TRAINING MODULE FOR COMPETENT PERSON (TOWER CRANE)

Disediakan untuk:

Jabatan Keselamatan dan Kesihatan Pekerjaan
Kementerian Sumber Manusia

Disediakan oleh:

UKM PAKARUNDING

TRAINING MODULE FOR COMPETENT PERSON

(TOWER CRANE)

Disediakan Oleh:

UKM Pakarunding Sdn Bhd
Universiti Kebangsaan Malaysia
43600 Bangi
Selangor
Tel: 03-89213142
Fax: 03-89252469
Website: http://www.pakarunding.ukm.my/

Disediakan Untuk:

Jabatan Keselamatan dan Kesihatan Pekerjaan
(Kementerian Sumber Manusia)
Arasl 2, 3 & 4, Block D3, Kompleks D
Pusat Pentadbiran Kerajaan Persekutuan
62530 W. P. Putrajaya
Tel : 03-8000 8000
Fax : 03-8889 2443
Website : http://www.dosh.gov.my

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CHAPTER 1

LEGISLATIONS

1.1 Introduction

For Malaysia, the major legislations enacted to address occupational safety and health issues are the **Occupational Safety and Health Act (OSHA) 1994** and the **Factories and Machinery Act (FMA) 1967** (Figure 1.1). The Regulations and Rules drawn up by the Ministry under these Acts are enforced by the Department of Occupational Safety and Health (DOSH), Ministry of Human Resources.

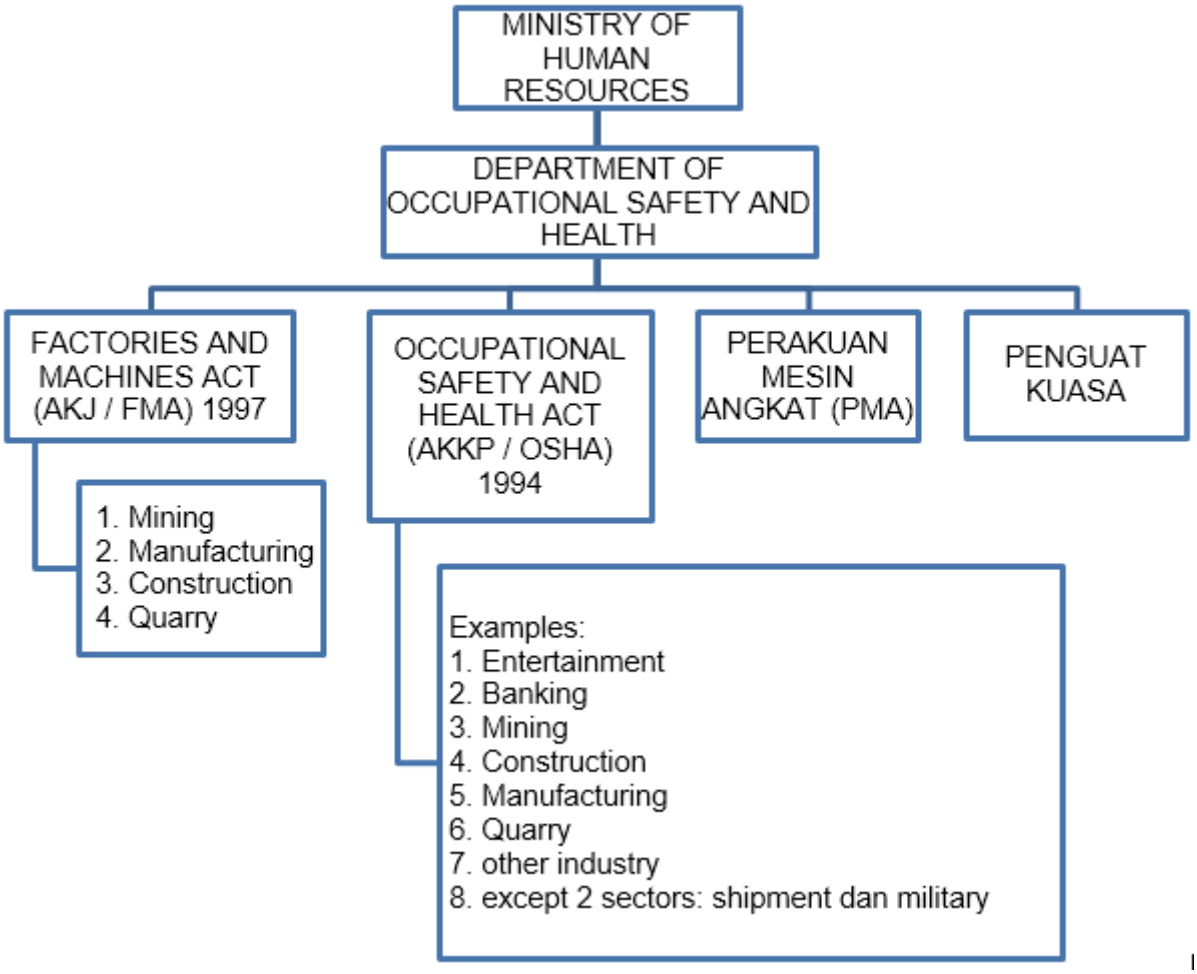

Figure 1.1 Acts that have been adopted in Malaysia

1.2 Occupational Safety and Health Act (OSHA) 1994

The primary aim of this Act is to inculcate a caring attitude towards safety and health at the workplace, and to create effective safety measures that are tailored to the relevant industry or organization through self-regulatory schemes, consultation, collaboration, cooperation and engagement with workers. The main long-term goal of the Act is to produce a healthy and safe work culture among all workers and employers in Malaysia.

Objectives of OSHA (Act 514)

(Part I; Section 4 Paragraph (a), (b), (c) and (d) Act 514)

1) To ensure the safety, health and welfare of employees;
2) To protect workers and others from activities that involve risk;
3) To promote a safe and healthy workplace environment;
4) To provide legislations for occupational safety and health with regulations and an industrial code of practice approved under the provisions of the Act (not limited to acts and regulations).

Scope of Act 514

THOSE WHO ARE EMPLOYED:-

In all sectors in Malaysia as follows:-

- Manufacturing
- Mining and quarrying
- **Construction**
- Agriculture, forestry and fishery
- Utilities: Electricity, gas, water and sanitary services
- Transportation, storage and communication
- Wholesale and retail trades
- Hotels and restaurants
- Finance, insurance, real estate and business services
- Public services and statutory authorities

With the exception of:-

Work on board ships (as stipulated under the Merchant Shipping Ordinance 1952) and the armed forces.

General Duties of Employers and Self-Employed Persons (Part IV)

Section 15. The general duties of employers and self-employed persons to their employees

It is the duty of employers and self-employed persons to ensure the safety, health and welfare of their employees while at work. The general duties of employers are summarized as follows:

Paragraph (1) and Paragraph (2);

- The provision of plants and systems of work that are safe
- The provision of self-protective gear
- The provision of information, instructions, training and supervision in relation to safety and health
- The provision of the means to access and egress safely
- The maintenance of a safe working environment for employees

Section 16 Duty to formulate a safety and health policy

It is the duty of the employer to prepare and revise a written statement of his general policy with respect to the safety and health of his employees, and to bring it to the notice of all his employees.

Section 19 Penalty for an offence under sections 15 and 16

Anyone who contravenes the provisions of sections 15 and 16 shall be guilty of an offence, and shall, on conviction, be liable to:

- A fine not exceeding RM 50,000.00
- Imprisonment for a term not exceeding two years.
- Or both.

General Duties of Employees (Part VI)

Section 24. General duties of employees at work

1) Paragraph (1) sub-paragraphs (a),(b),(c) and (d), and Paragraph (2)
    - To take care of the safety and health of himself and of other persons.
    - To cooperate with his employer and other persons in the discharge of the requirements imposed by this Act.
    - To wear the self-protective gear provided.
    - To comply with the instructions and measures on occupational safety and health.

2) A person who contravenes the provisions of this section shall be guilty of an offence and shall, on conviction, be liable to:
    - A fine not exceeding RM 1,000.00
    - Imprisonment for a term not exceeding 3 months.
    - Or both.

Section 25. Duty not to interfere with or misuse things provided pursuant to certain provisions

A person who intentionally, recklessly or negligently interferes with or misuses anything provided or done in the interests of safety, health and welfare in pursuance of this Act shall be guilty of an offence and shall, on conviction, be liable to:

- A fine not exceeding RM 20,000.
- Imprisonment for a term not exceeding 2 years.
- Or both.

The regulations under OSHA 1994 are as follows:

1. Occupational Safety and Health (Classification, Labelling and Safety Dat Sheet of Hazardous Chemicals) Regulations 2013;
2. Occupational Safety and Health (Notification of Accident, Dangerous Occurrence, Occupational Poisoning and Occupational Disease) Regulations 2004;
3. Occupational Safety and Health (Use and Standards of Exposure of Chemicals Hazardous to Health) Regulations 2000;

4. Occupational Safety and Health (Safety and Health Officer) Regulations 1997;
5. Occupational Safety and Health (Classification, Packaging and Labelling of Hazardous Chemicals) Regulations 1997 (Repealed);
6. Occupational Safety and Health (Safety and Health Committee) Regulations 1996;
7. Occupational Safety and Health (Control of Industrial Major Accident Hazards) Regulations 1996;
8. Occupational Safety and Health (Employers' Safety and Health General Policy Statements) (Exception) Regulations 1995.

- ORDERS:
  - Occupational Safety and Health (Safety and Health Officer) Order 1997
  - Occupational Safety and Health (Prohibition of Use of Substance) Order 1999

1.3 Factories and Machinery Act (FMA) 1967

The relevant regulations and orders under the Factories and Machinery Act, 1967 in relation to machinery and the safe construction of buildings are:

1. Factories and Machinery (Exemption of Certificate of Fitness for Hoisting Machine) Order 2015;
2. Factories and Machinery (Building Operations and Works of Engineering Construction) (Safety) Regulations 1986;
3. Factories and Machinery (Notification of Fitness and Inspections) Regulations 1970;
4. Factories and Machinery (Safety, Health and Welfare) Regulations 1970 (Amendment – 1983).

Although there are no specific regulations under either one of the Acts (OSHA 1994 and FMA 1967) pertaining to the proper use or operation of tower cranes at the

worksite, the following guidelines are available:

1. Guidelines for Occupational Safety and Health (OSH) in the Construction Industry (Management) 2017;
2. Guidelines for Public Safety and Health at Construction Sites, 2007;
3. Guidelines for the Prevention of Falls at the Workplace, 2007;
4. Standard Malaysia, MS 1803:2008: Cranes - Safety - Tower Cranes

1.4 Construction Industry Development Board (CIDB) (ACT 520)

The Construction Industry Development Board of Malaysia is a department under the Public Works Ministry. The history of its establishment is as follows:

- Tabling of the Construction Industry Development Board Act in Parliament in May 1994.
- Gazetted as Act 520 in July 1994.
- Came into effect officially on 1 December 1994.

Objectives of Act 520:

1) To register contractors/workers in the construction sector according to their class/skills.
2) To accredit and certify skilled construction workers and construction site supervisors according to the methods and forms specified.
3) To conduct investigations into any offence and inspections.

Jobs that require skills and certification

1) Blaster and painter
2) Air-conditioning and mechanical ventilation specialist
3) Drywall installer
4) Ceiling installer
5) Petrochemical fitter
6) Roof truss installer
7) Precast concrete installer

8) Formwork system installer
9) Block system installer
10) Bar bender
11) Wireman
12) Bricklayer
13) Plant operator
14) Crane operator
15) Chargeman
16) Cable jointer
17) Slinger and rigger
18) Painter
19) Tiler
20) Carpenter
21) Welder
22) Plasterer
23) Plumber
24) Scaffolder

Why is it necessary for construction site workers and supervisors to register with the Malaysian Construction Industry Development Board (CIDB)?

1) To gain recognition for their skills.
2) To enhance their career opportunities.
3) To acquire opportunities to improve their skills.
4) To enjoy the benefits of protection through the Takaful scheme.

1.5 Other Regulations and Code of Practice in relation to Tower Cranes

Occupational Safety and Health (Control of Industrial Major Accident Hazards) Regulations 1996

PART I

Regulation 1: Preliminary

These regulations may be cited as the Occupational Safety and Health (Control of Industrial Major Accident Hazards) Regulations 1996, and take effect on 1 February 1996.

Regulation 5: Obligations of Manufacturer and Employee

(1) Every manufacturer who undertakes an industrial activity shall -

(a) comply with the requirements of these Regulations;

(b) take immediate action to rectify the situation as soon as he becomes aware of an imminent danger which may affect the safety of persons or the environment; and

(c) establish and maintain a good management system for controlling any major accident, as described in the report made under sub-regulations 14 (1) and regulation 16.

(2) Every employee shall:

(a) cooperate with the manufacturer in complying with the requirements of these Regulations;

(b) act in such manner so as not to endanger himself or to cause or be likely to cause bodily injury to himself or to other persons, or damage to life and property; and

(c) notify the manufacturer as soon as he becomes aware of any potential hazard he considers is capable of generating a major accident, and shall have the right to notify an officer of the potential hazard.

PART III:

Regulation 9: Demonstration of Safe Operation

A manufacturer who has control of an industrial activity to which this Part applies shall, at any time, at the request of the Director General, provide evidence, including the production of documents, to show that he has:

(a) identified the possible major accident hazards; and

(b) taken adequate steps to -

(i) prevent any major accident or minimize its consequences to persons and the environment; and

(ii) provide persons working on the site with the information, training and equipment necessary to ensure their safety; and

(c) prepared and kept up-to-date an adequate on-site emergency plan detailing how major accidents will be dealt with.

PART V

Regulation 23: Notification of Major Accident

Where a major accident occurs on a site, a manufacturer shall notify the nearest Occupational Safety and Health office of the accident by the quickest means available and the manufacturer who makes the notification shall provide:-

(a) the following information relating to the accident as soon as it occurs:

(i) the circumstances of the accident;

(ii) the hazardous substances involved;

(iii) a suitable date for assessing the effects of the accident on persons and the environment; and

(iv) the emergency measures taken; and

(b) a statement of the steps envisaged to alleviate the medium or long-term effects of the accident (if any), and prevent the recurrence of such an accident.

PART VI

Regulation 24: Penalty

(a) A manufacturer who commits an offence against any of the provisions of these Regulations shall, on conviction, be liable to a fine not exceeding fifty thousand ringgit (RM 50,000.00) or to a term of imprisonment not exceeding TWO (2) years or to both.

(b) An employee who commits an offence against any of the provisions of these Regulations shall, on conviction, be liable to a fine not exceeding one thousand ringgit (RM 1000) or to a term of imprisonment not exceeding THREE (3) months or to both.

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Notes of Tower Crane Operators, National Youth Skills Higher Institute (IKTBN), Ministry of Youth and Sports, Chembong, Negeri Sembilan, 2003.

Notes of Tower Crane Operators, Gamuda Plant Operator School (GPOS), Shah Alam, Selangor, 2002.

Key Provisions of the Occupational Safety and Health Act 1994. Published by the Department of Occupational Safety and Health (DOSH).

CHAPTER 2

INTRODUCTION TO CRANES

2.1 Main Functions of Cranes

Cranes are included in the load lifting equipment category. A crane is a mechanical tool that is used for raising or lowering a load and to move the load horizontally to the required location. Its use is also aimed at facilitating and speeding up the construction of tall, huge and wide structures such as buildings and bridges. There are also several types of cranes, namely mobile cranes, crawler cranes, derrick cranes and tower cranes. The selection and use of a crane depend on its suitability for the work requirements at a construction site.

(a) Mobile Cranes

A mobile crane is a type of crane on wheels that is be powered by its own engine and can be driven on the road. It is used to raise and lower loads from a moderately high place and is easy to handle for work in a confined space (Figure 2.1).

Figure 2.1 Example of a mobile crane (Occupational Health and Safety Code 2009, Alberta Canada; www.cccme.org.cn)

(b) Crawler Cranes

A crawler crane is a type of crane for climbing. It moves by means of tyres or on crawler tracks, and it can be manually driven. However, its movements are restricted to the appropriate roads only. Crawler cranes are suitable for use on all types of land and earth surfaces. This type of crane also has the power to raise and lower loads from a height

(Figure 2.2).

Figure 2.2 Example of a crawler crane (OSHAcademy Occupational Safety and Health Training, US; www.directindustry.com)

(c) Derrick Cranes

A derrick crane is a type of crane that is used on high-rise buildings, where it is placed in a static position on the building structure and cannot be moved (Figure 2.3). This type of crane is usually used to lower a tower crane structure that is to be dismantled after having completed works to raise or lower loads.

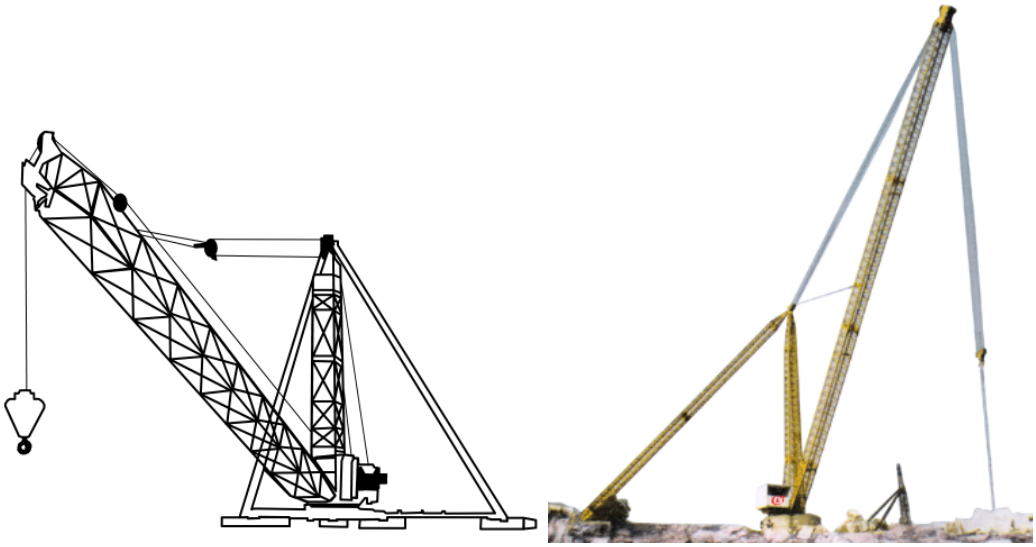


Figure 2.3 Example of a derrick crane (OSHAcademy Occupational Safety and Health Training, US; *http://jaipur.all.biz*)

(d) Tower Cranes

Tower cranes are designed using high-strength iron shaped into a tower. They are used

for industrial works and for the construction of high-rise buildings. Tower cranes can raise and lower heavy loads, and are better than other cranes. They are installed in a static position or move along rails (Figure 2.4).

Almost the entire tower crane structure is made of solid iron, and it is divided into several parts. These parts can be separated and joined back again. This technique of joining and separating the crane section by section is used to facilitate the process of installing and dismantling the tower crane. It is also meant to facilitate the transportation of the crane from one construction site to another.

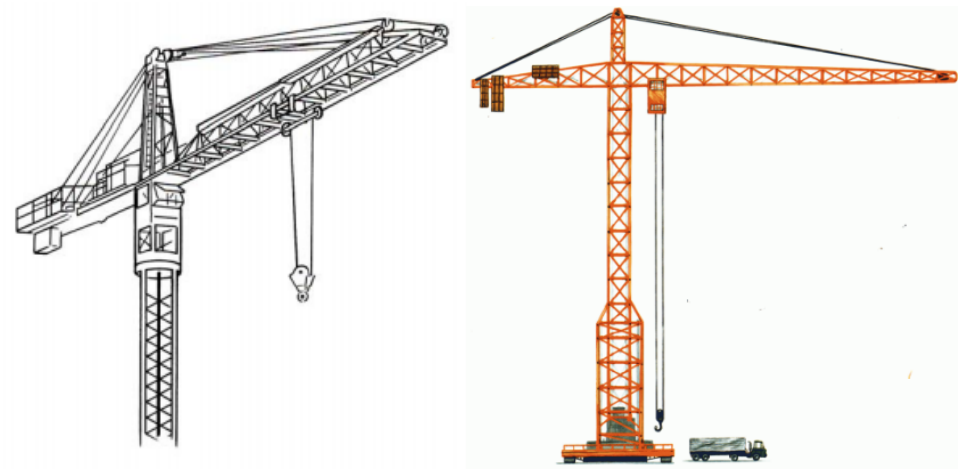


Figure 2.4 Example of a tower crane (Occupational Health and Safety Code 2009, Alberta Canada; www.ictinpractice.com)

2.2 Types of Tower Cranes

Tower cranes are one of several types of cranes in the heavy machinery category that are commonly used to raise and move any heavy and massive load from one place to another. A tower crane is a rectangular tower fitted with several important components such as bolts, nuts, and pins, and its base is made of cast concrete supported by beams or mounted on rails. The slewing platform, hoist, mast and boom are mounted on the base of the tower.

Before a tower crane is installed, safety inspections should be carried out first, and these must be carefully planned according to the established procedures. The installation of the boom and counterweight is a hazardous job, and if it is not carefully planned or

studied, it can result in the failed installation of the tower crane. Generally, there are many types of tower cranes, but among the popular types used in Malaysia are the hammerhead (saddle top), hammerhead (topless) and luffing cranes. These cranes can be divided into several categories depending on their size and manufacturer.

