primary importance for the operator. Hirers/Users must complete a risk assessment as to the route and means of access to the base or point of access on the mast of the crane. Adequate measures must be put in place to control the risks identified by the risk assessment. The following points should be born in mind when considering access:-

- clear access to the tower crane base is essential to enable daily checks, inspections, maintenance and thorough examination to be carried out. Bases must be kept free from water and debris at all timesm,
- on high rise structures tower crane operator access is sometimes provided from the structure as the building progresses to reduce the distance and climbing time to the operators cab. In such a case it is essential that any access is designed to provide adequate strength and fall protection. Under no circumstances should the access be fixed to both the tower of the crane and the adjacent structure as this will prevent the tower from deflecting and may well cause the access to collapse,
- the tower/mast of a tower crane must always have a clearance from adjacent structures in all directions to allow for tower deflection,
- when selecting a cab operated top slewing crane tower crane for a project ,a safe means of access shall be provided for the operator. For best practice, tower cranes with cabs above 30 HuH(height under hook), the provision of power operated man hoist is highly recommended,
- access by Ladder,

- ladders should be inclined and constructed in accordance with I.S EN 13586. Use of vertical ladders for access should be avoided but if used suitable fall, arrest equipment should be provided. Care shall be taken that the protective equipment does not conflict with manufacturers' instructions.

6.4 Jib & counter jib access

Safe access to and along jibs and counter jibs for inspection and servicing should be provided. Where full edge protection is not provided personnel should wear fall protection equipment at all times. Lanyards should be connected to a suitable anchor point at all times and where lifelines are provided, a suitable device should be used in conjunction with the lanyard to permit full passage along the jib without detachment.

For cranes manufactured to I.S. EN 14439 2006 , they should comply with the following :

If it is not possible to lower the jib to the ground to carry out a visual inspection of the jib, a basket fixed to the trolley shall be provided. In addition a walkway with:

- side protection , or
- personal protective device against the falls

shall be fixed along the jib to reach the mechanism (s).

When during erection/dismantling, repair or maintenance, the basket cannot be used, the use of a personal protective device against falls shall be possible all along the jib.

NOTE Personal carrying cages attached to the trolley may provide suitable alternative safe access along the jib

In the case of inspection or other work on a jib there should be a second person on hand to initiate any rescue procedures in the case of mishap.

6.5 Tying to a fixed structure

Where non-slewing towers have to be tied to a fixed structure, it is imperative that the manufacturer's instructions are followed. The ties should be designed by a competent person to withstand the loads specified by the manufacturer, and be attached to a structure capable of withstanding the imposed loads.

6.6 Proximity hazards

Details of any proximity hazards that might impinge on the operation should be recorded as part of the site survey.

Consideration should be given to the presence of proximity hazards such as overhead electric lines or cables, nearby structures, other cranes, vehicles or ships being loaded or unloaded, stacked goods and public access areas including highways, railways and waterways. Where any part of the crane or its load cannot be kept clear of such hazards the appropriate authority should be consulted. The danger to or from underground services, such as gas mains or electric cables, should not be overlooked. Precautions should be taken to ensure that the crane foundation is clear of any underground services or, where this is not possible, that the services are adequately protected against damage.

At any place where a crane or its load passes an obstacle, a clearance of not less than 600 mm should be maintained.. Where it is not reasonably practicable to achieve this clearance, effective precautions should be taken to prevent access to any crushing zones.

Where tower cranes inter-arc, a vertical distance should be maintained to prevent collisions. This distance should be a minimum clearance of 3 m; or as per manufacturer's recommendations.

The positioning of the crane and components in the out-of-service condition, as specified by the manufacturer's instructions, should be such that no collisions can take place. This activity should be part of the initial planning process.

6.6.1 Ground conditions & adjacent structures

Where tower cranes are to be erected close to the foundations of existing buildings or buildings to be constructed, the appointed person should ensure that the ground is consolidated as required by the designer of the crane base.

Where disturbance to the ground has occurred in the construction of adjacent foundations, a retaining wall should be constructed or deeper foundations used for the tower crane.

The assessment of ground conditions should take into account the ability of the ground to accept the loads imposed by the tower crane and also those imposed by mobile cranes used for erection or dismantling purposes..

Some of the hazards that need to be considered when assessing ground include:

- underground services,
- paved areas,
- un-compacted fill,
- open excavations,
- high water table,
- basements,
- cellars,
- proximity to canals and rivers,
- changes to site conditions during construction.

The loads imposed by the crane should be obtained from the crane manufacturer or other authority on crane design and construction. The loadings should include the combined effects of the following:

the dead weight of the crane (including any counterweight, ballast or foundation where appropriate);

the dead weight of the load(s) and any accessories for lifting;

dynamic forces caused by movements of the crane;

wind loadings resulting from wind speeds up to the maximum permitted, taking into account the degree of exposure of the site.. It is likely that in-service conditions produce the greater imposed loading but out-of-service and erection/dismantling conditions should be taken into account. The vertical and horizontal forces are unlikely to be uniformly distributed and an allowance should therefore be made for these and for any other unpredictable effects.

NOTE 1 Further guidance can be found in I.S. EN 1991-1-4 and FEM 1.004, 1.005

NOTE 2 Further guidance on assessment of ground conditions and the design of tower crane foundations is given in:- "Tower Crane Stability" and "Crane Stability on Site" published by CIRIA

6.6.2 Avoidance of collisions

On sites where there is a possibility of collision between cranes and other equipment the crane coordinator should plan the sequence of crane movements to prevent collisions. A suitable allowance needs to be made for deflection when calculating the clearance between adjacent cranes .

6.6.3 Overhead electric lines and cables

A prior risk assessment will help identify situations where any lifting or crane movements are likely to be in such close proximity to live overhead conductors so that, in conjunction with the electrical utility company, such lines can be isolated, switched out, and earthed, with written proof that this has been done prior to under taking such lifts.

When operating a crane in close proximity to aerial conductors, the following precautions shall be observed by the appointed person, operator and other persons working with the crane:

Each crane type has different operating/equipment characteristics that dictate varying requirements for safe operating distances from electrical overhead conductors. Where contact can be made with live power lines, advice from the electrical utility company shall be sought prior to commencement of any work;

The load and crane shall not approach the power lines any closer than shown in Figure 14;

Cranes shall not be used to remove material from under a power line if any part of the crane, lifting attachments or jib is capable of contacting or coming within the danger zone of the power line, unless approved by the electrical utility company engineer. Overhead power lines shall be protected/identified in accordance with the electrical utility company guidelines (Figure 14). The electrical utility company's relevant safety instructions when working near overhead electrical lines shall be followed;

Where wind speed and wind direction are factors, these shall also be taken into account when lifting loads close to overhead lines. (The use of anemometers are dealt with in 9.4.3. of this Code of Practice relating to Tower Cranes.);

Crane operators, slingers and anybody else at risk should be advised of the action to take in the event of contact with live conductors.

The criteria above, along with suitably detailed Method Statements, shall be outlined in writing in the Safety and Health Plan for the projects.

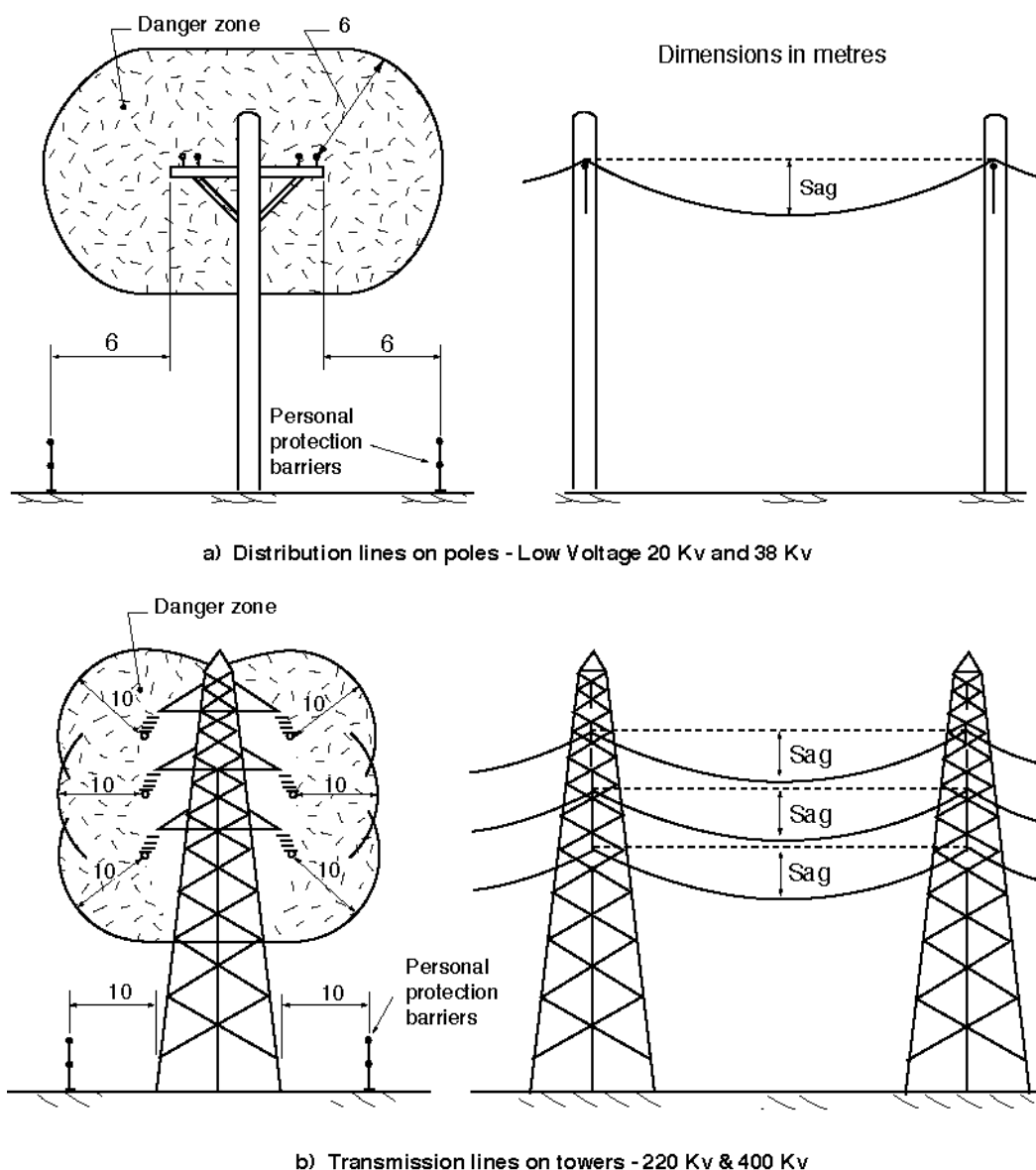


Figure 13 — Clearance from live aerial conductors

NOTE For transmission lines the danger zone is a minimum of 10m unless designated otherwise by the electrical utility

6.6.4 Crane control in the vicinity of aerodromes/airfields

In accordance with the Irish Aviation Authority's guidance, the appointed person should consult, at least 30 days prior to erection, the aerodrome/airfield manager for permission to work if a crane is to be used within 5 km of the aerodrome/airfield. Restrictions can be placed on the overall height of the crane and there may be a requirement to fit warning (obstacle) lights to the top of the crane.

6.6.5 Proximity to railway & tram lines

The Railway Safety Act places an obligation on all persons carrying out any works on or near a railway/tram line to ensure that there is no increase in risk as a result of carrying out this work

If the tower crane can impinge on the operations or property of the railway line the hirer/user should contact the operator of the railway line prior to erection of the crane as they may well impose restrictions. There are

limiting/zoning devices which can be fitted to restrict the operating of a crane which the railway line operators may insist on having fitted.

NOTE Further information is available from the Railway Safety Commission, Irish Rail & Luas.

6.6.6 Floodlights, Decorations & Advertising Panels

See section 9 of this Code of Practice for further information

6.7 Assessment of support conditions

Tower crane installation generally involves the design and construction of a suitable base to transfer the loads and moments from the crane tower into the ground or another structure. As part of the planning process it is important that the design and construction of the base is taken into account, together with any connection to ground or adjacent structures. All design work should be carried out by a competent engineer.

Upon completion of the assessment a written "Permit to Erect" should be issued. A Permit to Erect must be supplied to certify that the foundation of the Tower cranes is sufficient to support erection. (see Annex A for example)

The permit to erect applicable to conventional tower cranes is also applicable to foundations constructed for self erecting cranes.

6.8 Power supply considerations-

The adequacy of the power supply whether from a mains supply or generator needs to be assessed. Socket outlets supplies at mains voltage shall be protected by a 30mA RCD. Some control systems require power to the control panel heaters to be left on all the time.

6.9 Rescue arrangements

Arrangements should be made for the rescue of personnel from the tower crane including:

- a) from the cab of the crane in the event of a medical or other emergency;
- b) if a person wearing fall arrest equipment falls from the jib and is left suspended below the jib.

Rescue needs to be enacted quickly, i.e. unconscious person could die in under 30mins.

There should be a written rescue plan that covers rescue and the provision of any necessary first aid.. All staff that will be involved should be properly trained. Refresher training and practices should be carried out. Any equipment involved in the rescue (e.g. rescue kits) should be regularly inspected.

NOTE Further information can be obtained in the following document: Guidance on Rescue during work at height (Technical Guidance Note 5), published by the Work at Height Safety Association(WAHSa).

7 Erecting, dismantling and alteration of height

7.1 Planning

7.1.1 General

Effective planning of a tower crane erection, dismantling or alteration is essential if the operation is to proceed safely, effectively and without incident. Erection, dismantling and alteration of height of tower cranes should not be undertaken after dark because of the difficulties in ensuring suitable and adequate lighting.

7.1.2 Working hours and resources

Planning should take account of the effect that long working hours can have on the concentration of personnel engaged in the installation of tower cranes and ensure that the work is properly resourced to allow adequate rest breaks to be taken. Allowance should be made for unforeseen stoppages and delays.

Planning for the erection, dismantling or alteration of a tower crane should begin at the earliest possible moment, often at the pre-construction stage. This ensures that operation can be phased effectively with other construction activities and that the requirements of adjacent occupiers such as railways or airports can be accommodated. It is essential that the Principle Contractor on a site is fully involved in the planning as they have overall responsibility for ensuring that the operations are carried out safely and without incident. They are also able to provide access to the Project Supervisor Design Phase (PSDP) in cases where the building structure is being used to absorb the loads from the tower crane base or ties supporting an external tower crane or the collars of an internal tower crane.

7.1.3 Site visits

As part of the planning process it is essential that the person carrying out the planning visits the site at which the operation is to be carried out. This enables them to ensure that they are familiar with the constraints of the site such as road access for crane components and installation equipment, laydown areas, other cranes on site, over-sailing cranes on adjacent sites, adjacent railway lines and other site activities that could impinge on the erection, dismantling or alteration operation. Sites with restricted space can impose additional constraints on the installation which should be taken into account in the risk assessment and method statement, for example more complicated jib installation, space for assembling test weights.

7.1.4 Risk assessment

As part of the planning process a risk assessment should be carried out to identify the hazards associated with the proposed operation. The assessment should evaluate the risks involved and the nature and extent of any measures required to eliminate those risks or reduce them to an acceptable level. For tower crane installation operations generic risk assessments are unlikely to be sufficient as every site and installation operation has hazards that are unique to that situation and should be taken into account in the assessment. The results of the risk assessment should be recorded in writing and made available to the person responsible for the preparation of the method statement.

7.1.5 Method statement preparation

7.1.5.1 General

Once the risk assessment has been carried out, the appointed person should ensure that a full method statement document is prepared, detailing the safe system of work for the installation operation. The appointed person may either prepare the method statement himself or delegate it to another person who has sufficient knowledge and experience to undertake the task. If the task is delegated to another person the appointed person should review and approve the method statement before the operation takes place. The method statement should address the issues given in 7.1.5.2 to 7.1.5.20..

7.1.5.2 Issue and revision

The front cover of the document should clearly identify the site, crane, task to be undertaken, author, date of original issue, issue number, date of any subsequent revisions and distribution list. Any changes to the method statement following its initial issue should be recorded by a revision to the document and the document reissued. The Appointed Person should ensure that all persons on the distribution list are in receipt of the latest version before the start of the operation.

7.1.5.3 Tower crane configuration

Details of the crane configuration before and after the operation to be undertaken should be recorded.

7.1.5.4 Programme

A detailed programme should be included indicating the tasks to be achieved each day, with a start and finish time for each task, together with the configuration of the crane at the end of each days' work.

7.1.5.5 Responsibilities

The responsibilities for each part of the preparation and execution of the operation should be clearly stated (e.g. site access, exclusion zones, base preparation for mobile crane, tying points, oversailing cranes). The appointed person should be clearly identified.

7.1.5.6 The erection team

The composition and responsibilities of the erection team should be detailed, together with the duties of each member of the team.

7.1.5.7 Briefing arrangements

The arrangements for a full briefing of the erection team on the contents of the method statement and any sections of the manufacturer's manual to which it refers should be detailed. The briefing should take place on site before the start of the installation operation and should be given by either the appointed person, if they are on site, or the erection supervisor.

The person giving the briefing should confirm that all are in possession of the latest revision of the method statement and manufacturer's manual before the briefing. The aim of the briefing is to ensure that each member of the erection team is clear on the overall objectives of the task and their role in achieving that objective. Particular emphasis should be placed on contingency arrangements and those being briefed should be encouraged to ask questions and seek clarification on any points on which they are not clear.

All those attending the briefing should be asked to sign a declaration confirming that they have attended and understood the briefing.

7.1.5.8 Preparation of components and equipment

Arrangements for the off-site preparation of crane components together with equipment such as climbing frames, power packs and torque gear should be detailed, together with details of any on-site assembly and inspection required before climbing begins.

7.1.5.9 Transport of components to and from site

Arrangements for the transport of components and equipment should be detailed, taking into account the sequence in which they are required, to ensure that the installation programme is not delayed. These arrangements should take into account any parking restrictions both on site and in the surrounding area.

7.1.5.10 Access for vehicles and persons

Details of access to the site for both the vehicles involved in transportation of tower crane components and installation equipment as well as the crane(s) used for erection should be recorded. This should include agreed access routes, taking into account ground conditions and also the need for traffic management personnel.

7.1.5.11 Craneage arrangements

The arrangements for any cranes required to assist with the erection, dismantle or alteration operation should be detailed. These might be either cranes already on site (tower, or mobile) or mobile cranes brought to site specifically for the task to be undertaken. These arrangements should include the assessment of ground conditions, preparation of suitable outrigger foundations and any road closures. Selection of these cranes

should take into account that when removing components from a height the assisting crane is carrying the entire load with no opportunity for safely replacing it once the attachment pins have been removed. In this case the crane should have sufficient excess capacity to allow for any error in the slinging of the component concerned or its sudden release.

7.1.5.12 Protection from falling objects

Arrangements for the protection of persons from falling objects in the area below the installation operation should be detailed. The primary method of control should be the establishment and enforcement, by the Principal Contractor, of exclusion zones around the base of the crane. Secondary control measures could include the use of lanyards for hand tools, toeboards and mesh panels on working platforms.

7.1.5.13 Protection from falls from height

Arrangements for the protection of those involved in the installation operation from falls from height should be detailed. This should include adequate edge protection on working platforms, the use of fall protection Personal Protective Equipment (PPE) such as harnesses and appropriate rescue procedures. If fall protection PPE is used the method statement should refer to the arrangements for ensuring that the personnel are trained and that the PPE is appropriate and regularly inspected.