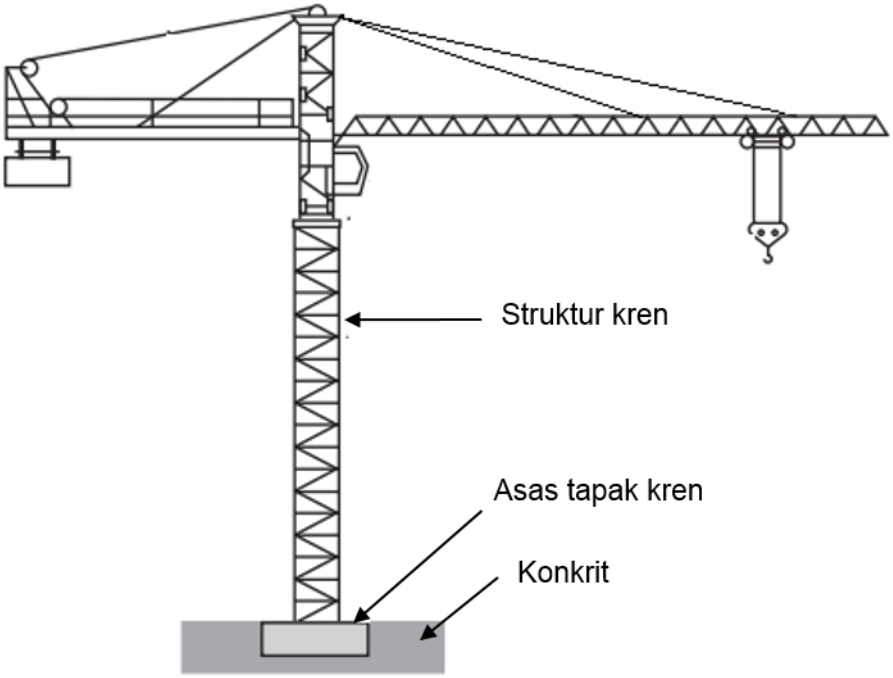


Figure 2.5 Saddle top hammerhead tower crane (Occupational Safety and Health Program, A Guide to Cranes and Derricks, US)

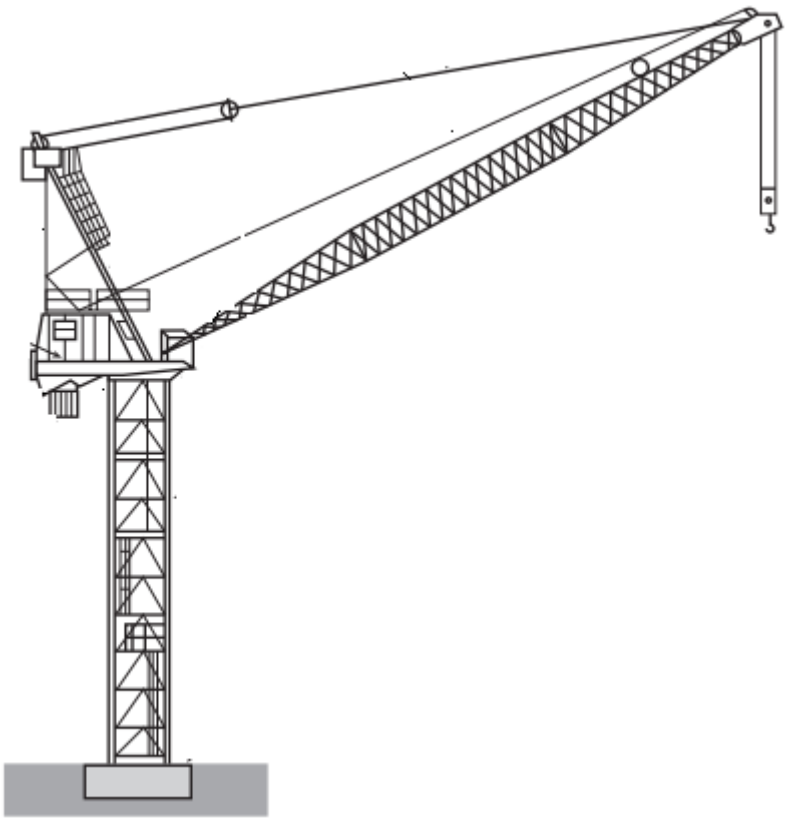


Figure 2.6 Luffing tower crane (Occupational Safety and Health Program, A Guide to Cranes and Derricks, US)

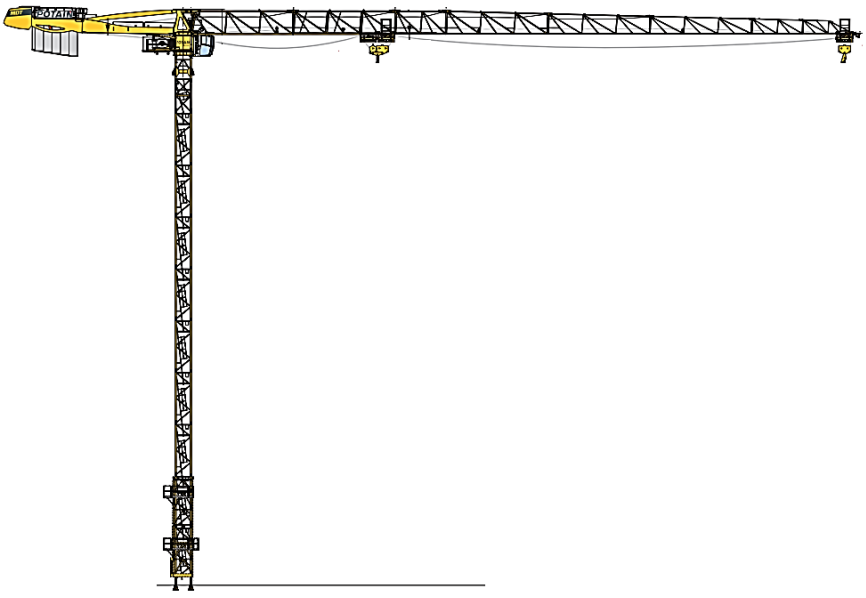


Figure 2.7 Topless hammerhead tower crane *(www.nftcrane.com)*

In general, tower cranes can also be categorized according to their base installation. There are three main types of base installations for tower cranes, namely: -

(a) Static Base

This type of crane is generally popular and is the tallest among all the other types of cranes. It is suitable for installation in open sites, and is usually placed at the front or in any place where there is enough space for the boom to move/rotate (Figure 2.8).

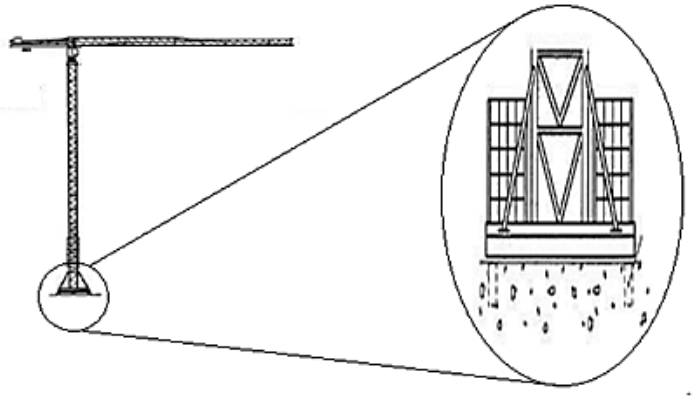


Figure 2.8 Example of a tower crane with a static base installation (Environmental, Health and Safety (EHS) Departments, US)

For the static base category, there are two methods of installation for the tower crane base, namely:

(i) In-situ cast base

This type of base requires a special anchor (known as an expandable anchor) to be embedded in a concrete block (Figure 2.9).

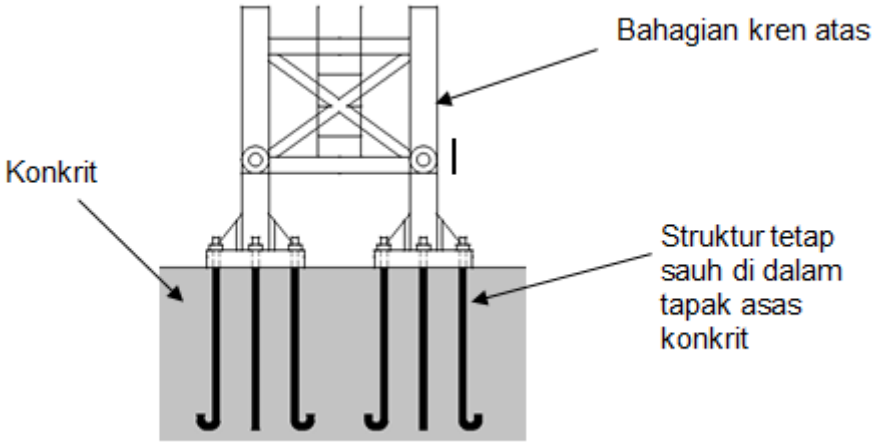


Figure 2.9 In-situ cast base

(ii) Own base

The base of the crane is constructed by placing ballast at the crane base with the

chassis as the weight (Figure 2.10).

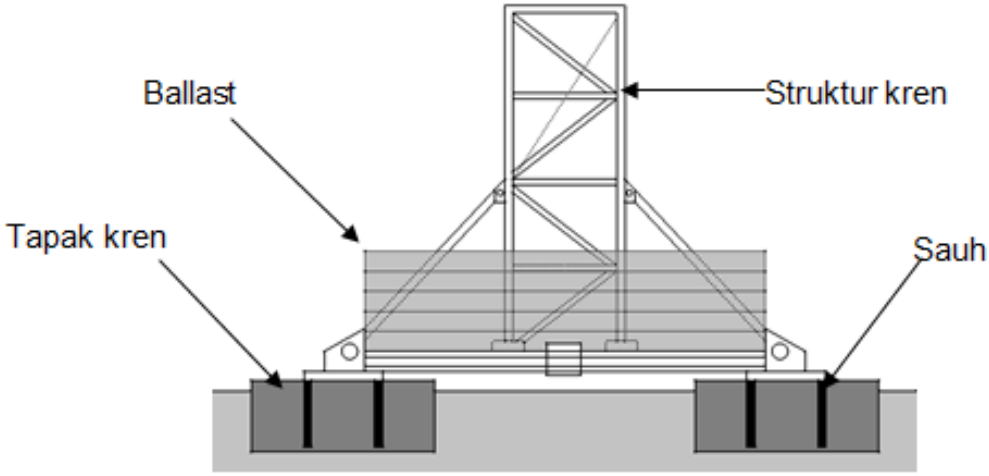


Figure 2.10 Static base (own base type)

(b) Climbing base

Tower cranes with this type of installation are usually used for the construction of high-rise buildings. The installation process involves installing the base starting from one level to a higher level. There are two methods for the installation of a climbing base, namely:

(i) Externally supported static crane

The base is supported by a construction/building structure joined by a climbing frame. The height of the crane can be extended, depending on the height of the building structure, and it should be aligned with the climbing frame (Figure 2.11).

Figure 2.11 Installation of crane with external climbing base

(www.dcm.milgromandassociates.com)

(ii) Internal climbing crane

This type of tower crane installation is usually designed for tall buildings, and it is placed in a location where it can be supported by structures within the building that is under construction (Figure 2.12). The crane can be adjusted from one level of the building under construction to a higher level.

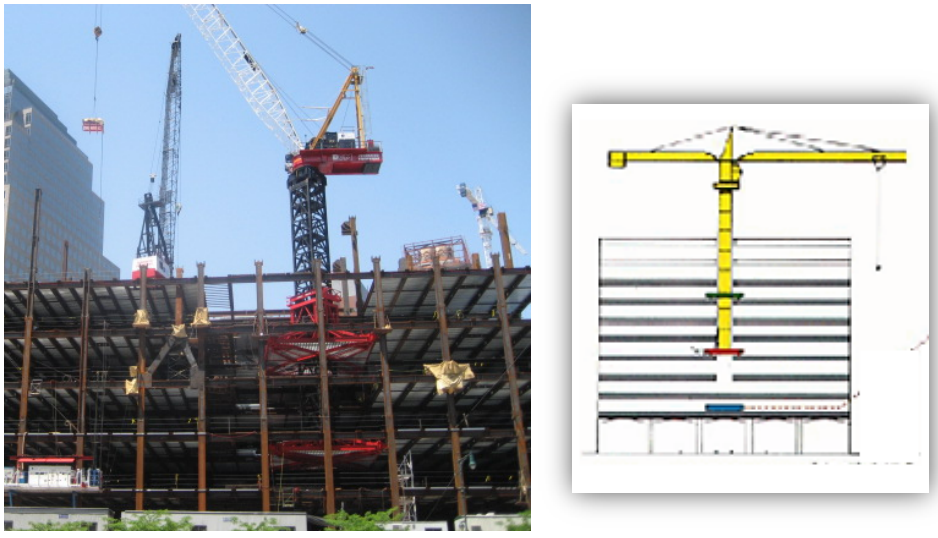


Figure 2.12 Installation of a crane with an internal climbing base

(www.dcm.milgromandassociates.com)

(c) Travelling rails

This type of tower crane moves on heavy-wheeled bogies placed on rails. The bogies have no fixed grade but change according to the height of the mast mounted on the tower crane (Rajah 2.13-14).

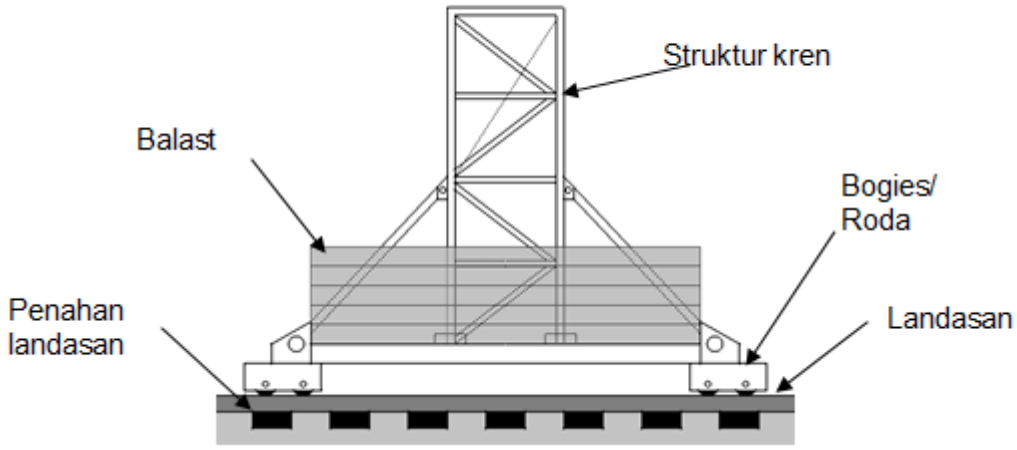


Figure 2.13 Travelling base (type of platform)

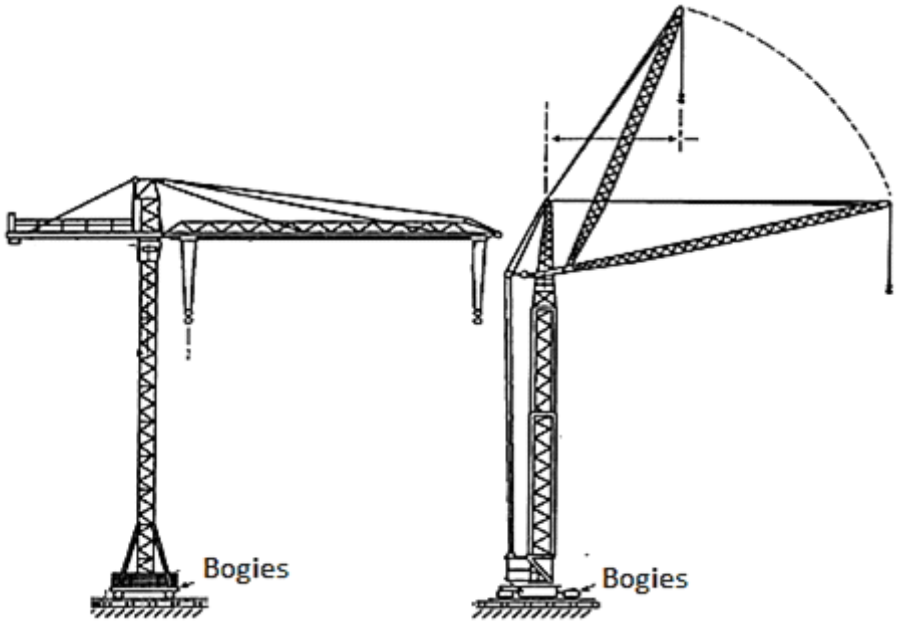


Figure 2.14 Crane with travelling rails base (Environmental, Health and Safety (EHS) Departments, US)

2.3 Conditions for the Selection of Tower Cranes

Each tower crane design is reasonably based on the requirements of its use. The explanation for the suitability of two main types of tower cranes is as follows:

(a) Hammerhead tower crane

This type of tower crane is suitable for industrial projects that have the following criteria:

- wide load area or reach
- limited strength of load to be lifted
- this type of tower crane is driven by electric power

If the area or site meets the above criteria, then the type of tower crane that is suitable for use is the hammerhead.

(b) Luffing tower crane

This type of tower crane is adapted for industrial projects that have the following criteria:

- limited load area or span
- a high load strength to be lifted
- most of these cranes use engine power

If the area or site meets the above criteria, then the luffing tower crane should be used. Table 2.1 gives a clearer picture of the differences in the suitability of these tower cranes.

Table 2.1 Differences between the requirements of hammerhead and luffing tower cranes

HAMMERHEAD	LUFFING
• Wide span of radius or rotation. • Load strength that can be hoisted is higher.	• Limited span of radius or rotation. • Load strength that can be hoisted is limited.

2.4 Selection of Power Supply

Project managers must ensure that power supply is available for every crane used on the construction site. This is to avoid a situation where there is no power to operate the tower crane once it has been installed. When the crane is to be used in an area where there are electric cables, before commencing work advice should be sought from the electric utility company, such as Tenaga Nasional Berhad (TNB), to determine the safe operating distance from electrical conductors for live power lines. The management should hold discussions as early as possible with those controlling the power lines to identify whether the source of the electricity supply is:

- An electric utility company such as Tenaga Nasional Berhad (TNB), or
- Genset.

The main contractor, project manager or person appointed to ensure the safety of the workers and people in the vicinity should ensure that the workers/workplace are at a safe distance from nearby electric cables. Given below is the recommended voltage range and safe distance when doing work near an electric current:

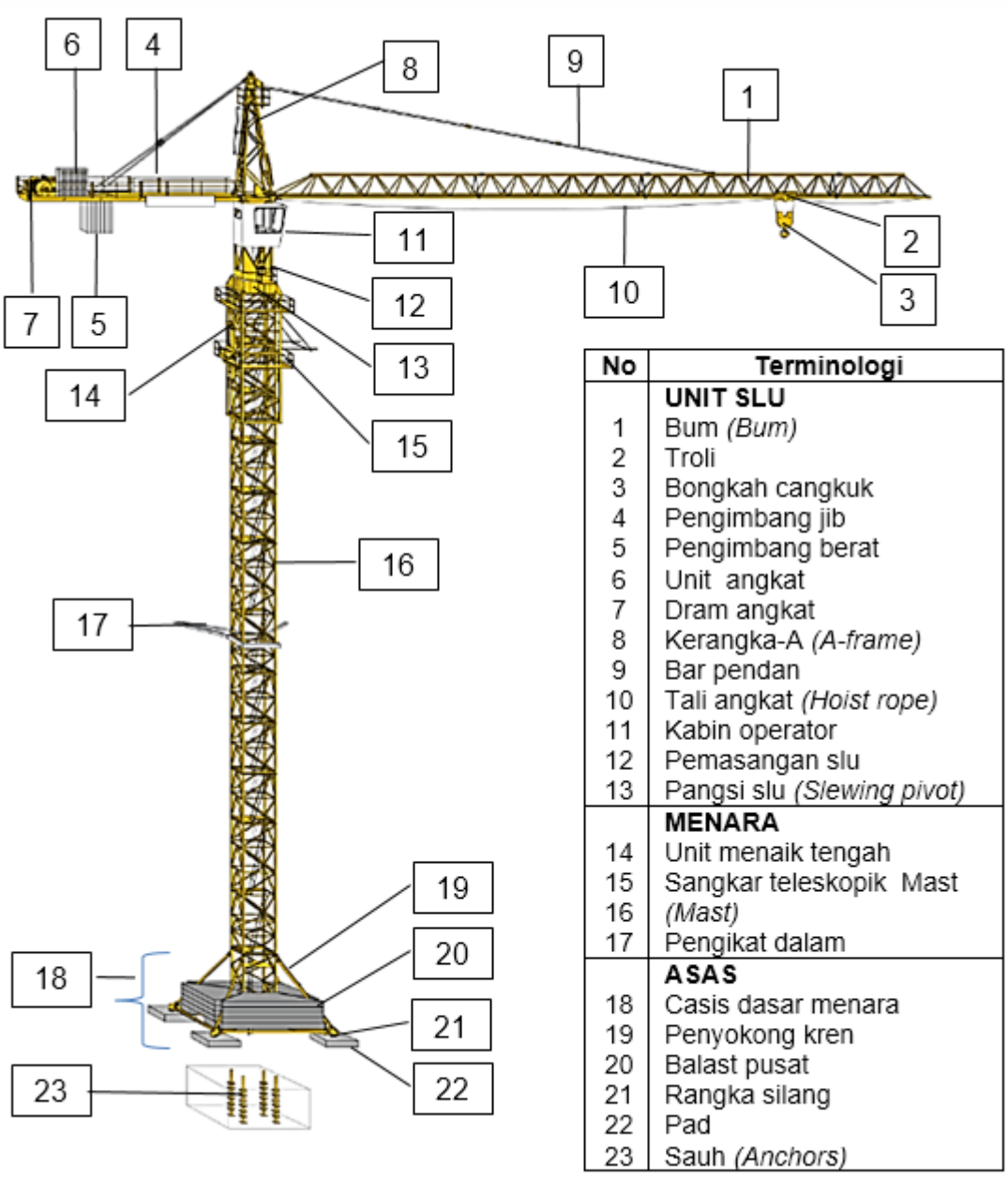
(a) 0-11,000 volts (distance of 5.79 m)
(b) 11,000-66,000 volts (distance of 6.10 m)
(c) 66,000-132,000 volts (distance of 6.70 m)
(d) 132,000-275,000 volts (distance of 7.00 m)
(e) Exceeding 275,000 volts (distance of 7.30 m)

CHAPTER 3

TOWER CRANE BASIC COMPONENTS

3.1 Terminology and Structure of Tower Crane

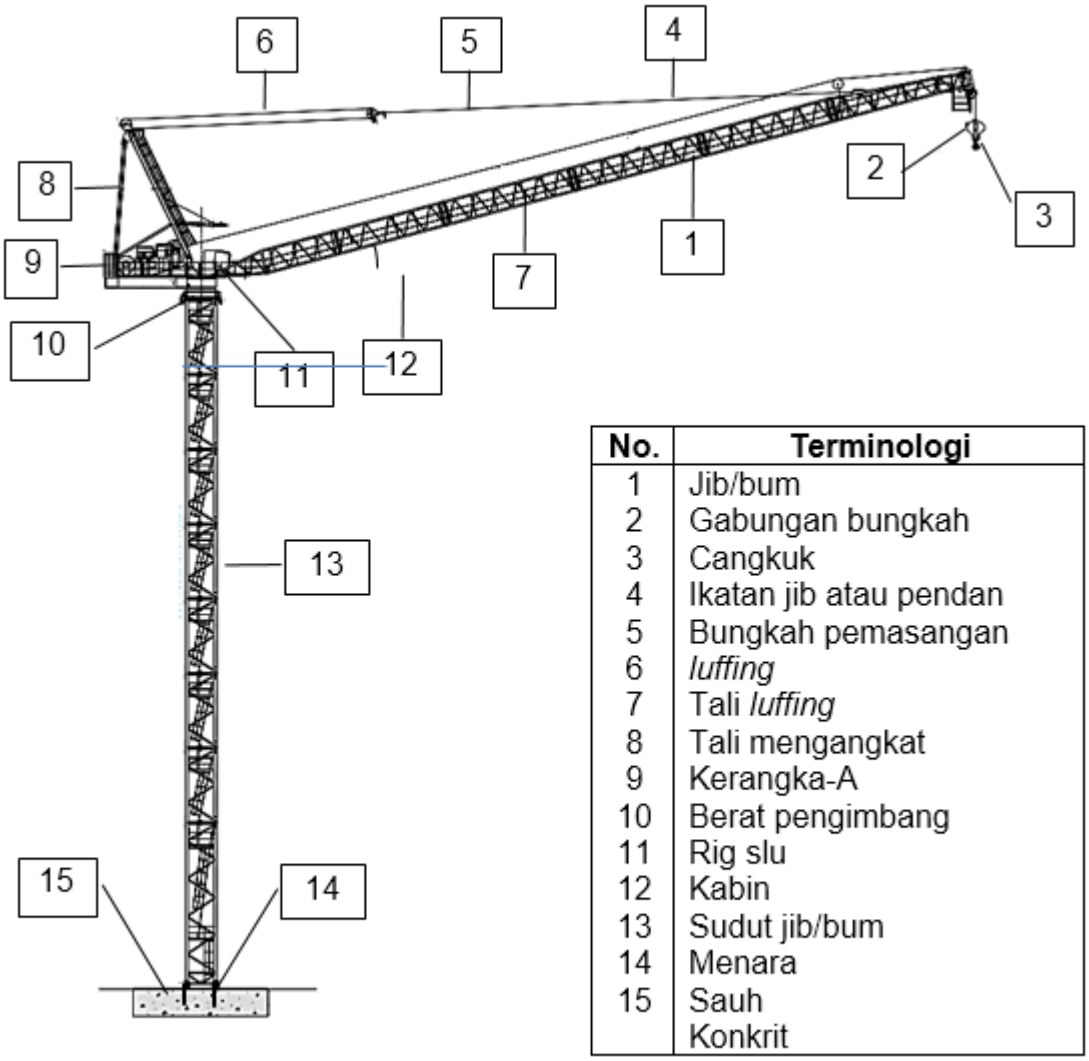
Generally, tower cranes have the same basic components which are mast, boom, counter jib, counterweight, telescopic cage, slewing platform, control cabin and hook block. Failure of any of these may result in an accident.