NOTE See Annex B for further information

7.1.5.14 Communication

Arrangements for ensuring that all members of the erection team can effectively communicate at all times during the installation operation should be detailed. Communication is normally required between personnel on the ground, personnel on the tower crane structure and the operators of any other cranes involved. This is normally achieved using hand held VHF/UHF radios and arrangements should be made to ensure that good communication is maintained at all times. These might include choosing a unique frequency to avoid interference from other sites, ensuring that batteries are fully charged and that spare handsets are available in case of breakdown.

7.1.5.15 Weather forecasting and monitoring

Tower crane installation operations can only be carried out in wind speeds below the limit set by the crane manufacturer. Arrangements should therefore be detailed to obtain accurate weather forecasts in the period leading up to the start of the operation. These enable the Appointed Person and the Erection Supervisor to decide if the operation may proceed. If the programme is of several days duration, daily forecasts should be obtained to ensure that the crane can be secured in a suitable configuration if high winds are indicated. During the installation operation, the wind speed should be periodically monitored.

7.1.5.16 Installation method

Details should be given of the procedure for carrying out the task to be undertaken. At the least this is by reference to specific sections of the manufacturer's installation manual for the individual crane.

7.1.5.17 Information

Any information required by the team carrying out the operation in addition to the method statement should be detailed. This should include the availability on site of a comprehensive manufacturer's erection/dismantling/operation manual. The manual should be specific to the individual tower crane and in the language most readily understood by the erection team.

7.1.5.18 Contingency arrangements

Contingency arrangements should be detailed for the occurrence of foreseeable circumstances that might affect the safety of the operation being undertaken (e.g. power failure, equipment failure, increase in wind

speed, personnel injury). This should include arrangements for the notification of problems to the Appointed Person if he/she is not present on site during the operation and the leaving of the part assembled crane in a safe condition. Reference should also be made to site specific emergency procedures.

7.1.5.19 Thorough examination including testing

The arrangements for carrying out a thorough examination and proof load test, after the erection or alteration operation has been completed and before the crane is returned to service, should be detailed.

7.1.5.20 Commissioning the crane

Arrangements for commissioning the crane and handing it over to the site following the successful completion of the thorough examination

7.2 Manufacturer's erection and dismantling instructions

A copy of the crane manufacturer's instructions should be available on site and closely followed. Any departure from the specified sequential procedure should be checked first with the manufacturer and then be approved by the designer or another competent engineer, to ensure stability of the crane and that structural and mechanical parts are not subjected to excessive loading.

Before starting installation operations, the erection supervisor should ensure that the erection/dismantling manual is appropriate to the particular crane, bears the crane manufacturer's serial and type numbers and the owner's identification. Manuals should have an issue date and reference so that the erection supervisor can ensure that he has the latest issue incorporating the latest revisions.

Manuals sometimes deal with dismantling procedures by the simple statement that they are the reverse of erection procedures. The appointed person should ensure that such a statement is correct and if there is any doubt obtains further information from the tower crane manufacturer.

7.3 Components and materials

7.3.1 Components

All major components that form part of a crane and are dismantled for transportation, particularly those that are load bearing or ensure the stability of the assembled crane, should carry a clear identification mark. Diagrams and drawings in the crane instruction manual relating to erection and dismantling should use the same system of marking and show the correct location and orientation of components.

The interchange of structural components between one model of tower crane and another may occur if the manufacturer has given approval. Having carried out such an interchange, a tower crane shall be retested in its new combination, and supporting documentation relevant to the manufacturers approval shall be attached to the test certificate/ become part of. When a tower crane is erected using components from two or more manufacturers, it is essential that the written agreement of at least one of the manufacturers, where they remain available, is obtained before erection starts. In the absence of the manufacturers' approval the combination of components should be approved by a competent design person.

7.3.2 Materials

Most tower crane parts are made from special materials and may only be repaired or replaced in accordance with the manufacturer's specification. Welding or other heat treatments should only be carried out as specified by the manufacturer. Nuts and bolts manufactured from high tensile steel or other special steels carry markings so that they can be distinguished from other nuts and bolts. Bolts used to secure slew races should be renewed whenever they are removed. It is essential that the re-use of high tensile bolts is in accordance with the manufacturer's conditions.

High strength friction grip bolts should not be reused once a joint has been dismantled.

7.4 Electrical supply

The installation of electrical supplies to tower cranes should conform to the National Wiring Rules. The following points are important.

Electrically operated cranes should have an effective earth connection. In the case of cranes mounted on rails, at least one rail track should be electrically bonded at each rail joint and the track should be effectively earthed. Crane wheels should not be used for earthing the crane.

The crane structure, motor frames and conducting cases of all electrical equipment, including metal conduit and cable guards, should be effectively and directly connected to earth.

The characteristics of the power supply and of the crane equipment should be checked for compatibility before connection.

Cables providing power to the crane should be protected from mechanical damage by one or more of the following means:

- running in conduit, trunking or on trays;
- being clipped to a structure in a position where they are protected from mechanical damage;
- being of armoured construction.

Where conducting material is used for protection, it should be bonded to earth at each end. In no case should the protection be used as an earth conductor.

Where practicable, the power supply to a travelling crane should be through a cable winding drum or a properly installed, insulated and protected collector system.

Care should be taken to ensure that any trailing cable is not damaged during operational movement or when the crane is travelling. The travel distance should be well within the length of the trailing cable. In addition to any isolator within the crane that is capable of cutting off the electrical supply to the crane motions, there should be an identified isolator remote from the crane that can be used to cut off the electrical supply to the crane itself. All isolators should be capable of being locked in the off position and should be identified with the individual cranes whose power supplies they control.

If a suitable mains supply is not available on site, the alternative is to use an engine driven generator which must be adequately earthed and sized to cope with the potentially high starting currents. The use of frequency controlled motors on later designs of crane will reduce starting currents and consequently the capacity of the power supply which is particularly beneficial when a generator is used. Some control systems however require that the power supply to the control panel heaters is left on at all times to ensure to maintain a stable temperature. In this case when power from a generator is not available, a temporary night supply will be required.

The power supply should terminate in a suitable weatherproof isolator adjacent to the crane. RCD's with a 30mA rated tripping current are required on final sub circuits such as socket outlets.

7.5 Personnel

The erection, dismantling and alteration of the height of tower cranes should be carried out by specialist personnel under the continuous control of the erection supervisor and in accordance with the manufacturer's instructions. This supervisor should be given the authority to stop the operation if he or she considers such action is warranted by ground conditions, weather, obstructions or any other cause. The erection supervisor should be in close liaison with the site management and should carefully consider any comments or warnings that management, any members of the site team, or any other appropriate person or body make.

7.6 Inspection before erection

All parts should be inspected prior to erection to ensure they belong to the crane being erected and are in good condition, free from defect. Slings points should be identified for all components.

7.7 Weather

Tower cranes should not be erected or dismantled in weather conditions likely to affect the stability of the crane, e.g. high winds (reference should be made to the manufacturer's instructions for the maximum permissible wind speed for these particular operations), or under conditions of impaired visibility, e.g. fog.

Installation work should be avoided if the conditions (e.g. ice on component parts and walkways) are likely to endanger the erectors.

7.8 Working area and exclusion zones

The area in which a tower crane is to be erected or dismantled should be roped or fenced off and all personnel not immediately connected with this duty should be excluded. See 7.1.5.12. The size and extent of the exclusion zone should be the subject of a site specific risk assessment.

7.9 Support and Siting of Outriggers

Careful attention needs to be given to ground conditions when using outriggers. The following diagrams illustrate good and bad practice.

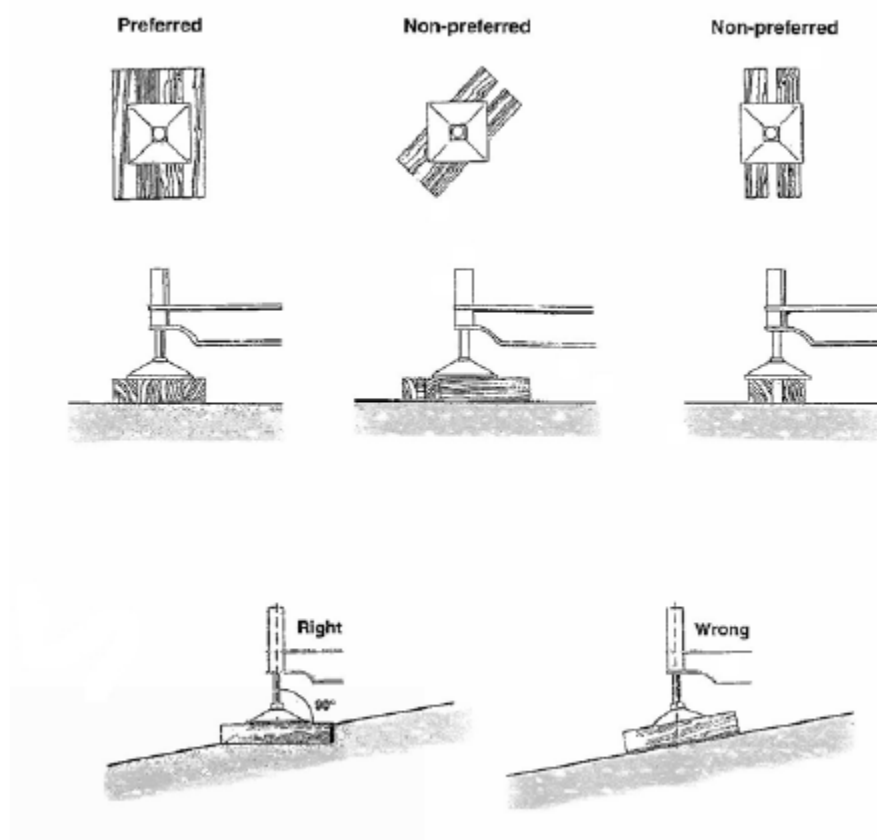


Figure 14 — Timber packing under outriggers (Good quality timber must be used)