No	Terminologi
	UNIT SLU
1	Bum *(Bum)*
2	Troli
3	Bongkah cangkuk
4	Pengimbang jib
5	Pengimbang berat
6	Unit angkat
7	Dram angkat
8	Kerangka-A *(A-frame)*
9	Bar pendan
10	Tali angkat *(Hoist rope)*
11	Kabin operator
12	Pemasangan slu
13	Pangsi slu *(Slewing pivot)*
	MENARA
14	Unit menaik tengah
15	Sangkar teleskopik Mast
16	*(Mast)*
17	Pengikat dalam
	ASAS
18	Casis dasar menara
19	Penyokong kren
20	Balast pusat
21	Rangka silang
22	Pad
23	Sauh *(Anchors)*

Figure 3.1 Terminology of *hammerhead* tower crane

(http://www.morrow.com/crane101)



No.	Terminologi
1	Jib/bum
2	Gabungan bungkah
3	Cangkuk
4	Ikatan jib atau pendan
5	Bungkah pemasangan
6	*luffing*
7	Tali *luffing*
8	Tali mengangkat
9	Kerangka-A
10	Berat pengimbang
11	Rig slu
12	Kabin
13	Sudut jib/bum
14	Menara
15	Sauh
	Konkrit

Figure 3.2 Terminology of *luffing* tower crane *(http://www.morrow.com/crane101)*

3.2 Tower Crane Basic Components

3.1.1 Cabin Operator

Operator cabins for a tower crane are usually in line or under the boom. The cabin size space should be comfortable enough to accommodate an operator and the comfort of the cabin should be emphasized to ensure the crane operator is comfortable to carry out the task because the working duration of a crane operator is at least 4 hours straight and the total of maximum working hours is 12 hours. This allocated period requires complete cabin fittings for the purpose of comfort and safety such as air conditioning, electrical equipment box, fire extinguisher, computer monitor, weather gauge, and left and right control buttons (Diagram 3.3).

Some of the equipment functions in the cabin:

- Computer monitor: Display high information, weight and load position at jib

- Weather gauge: Monitor wind speed and direction, air pressure and temperature.
- Right control button: Lift loads when pulled and lowered loads when rejected
- Left control button: Controls the jib swing when moving left and right and controls the movement of the exit and the trolley from jib.

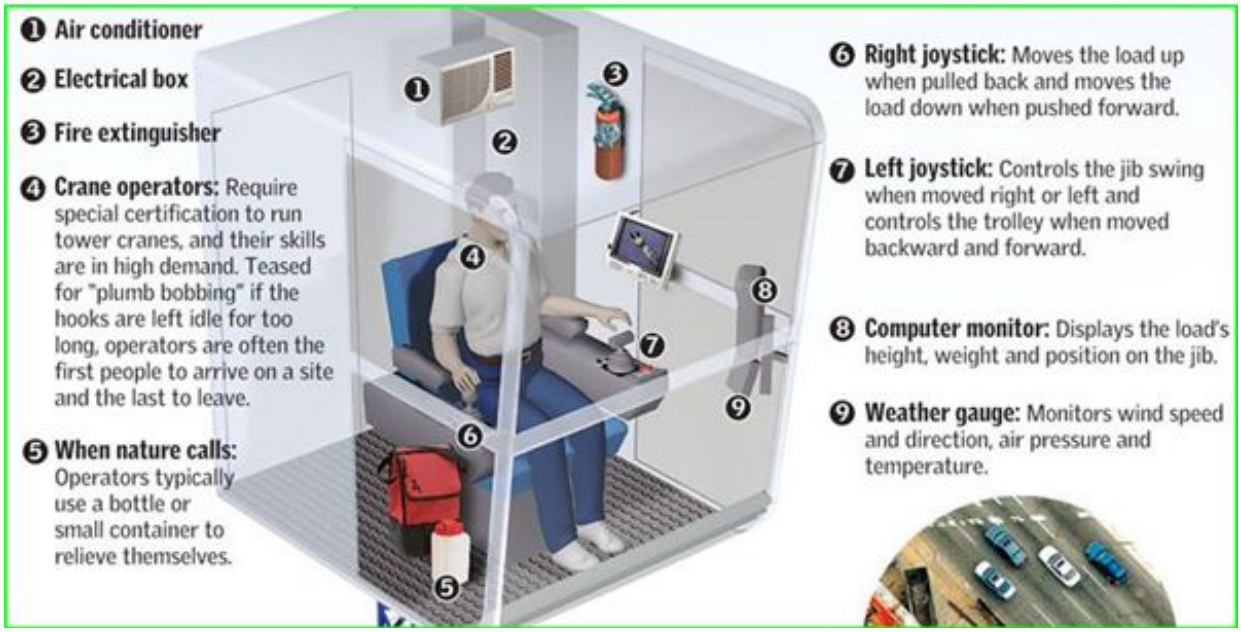


Figure 3.3 Parts of the Operator Cabin

3.1.2 Mast Section

The mast is the most important support for a tower crane. It is made of a metal knot that connects all the mast parts. Mast has three components, namely base mast, ladder and rear loop (Figure 3.4).

Figure 3.4 The main parts of the mast

3.1.3 Slewing Platform

Slewing platform is a component connected to the highest mast. Slewing platform serves as machinery that turns the tower crane and is controlled by using the left control button by the tower crane operator (Figure 3.5).

Figure 3.5 Slewing platform

3.1.4 Counter Jib

Counter jib is a short horizontal jib and is in opposite side with boom. This section works to accommodate lead weight which is placed based on the length and weight of the boom that will be used for lifting operations.

Figure 3.6 Counter Jib

3.1.5 Boom

The boom serves as a steering arm and is longer than the counter jib. When controlling the hammerhead type of crane, the trolleys are moved in and out to move the load closer or away from the mast. The boom can be divided into parts, the tip, the middle and the start. All these parts work to hold lifting cables, trolleys and hooks. Figure 3.7 shows the parts of the boom of the hammerhead cranes. If a luffing tower crane is used, the boom is cranked up and down to move the load closer or away from the mast. The distance to lift the item for the luffing type cranes is shown in Figure 3.8.

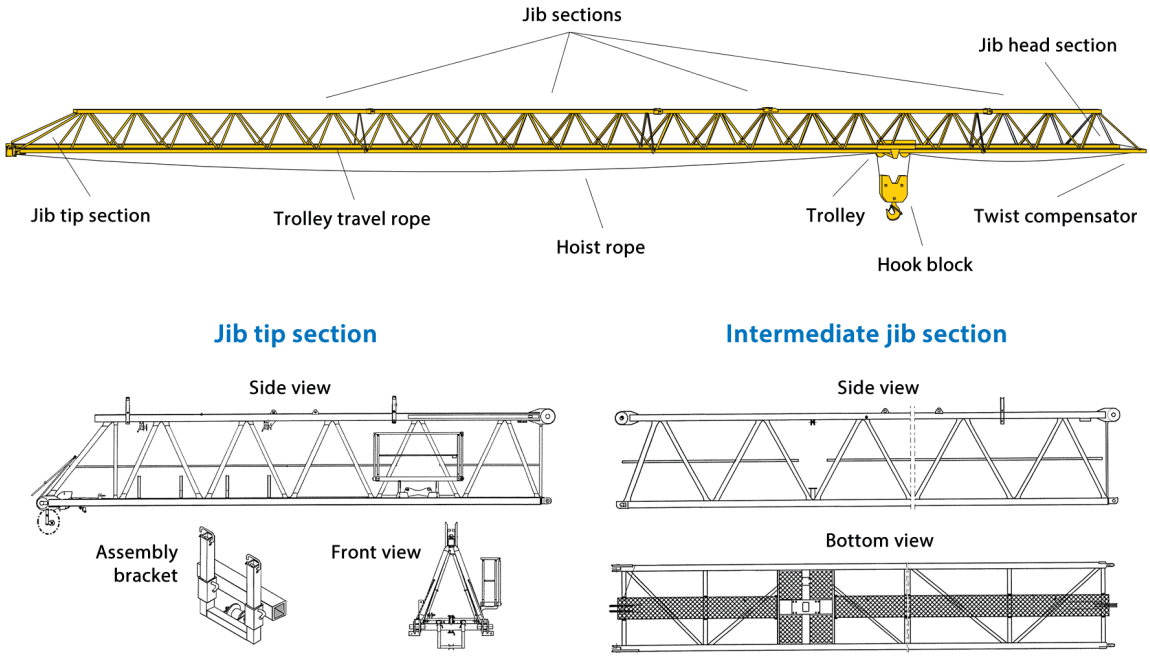


Figure 3.7 Boom hammerhead crane parts

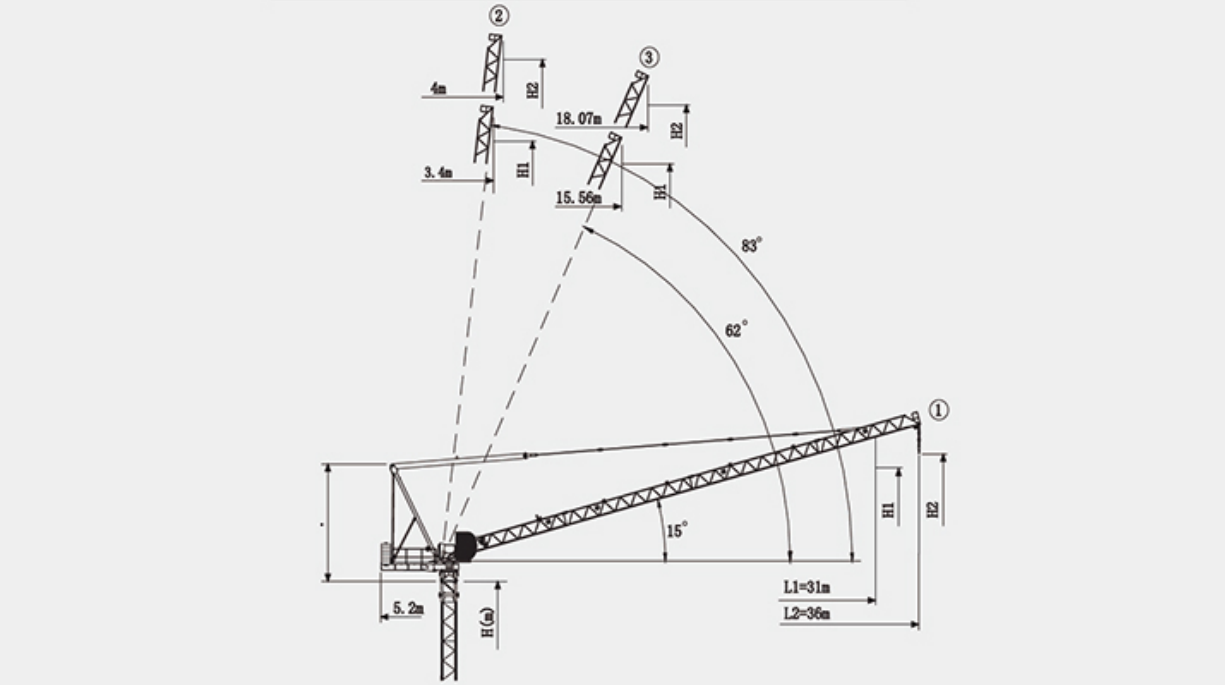


Figure 3.8 Movement of the luffing tower cranes for different load spacing

3.1.6 Pulley

Pulley is used to support lifting cable movements and changing the power of the cable to facilitate lifting and moving loads. The pulleys are placed together with a hook block to connect the hook block to the trolley on the jib. Figure 3.9 shows a pulley connection system, trolley and load during load lifting process.

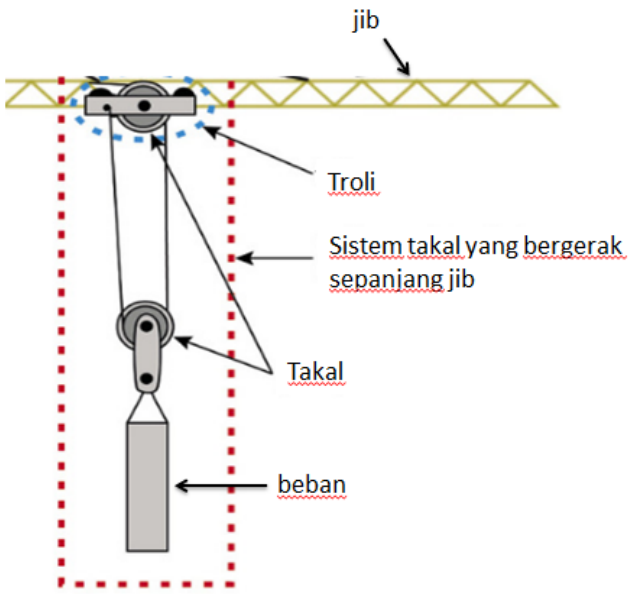


Figure 3.9 The pulley system on the jib

3.1.7 Trolley

The trolley is used to move the load closer or away from the mast for the hammerhead tower crane.

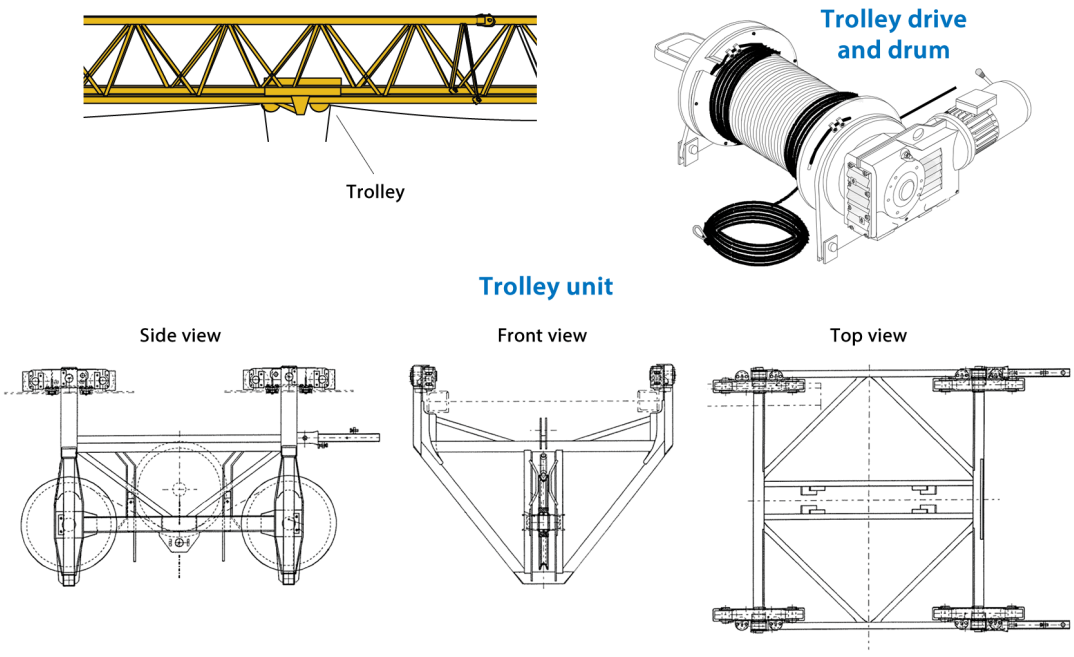


Figure 3.10 Installation of trolleys, motor trolley, and trolley unit on the jib

3.1.8 Hook Block

The hook block is hung on the lifting cord to lift the load. The hook block function is to allow the load to be hung on the lifting cables. Hooks used for lifting items should be equipped with safety

latch. The hook should be checked so that it is free of any damage such as wear, rust, cracks or bent.

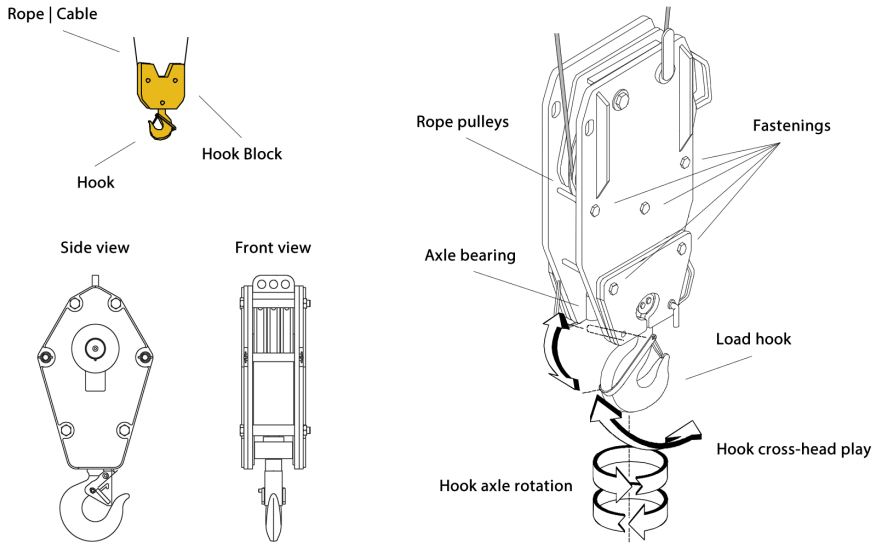


Figure 3.11 Structure of hook block

3.1.9 Telescopic Cage

Telescopic cages are installed for the purpose of the tower crane raising process. Before the new mast part is added, the highest mast part of the tower is jacked and reinstalled after the mast is properly inserted as shown in Figure 3.12.

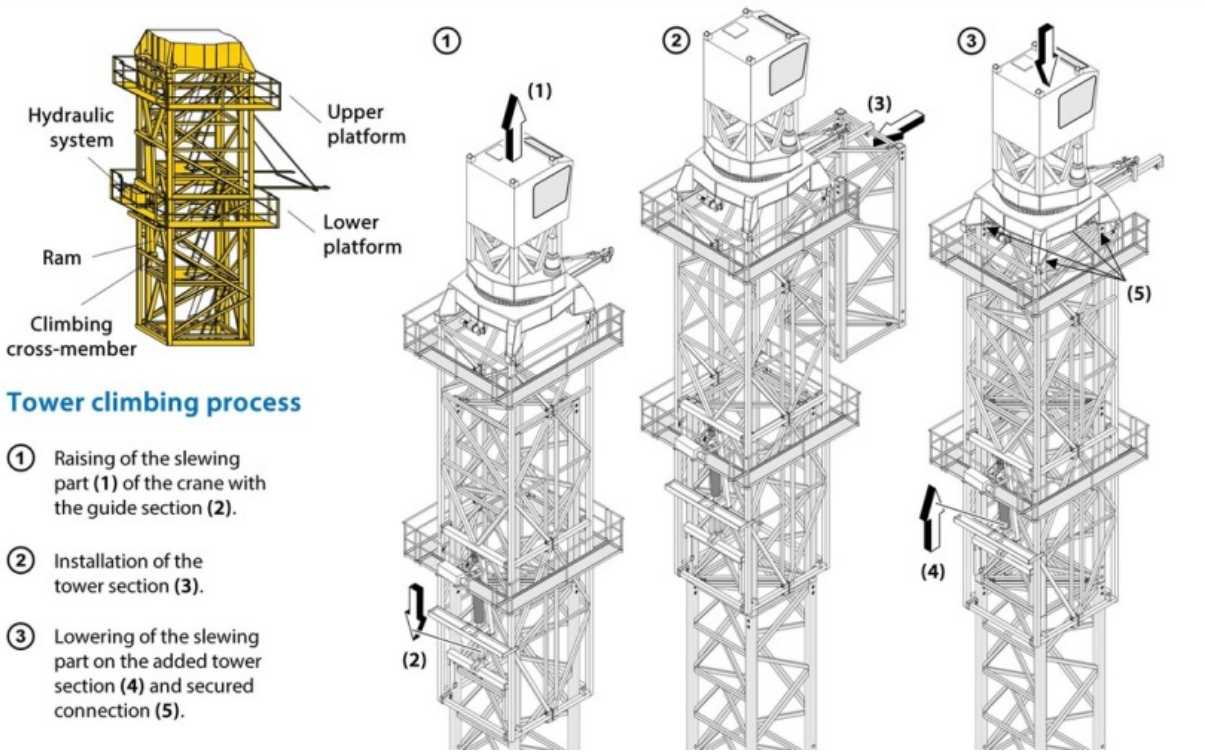


Figure 3.12 The process of stepping up the tower crane

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Shandong Minglong Construction Machinery Co., Ltd.

CHAPTER 4

APPLICATION DOCUMENTS OF INSTALLING AND DISMANTLING CRANE TOWERS

4.1 Document Checklist

Before the tower crane is installed, competent person must ensure the following documents are provided for the application of installation.

1. Application Letter to install a tower crane
2. Letter of appointment as a firm of installation
3. Letter of approval as an installation, maintenance and dismantling firm
4. Competent Person Declaration Letter
5. Form JKJ 105 (Factories and Machinery Act)
6. Design Approval Letter from JKKP (for new tower cranes)
7. Copy of Site Registration letter
8. Drawings and Designations of Site Base Structure certified by Professional Engineers
9. Declaration Letter of Slew Limiting Switch installation signed by Competent Person.
10. The plan of the tower crane and the 'Slewing Radius'
11. Crossed procedure (if the crane tower crossed)
12. Latest Permit of Lifting Machinery (PMA) certificate
13. Copy of Application Letter of file and card transfer (if the tower crane is moved from another state)
14. Authorization letter from the Local Authority (PBT) if the tower crane operates beyond the site of the site
15. Basic image of built site
16. Ground Inspection Checklist - Form KPKM 01 and KPKM 02 (Load test)
17. Piling Report
18. Concrete Cube Test Report
19. Certificate of Site Base
20. HIRARC
21. Standard Operating Procedures (SOPs)
22. Technical Specifications of Tower Crane

4.1.1 Application letter of installing tower crane

This application letter must be addressed to Department of Occupational Health and Safety (JKKP) of the state where the tower crane is installed. Application letter must clearly state the address of the built site and the Certificate of Fitness (PMA) number of cranes installed.

4.1.2 Letter of appointment as an installation firm

An appointment letter from the main contractor must be addressed Department of Occupational Health and Safety (JKKP) of the state where the tower crane is installed and clearly state the appointment of the competent firm name appointed for the purpose of installing, maintaining and dismantling the tower cranes. If there is more than one crane to be installed, all cranes must be listed with serial number and Certificate of Fitness (PMA) number.

4.1.3 Letter of approval as an installation, maintenance and dismantling firm

Competent firms must provide evidence that the companies are registered under the Tower Crane category (EMD01). The Competent Person name must be specified in the letter for each installed tower crane. The approval requirements must also state clearly that the Competitive Firm is responsible for:

a) Implement each planned activity according to plan of action plan
b) Inform Department of Occupational Health (JKKP) if there is any change, increase, emptying of officers or changes in organizational structure, existing machinery and premises
c) Supervise Competent Person scope of work to ensure that the work is carried out in accordance with quality plan, inspection and testing procedures, procedures and safe working instructions
d) Complete the report for all completed work
e) Professional Engineers will verify the strengths and suitability of the site and obtain permission from the state Department of Occupational Health (JKKP) director
f) Do not perform unauthorized modification of Department of Occupational Health (JKKP)
g) Immediately report any damage to the structure, incident or accident at the installation site to Department of Occupational Health (JKKP)

h) Pay attention to the controls and the maintenance records that were specified in the Quality Management System and Occupational Safety and Health Management System and keep it in completely with all the relevant records

i) Comply to all additional conditions by Factory and Machinery Inspectors

4.1.4 Competent Person Declaration Letter

The Competent Person declaration should include by clearly explaining the activities of installing the tower cranes with the model number, Permit of Lifting Machinery (PMA) number and serial number. A letter of declaration must also indicate clearly the address of the tower crane installation. The letter must be signed by the Competent Person and the project manager. The letter must state the following:

a) The Competent Person will ensure the safety of the public during the installation, maintenance and dismantling of the tower crane
b) The Competent Person must always monitor and keep all work done during the monitoring period and the work is not performed without the presence of Competent Person
c) Every machine that will be used to install, upgrade, repair and maintain must have a qualification certificate for use.
d) Employees must be skilled and experienced people. All employee details must be included in the attachment.
e) Work is carried out by ensuring the safety and health of workers. All requirements such as personal protective equipment must be supplied.
f) Work procedures must be approved by professional engineers
g) Comply with all official requirements of the Department of Occupational Safety and Health examiner which are issued from time to time.

4.1.5 Form JKJ 105

The form must be filled in completely and state the name and address of the main contractor and the address of the construction site. The name of the owner of the tower crane and the company's address must also be included. All machinery must comply with the requirements of the Factories and Machinery Act 1967 to qualify for use or installation. Tower Cranes and complete specifications must be specified in this form including the Tower crane model, country made, horsepower, registration reference number, and safe workload to be complied with.

4.1.6 Design Approval Letter from JKKP

The design approval letter from JKKP must be provided if the tower crane is first installed at the construction site.