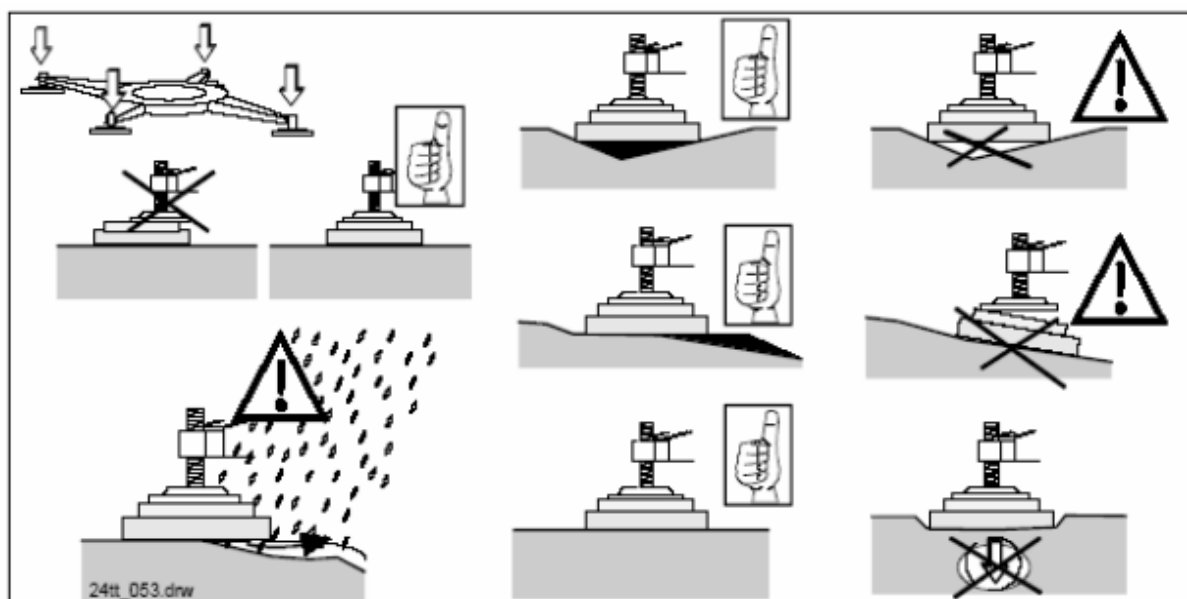


Figure 15 — Siting of Outriggers

8 Tower crane climbing systems

8.1 General

Tower crane climbing is a specialized technique used in the installation of tower cranes. Successful climbing depends on detailed planning and effective team work by suitably trained and experienced personnel. This clause deals with the matters that need to be taken into account in addition to those in Clause 7 when climbing is being undertaken.

8.2 Basic principles

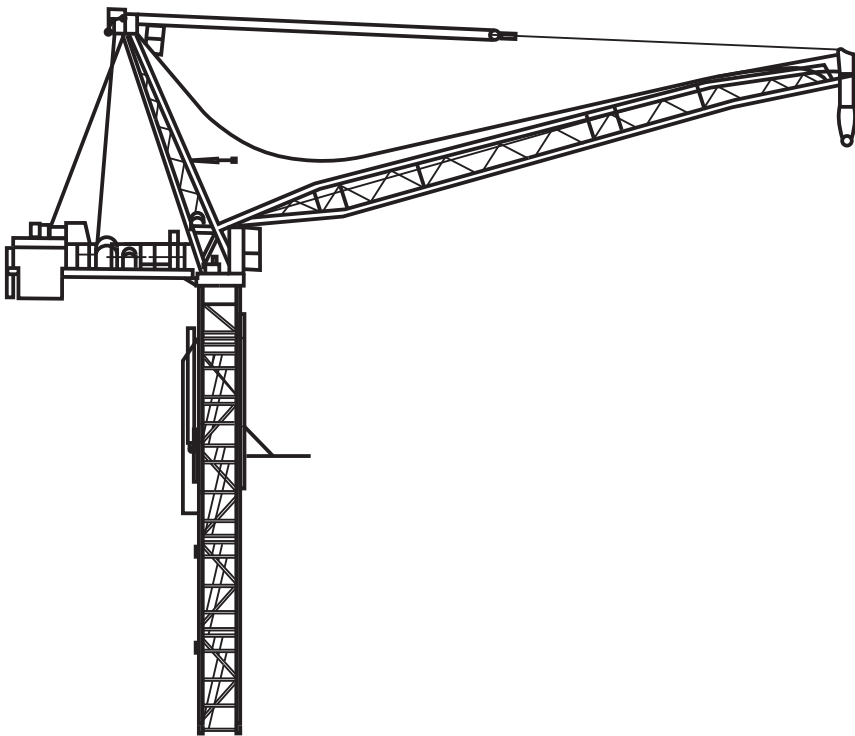
8.2.1 General

Most tower cranes are initially erected to their full height using another crane, either a mobile crane or another tower crane. This is however not always possible as very tall cranes might require tying to an adjacent structure, often the building they are helping to construct, and consequently need erecting in stages. Additionally, congested city centre sites often do not have sufficient room on which to stand the large mobile cranes required to erect tower cranes to great heights. In these cases the height of the tower crane may be extended using climbing techniques. These fall into two main categories, external (where the tower of a crane outside a building is extended with a jacking system to allow additional tower sections to be inserted), and internal (where the crane tower is supported by the building floors and is jacked up as the building rises). See Figure 16

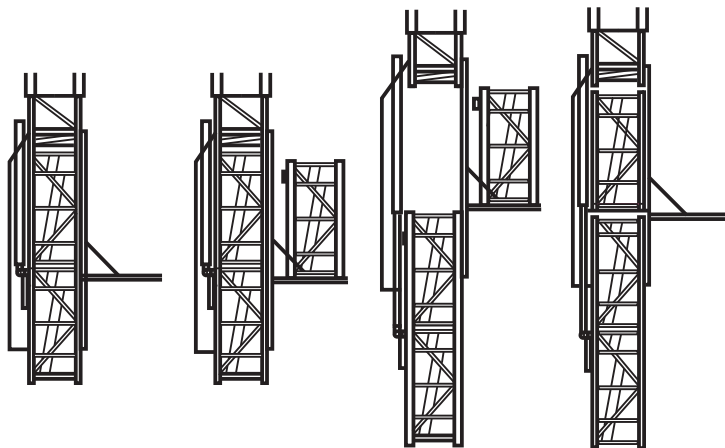
8.2.2 External climbing

When carrying out external climbing, the most common method of increasing the height of a tower crane is by the use of a climbing frame. This consists of a lattice steel frame surrounding three sides of the crane tower, with an opening on the fourth. A hydraulic cylinder(s) allows the frame to be raised or lowered and guide wheels or rollers are provided to keep the frame aligned on the tower. The open side of the frame incorporates means of holding a new tower section prior to raising the climbing frame, moving it into the tower after

climbing and then lowering it on to the top of the previous section. At the start of the climbing process the climbing frame, generally in two parts, is assembled on the crane tower and then lifted to the top of the tower by the crane. Once at the top of the tower the frame is secured to the underside of the crane slewing section. The foot of the climbing cylinder(s) is then located on reaction points on the tower. See Figure 16b.



(a) Figure 16 — Typical external climbing sequence



(b) (c) (d) (e)

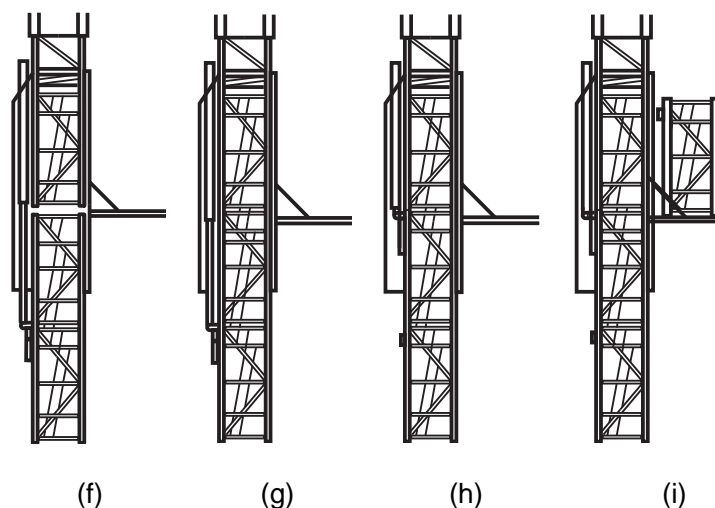


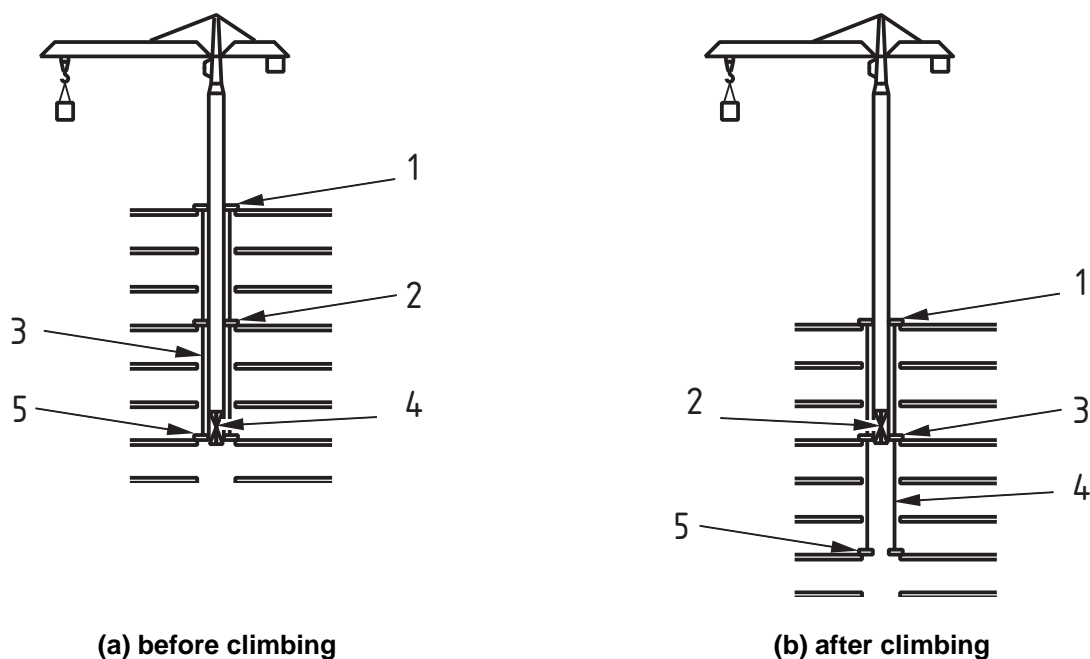
Figure 16 — Typical external climbing sequence

A tower crane section is then lifted by the crane and transferred to the climbing frame. The crane is then slewed square with the tower and put in balance to ensure that the overturning moment on the climbing frame is kept to a minimum. Balancing is achieved by either lifting a specified weight (normally another tower section) and moving it to a specific radius or using the self weight of the jib and hook block. This ensures that the superstructure of the crane is balancing about the centre of the climbing cylinder(s) . See Figure 16c.

The climbing cylinder(s) is then pressurized to take the weight of the crane superstructure, allowing the fastenings connecting the superstructure of the crane to the uppermost tower section to be removed. Once the fastenings have been removed the cylinder (s) is extended to lift the crane superstructure a sufficient distance to allow a new tower section to be inserted. See Figure 16d. when the climbing frame has been extended sufficiently, the new tower section is pulled into the frame. See Figure 16e. The frame is then lowered until the joints on the crane superstructure engage with the top of the new section. The crane superstructure/tower joints are then secured and the new tower section lifted clear of the transfer device to allow it to be pushed out of the climbing frame. See Figure 16f.

Once the transfer device is clear of the frame, the crane superstructure is lowered to allow the bottom of the new section to engage with the joints of the previous section. When the joints are fully engaged, fastenings are secured to lock them. See Figure 16g.

The climbing cylinder(s) is then retracted and its foot located on the tower reaction points (Figure 16h), allowing the climbing cycle to be repeated. See Figure 16i.



Key

- 1 New Top collar (installed before climbing)
- 2 Middle (previously top) collar
- 3 Climbing support
- 4 Hydraulic climbing section

Key

- 1 Top collar
- 2 Hydraulic climbing section
- 3 Bottom collar
- 4 Climbing support

Figure 17 — Typical internal climbing sequence

8.3 Climbing systems

8.3.1 General

Whilst most tower crane climbing systems are based on the same principles, the details vary widely between makes and models and it is essential that the specific procedures for the exact climbing equipment type and crane configuration are followed. The assumption that a procedure for a similar looking crane can be safely followed should not be made. It is also important that only components specified by the manufacturer are used in the climbing process.

8.3.2 External

External climbing frames are all basically a steel lattice frame forming a sleeve around the tower with guide wheels or rollers to transfer any horizontal forces resulting from any overturning moment to the tower. The guide wheels or rollers may bear on either the corners or faces of the tower section corner posts. Lifting of the climbing frame is carried out by a hydraulic cylinder(s) attached to the frame with the free end located on reaction points on the tower. These reaction points are either tower structure members or lugs welded to the tower. On some designs of climbing frame the cylinder(s) has sufficient stroke to lift the crane superstructure the distance required to insert a new tower section. On others a cylinder(s) with a shorter stroke is used in conjunction with a ratchet mechanism requiring the cylinder(s) to be extended and retracted several times to lift the climbing frame the required distance. On most designs of climbing frame the climbing cylinder(s) is located on one side of the tower but on some it is located centrally, making it easier to balance the crane superstructure. The means of holding the new tower section on the climbing frame and transferring it in to the

tower may either be an overhead runway beam projecting from the climbing frame from which the tower section is suspended or a guided platform on which the tower section is placed. Climbing frames are generally provided with personnel platforms located at the top and bottom of the frame to provide safe access for the erection team, with connecting ladders between the platforms. A far less common type of external climbing system has the crane superstructure located on an inner tower which telescopes from an outer tower. Once the inner tower has been extended additional tower sections, in halves, are lifted up and bolted together around the inner tower. The climbing equipment can then be engaged in the new section and the climbing process repeated.

8.3.3 Internal

Internal climbing arrangements generally consist of climbing supports suspended from the top collar and a hydraulic climbing device which lifts the crane up the climbing supports in a series of strokes of the cylinder(s), with a ratchet arrangement to support the crane during cylinder(s) retraction. Climbing supports can be ladders, rods or tubes.

8.3.4 Planning

Effective planning of a tower crane climbing operation is essential if the operation is to proceed safely, effectively and without incident. When planning a tower crane climbing operation the process detailed in 7.1 should be followed.

8.3.5 Structural considerations

8.3.5.1 General

Tower crane climbing frequently involves tying to an adjacent structure, often the building on which the tower crane is being used for lifting operations. As part of the planning process it is important that the design and fabrication of the ties are taken into account, together with the connection to the structure. Corresponding structural issues arise with the use of internally climbed cranes. All design work should be carried out by suitably qualified engineers.

8.3.5.2 External ties

External tower crane ties normally take the form of three steel “legs” which transfer horizontal forces from the crane tower to the adjacent structure. See Figure 18. The legs are triangulated to minimize twisting of the tower and are pin jointed to the tower and structure to eliminate bending from the leg members. The tower is generally surrounded with a “collar” onto which the legs are connected. This collar provides convenient attachment points and ensures that forces are transmitted without local overloading. Certain designs of tower and collar only permit the collar to be located at certain points vertically on the tower and the manufacturer’s instructions should be followed.

Connection of the legs to the structure is generally made via pin jointed brackets, which are then fastened to the structure. The method of fastening depends on the magnitude of the tie loads and the strength and construction of the structure. Consultation between the designers of the structure and the person planning the climbing operation should take place at the earliest opportunity as substantial internal bracing might be required to transfer the tie forces to a strong point in the structure. When a tie is installed measures should be taken to ensure that the crane tower remains vertical within the limits set by the manufacturer. Ties should be provided with adjustable length tie legs to enable the tower to be set vertical during and after installation. Guidance on checking of verticality is given in the CIRIA document on Tower Crane Stability. Tower verticality is especially important during climbing as any substantial deviation from the vertical can affect the hook radius specified for balance by the manufacturer.

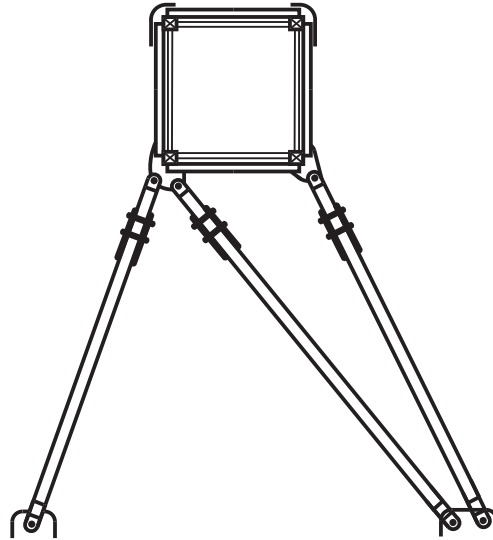


Figure 18 External tower crane ties

8.3.5.3 Internal climbing frames or collars

When a tower crane is climbed within a building structure, openings are left in each floor to accommodate the crane tower and climbing equipment as it is climbed up the structure. The climbing frames or collars, which serve as guides and reaction points for the crane tower, are located around the periphery of the floor apertures and are either connected directly to the floor slab or more usually to steel grillages connected to the structure. The method of fastening depends on the magnitude of the tie loads and the strength and construction of the structure. Consultation between the designers of the structure and the person planning the climbing operation should take place at the earliest opportunity as substantial shoring and bracing could be required to safely transfer the collar forces to the structure.

8.3.6 Risk assessment

A risk assessment should be carried out in accordance with 7.1.4 and additionally take into account the particular hazards that are associated with tower crane climbing operations. These hazards might include:

- collapse due to changing wind loading;
- collapse due to incorrect balancing of the crane top;
- collapse due to inadvertent slewing during climbing;
- loss of support for the climbing frame during jacking;
- falling from walkways, platforms or ladders on the climbing frame;
- falling objects;
- incorrect operation of the climbing frame;
- mechanical/electrical failure of the climbing frame.

It is essential that the appointed person carrying out the risk assessment has sufficient detailed knowledge of the specific crane and specific climbing equipment to be used in order to identify hazards.

8.3.7 Method statement preparation

8.3.7.1 General

The method statement should be prepared in accordance with 7.1.5 and additionally address the issues given in 8.4.1 to 8.4.5 associated with tower crane climbing operations.

8.3.7.2 Communication

Arrangements for ensuring that all members of the erection team can effectively communicate at all times during the climbing operation should be detailed.

Communication is normally necessary between personnel on the ground, personnel on the climbing frame, the operator in the cab of the crane being climbed and the operators of any other cranes involved.

8.3.7.3 Weather forecasting and monitoring

Tower crane climbing operations may only be carried out in wind speeds below the limit set by the crane manufacturer (generally 12.5 m/s). Unless specified otherwise this limiting wind speed should be taken as the maximum gust speed. Arrangements should therefore be detailed to obtain accurate weather forecasts in the period leading up to the start of climbing. These enable the Appointed Person and the Erection Supervisor to decide if climbing should go ahead. If the climbing programme is of several days duration, daily forecasts should be obtained to ensure that the crane can be secured in a suitable configuration if high winds are indicated. Arrangements should also be made to monitor wind speed just prior to and during the climbing operations. This is often achieved by the operator monitoring the tower crane's anemometer and the Erection Supervisor using a calibrated hand held anemometer.