4.1.7 Construction Site Registration Letter

The registration letter to the main contractor from JKKP included with the following:

a) Construction activities must comply with the Occupational Safety and Health Act 1994 and Factories Act and Machinery 1967
b) Any additional tower cranes installed must be approved and reported to JKKP through the JKJ 105 form.
c) Certificate of Fitness must be obtained before the operation
d) Any accident is compulsory to be reported
e) Any dangerous occurrence involving public property damage and threatening employee safety must be reported.
f) All documents relating to safety at the site of construction should be kept and arranged in order

4.1.8 Drawings and Approximate Design of Site Base Structure certified by Professional Engineers.

Professional engineers must confirm all arrangements and drawings that have been made during the process of re-designing the base structure of the site. All these drawings and calculations must clearly state the following:

a) Tower crane model
b) the ability to free standing within the correct metre measure based on manufacturer's manual
c) The address of the site where the installation is located
d) All the important things in the design of the tower crane take off all the forces and certain moments
e) Concrete grade
f) Water treatment in site environment and barrier fence for safety
g) All designs that do not follow the drawings must be reported to the supervisor engineer

Drawings must be complete by specifying the piling layout and accuracy of distance and depth with manufacturer's calculations and manuals.

4.1.9 Declaration Letter of Slew Limiting Switch installation signed by Competent Person

If the crane is not allowed to rotate 360 degrees, the Slew Limiting Switch must be activated. Restricted rotation degrees should be clearly stated in the certificate letter addressed to JKKP. This letter must be accompanied by a plan showing the work radius of the correct scale. Each tower crane that needs to be switched on the Slew Limiting Switch must clearly state the serial number of the crane and the model.

4.1.10 Slewing radius plan

The complete plan of the entire construction site must be enclosed as specified on the certificate of installation of the Slew Limiting Switch. The plan must be signed by a Professional Engineer and has a complete address of the built site. The scale of the drawing should also be precise to ensure the slewing radius of the adapter.

4.1.11 Crossed procedure (if the crane tower crossed)

If there are two or more tower cranes to be installed, that cause crossing between each other, then the complete procedure and the safety measures taken have to be clearly stated. Maximum distance of intersections must also comply with the designated practice. If this procedure is not complied with, the tower crane is not allowed to operate as a whole and it will not be only a tower crane that has to be stopped its operation.

4.1.12 Permit of Lifting Machinery (PMA) certificate

Permit of Lifting Machinery (PMA) certificate of construction site before installation must be included. This certificate is for a tower crane which is not used for the first time. This certificate clearly states the prior to construction site and the name of the registered contractor. The valid date of the certificate is also clearly stated. Inspection date must also be clearly stated. This certificate must state the tower crane registration number and model and manufacturer's name.

4.1.13 Copy of file transfer application letter

If involving installation in a different state, the file transfer application letter to state JKKP must be included. This is to ensure that the crane record is current and the location of its use is registered in the system.

4.1.14 Authorization letter from Local Authority (PBT) if the tower crane operates beyond the site of the site

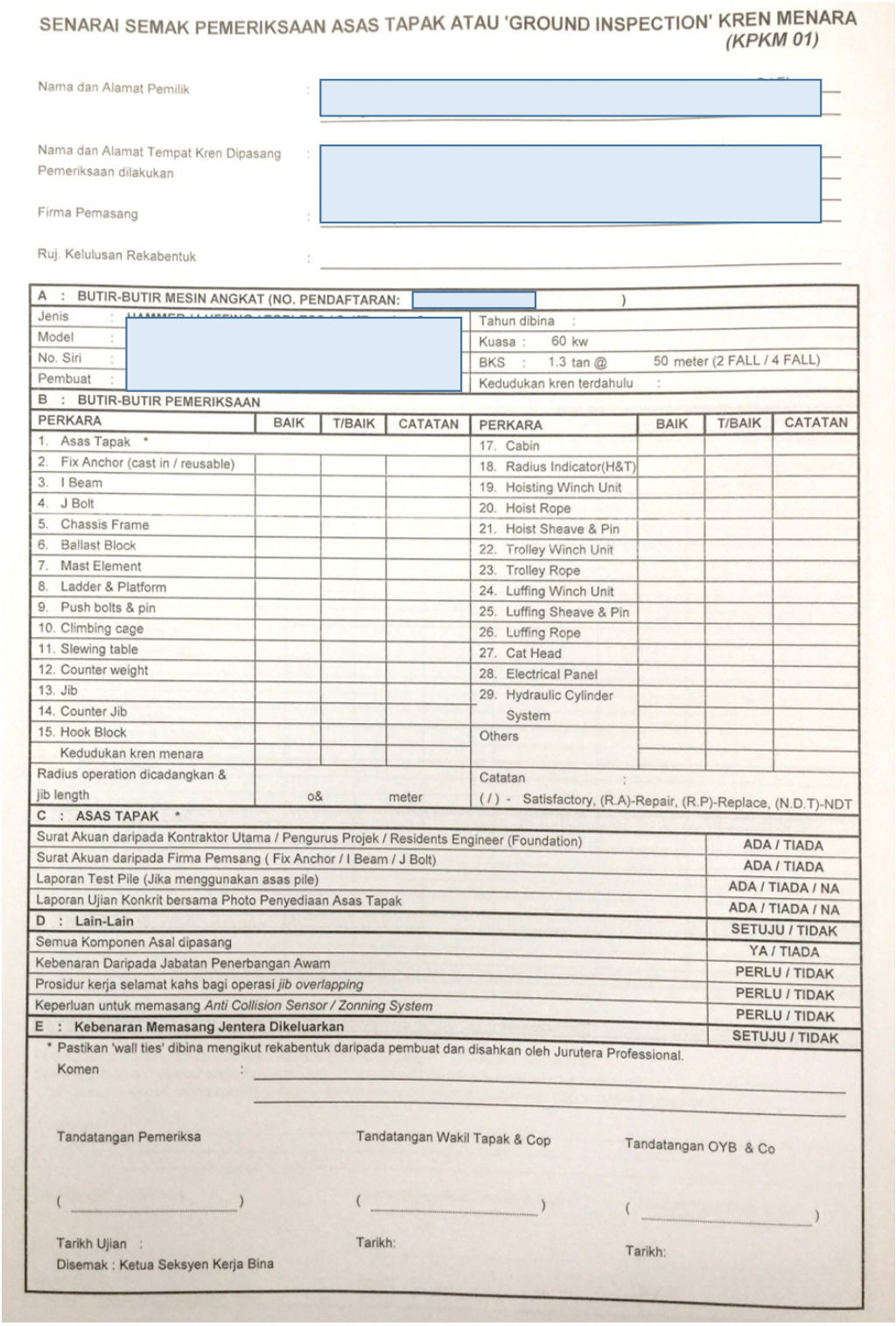
If the crane has to operate beyond the construction site, a letter of application to the PBT shall be made. Generally, operations must be limited and controlled so as not to exceed the permitted limiting. However, operations beyond the life-threatening limiting and the safety of the public are not allowed at all.

4.1.15 The base image of the site

The base image of the site must be included as a proof of compliance with design arrangements that have been certified by a professional engineer. Site bases are not allowed to be closed as long as the inspection is not conducted by JKKP officers.

4.1.16 Basic site inspection checklist and tower crane test

The basic site inspection checklist and tower crane test must state the following in accordance with the form KPKM 01 and KPKM 02. All such forms must be signed by the Examining Officer, Competent Person and the construction site builder.



SENARAI SEMAK PEMERIKSAAN ASAS TAPAK ATAU 'GROUND INSPECTION' KREN MENARA *(KPKM 01)*

Nama dan Alamat Pemilik :

Nama dan Alamat Tempat Kren Dipasang Pemeriksaan dilakukan :

Firma Pemasang :

Ruj. Kelulusan Rekabentuk :

A : BUTIR-BUTIR MESIN ANGKAT (NO. PENDAFTARAN:)

Jenis :		Tahun dibina :	
Model :		Kuasa : 60 kw	
No. Siri :		BKS : 1.3 tan @	50 meter (2 FALL / 4 FALL)
Pembuat :		Kedudukan kren terdahulu :	

B : BUTIR-BUTIR PEMERIKSAAN

PERKARA	BAIK	T/BAIK	CATATAN	PERKARA	BAIK	T/BAIK	CATATAN
1. Asas Tapak *				17. Cabin			
2. Fix Anchor (cast in / reusable)				18. Radius Indicator(H&T)			
3. I Beam				19. Hoisting Winch Unit			
4. J Bolt				20. Hoist Rope			
5. Chassis Frame				21. Hoist Sheave & Pin			
6. Ballast Block				22. Trolley Winch Unit			
7. Mast Element				23. Trolley Rope			
8. Ladder & Platform				24. Luffing Winch Unit			
9. Push bolts & pin				25. Luffing Sheave & Pin			
10. Climbing cage				26. Luffing Rope			
11. Slewing table				27. Cat Head			
12. Counter weight				28. Electrical Panel			
13. Jib				29. Hydraulic Cylinder System			
14. Counter Jib							
15. Hook Block				Others			
Kedudukan kren menara							
Radius operation dicadangkan & jib length	o& meter			Catatan : (/) - Satisfactory, (R.A)-Repair, (R.P)-Replace, (N.D.T)-NDT			

C : ASAS TAPAK *

Surat Akuan daripada Kontraktor Utama / Pengurus Projek / Residents Engineer (Foundation)	ADA / TIADA
Surat Akuan daripada Firma Pemsang (Fix Anchor / I Beam / J Bolt)	ADA / TIADA
Laporan Test Pile (Jika menggunakan asas pile)	ADA / TIADA / NA
Laporan Ujian Konkrit bersama Photo Penyediaan Asas Tapak	ADA / TIADA / NA
D : Lain-Lain	SETUJU / TIDAK
Semua Komponen Asai dipasang	YA / TIADA
Kebenaran Daripada Jabatan Penerbangan Awam	PERLU / TIDAK
Prosidur kerja selamat kahs bagi operasi *jib overlapping*	PERLU / TIDAK
Keperluan untuk memasang *Anti Collision Sensor / Zonning System*	PERLU / TIDAK
E : Kebenaran Memasang Jentera Dikeluarkan	SETUJU / TIDAK

* Pastikan 'wall ties' dibina mengikut rekabentuk daripada pembuat dan disahkan oleh Jurutera Professional.

Komen :

Tandatangan Pemeriksa ( )

Tarikh Ujian :

Disemak : Ketua Seksyen Kerja Bina

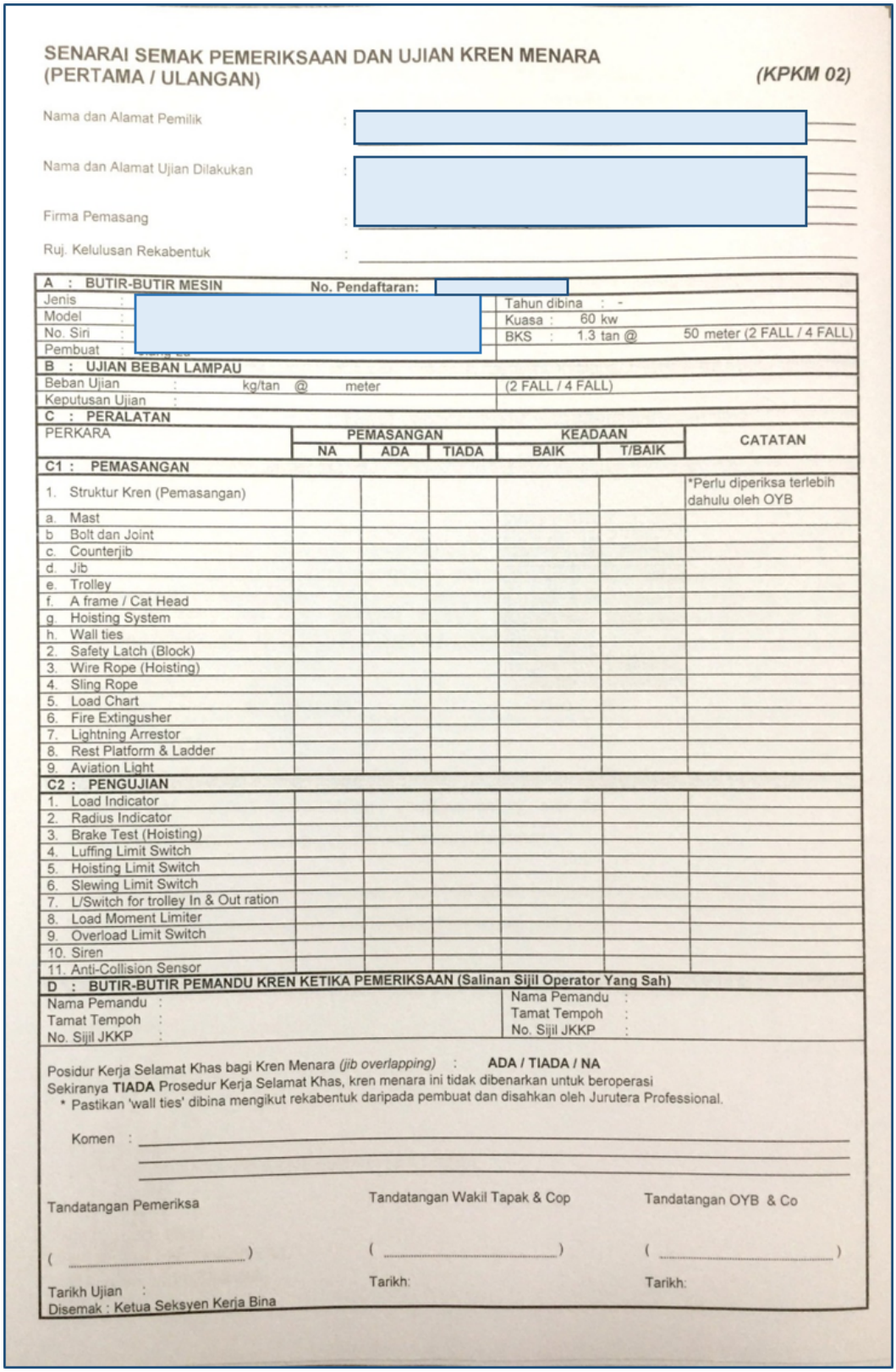
Tandatangan Wakil Tapak & Cop ( )

Tarikh:

Tandatangan OYB & Co ( )

Tarikh:

Figure 4.1 Basic site inspection checklist form



SENARAI SEMAK PEMERIKSAAN DAN UJIAN KREN MENARA
(PERTAMA / ULANGAN) *(KPKM 02)*

Nama dan Alamat Pemilik :

Nama dan Alamat Ujian Dilakukan :

Firma Pemasang :

Ruj. Kelulusan Rekabentuk :

A : BUTIR-BUTIR MESIN **No. Pendaftaran:**

Jenis :
Model :
No. Siri :
Pembuat :

Tahun dibina : -
Kuasa : 60 kw
BKS : 1.3 tan @ 50 meter (2 FALL / 4 FALL)

B : UJIAN BEBAN LAMPAU

Beban Ujian : kg/tan @ meter (2 FALL / 4 FALL)
Keputusan Ujian :

C : PERALATAN

PERKARA	PEMASANGAN			KEADAAN		CATATAN
	NA	ADA	TIADA	BAIK	T/BAIK	
C1 : PEMASANGAN						
1. Struktur Kren (Pemasangan)						*Perlu diperiksa terlebih dahulu oleh OYB
a. Mast						
b Bolt dan Joint						
c. Counterjib						
d. Jib						
e. Trolley						
f. A frame / Cat Head						
g. Hoisting System						
h. Wall ties						
2. Safety Latch (Block)						
3. Wire Rope (Hoisting)						
4. Sling Rope						
5. Load Chart						
6. Fire Extingusher						
7. Lightning Arrestor						
8. Rest Platform & Ladder						
9. Aviation Light						
C2 : PENGUJIAN						
1. Load Indicator						
2. Radius Indicator						
3. Brake Test (Hoisting)						
4. Luffing Limit Switch						
5. Hoisting Limit Switch						
6. Slewing Limit Switch						
7. L/Switch for trolley In & Out ration						
8. Load Moment Limiter						
9. Overload Limit Switch						
10. Siren						
11. Anti-Collision Sensor						

D : BUTIR-BUTIR PEMANDU KREN KETIKA PEMERIKSAAN (Salinan Sijil Operator Yang Sah)

Nama Pemandu :
Tamat Tempoh :
No. Sijil JKKP :

Nama Pemandu :
Tamat Tempoh :
No. Sijil JKKP :

Posidur Kerja Selamat Khas bagi Kren Menara *(jib overlapping)* : **ADA / TIADA / NA**
Sekiranya **TIADA** Prosedur Kerja Selamat Khas, kren menara ini tidak dibenarkan untuk beroperasi
* Pastikan 'wall ties' dibina mengikut rekabentuk daripada pembuat dan disahkan oleh Jurutera Professional.

Komen :

Tandatangan Pemeriksa

( )

Tarikh Ujian :
Disemak : Ketua Seksyen Kerja Bina

Tandatangan Wakil Tapak & Cop

( )

Tarikh:

Tandatangan OYB & Co

( )

Tarikh:

Figure 4.2 Tower crane test checklist form

4.1.17 Site base declaration letter

If the Tower crane uses a J-bol type site then a letter of approval is to be obtained by the Competent Person before the site base installation is started. The design is according to specifications and certified by professional engineers. The used J-bol must comply with the same calculation as the standard set by the manufacturer's manual and use the original material. If permission is not obtained, Competent Person must install the site using the original site provided by the manufacturer.

4.1.18 HIRARC

The HIRARC document must be provided by Competent Person before approval of installation is obtained. Further details on HIRARC may be referred in the general safety section. This is to ensure that all risks and hazards are accounted for when installing, raising, dismantling and maintaining the tower cranes. Some of the things are taken into account but not limited to the following:

a) Conduct risk assessment on site construction
b) Working safety in high places
c) Using effective engineering control methods
d) Use of personal protective equipment
e) Records and storage are well organized

The following must be taken into account in assessing the risk of installing, raising and overhauling the tower cranes:

a) Weather and wind
b) Traffic
c) Loading and unloading of goods
d) Fall from height
e) Object fall
f) Ease of access to the tower crane
g) Hand tools
h) Other personnel involved around the build site
i) Communication

4.1.19 Standard Operating Procedures (SOPs)

A standard operating procedure to install and dismantle the tower crane must be provided by Competent Person. The item must include the procedure of installing and

dismantling the tower cranes in the correct manner according to manufacturer's manual, safety measures, and employees involved in the whole operation of the installation, assembly and dismantling.

a) Examples of SOP procedures for assembling or dismantling hammerhead cranes:
   i. Site base inspection is carried out with professional engineers and according to specification
   ii. inspect the structure and components of the tower cranes including pins, pulley, bolts and nuts, hook block and electrical systems
   iii. using moving cranes with the appropriate capacity of component loads and towed crane structures
   iv. Base mast must be used based on manufacturer's manual and suitable for maximum crane height whether free standing or wall-tie
   v. Install the slewing platform on the mast
   vi. Assemble the operator cabins
   vii. Assemble framework-A
   viii. Assemble counter jib and switchboard
   ix. Assemble and inserting lead weight based on manufacturer's manual and correct sequence
   x. Connect the connection rod between the counter jib and the framework-A
   xi. Assembly connection rods and booms on the ground before being raised
   xii. Assemble trolleys and wire rope

b) Examples of SOPs regarding public safety
   i. Only competent people can assemble and dismantle the tower cranes
   ii. Safety protective equipment must be used at all times and supplied by the employer
   iii. Briefings on safety are to be held to all members every time before starting the process of assemble or dismantling
   iv. All areas involving the assembling or dismantling process must be marked with safety tape etc. and monitored by a Station House Officer (SHO)
   v. Moving cranes are fully functioning
   vi. No other worker aside from the assembling or dismantling team along in the building or under the tower crane

vii. The moving crane has the capacity to hold the heaviest load of the tower crane to be installed or dismantled
viii. all the small equipment that were brought up must be firmly tied and held by the assembling team to avoid falling objects

c) Complete lifting team must consist of:
   i. Competent Person
   ii. Technical Manager
   iii. Lifting Supervisor
   iv. Crane Operator
   v. Technician
   vi. Senior Rigger
   vii. Rigger
   viii. Signalman
   ix. Welder
   x. Wireman

4.1.20 Technical specifications of the tower crane

Technical specifications of cranes must be included when applying for the crane installation. This general specification is available in the manufacturer's manual. The specifications include height of the cranes, the length of the counter jib and boom, distance of hook block and load chart.

CHAPTER 5

PROCESS OF BUILDING CRANE TOWERS SITE BASE

5.1 Basic Ground Evaluation for Tower Cranes Site

5.1.1 Basics and Requirements for Evaluation

a) When a tower crane is to be installed near a completed or constructed building, Competent Person needs to make sure the ground for the tower cranes is safe as recommended by the tower crane manufacturer and the basic evaluation of the site must be verified by a professional engineer.

b) If there is a disturbance to the land during the construction of the tower crane site base, the retaining wall needs to be built or the depth of the site base for the tower crane is improved.

c) Evaluation of ground conditions should take into account the ability of the ground to receive the load and the weight imposed by the crane tower and the load imposed by the moving crane used to erecting or dismantling the crane tower.

d) Part of the hazards to be considered in ground evaluation, are:

i. The condition of the ground
ii. Moisture of the ground
iii. Uncompressed area
iv. Land near the canal and river
v. Changes of site conditions during construction

e) Cranes cannot be erected in areas that can endanger the base of cranes and support structures from underground conditions such as density, excavation, embedded pipes, roadblocks, water and so on. If there is a danger in relation to the land, additional support must be provided on the base of the site to ensure the safety of the crane.

5.1.2 Tower Crane Site Base and Support Structure

a) Land or the site base, temporary support structures, grillages, stuffing, connecting and anchoring of the tower crane shall be strong enough to withstand maximum load of crane

either during operation or not without failure. Specifically, the provision of suitable ground surfaces for fixed-type cranes must be carried out for safety reasons.

b) The tower crane placement, maximum load assessment, crane site base design, support structure and ancillary requirements shall be certified by the competent person or designated Registered Engineer. Observation is required to ensure that the burden imposed does not exceed the permissible load limiting.

c) While at the construction site, when the tower crane installation affects the permanent structure of the crane by way of extreme stress or extreme loads, the Competent Person must submit a certified site-based plan, design information and / or job description to the project engineer and confirm the job has been completed.

d) It is very important to ensure that the information regarding the features of the tower cranes provided by designers or cranes manufacturers is accurate, and reviews should be made before crane enforcement works are carried out to ensure that the installed cranes meet the criterion for the base design of the crane site. The base of the crane site should be performed daily checks by the responsible party to detect any signs of damage, looseness of connections or cracks in the basic structure of the site

5.1.3 Basic Ground Evaluation on Construction Site

Assessment of ground strength can be different from visually examined ground surface and geotechnical survey. Therefore, it is important that the evaluation to be made by person with sufficient knowledge and experience to know the necessary needs and assessments. Ground failures can be the cause of minor incidents and dangerous events at construction sites, and can cause serious injury and death. The hazard of ground conditions may be due to:

a) Uncompacted fill

Soil or other material may be buried without compacting. The ground cracks along the area are an indication that the ground state is not solid and can cause accidents as shown in Figure 5.1.

Figure 5.1 Machinery that sink in dense ground areas (*Ground Conditions for Construction Plant Strategic Forum for Construction, Good Practice Guide, London, 2014)*

b) The position is close to the excavation area.

The crane / structure should not be placed near the edge of the ditch and other excavations as it may collapse without warning. If the machinery needs to be used near the slope or excavation, with outriggers or wheels in a "danger area", engineering evaluations by authoritative geotechnical engineers need to be made. The location and the safe distance for placement of machinery are shown in Figure 5.2.