For climbing operations the weather forecasts should be site specific, giving mean and gust wind speeds (at required heights), wind direction and weather for the next five days. This information is obtainable from a number of specialist providers (such as the Met Office).

NOTE See 8.4.3 for further information on environmental monitoring.

8.3.7.4 Inspection of climbing equipment before and during climbing

Arrangements for the inspection of climbing equipment before climbing starts should be detailed, together with procedures for the reporting of any defects, to ensure that the climbing process is not started with faulty equipment.

Procedures for the monitoring and reporting of defects such as vibration during the climbing process should also be documented.

8.3.7.5 Specific climbing procedures including balancing

The specific climbing procedures for the make, model and configuration of the crane to be climbed should be detailed. If this is by reference to the manufacturer's instruction manual, the arrangements for ensuring that a copy of the relevant manual is available on site should be given.

Particular attention should be paid to the manufacturer's specified arrangements for ensuring that the crane is balanced. Balancing is often carried out by altering the hook radius about a nominal balance radius detailed by the manufacturer. A +/- tolerance on this nominal figure should be given outside which the climbing team should not go without reference to the Appointed Person.

8.3.7.6 Contingency arrangements

Contingency arrangements should be detailed for the occurrence of any circumstance that might affect the safety of the climbing operation (e.g. power failure, hydraulic failure, and increase in wind speed). This should

include arrangements for the notification of problems to the Appointed Person if he is not present on site during the climbing operation. Reference should also be made to site specific emergency procedures.

8.3.7.7 Thorough examination including testing

NOTE See Annex C for guidance on climbing frame thorough examination and checks.

The arrangements for carrying out a thorough examination after installation and overload test, after the climbing operation has been completed and before the crane is returned to service, should be detailed.

8.3.7.8 Commissioning the crane

Arrangements for commissioning the crane and handing it back to the site following the successful completion of the thorough examination should be detailed.

8.4 Climbing process

8.4.1 Briefing of erection team

Once the erection team has arrived on site and before the climbing process is started a comprehensive briefing of all those involved with the climbing process should be carried out by the Appointed Person or Erection Supervisor using the final edition of the method statement. The briefing should cover the contents of the method statement, any sections of the manufacturer's manual to which it refers, and in particular, those features of the operation that are peculiar to the site (e.g. proximity of other cranes, interface with the public, proximity of other trades, noise restrictions, work hours restrictions).

Work should not commence until a "Permit to Climb" has been received from the appointed person.

8.4.2 Liaison with site

The company carrying out the climbing operation should maintain a close liaison with the nominated representative of the organization with overall charge of the site and, if a different person, with the PSCS (Project Supervisor Construction Stage) to ensure that those matters for which the Main Contractor is responsible, such as monitoring of exclusion zones and liaison with other trades, are dealt with effectively.

8.4.3 Environmental monitoring

8.4.3.1 Wind

Tower crane climbing operations may only be carried out in wind speeds below the limit set by the crane manufacture. Unless specified otherwise this limiting wind speed should be taken as the maximum gust speed. Wind speeds in excess of the manufacturer's limits can affect the balance, and hence the integrity, of the crane during climbing, as can gusts and shifts in wind direction. Arrangements should therefore be made to obtain accurate site area specific weather forecasts in the period leading up to the start of climbing. These forecasts should indicate wind direction, mean wind speed and maximum gust speed at intervals over a 24 h period. Wind speed increases with height above the ground and as forecast wind speeds are predicted for a specific height above ground level (often 10 m) these should be corrected for the height at which climbing takes place. These forecasts enable the Appointed Person and the Erection Supervisor to decide if climbing should go ahead. If the climbing programme is of several days duration, daily forecasts should be obtained to ensure that the crane can be secured in a safe configuration if high winds are indicated. Once on site, wind speed should be monitored by the tower crane operator using the anemometer mounted on the crane "A" frame and by the Erection Supervisor using a calibrated hand held anemometer. The supervisor should monitor the wind speed for a period of 15 min before starting the climb to assess the degree of gusting and to ensure that the wind speed does not exceed the manufacturer's limit for climbing.

8.4.3.2 Visibility

Good visibility is required during tower crane climbing to enable the effective monitoring of the climbing process. Climbing should not be carried out when visibility is poor or after dark.

8.4.4 Monitoring of exclusion zones

An important part of the safe system of work for climbing tower cranes is the protection of persons below the crane by the establishment and enforcement of exclusion zones. These ensure that all persons not directly concerned with climbing operation are excluded from the area at risk from falling objects. However once established it is important that these are monitored to ensure that unauthorized persons do not enter the zone. The responsibility for this monitoring should be established at the planning stage.

8.4.5 Craneage arrangements

The climbing of a tower crane is often accomplished by using the crane being climbed to unload and handle all the equipment and components involved in the climbing operation. However site or programme constraints, or requirements for ties or internal climbing frame supports might dictate the use of additional cranes. These may be either existing cranes on the site, tower or mobile, or mobile cranes brought onto site specifically for the climbing operation. In all cases the lifting operations should be planned by the Appointed Person. In the case of mobile cranes particular attention should be paid to positioning the crane and ensuring that the ground has sufficient capacity to safely absorb the loads imposed by the crane's wheels and outriggers.

NOTE BS 7121-3 for guidance on the selection, siting and use of mobile cranes.

8.4.6 Assembly and inspection of climbing equipment

Once the climbing equipment, either an external climbing frame or internal climbing collars and ladders, has arrived on site it should be inspected to ensure that damage has not occurred during transport and offloading. It should then be assembled in accordance with the manufacturer's instructions, before installation on the crane. Once installed around the crane tower the equipment should be inspected again to ensure that it is complete and ready for use. The tower sections should be checked before use to ensure that they are of the correct type for the particular crane.

8.4.7 Positioning of tower sections

Tower sections that are to be incorporated into the tower during the climbing process should be positioned in a line away from the base of the tower, normal to the open side of the climbing frame. This avoids the need for slewing during climbing.

8.4.8 Checks before and during climbing

There are a number of checks that should be made before starting and during the climbing process to ensure that the climbing equipment is correctly installed and fully operational. These should include checks that:

- a) the power supply cable has sufficient spare length to accommodate the increase in the crane's height;
- b) the hydraulic power pack relief valve is set at the correct pressure for the crane configuration;
- c) the foot of the hydraulic cylinder(s) reacting on the tower is correctly located on the reaction points;
- d) the foot of any ratchet mechanism used to support the superstructure temporarily between strokes of a multi stage cylinder(s) is correctly located on the reaction points;
- e) the tower section joints are correctly aligned before a new section is lowered onto the previous section;

- f) hand held radios are in working order with fully charged batteries;
- g) any system to prevent slewing of the superstructure during climbing is functioning correctly;
- h) the crane superstructure is balanced;
- i) the climb can take place within the wind speed limits set by the manufacturer;
- j) arrangements are in place to ensure that the operator cannot inadvertently slew the crane;
- k) after lowering the crane top, the foot of the hydraulic cylinder(s) reacting on the tower remains correctly located on the reaction points.

NOTE See Annex C for further information

8.4.9 Balancing the crane

Before starting to lift the superstructure of the crane, in the case of external climbing, or lifting the complete crane, in the case of internal climbing, the crane should be “balanced” to ensure that the centre of gravity of the crane components being supported by the climbing equipment is over the centre of the climbing cylinder(s). This ensures that the climbing equipment is operated within its design criteria. The procedure for balancing varies with the type and model of crane, but generally consists of placing the movable components of the crane superstructure (luffing jib or trolley) at a specified radius, with or without a weight on the hook, in accordance with the manufacturer's instructions. The manufacturer's instructions should include a procedure for establishing that the crane is in balance. This should be strictly adhered to. The balance of the crane should be checked before each extension of the climbing equipment.

A tolerance for the balance radius should be obtained either from the manufacturer or if the manufacturer is no longer available, from a competent engineer. If balance cannot be achieved within this tolerance climbing should be stopped whilst expert advice is sought.

8.4.10 Climbing in new tower sections

Once the crane has been balanced, the climbing equipment should be extended and new tower sections inserted, in accordance with the manufacturer's instructions. The climbing process should be repeated until the required number of sections have been added to the crane tower.

8.4.11 Re-commissioning the crane

Once the climbing process has been completed and the thorough examination carried out the crane should be returned to its working configuration and handed back to the user. This handover of the climbed crane should be recorded in writing so that it is clear to all parties that the crane may be used for normal lifting operations.

8.4.12 Storage and removal of the climbing equipment

Internal climbing equipment is normally left in place between climbs as it forms part of the support arrangements for the crane during normal working. External climbing frames may either be removed after each climbing operation for use on another crane or left on the crane tower. Removal of the climbing frame should be planned as part of the climbing operation. If the frame is to be left on the tower between climbing operations this should be done in accordance with the manufacturer's instructions, taking into account any possible increases in wind loading etc.

8.4.13 Climbing down

Climbing down is generally the reverse of the climbing process, requiring the same planning and preparation as climbing up. If a crane that is tied to an adjacent structure is being climbed down, particular attention

should be paid to ensuring that the crane is left in a suitable configuration at the end of each day or climbing shift to avoid excessive tie or tower forces in the out-of-service condition.

8.4.14 Contingency arrangements

The safety of tower crane climbing operations depends on keeping within a number of set parameters such as tower verticality, wind speed, crane balance and slew orientation throughout the operation. To avoid going outside these parameters arrangements should be put in place to deal with events such as, but not limited to, increase in wind speed, change of wind direction, gusting, electrical power failure, hydraulic and mechanical breakdown. All possible events should be included in the risk assessment and contingency arrangements drawn up and recorded in the method statement.

8.5 Thorough examination including testing of the crane after climbing

After each climbing operation has been completed, and before the crane is returned to service, it should be thoroughly examined and tested in accordance with the relevant clauses of BS 7121-2. On completion of the test any load limits altered to facilitate the test should be reset to the rated load and a thorough examination of the crane should be carried out. The competent person should issue a report of thorough examination with an appropriate test certificate appended to it.

8.6 Maintenance of climbing equipment

8.6.1 General

The effective maintenance of climbing equipment plays a significant part in the safe and efficient completion of tower crane climbing operations.

8.6.2 Records

A full record of all use and maintenance, including checks and inspections, should be kept to ensure that a full history of the equipment is available.

8.6.3 Checks and inspections

Pre-use checks and inspections of the climbing equipment should be carried out in accordance with the manufacturer's instructions, and should include the following as a minimum:

- a) an inspection of the equipment before transport to site;
- b) an inspection of the equipment on arrival at site;
- c) an inspection check of the equipment after assembly;
- d) a pre-use check of the equipment at the start of each shift;
- e) checks during the climbing operation.

8.6.4 Defect reporting

The erection supervisor in charge of each climbing operation should report any defects in the equipment to his manager so that the defects can be rectified before any use of the equipment.

8.6.5 Thorough examination

Climbing frames, whilst not always part of the crane's permanent equipment, are devices for lifting persons and should be thoroughly examined by a competent person within the previous six months.

NOTE Further advice on the extent of examination of these devices is given in Annex C.

8.6.6 Maintenance intervals and procedures

Maintenance of both internal and external climbing equipment, including the servicing of hydraulic systems, should be carried out at the intervals and to the procedures prescribed by the manufacturer.

NOTE Heavy usage of the climbing equipment or usage in harsh environments might require maintenance activities to be carried out at more frequent intervals.

9 Crane operation.

9.1 Training and certification

Any crane operator and signaller should be suitably trained and certified in accordance with the requirements set out in the Safety, Health and Welfare at Work (Construction) Regulations.

Cranes should be operated in a safe manner and any defects should be immediately reported to the employing organization. It is essential the operator does not tamper with any controls, mechanisms or equipment, including limiting and indicating devices, either to enable the crane to function outside the operational range or loads specified by the crane manufacturer or other competent person, or to attempt to correct any suspected defect.

Crane operators and signallers/slingers should be able to conduct their business through English/Irish.

The crane operator shall be authorized to decide whether it is safe to conduct a particular lift, taking into account the prevailing conditions.

Mobile phones should not be used whilst operating the crane.

Crane cabs shall be provided with adequate means of heating and ventilation. Windows, window wipers and doors shall be properly maintained. Seating should be adjustable and provide proper support for the body.

Each control should be appropriately marked to identify the motion controlled and the direction of movement.

NOTE Further references can be found in ISO 7296-1

9.2 Control of Access

Fencing or barriers should be erected around the base of cranes to restrict access to pedestrians or damage from workplace transport moving in the immediate vicinity. Entry to the area should be controlled by a safe system of work.

9.3 Floodlights, decorations & advertising panels

Advertising panels if fitted shall conform to the cranes manufacturer's instructions as they can cause excessive wind loading.

Floodlights if fitted must be installed in a safe manner.

Where the installation of decorations is intended they should be fitted prior to the erection of the crane and should be of low voltage.

Care needs to be taken to ensure that floodlights and decorations do not present a hazard to any personnel who may need to work on the crane.

All work at height shall be in compliance with the Working at Height Regulations

9.4 Limiting and indicating devices

The correct operation of all limiting and indicating devices should be verified regularly and they should be maintained in good working order in accordance with the manufacturers' instructions.

NOTE Limiting and indicating devices are described in IS EN 12077-2

9.4.1 Rated Capacity

The rated capacity of a crane may only be exceeded when testing the crane under the supervision of a competent person. Care should be taken to prevent pendulum swinging of the load, by careful control of the operating motions to match the swing of the load and to keep it under control at all times. Rated capacities apply only to freely suspended loads. The hoisting, slewing, traversing, luffing or travelling motions of a crane should not be used to drag any load along the ground with the hoist rope out of the vertical position. Before lifting a load, the hoist line should be plumb. Failure to observe these points can adversely affect the stability of the crane or introduce loadings (stresses) into the crane for which it has not been designed and, even with a rated capacity indicator/limiter fitted, a structural failure can result without warning.

9.4.2 Level indicators and inclinometers

Where fitted, crane level indicators and inclinometers should be used in accordance with the instruction manual and maintained in good working order.

9.4.3 Wind-speed indicating and monitoring devices

It is essential that tower cranes are fitted with anemometers or other wind-speed monitoring devices. These should have their indicators located in clear view of the crane operator. The correct operation of these devices should be determined regularly and they should be maintained in good working order. The sensor of the indicator should be positioned so that it can measure air flow uninterrupted by the crane or adjacent structures. Sensors are often positioned on the highest point of the crane. After installation the wind speed monitoring device should be checked against a calibrated hand held anemometer to confirm the device is functioning correctly.

NOTE The operator uses the information from the anemometer in making a judgement of safe operating wind speed depending on the size and nature of the load being lifted. This may be below the maximum in-service wind speed specified by the crane manufacturer.

9.4.4 Working space limiter (zoning device)

A working space limiter should be fitted to prevent a fixed load attachment and/or parts of the crane from entering a prohibited space.

9.4.5 Anti-collision device

An anti-collision device may be used to prevent a fixed load attachment and cranes or parts of cranes from colliding when they are manoeuvred simultaneously in the same space. These devices are a useful aid to the operator when operating on multi crane sites but should not be relied on exclusively in place of the primary safe system of work including the crane coordinator, operator vigilance and crane to crane communication using anti-collision radios.

9.5 Mode of operation and control

9.5.1 General

Before starting any lifting operation with a crane, the crane operator should:

- have a clear and unrestricted view of the load and operational area or act under the directions of a slinger or an authorized signaler who is positioned to have a clear and uninterrupted view. The operator should also be in a position to receive warnings from any indicating devices;
- ensure that lifts can be carried out without causing damage and that loads and crane hoist ropes are suitably clear of obstructions;
- ensure that verbal messages can be clearly heard, especially where telephone, radio or closed-circuit television communications are being used.

The hoist rope should be vertical at the start of and throughout the hoisting operation. The load should initially be lifted just clear of the supporting surface and be brought to rest while the slings, balance of the load, etc. are checked, before proceeding. Care should be exercised by the operator at all times to avoid shock or side loadings on the jib or structure. Care should also be taken to avoid the hook or lifting accessories coming into contact with the structure.

Motion motors should only be reversed before the motor has come to rest when the control gear is specifically designed to allow this.

The crane safety devices should not be regarded as routine means of stopping the motion(s).

Before any crane is moved along its track(s), a warning should be given to all personnel who might be endangered. A warning bell or klaxon may be fitted for this purpose.

9.5.2 Remote-controlled cranes

To prevent unauthorized use, the operator of a crane that is controlled by transmitted signals, e.g. radio, should either retain the transmitter in their physical possession or remove the key from its key-lock switch and, for short periods, retain the key in their possession. For longer periods, or when the crane is not in use, the transmitter should be deposited in safe storage. Provision should be made for the security of the transmitter when the crane is not in use. When the transmitter is fitted with a belt or harness, the operator should be wearing the harness before switching on the transmitter so that accidental operation of the crane is prevented. The transmitter should only be switched on when operating the crane and be switched off before removing the harness. Where it is provided on a remote-controlled crane, the operator should test the controlled-range feature at regular intervals. The controlled-range feature should also either be checked at the beginning of each shift or whenever there is a change of operator to ensure that it operates within the limits specified.

NOTE Specifications for cableless controls and control systems are given in I.S. EN 13557:2008, Annex C.

9.6 Handling of loads near persons

When loads have to be handled in the vicinity of persons, extreme care should be exercised and adequate clearances allowed. The route of the load should be planned to prevent lifting over persons. Operators and signallers should pay particular attention to possible dangers of persons working out of sight. All persons should be instructed to stand clear of the load being lifted. When lifting a load from a stack, all persons should be instructed to stand away from the stack in case adjacent materials or objects are displaced. Where possible lifting of loads over highways, railways, rivers or other places to which the public have access should be avoided. If this is not possible, permission should be obtained from the appropriate authority and the area kept clear of traffic and persons.

9.7 Multiple lifting

Tower cranes should not be used for multiple/tandem lifts.

9.8 Special duties

Tower cranes should not be used for carrying out special duties such as grabbing, lifting by magnet, balling operations, pile driving, or extracting.

9.9 Weight of the load

Project planning will involve consideration of the loads to be lifted and any special issues that may arise from non-uniform or large surface area loads. A lifting schedule should be drawn up which will provide information on loads and their corresponding travel distance and heights (see appendix D for an example of a lifting schedule illustrated in the CPA guidance on the use of self-erecting cranes)

Special care is required in the case of containers and skips which may be overlooked at the planning stage. These items should not be lifted until their contents have been ascertained.

Information on weights may be available from markings on loads, drawings or other project documentation, weighbridge readouts.

Finally if the volume of the load is known, the weight may be calculated from density information e.g.

earth-1600 kg/m³

concrete-2400 kg/m³

water-1000 kg/m³

9.10 Signaling systems

Copies of the code of hand signals can be found in I.S. 360 (Annex E) and should be issued to all crane operators, slingers and other personnel involved in the carrying out of a lifting operation to ensure that a universal signalling code is used. In situations where hand signals alone are inadequate, other forms of communication should be used, by means of either radio or telephone, to supplement the hand signal code. When radio is used as a means of signalling, the channel selected should be kept clear of all other communications. All personnel involved in the signalling should be given a clear and unique call sign and all communications should be preceded by this call sign. The crane operator should not respond to any command that is not preceded by the given call sign. During the carrying out of the lifting operation, hand signals and any voice instruction to the crane operator(s) should only be given by one person at a time. In multiple tower crane installations it is essential to have an anti-collision radio system installed. This comprises of a separate radio in each tower crane cab operating on a unique frequency to allow open unimpeded communication between all tower crane operators. In the event of the jib or counter jib of one crane approaching the hoist rope of a higher crane the operator of the higher crane can immediately warn the operator of the lower crane.