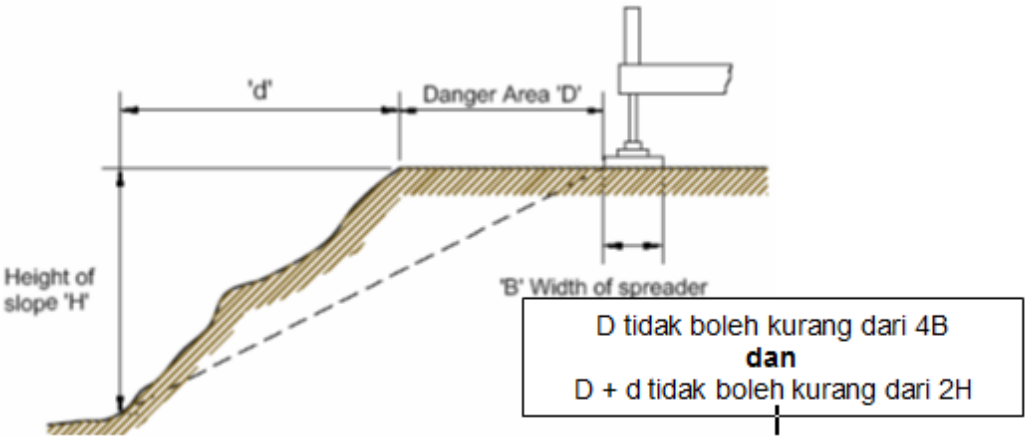


Figure 5.2 Location and safe distance for placement of machinery / structure (*Ground Conditions for Construction Plant Strategic Forum for Construction, Good Practice Guide, London, 2014)*

c) Weather

Heavy or prolonged rains can also alter the ground conditions and cause outriggers or tires to sink. If it is suspected that the support ground becomes soft, periodic checks should be made. Periodic checks should be performed when the ground freeze / harden because of its appearance it is stronger but rather weak.

5.2 The types of fixed tower cranes site base

Figures 5.3 and 5.4 indicate the position of the tower crane installation site base. The site base of the tower cranes is provided by installing fixed anchor on concrete. There are two types of anchors used in the tower cranes that are permanent anchor and variable anchor. Figure 5.3 shows the position of binding and depth of binding in the concrete. Figure 5.4 illustrates how the installation of variable anchor can be changed.

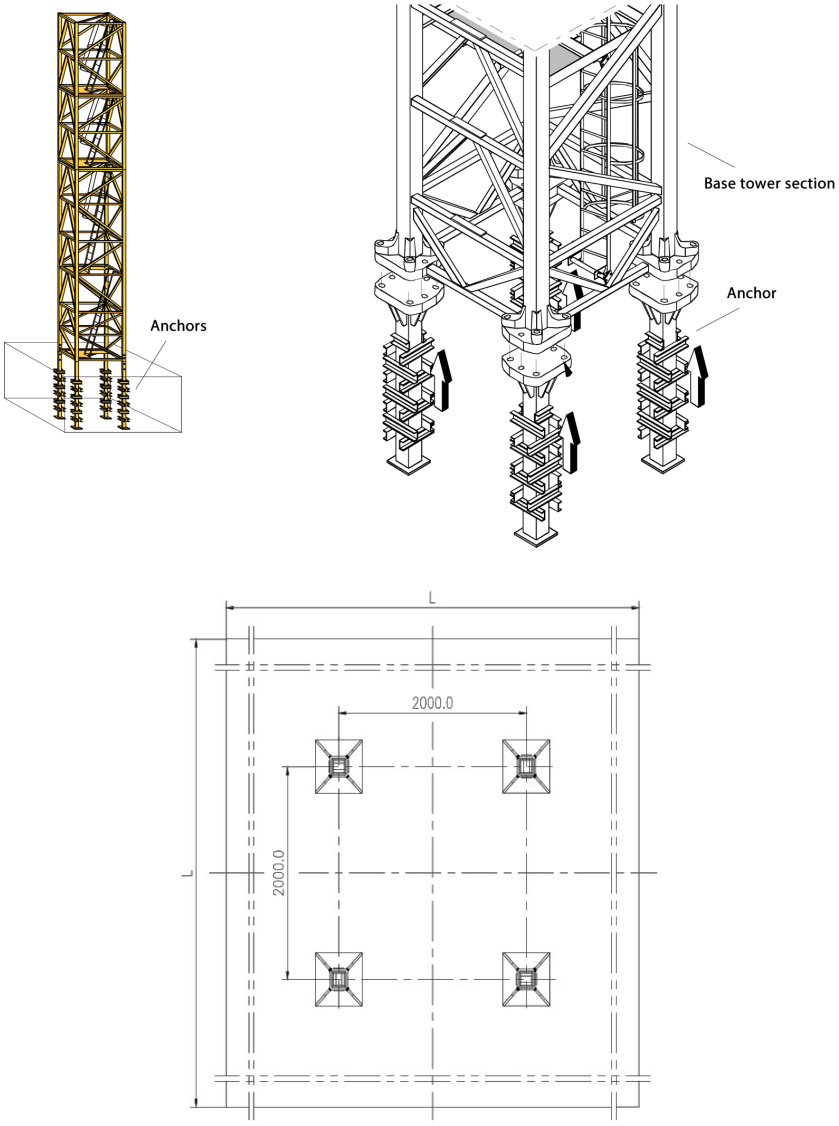


Figure 5.3 Fixed anchor installation plan

In the process of assembling a concrete bonded concrete mount, all binds shall be in the symmetry position of the concrete where the concrete block axis forms the square according to the designated pile size as shown in Figure 5.4

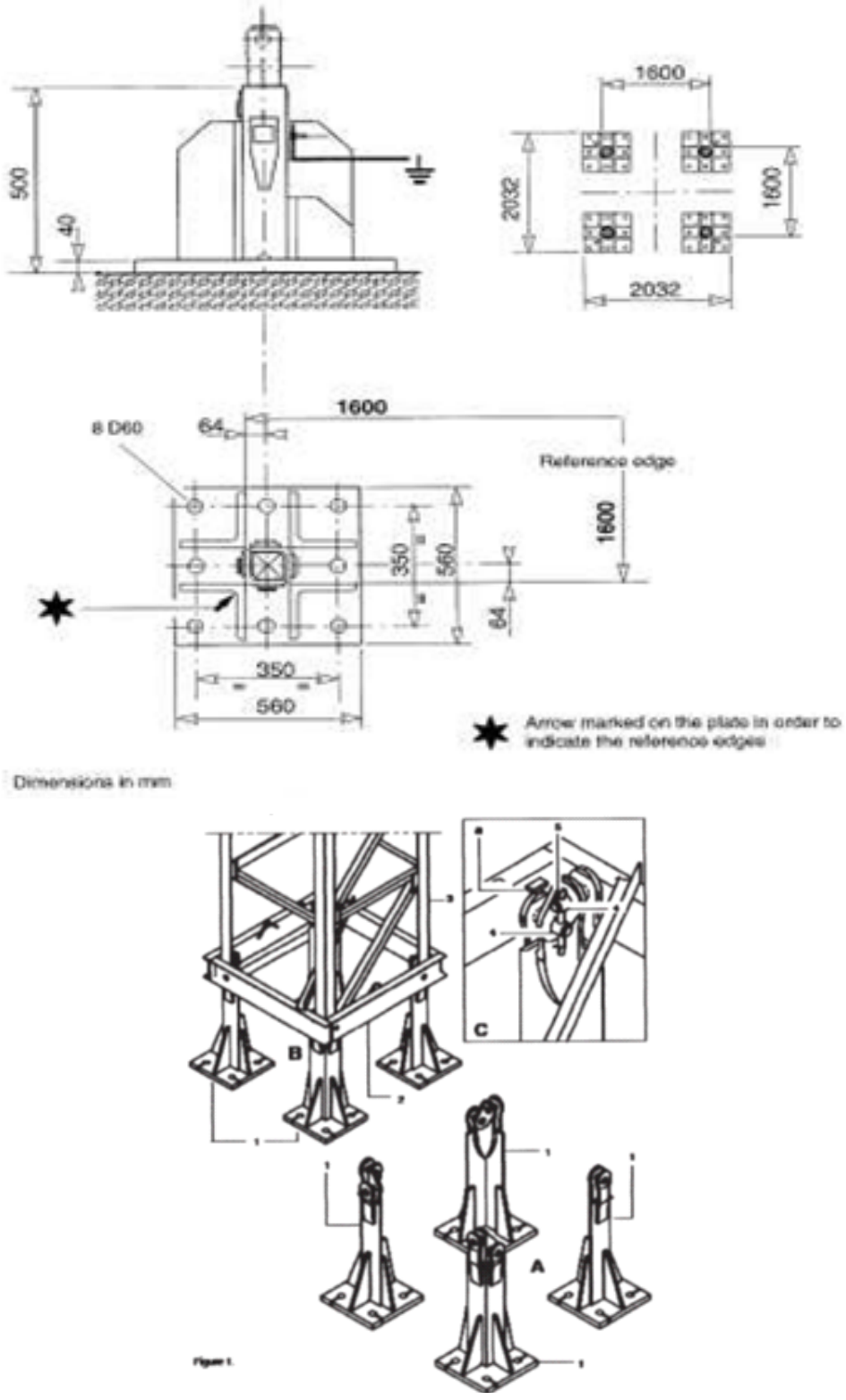


Figure 5.4 Variable anchor installation plan

In the construction of a base site, a high strength bolt is also indispensable to increase the bond strength of the base mast (Figure 5.5). In choosing a good anchor, a metal grade rating needs to be done. Aside from that, installation steps should also be taken into account to ensure that the anchor used is stronger. Common plates require at least 16 bolts. Specs of bolts used must be the same as specified by the manufacturer.

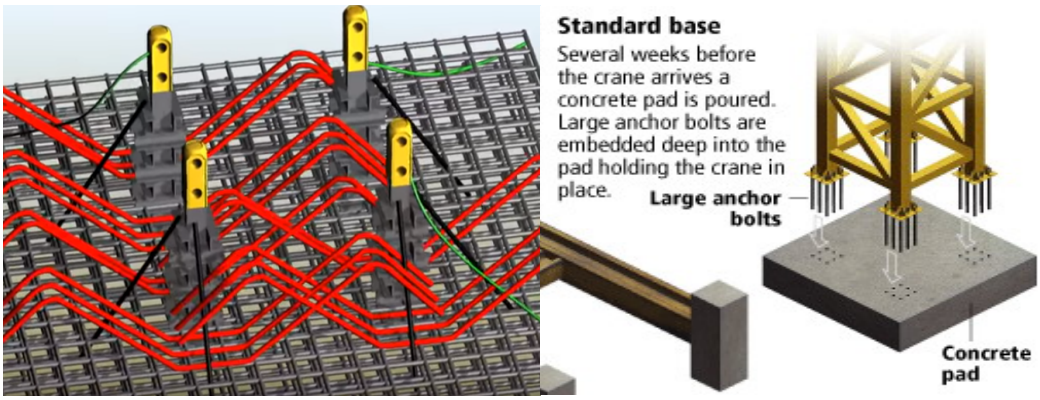


Figure 5.5 Description of high strength bolts in the construction of site bases

CHAPTER 6

THE PROCESS OF INSTALLING TOWER CRANES

6.1 Mast Parts

6.1.1 Basic mast

The basic mast length is longer than the rest of the mast. This mast portion is placed on the site base of a tower crane (Figure 6.1). The middle part of the mast has a length of about 3 m high and is connected with anchor connector, resting platform, short staircase, long staircase and stair support (Figure 6.2). The highest mast is connected to the slewing platform (Figure 6.3).

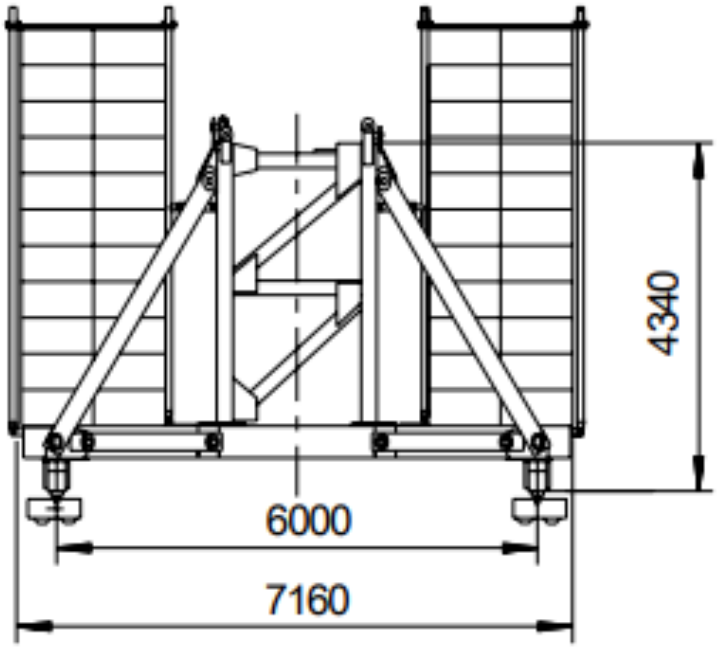


Figure 6.1 Basic mast part

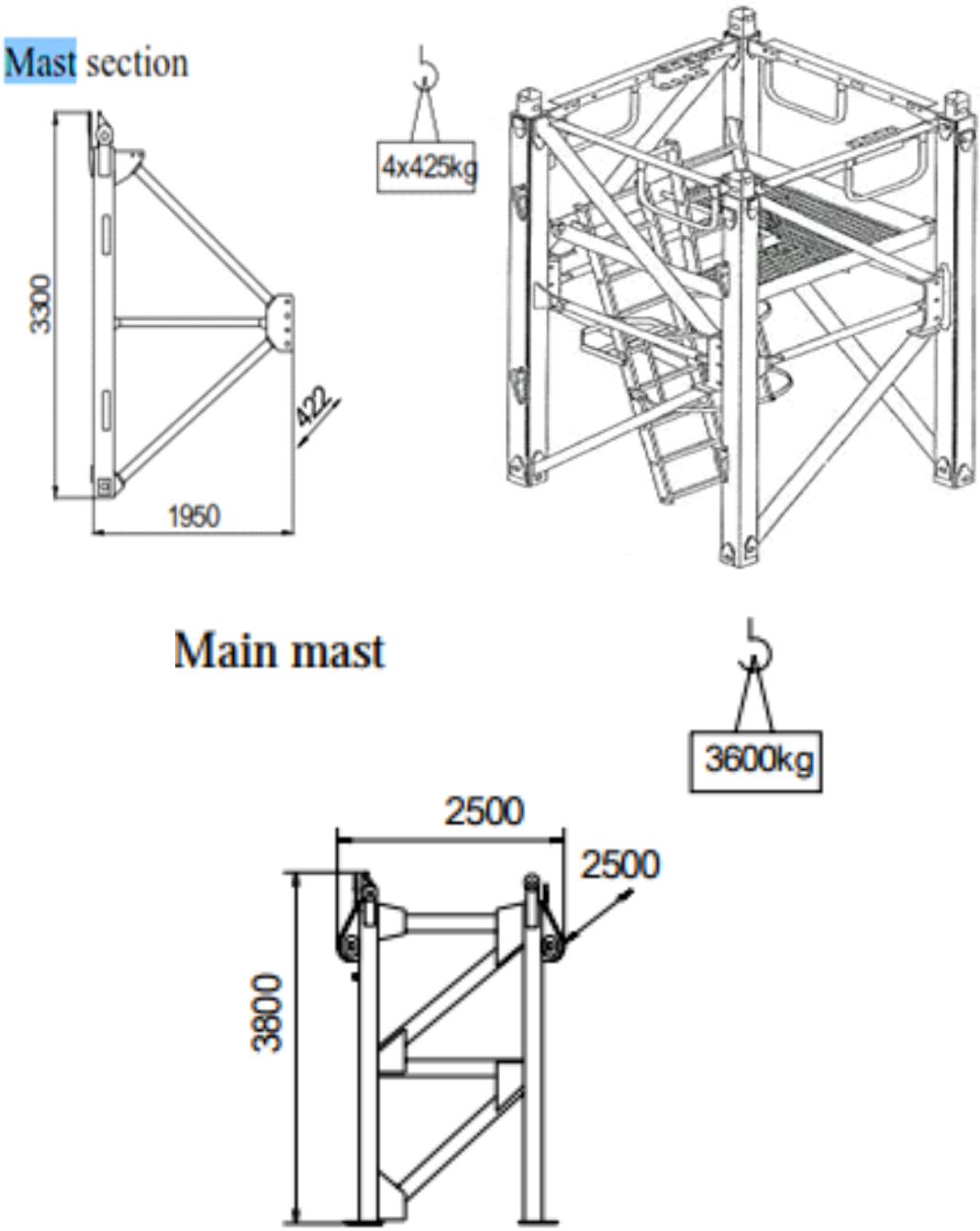


Figure 6.2 Mast

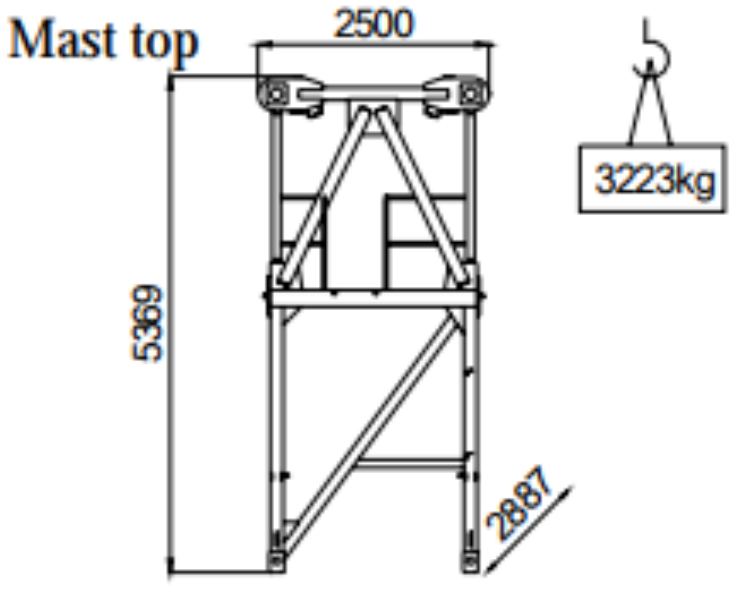


Figure 6.3 The highest part of the mast

6.2 Preparation of parts of the tower

6.2.1 Installation of slewing platform

The top of the mast will be joined with a slew table, slew tables are lifted using a moving crane and positioned accurately above the mast part Figure 6.4.

Figure 6.4 Preparation of slewing platform

6.2.2 Installation of A-frame

In merging and installing the A-frame, the listing is done by placing the A-frame in the vertical position. The position of the A-frame is arranged at the top of the tower pole

under slewing platform (Figure 6.5). Before the raising process starts, the slewing platform is first installed on the tower pole in the correct position using the bolt (Figure 6.6)

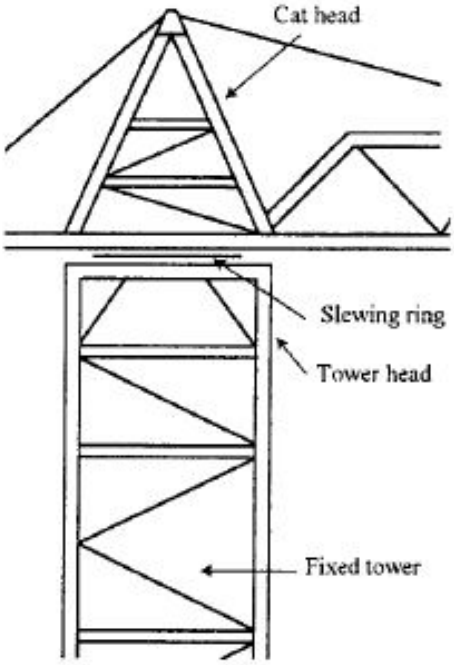


Figure 6.5 Steps to install a tower top

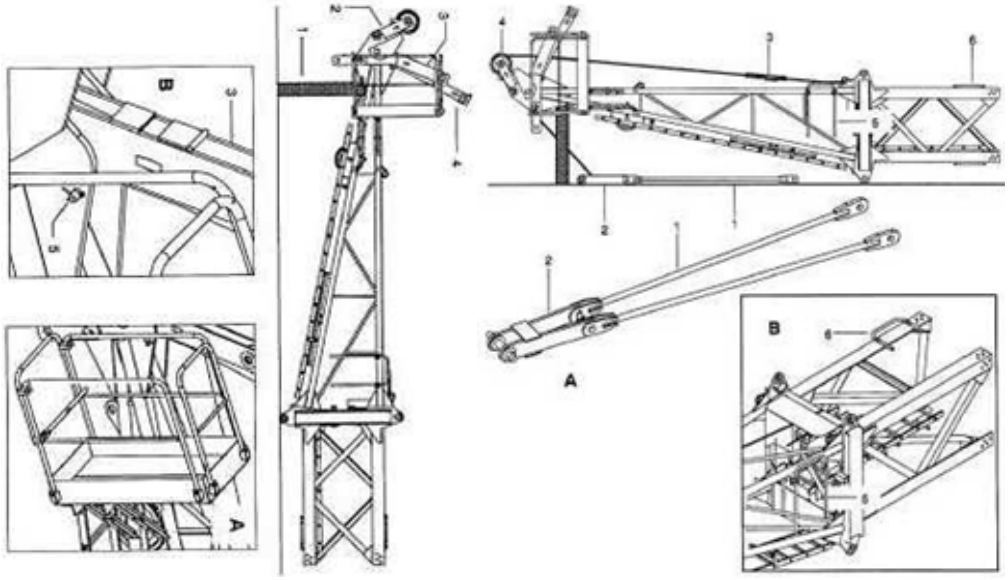


Figure 6.6 The A-frame preparation steps

The Installation of the A-frame is made by lifting the A-frame using the moving crane to the top of the tower and connecting the A-frame on the slewing platform by using bolts as shown in Figure 6.7

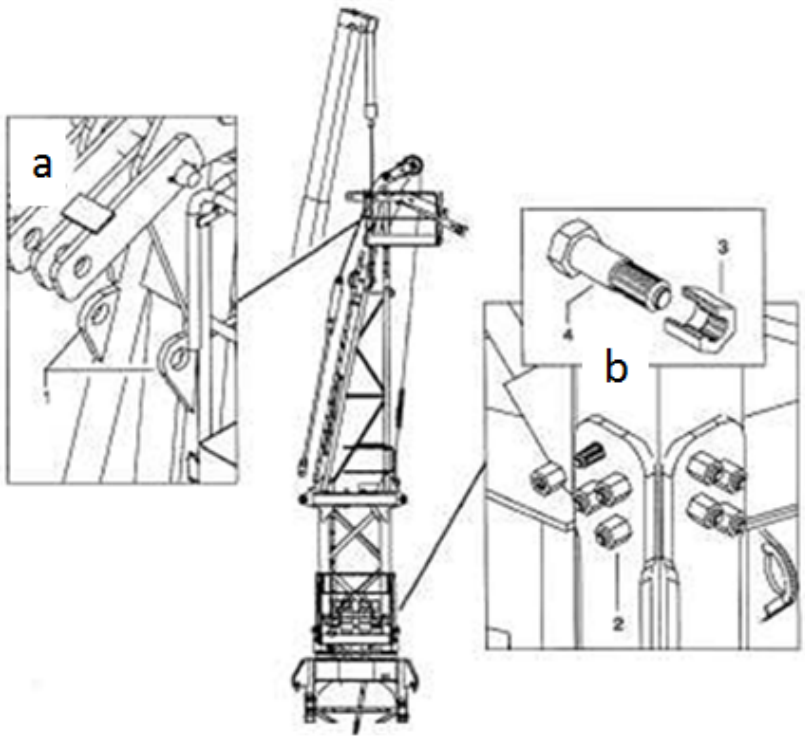


Figure 6.7 Installation of frame A (a) tied rod (b) bolt connection to the pole

6.2.3 Cabin Installation

Cabin installation steps are as shown in Figure 6.8.

a) The cabin is lifted using a moving crane and is rotated to the right position (a)
b) The cabin is placed on the platform (b)
c) Interconnecting pin between cabin and platform mounted (c) and tightened (e)
d) The pedestal is connected to the crane platform (d)
e) Move the grab rails and lock the track position using the safety pin

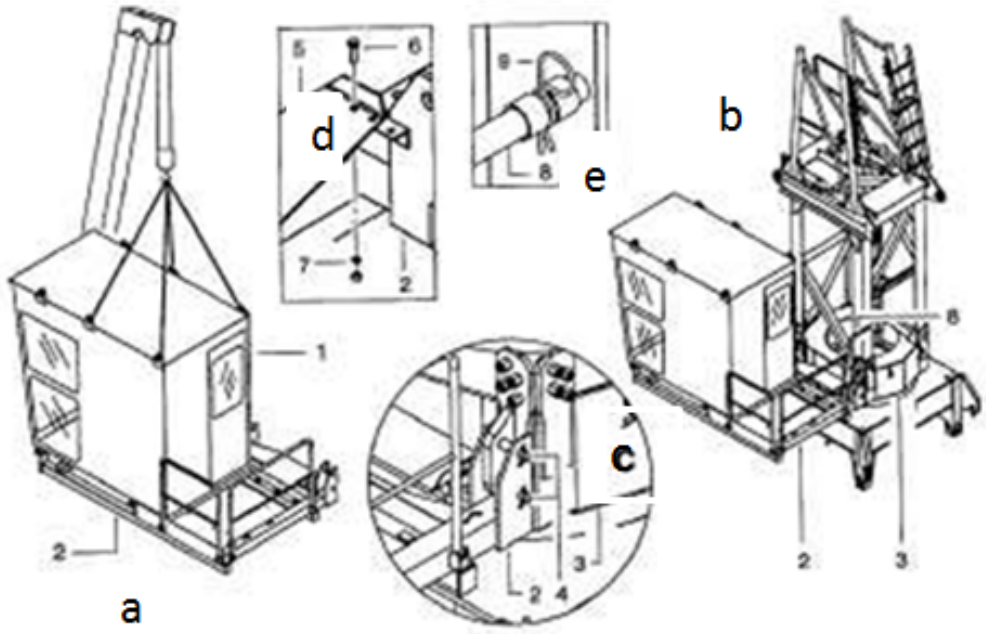


Figure 6.8 Operator cabin installation step

6.2.4 Installing counter jib

The counter jib that holds the counterweight should be mounted to the correct position before lifting Figure 6.9 (a). Counter jib is lifted using a moving crane and is connected to the slewing platform. Connection is tightened so jib does not slide when lifted (b).