9.11 Maintenance

Provision should be made to ensure that throughout its use the crane and other equipment used in the lifting operation are maintained in a satisfactory condition in accordance with manufacturers guidelines and national legislation such as the provisions on the use of work equipment contained in the Safety, Health and Welfare at Work (General Application) Regulations. Where cranes are left on their base long after their work has ceased, there is a need to ensure that they are periodically examined and maintained to ensure that they do not fall into a dangerous condition.

9.12 Thorough examination :

Tower cranes are subject to thorough examination after erection, major repairs and periodically (12 monthly) thereafter.

9.13 Other safety provisions

9.13.1 Fire extinguishers

Fire extinguishers should be provided but care is required when used in the cabs of tower cranes as the confined nature of such cabs exposes the user to the risk of suffocation.

9.13.2 Machinery guarding

Access to dangerous parts of machinery except for maintenance/inspection shall be prevented. All machinery guarding should be properly fitted whenever the crane is in motion or use and maintained in good condition.

NOTE Attention is drawn to IS EN ISO 13857 (supercedes EN 294 and EN 811) with respect to safety distances to prevent hazard zones being reached by upper and lower limbs.

9.13.3 Lightning protection

Tower cranes are continuous metal structures, in the event of a lightning strike the structure provides an adequate conducting path to earth. To ensure an adequate earth is achieved the resistance path between the bottom of the tower and earth should be measured and it is preferred that it does not exceed a value of 10Ω . If the resistance to earth exceeds 10Ω , the crane base should be bonded to a suitable earth network via a single core cable of not less than 70 mm² cross sectional area and the earth resistance measured again to ensure that it has been reduced to an acceptable value. In the event of a known lightning strike the crane should be thoroughly examined before being returned to service, to ensure that damage has not occurred to the crane or any of its components including the slew ring, safety and control systems.

NOTE: Information on lightning protection is given in I.S. EN 62305-1, I.S. EN 62305-2, I.S.62305-3, I.S. EN 62305-4 and BS 7430.

9.13.4 Use of suspended baskets:

Regulations controlling working at height discourage working at height if the job can be safely done on or from the ground. If access equipment is required then it should be the most suitable type for the job. Normally this means that the person at height has control over movements of their working platform.

If the work requires the use of suspended baskets then compliance with the requirements of I.S. EN 14502-1 should be ensured.

Annex A (informative)

Example of Permit to Erect Record

PERMIT TO ERECT - CRANES
TOWER CRANE CANNOT BE ERECTED UNTIL THIS FORM HAS BEEN COMPLETED AND RETURNED TO THE OPERATIONS DEPARTMENT
TOWER CRANE FOUNDATION /GRILLAGE - APPROVAL CERTIFICATE
This foundation/grillage for a tower crane, (Reference No of Crane)..... At(Site Name /Address) Drawing Reference Number:.....
DETAILS OF CRANE: Make & Model:..... Serial number:..... Height under hook:.....Jib length as erected:..... Type of base:.....
FOUNDATION /GRILLAGE INFORMATION : Foundation/Grillage Designed by: (Name).....: (Signature)..... Company Name..... Approved by: (Name)..... (Signature)..... Date:.....
NOTE: A SEPARATE APPROVAL CERTIFICATE IS REQUIRED FOR EVERY TOWER CRANE
<p style="text-align: center;">PERMIT TO ERECT</p> <p>I confirm that the Tower crane foundation/grillage has been constructed in accordance with the Specification (specified above) and all foundation /grillage loads are in accordance with the Tower Crane Manufacturer's recommendations.</p> <p>We confirm the foundation anchors/base pads are level and plumb as required.</p> <p>The Tower crane can be erected (Approval /Sign off is required to be completed by a Competent engineer)..... (Name) (Signature)</p> <p>Position.....Company</p> <p>Date:.....</p>

Annex B

(informative)

Access

The appointed person should ensure that ladders, rest platforms and other means of access of cranes manufactured after June 2004 are in accordance with I.S.EN 13586. The erection supervisor should ensure that access equipment is correctly installed progressively as erection proceeds, so that the erection team have the benefit of their use. Particular attention should be paid to:

- f) ladder joint bolts;
- g) guard rails, particularly on rest platforms and inspection platforms;
- h) access from ground to the foot of the lowest ladder or to the
- i) chassis of the crane;
- j) access from levels of the construction to the crane;
- k) checking all access equipment before handover to the user.

Annex C (informative)

Example of typical procedure for climbing frame thorough examinations and checks

C.1 Procedure for the thorough examination of frame for top climbing of tower cranes

C.1.1 Procedure for 6th monthly thorough examination

Confirm the identification number of the frame and all corresponding sections, to confirm all parts are of the same frame.

Carry out a visual check of the frame structure, checking for any damage to structural members or evidence of cracking in welds. Pay particular attention to the suspension brackets and the jointing plates.

Confirm the free movement of all guide rollers and check for damage.

Check the rollers for undue wear and check that all keep plates are kept in place and secure.

Check the hydraulic ram mounting brackets for security and check the welds for signs of cracking.

Check the hydraulic ram joint pin for lift and that it is correctly locked in position.

Check that the rollers, to allow horizontal motion of the ram, are free to rotate.

Carry out a visual inspection to check that the hydraulic system is free from leaks and has no damage to the pipework or the connections.

Check the travelling platform for damage to itself and its supports.

Check the walkways for damage and security of fixing. Close off the walkways.

Record the results of the examinations on the appropriate form and retain on file.

C.1.2 Procedure for 2 yearly thorough examination

Carefully examine the main load bearing parts and subject them to NST examination as necessary. The examination should include the following:

- The jointing plates and associated supporting structures
- The reaction roller supports and associated structures
- The main suspension lugs
- The correct nodes
- The main lifting yoke

Remove the reaction roller pins and measure them to assess wear. Subject the pins to NDT examination.

Carry out the 6 monthly thorough examination at this time.

C.1.3 Procedure for 4 yearly thorough examination

Subject the hydraulic ram and relief valves to a pressure test in accordance with the manufacturer's recommendations for the system.

Remove the ram-jointing pin. Measure it for wear, and subject it to NDT examination.

Carry out the 6 monthly thorough examination at this time.

C.2 Procedure for post installation thorough examination report

Confirm the identification number of the frame and all corresponding sections to confirm all parts are of the same frame.

Carry out a visual check of the frame structure, checking for any damage to structural members or evidence of cracking in welds. Pay particular attention to the suspension brackets and the jointing plates.

Confirm the free movement of all guide rollers and check for damage.

Check the rollers for undue wear and check that all keep plates are in place and secure.

Check the hydraulic ram mounting brackets for security and check the welds for signs of cracking.

Check the lifting yolk at the base of the hydraulic ram for signs of wear and any cracking or deformity.

Check the hydraulic ram joint pin for lift and that it is correctly locked in position.

Check that the rollers, to allow horizontal motion of the ram, are free to rotate.

Carry out a visual inspection to check that the hydraulic system is free from leaks and has no damage to the pipework or the connections.

Check the travelling platform for damage to itself and its support.

Check the walkways for damage and security of fixing. Close off the walkways.

Record the results of the examination on the appropriate form and retain whilst the frame is installed for use at the location.

Procedure for pre-use check of frame for top climbing of tower cranes

Confirm that the frame has current thorough examination and installation reports.

Confirm that the test of the hydraulic system is current.

Confirm that all personnel have been issued with a copy of this code of practice or a checklist that relates to it.

Confirm that all personnel are trained in the operation and understand the procedure.

Confirm that communication either by radio or telephone is available.

Examine all connecting pins, bolts prior to erection to determine whether they are the correct type and undamaged.

Check the frame to ensure the jointing bolts are in place and secure.

Check the main guide roller pin keep plates are in place and secure.

Check the walkways are secure with no missing bolts or guardrails.

Check that the hydraulic system is free from leaks.

Check the apron for the support of the section to be inserted is secure and free to move.

Engage the slew lock or physically lock the slew and inform the operation of the importance of maintaining this action.

Obtain authorization of the checklist and permit to climb from an appointed person on site.

Annex D (informative)

Example of Lifting Schedule

Lifting Schedule									
Site Location	Canal Street, Bury		Employing Organisation	A & B Construction		Appointed Person	F. Bloggs	Contact Telephone No.	01 2345678
Item to be lifted	Item Weight	Lifted from	Lifted to	Max Radius	Max Lift Height	Lifting Accessories			Comments
						Type	SWL	Weight	
Crofters Brick Pack (500 pack)	1400 kg	Compound	Grid A12	22m	14m	Forks		2000 kg	180 kg Use net to prevent falling objects
Durox Superbloc 125 (100pack)	1100 kg	Compound	Grid B20	27 m	14 m	Forks		2000 kg	180 kg Use net to prevent falling objects
Roof Truss K480 (5 pack)	500 kg	Delivery Area	Grid D10	29 m	19 m	Violet Web sling 2m long with choker hooks		1400 kg	4 kg
Floor Beams 4m(10 pack)	800 kg	Delivery Area	Grid D10	28.5 m	14 m	2 leg 8mm chain sling 2m leg length		2000 kg	7.5 kg Double wrap choke hitch
Finishing Plaster (10 bag pack)	300 kg	Compound	Grid A6	25 m	14 m	Forks		2000 kg	180 kg Use net to prevent falling objects

Annex E (informative)

Code of Hand Signals (Extract from I.S. 360)