If installing without using a second crane aid, the installer cable should be properly rolled and the locking tool is used with caution. Counter Jib is connected to the A-frame and the bolt connection is tightened (c). All pins, bolts and nuts shall be inspected from time to time.

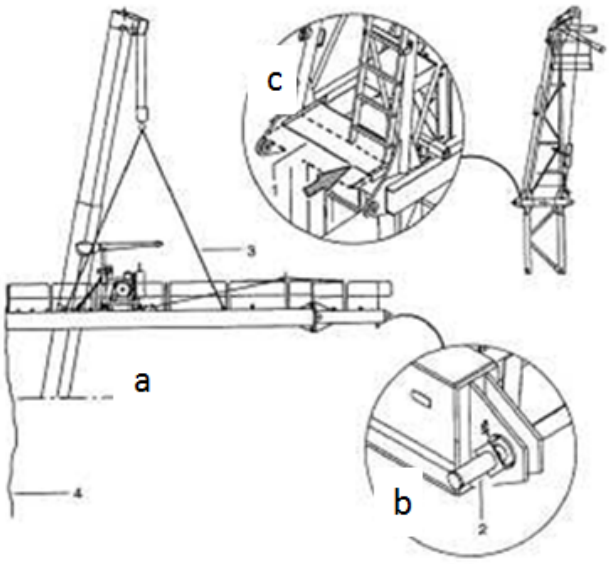


Figure 6.9 Lifting and mounting counter jib

6.2.5 Connecting Rod

The connecting rod works to connect the jib to the A-frame (Figures 6.10 and 6.11). This component requires periodic checks to prevent bending from occurring. Once the counter jib is connected to the tower crane Figure 6.11 (a), the connecting rod is connected to the A-frame Figure 6.11 (b) using the appropriate bolts.

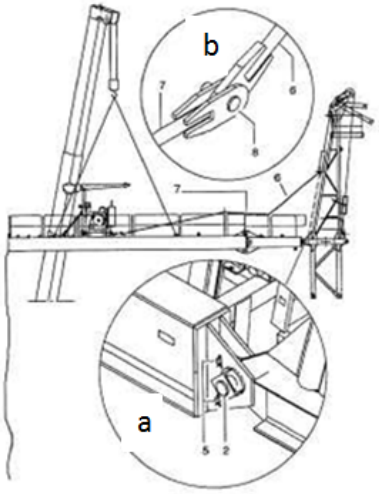


Figure 6.10 Tying the connecting rod

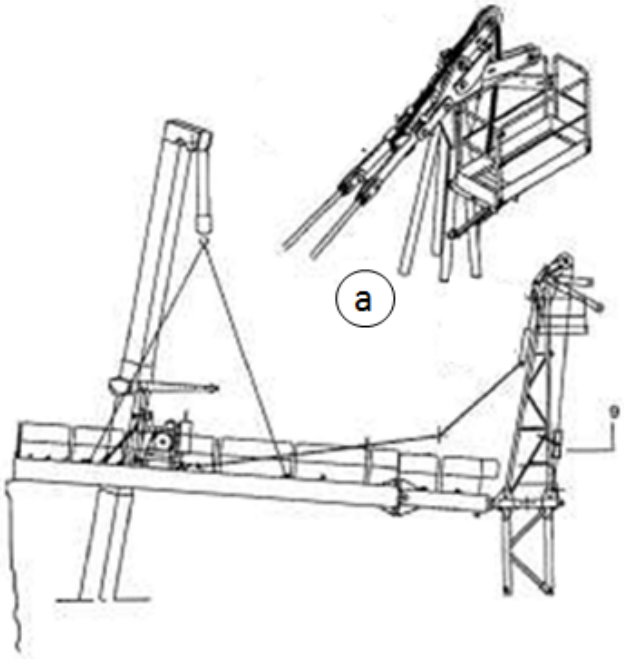


Figure 6.11 Example of a counter jib and A-frame connection using a connecting rod

6.2.6 Installing the counterweight

Figure 6.12 shows jib connected to the A-frame (a) and is connected using bol (b) before the counterweight is composed on jib (c).

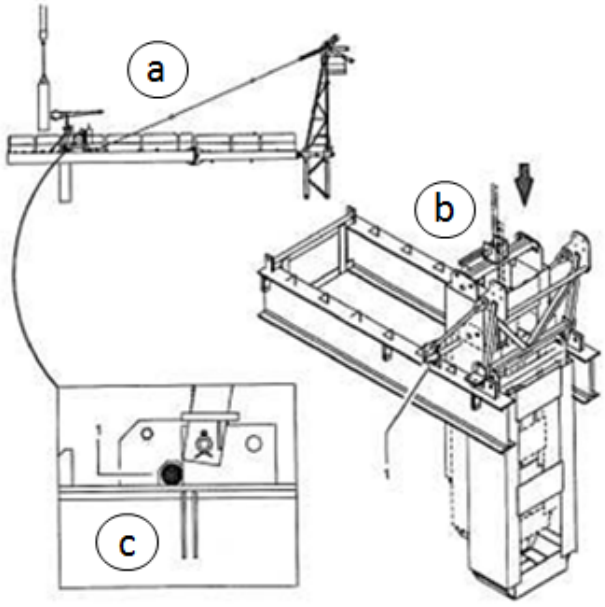


Figure 6.12 Installing counterweight

6.2.7 Identification and installation of boom

Boom is identified from the diameter of the tower crane rotation required by the built site. Figure 6.13 shows the rotation diameter standard that corresponds to the jib length.

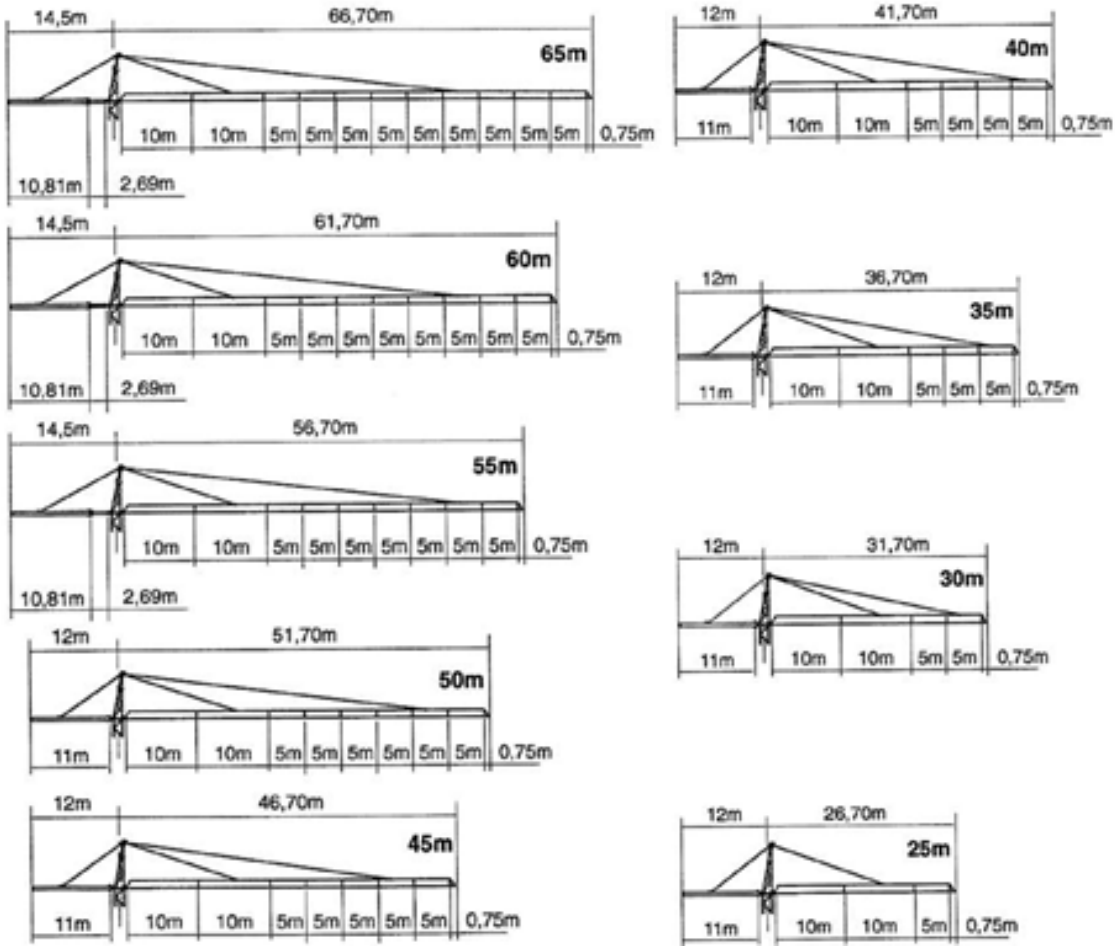


Figure 6.13 Identification standards of boom

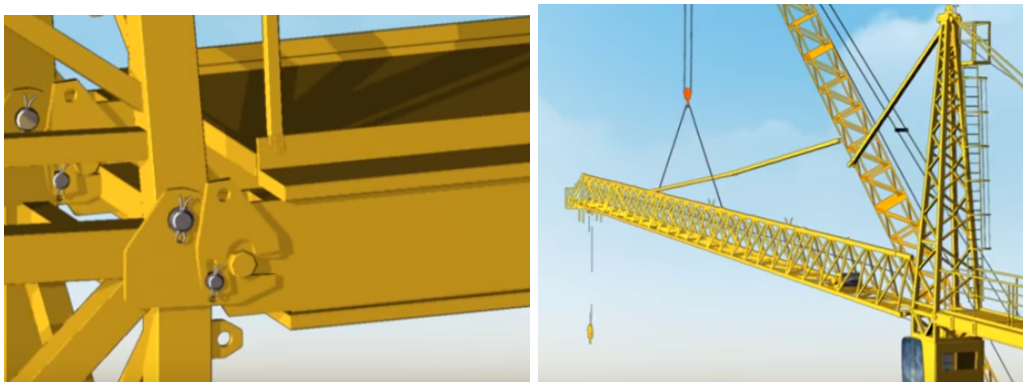
6.2.8 Installing the boom

The boom installation process depends on the type of tower crane. The steps of installing hammerhead crane boom are as follows:

a) A connecting rod should be connected to the boom before lifting; while another part of the connecting rod is connected to the A-frame. The trolley also needs to be installed on the boom before lifting.

b) The boom needs to be lifted slightly using the lifting cord on the moving crane before the trolley is mounted on the boom. The position of the trolley on the boom should be maintained to ensure that the boom is in balance when it is lifted on the tower. The main functions of trolley and other tools such as limiting switches and wiring need to be checked before the boom is raised.

c) The boom should be lifted horizontally to the mast. The booms are mounted on the slewing platform using pin (refer Figure 6.14 (a)) before both connecting rods are installed (refer Figure 6.14 (b)).



a) b)

Figure 6.14 (a) The pin is used to connect the boom with the slewing platform (b) The boom and A-frame connector rod are mounted using the pin

6.2.9 Tie the connecting rod to the A-frame

The connecting rod is connected to the frame before the jib is raised and at the same time another connector rod is tied to the A-frame diagram 6.15 (a). The extension rod connection structure is shown in fig. 6.15 (b) After the jib is lifted and connected to the slewing platform, The connecting rod on the A-frame and the boom is then connected to Figure 6.15 (c).

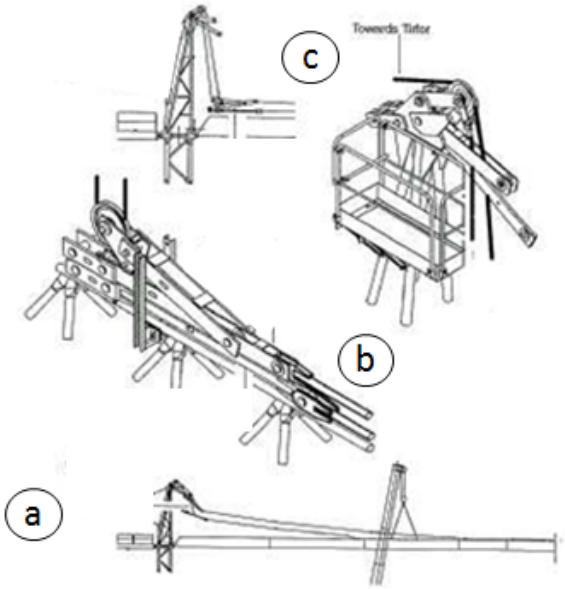


Figure 6.15 Steps of connecting boom and A-frame

6.2.10 Installation of the drum on the counter jib

There are two methods of installation of the drum and wire rope on the crane:

a) Ready to roll wire rope on the drum

- Wire rope rolled in drum (Fig. 6.16) is prepared before being raised to the counter jib using the mobile crane.
- Wire rope is connected to the trolley and pulley in the boom area and is connected directly to the hook to lift the load

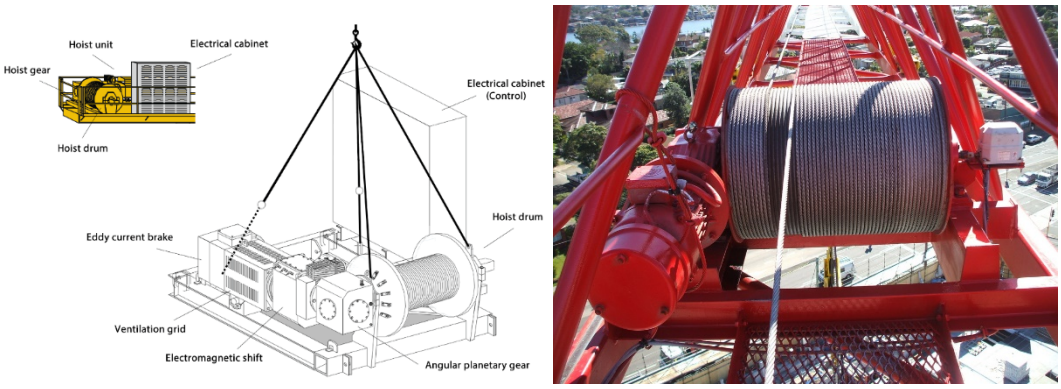


Figure 6.16 Some examples of diagrams that showed rolled drums rope and are on the counter jib

b) Wire rope rolls from below

When rolling the cable, the motor gear can be changed according to the speed of the cable to be rolled. When changing the motor gear, the hook block should be placed on the ground to prevent the load from falling. The cable position before rolling on the motor is shown in Figure 6.17. The type and size of lifting cable should comply with BS302 standards (Malaysian Standard MS551: 1978, Specification for wire ropes for cranes, excavators and general engineering purposes).

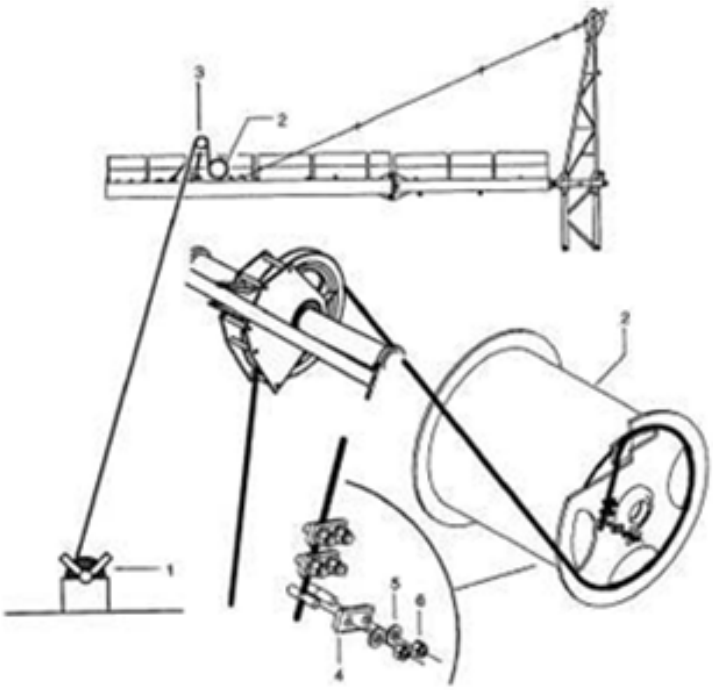


Figure 6.17 Flow of rolling the lifting cable on the motor

6.2.11 Rolling cables for self-ballasting

The safest workload for the tower crane is determined from the hook position and the length of the cable used is within the specified radius and the cable is good. In obtaining appropriate load values for lifting, weight tolerance should be made (Figure 6.18).

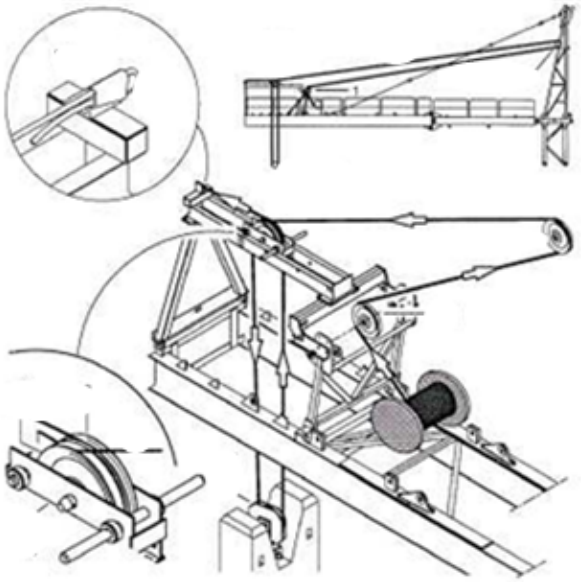


Figure 6.18 Rolling the lifting cable for the self-ballast

6.2.12 Installing the counterweight

Counterweight made of concrete is a balancer used as ballast that was placed on the counter jib part of the tower crane counter. Counterweight can also be used as a weighted ballast on own base of the tower crane and the one that is rail mounted. Ballast cannot be cracked either during transmission, before installation or during installation. The ballast installation at the counter jib steps are shown in Figure 6.19.

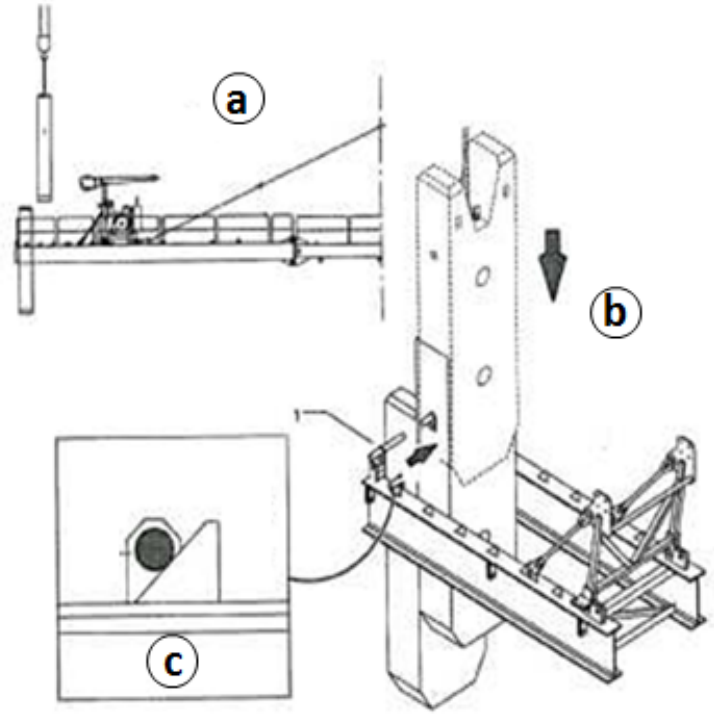


Figure 6.19 Ballast installation on the counter jib: a) Ballast was raised one by one using another crane beginning with the farthest ballast from the mast; b) Ballast is inserted into the space reserved on the counter jib; c) Ballast lock pin

The ballast installation steps at the crane base are shown in Figure 6.20 i.e.:

a) The number of ballasts to be used is determined from the height of the tower crane (see manual)
b) Ballast is placed on the frame of the tower crane (locked in both the top and bottom of the ballast).
c) The ballast weight is determined by the size and density of the concrete (commonly used concrete density is 2400 kg / m3).

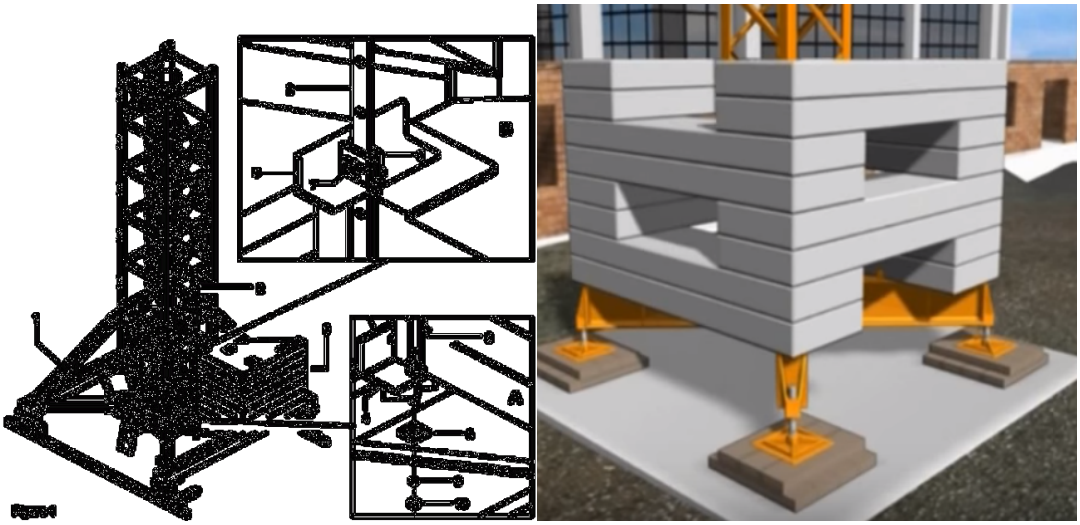
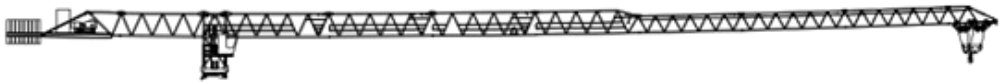


Figure 6.20 Ballast installation on the tower crane site base with own base type

6.2.13 Installation of ultimate counterweight

The amount and grade of counterweight attached to the counter jib depends on the length of the boom and the counter jib (see Table 5.1). Ballast sequences based on the different grades can be referred to in Figure 6.21.

Table 6.1 Standards for boom lengths and counter jib



Length of jib		30	35	40	44	50	54	60	64	70	74
Length of counter jib		16.2	16.2	20.2	20.2	20.2	20.2	20.2	20.2	20.2	20.2
During working and telescoping	Blocks	2A+C	2A+B+C	3A+C	3A+B	4A+C	4A+C	5A	5A+C	5A+B+C	6A
	Weight (kg)	9000	11000	13000	14000	17000	17000	20000	21000	23000	24000

Block type	Density (t/m^3)	Weight (kg)	Tolerance
A	2.4	4000	±1%
B	2.4	2000	±2%
C	2.4	1000	±2%

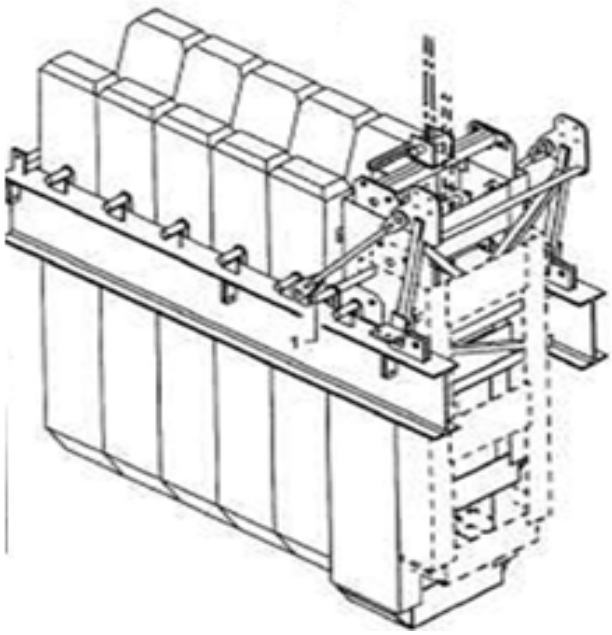


Figure 6.21 Ballast arrangement on the counter jib

6.3 Introduction to the merging of bolt / pin

During the merging process, the quality and condition of bolts and pins should be checked to ensure that the bolts and pins to be used have high pre-tension strength. The pre-tension strength is a bolt connection consisting of bolt, nut, and bush made of high quality and strong materials. All bolt connections must be monitored, inspected and fixed from time to time. This is because this connection can be used when the crane is used. Failure to do this may result in accidents and damages. Bolts, pins, nuts and bush must comply with established standards.

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CHAPTER 7

SAFETY TOOLS

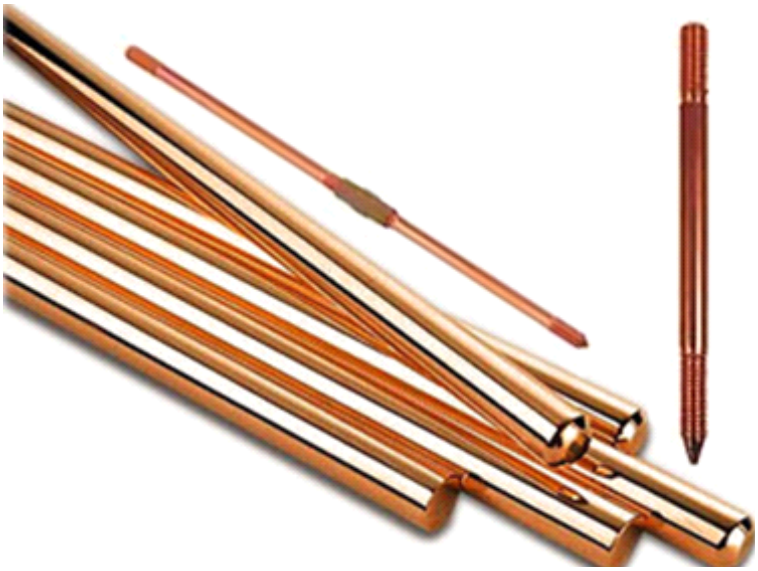
7.1 Lightning Arrester

The tower crane needs to be protected from lightning rays before being operated (Figure 7.1). For tower cranes that use the track, at least one track jib should be connected to the electric power of each connection and make sure it works.

Figure 7.1 The tower crane mounted with a lightning arrester

7.2 Copper Ground Rod

Copper grounding rods are the finest and most cost-effective ground rods for structural grounding and lightning protection. The grounding rods are suitable for use in high corrosion resistance and long-term use. It is made of solid copper and is formed into a radius for connectivity. It is suitable for use in shallow soils or ground areas with high voltage electrical equipment. Figure 7.2 shows an example of a grounding rod type made of copper and the way of assembly.



Grounding

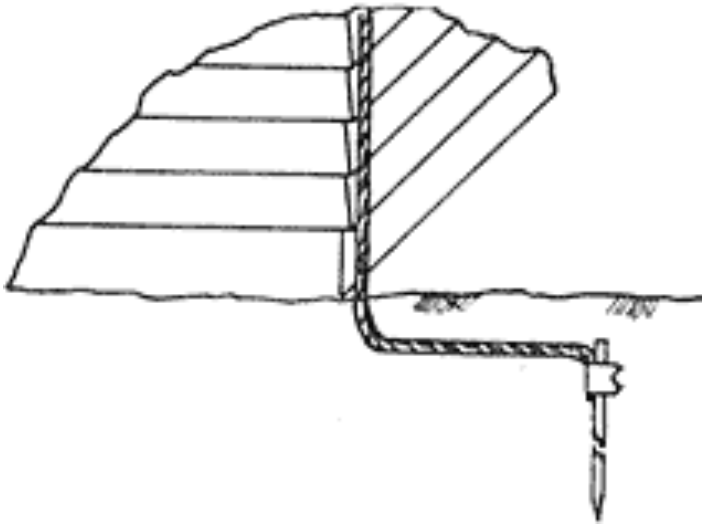


Figure 7.2 The grounding rod made of copper

7.3 Aviation light

The aviation light works to generate aircraft warnings. It is mounted on a tower crane such as the upper part of the A-frame, the end of the boom and also the tip of the counter jib. Figures 7.3 and 7.4 show examples of aviation lights and their positions on tower cranes.

Figure 7.3 Aviation Light

Figure 7.4 Aviation light positions on the tower cranes

7.4 Fire extinguisher

Fire extinguisher is a protective device used to eradicate and control small fires if it occurs and is used in emergency situations (Figure 7.5). It should be placed in the operator's cabin and the expiry date of its use should be checked.

Figure 7.5 fire extinguisher

7.5 Limiting Switch

7.5.1 Slewing Limiting Switch

Slew limiting switch acts as a limitation of rotating movement of the tower cranes to the degree of permissible movement only. At a narrow construction site especially in the city this limiting switch is used to ensure the safety of the off-site area around it in the safe state so that the crane boom does not go out of the allowed area.

7.5.2 Luffing Limiting Switch

The luffing limiting switch serves to limiting the control of luffing tower crane boom movement

7.5.3 Trolley Limiting Switch

The pulley limiting switch works to control load weight and pulley control. This control system is controlled by the same limiting switch as shown in Figure 7.6.

7.5.4 Load limiting switch

A load limiting switch is an essential component of a tower crane. This switch works to limiting the tower crane load to avoid accidents. This switch automatically stops the crane if the load is above the allowed load weight.

Figure 7.6 The limiting switch attached to the A-frame tower crane

7.6 Anti-collisions system

To avoid collisions between tower cranes, each tower crane can be equipped with an anti-collisions tool (Figure 7.7). The system works to measure the position and speed of the lifting load, calculating the risk of collision depends on the ability of the tower crane brake. Additionally, this system warns operators about the risks that will take place and perform automated braking systems as soon as risk of clash is identified.

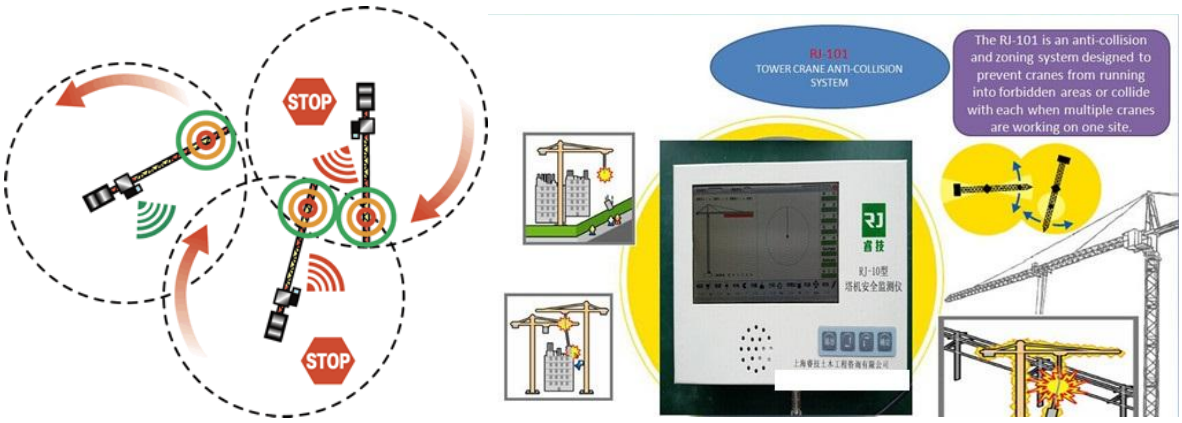


Figure 7.7 Anti-collisions system

CHAPTER 8

CRANES INSPECTION AND MAINTENANCE

8.1 Periodic Inspection and Maintenance (Routine Inspections)

Project managers need to ensure periodic inspection and maintenance must be done by Competent Person based on manuals from crane manufacturers. Periodic inspection and maintenance are as follows:

a) all functions and speed controls, smooth operation and crane movement limiting;
b) all emergency and safety switches, including indicator and load limiting devices;
c) lubrication of all moving parts
d) inspection of filter components and hydraulic fluid levels;
e) visual inspection and evaluation of crane structures and other critical components such as brakes, gear, pins, wire rope, locking devices and so on;
f) warning signs and controls;
g) wear on wheels and rails (rail mounting crane type); and
h) other things mentioned by the crane manufacturer.

All replaced crane components need to meet the minimum specification or the same as the specifications of the crane components. Inspection reports should be provided upon completion of the inspection.

8.2 Annual Inspection

The project manager should ensure that the annual inspection is done by Competent Person as it is part of the requirement during the registration of the tower crane. The annual inspection should involve all components or parts specified by the crane manufacturer. This includes parts / items that are relevant during periodic inspection and maintenance. An annual check involves a review of:

a) All parts / matters relevant to the current inspection and testing prior to installation of the crane
b) Function and calibration of all indicator and load limiting devices
c) Visual inspection in detail (examples such as pin or bolt inspection whether wear, corrosive, cracked or loose)

The inspection report shall be provided by Competent Person upon completion of the inspection and subsequently submitted to the project manager for review.

8.3 10 Year Inspection

The project manager also needs to ensure a major inspection for every 10 years from the date the crane is registered or the tower crane started operating. This examination should be performed by Competent Person. This 10-year inspection involves inspections of structures and mechanical components that are more comprehensive than annual surveys. Although cranes do not operate continuously for 10 years, the crane structure and components may experience deterioration of performance depending on the way and the storage environment.

The 10 year inspection involves all structures, components, control devices and crane safety. This inspection involves the following:

a) Structure, mechanical and electrical components, instrumentation, control devices and cranes handling
b) Non-destructive tests based on relevant standards
c) Controls and emergency switch
d) Brake system
e) Component safety / crane parts that have been through the repair and replacement process
f) Complete safety instructions and manuals

Some parts of the crane or tool that need to be checked during the 10-year inspection are as follows:

a) Slewing ring
b) Hydraulic motor
c) Hydraulic pump
d) Block valve
e) Lifting drum and luff
f) Brake System
g) Wire rope pulley
h) Luffing hydraulic cylinder
i) Main gear and drive shaft
j) Jib/Boom
k) Mast
l) A-frame

m) Pins and moving parts (e.g. boom heel pins, ram pins)
n) Static pin
o) Steel wire rope
p) Electrical system
q) Control system
r) Electric motor
s) Hook trolley (Other than luffing cranes)
t) Hook block

Some components or parts require non-destructive tests during the 10-year inspection as shown in Table 7.1.

Table 9.1 Non-destructive testing of tower crane components during a 10-year inspection

Component tested	**Non-destructive testing details**	**The frequency / timing of the non-destructive test**
The chord rod thickness on jib / boom	Material thickness test	10 years
Slewing ring	Crack detection test	10 years
Luffing hydraulic steel nuts	Crack detection test	10 years
Luffing hydraulic cylinder and ram (end and cover rods)	Crack detection test	10 years
Welding on jib connector	Crack detection test	10 years
A-Frame (all welded parts)	Crack detection test	10 years
Hook	Crack detection test	10 years
Welding on hook blocks and trolleys	Crack detection test	10 years

8.4 Examples of tower crane maintenance checklist form

SAMPLE CHECKLIST FOR TOWER CRANE

This checklist provides an overview of the basic requirements to be checked which would help to ensure that a tower crane is safe for use. Tower crane users should consult manufacturers, suppliers and owners to check on minimum requirements and address any concerns before using the equipment. These items in this checklist are non-exhaustive and users are recommended to make the necessary modification and customisation to suit your work processes and conditions at the workplace.

S/N	Items		Remarks
A. Tower Crane Approved For Use			
1.	The Tower Crane is of type-approved	☐ Yes ☐ No	
2.	The Tower Crane has a valid Lifting Machine (LM) certificate (issued less than 12 months ago).	☐ Yes ☐ No	
B. General Requirements			
3.	The Tower Crane is provided with markings of the Safe Working Load, Tower Crane serial number and LM number.	☐ Yes ☐ No	
4.	Proper and safe access and egress (with proper foot and hand holds/ supports) are provided to the crane operator.	☐ Yes ☐ No	
5.	A load capacity chart is displayed in the operator cabin.	☐ Yes ☐ No	
6.	Operator crane cabin is provided with a locking mechanism so as to prevent unauthorised entry.	☐ Yes ☐ No	
7.	A safety bar is fitted across the operator's cabin window where there is likelihood of the operator falling through it.	☐ Yes ☐ No	
8.	An approved fire extinguisher is provided in the operator cabin.	☐ Yes ☐ No	
9.	An Operation and Maintenance log book is available in the operator cabin.	☐ Yes ☐ No	
10.	A Manufacturer Operating Manual and Maintenance Manual are made available.	☐ Yes ☐ No	
11.	Crane hook is provided with a safety catch to prevent displacement of the sling or load from the hook.	☐ Yes ☐ No	
12.	Wire ropes are well lubricated and that there are no visible defects such as broken wires, kinks, excess wear, crushing etc.	☐ Yes ☐ No	
C. Safety and Operational Devices			
13.	A load radius indicator with warning alarm is installed.	☐ Yes ☐ No	
14.	A Jib angle indicator is provided (for Luffing Jib Tower Crane)	☐ Yes ☐ No	
15.	An emergency stop button, which will terminate the operation of the crane engine, is installed in the operator cabin and correctly identified.	☐ Yes ☐ No	

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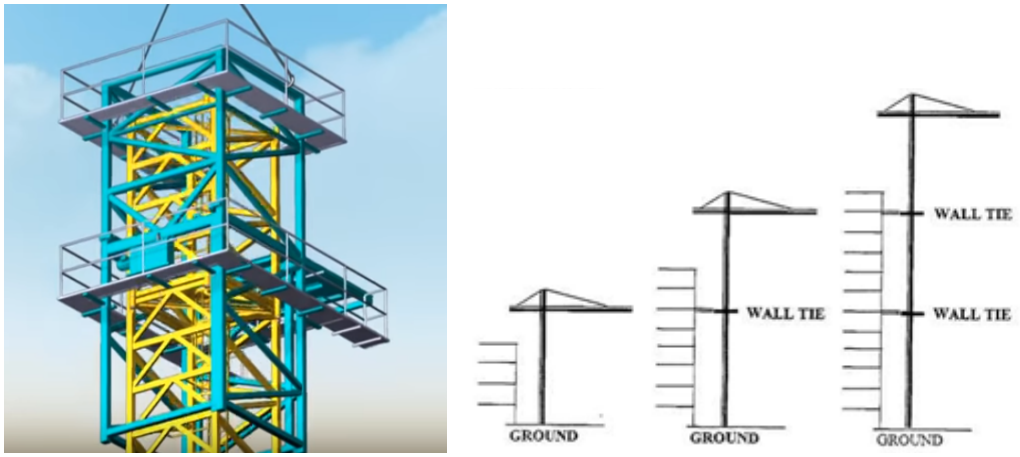
www.afscme.org

CHAPTER 9

TOWER CRANES CLIMBING PROCESS

9.1 Telescopic Method

The telescopic method is an external climbing method used to increase the mast portion of the tower crane. A hydraulic cylinder is used to reduce or increase the altitude of the tower using a telescopic cage. The telescopic cage becomes intermediary to connect the new mast portion to be added to the existing mast section during the climbing process (Figure 9.5).

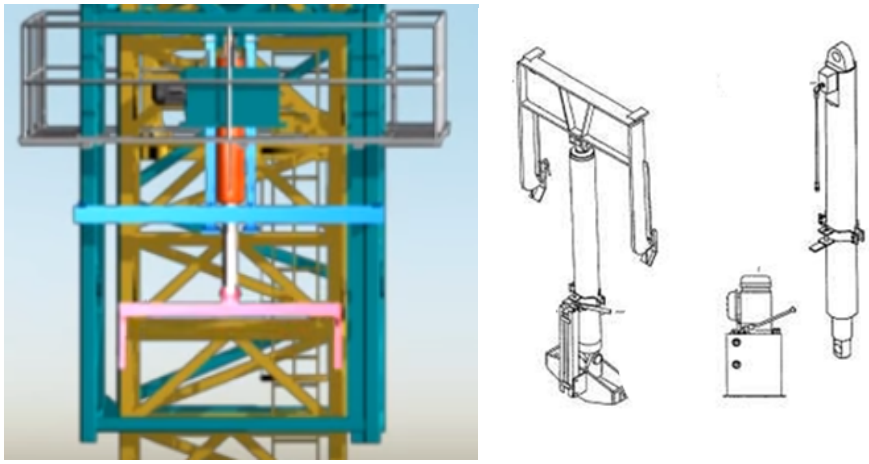


(a) (b)

Figure 9.1 Telescopic Methods: (a) telescopic cage, (b) schematic representation of telescopic method / external climbing method

9.1.1 Telescopic Cage

Climbing equipment using telescopic cages for a tower crane should be checked and connected according to manufacturer's instructions. The main parts of the telescopic cage are shown in Figure 9.2:

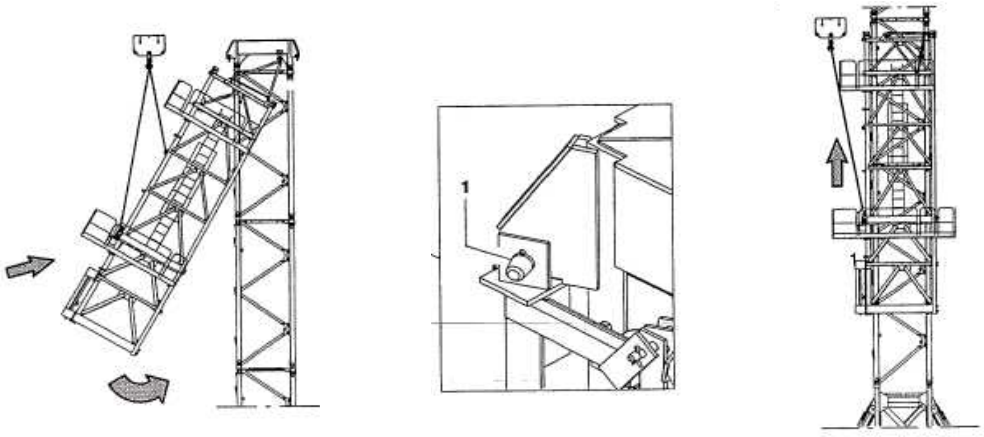


(a) (b)

Figure 9.2 (a) Telescopic cage installed to the mast; (b) Hydraulic system: 1. *Equipped Telescoping Yoke, 2. Hydraulic Cylinder, 3. Hydraulic Unit, 4. Cylinder Support Beam, 5. Cylinder Stop, 6. Lever*

9.1.2 Installing Telescopic Cage

During the installation of the telescopic cage on the crane, the open cage part is swivelled into the mast. The top of the cage inserted first on the mast before the bottom of the cage assembly process is done. Figure 9.2 shows the schematic picture of the telescopic cage installation.

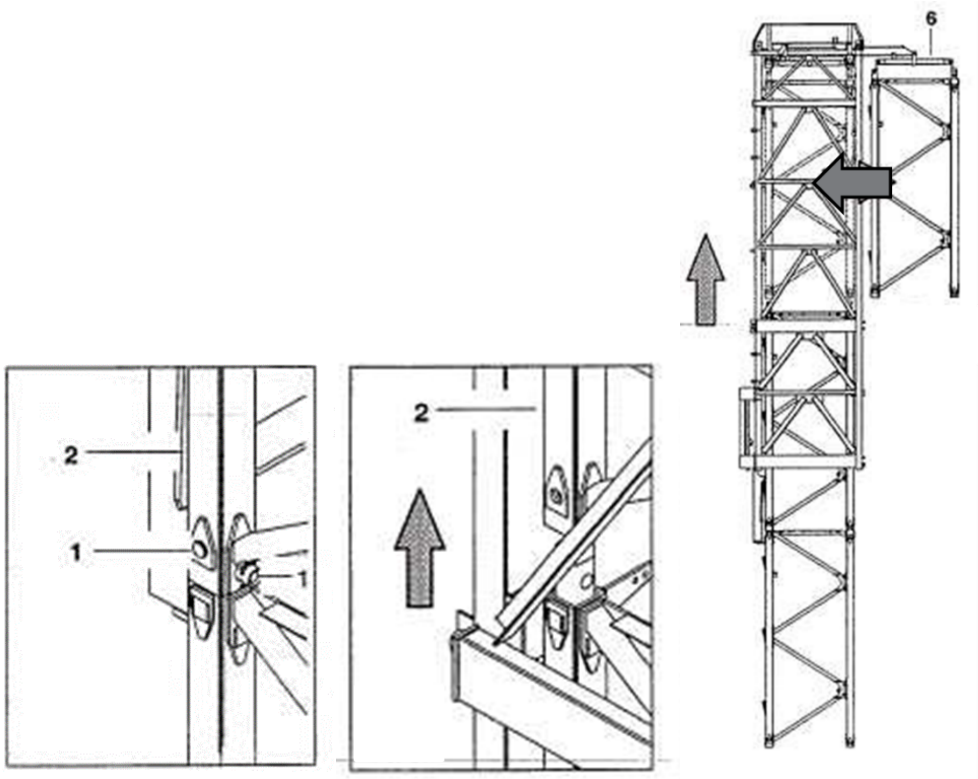


(a) (b) (c)

Figure 9.3 Method of installing telescopic cage: (a) Telescopic cage lifted and inserted into mast; (b) the top of the telescopic cage is locked first; (c) telescopic cage to be mounted on the mast

9.1.3 Insert the mast part

During the rising operation, the competent person for the crane installation should be on the platform, handling the hydraulic system, control the mast to stabilize so it will ease the installation process.



(a) (b) (c)

Figure 9.4 Method of inserting the mast part

Figure 9.4 The method of inserting the mast part during the climbing process is carried out: (a) The pin is removed from the mast; (b) The mast is raised using a hydraulic pump (c) The mast is inserted into the tower crane

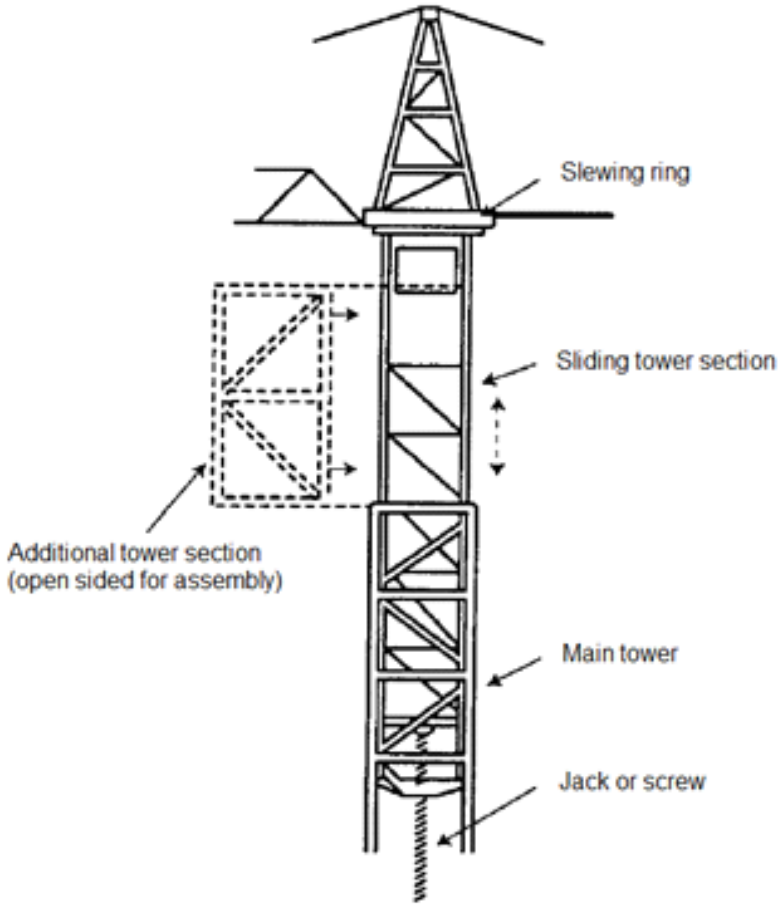


Figure 9.5 Crane towers climbing equipment during the crane lifting progress *(Code of Practice for Safe Use of Tower Cranes, Occupational Safety and Health Branch, Labour Department, Hong Kong, 2011)*

9.2 Climbing Collars

Collar climbing is a collar that binds the tower crane to the building and it is very necessary for the construction of tall buildings. The tower is assembled according to the structure of the tall buildings and the tower structure is erected so as to reach the height of the building to be built. Collars are installed depending on the height of the building. The collar is connected to the mast floor around the tower crane to move the load to the building. The decision to install the tower cranes must be done with caution and collar should be designed according to the suitability of the building structure.

9.2.1 Installing Climbing Collars

The connection between the tower crane and the connection structure includes three strut connection pins. The strut is connected to the collar surround the tower pole. The

strut will connect the tower crane parts to the cross-section building. The strut end is connected to the lug connected to the support structure. When planning a vertical position for ties, it should be noted that the collar position can only be installed in some places and allowed by the manufacturer (Figure 9.6).

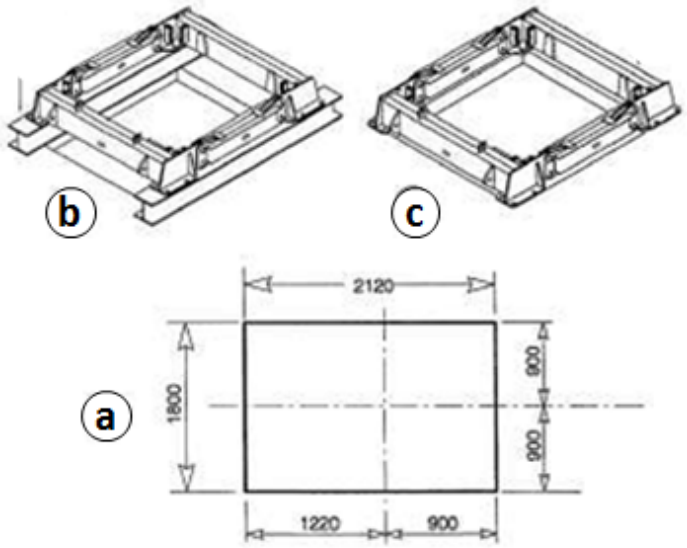


Figure 9.6 Installing Climbing Collar Steps: (a) The collar width and collar mounted on the support beam in Figure 9.2 (b)

9.3 Connecting the Rising Collars

The mast and building parts need to be connected using the collar (Figure 9.7). The height between the base of the crane site to the wall-tie or between the wall-tie to the wall-tie should be in accordance with the manufacturer of tower cranes. Inspection of the tower crane should be made a month before the climbing process is made and the condition of the collar and slab should be investigated by the project engineer.

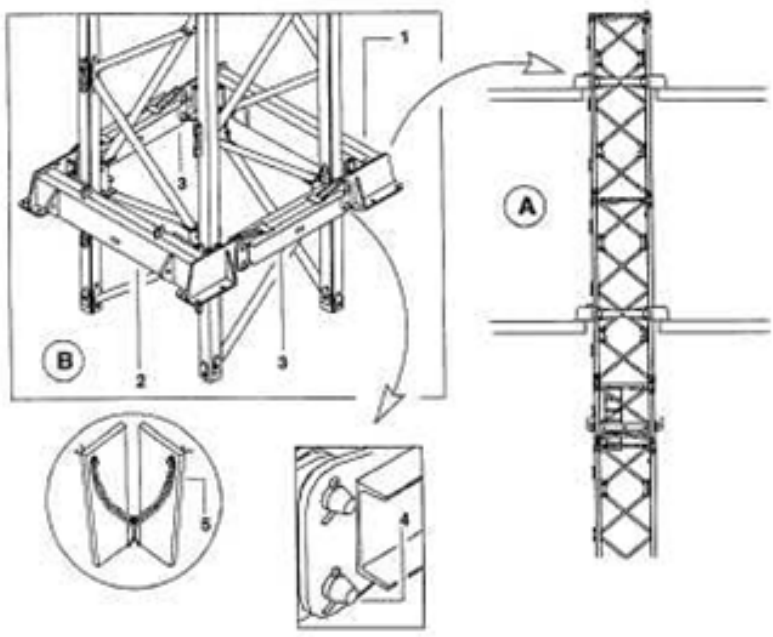


Figure 9.7 Steps of installing collar to the mast

The rising collars on the pole tower connected to the building using three wall-ties for each collar. Two struts are connected to double anchor shoes and one strut is connected to a single anchor shoe (Figure 9.8).

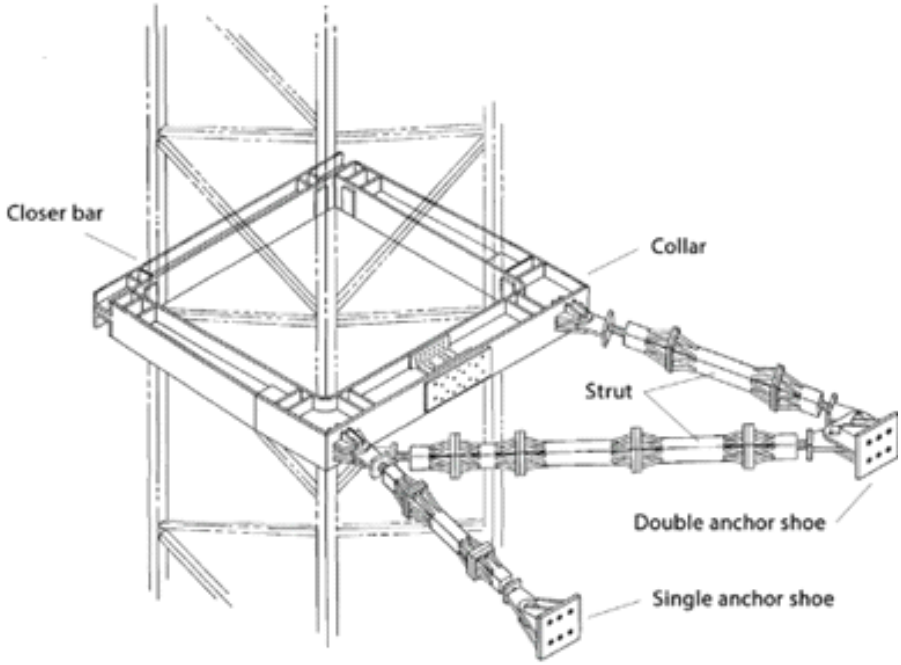


Figure 9.8 Binding rising collars method

9.4 Specialized rising collar design (for certain cases)

Figure 9.9 shows the sketch of the mast collar extension with reinforced concrete (RC, column) building and binders are used. This design is used if the bind is to be performed on the RC pole because the punch on this pole should be avoided.

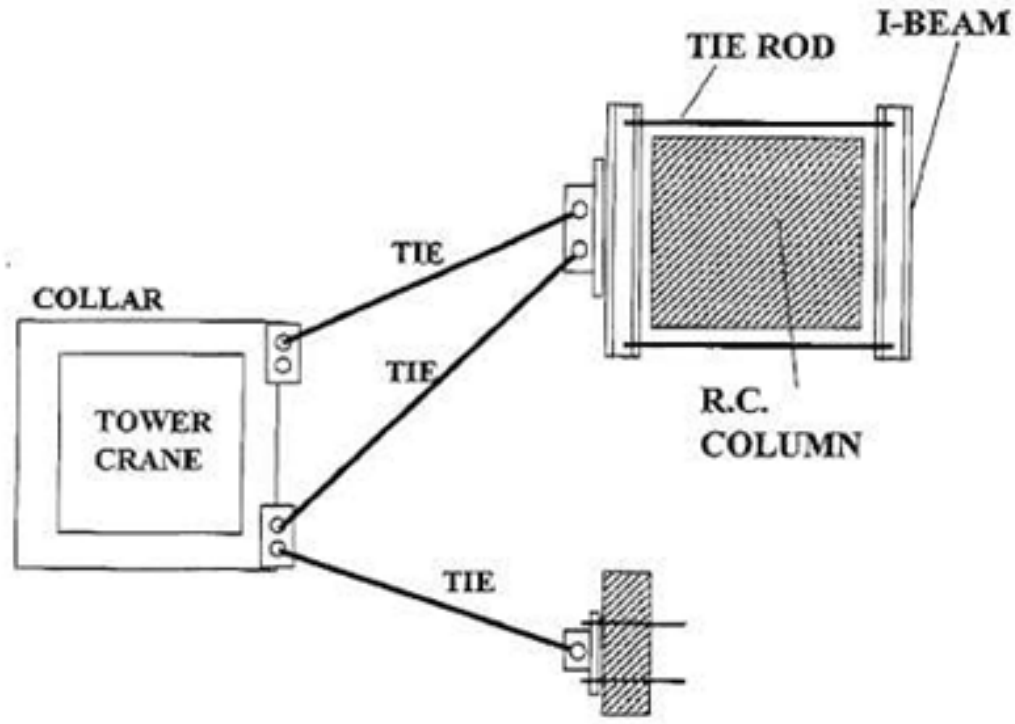


Figure 9.9 Specialized Design

9.5 Internal Climbing Method

Internal climbing method is used to elevate the crane inside the building in contrast to the external climbing. This method does not require the addition of a mast to the pole of the tower. This method is used by raising the entire tower crane to the higher building level by moving the collar as the base of the tower crane (Figure 9.10). Change of collar transfer shall be in accordance with the tower crane manual. Rising collar is bind up by ensuring the centre of the tower crane gravity is on the axis. To ensure that stability of the tower crane boom trolley is positioned at the most stable position.

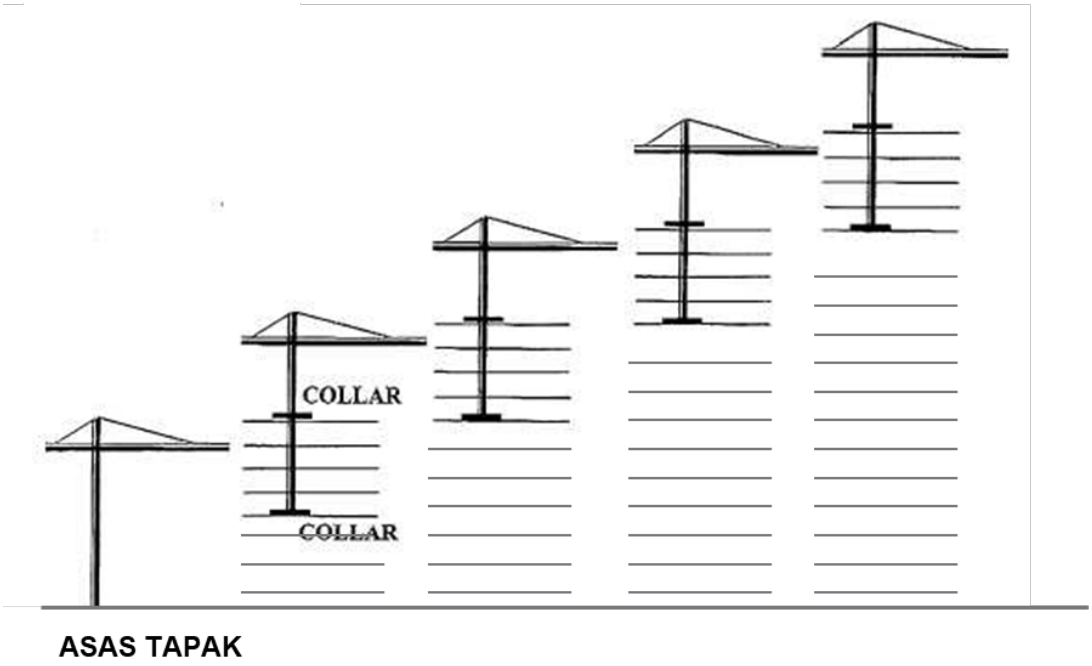


Figure 9.10 Tower Crane Internal Climbing Method

9.5.1 Internal climbing method: The first telescopic sequence

In the process of climbing, there are two internal climbing collars that are at a distance determined by the tower crane manual to ensure the crane is always in stable condition. Once the two collars are bind to the wall of the elevator core then the crane is separated from the base. The internal climbing part of the collar works to support the overall weight of the tower when the crane is being triggered up and then the crane site will stand on the bottom of the collar. During offset operation, the boom is not allowed to rotate and move, while the lifting cord also cannot be rolled. The first internal climbing sequence method is shown in Figure 9.11.

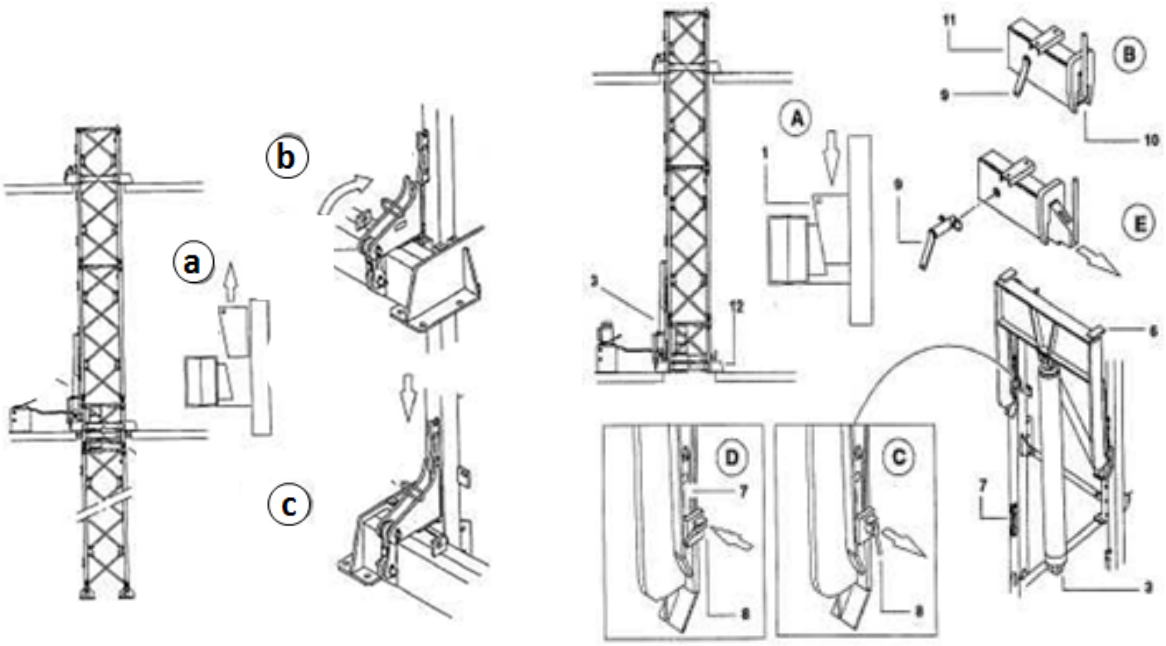


Figure 9.11 The first telescope sequence method

9.5.2 The second telescope sequence

If cranes need to be lifted again after the first sequence elevation due to the rise of the building level, the second sequence should be done. This sequence involves three collars to ensure the stability of the tower crane when triggered. The third collars are mounted first at the top level based on the setting of the tower crane manual before the first collars (which is made as the first sequence site base) is opened. The tower crane is then triggered until the height of the second collar and will be the new tower crane site base. This opened collar can be used as a binding collar for the next sequence. Steps to climb the second sequence are shown in Figure 9.12.

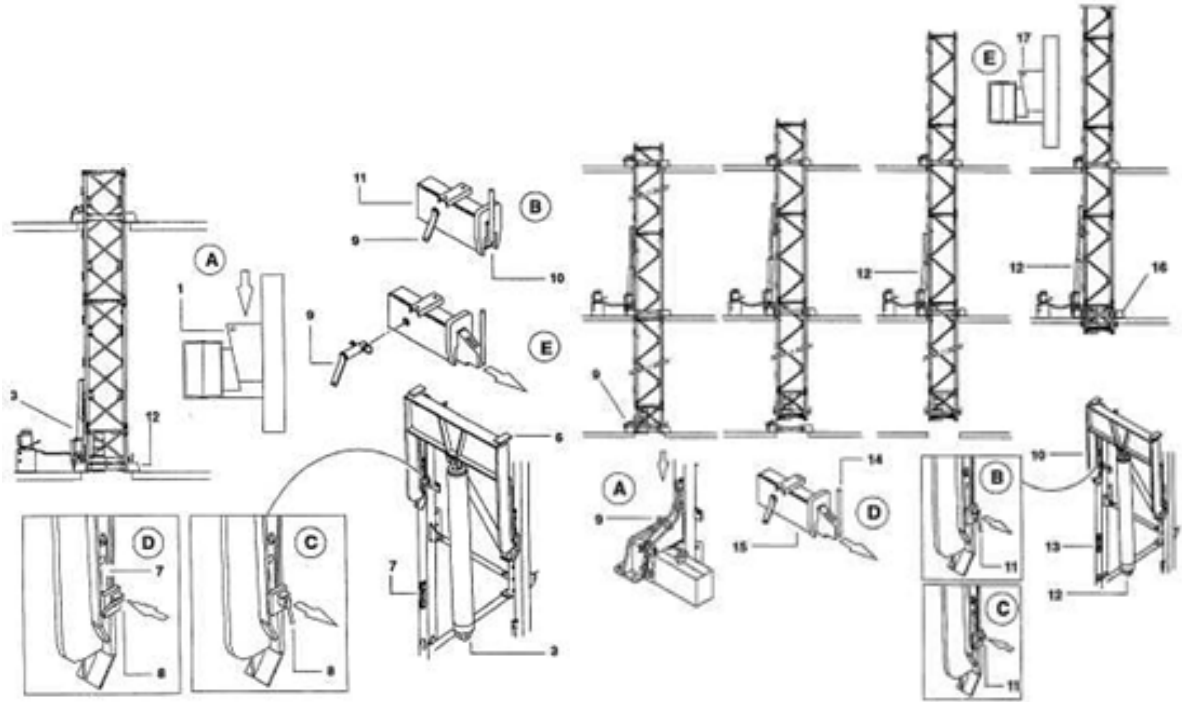


Figure 9.12 The second telescope sequence method

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CHAPTER 10

DISMANTLING TOWER CRANES PROCESS

10.1 Early Preparations and Dismantling Steps:

The dismantling process requires the help of a mobile crane that meets the specifications suggested by the manufacturer especially specifications involving maximum force loads. Before the dismantling process started, several steps need to be followed:

a) The tower crane components and parts should be checked including pins, bolts, hooks, trolleys and electrical systems.
b) Hooks, trolleys and cables need to be rolled.
c) Electrical power connections should be disconnected from the main power source.

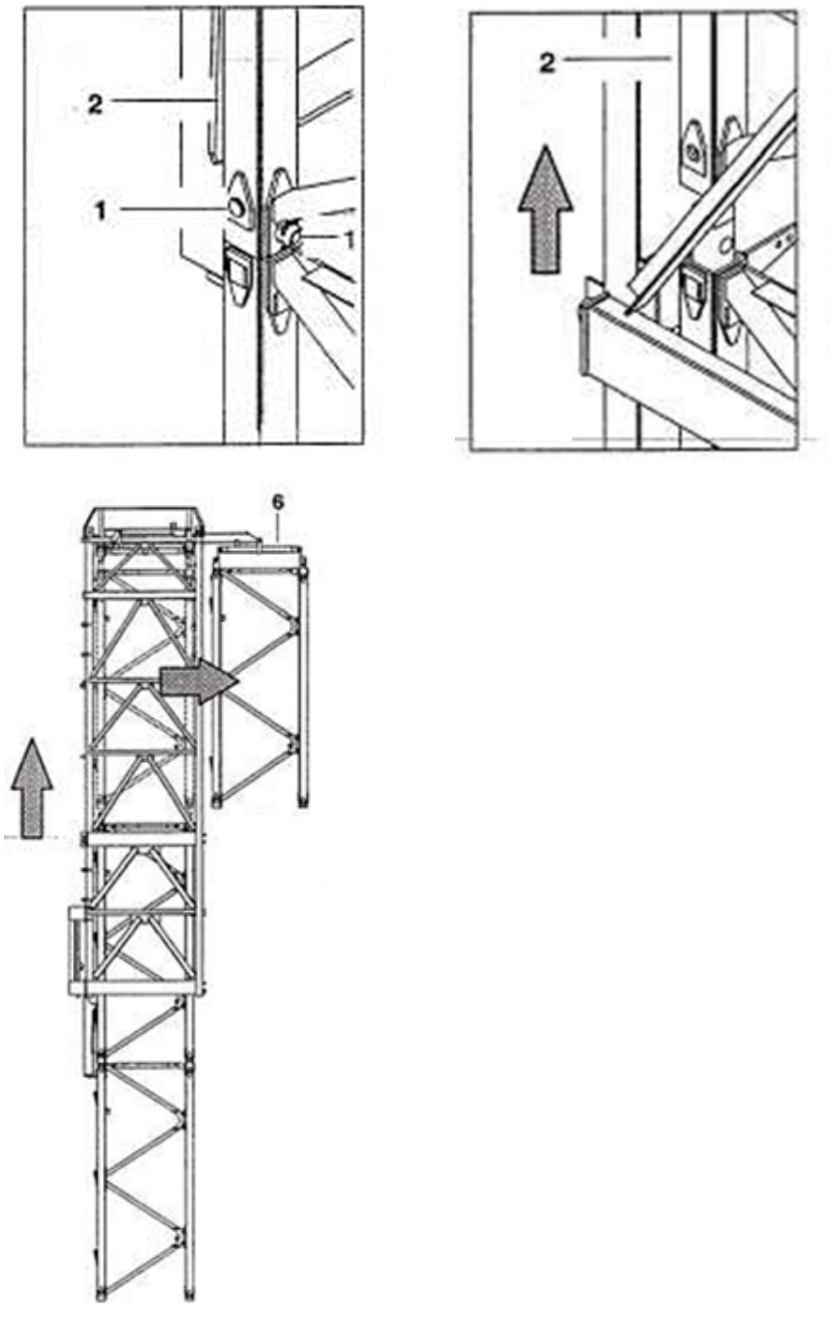
Steps of dismantling the tower crane outside the building are as follows:

a) The tower crane needs to be lowered so that the height can be reached by the mobile crane. The mast part should be lowered one by one by using telescopic cage to the appropriate height.
b) Dismantling the lifting cables and connecting wires
c) Boom is dismantled by lifting and lowering it using a mobile crane.
d) The counter load needs to be moved according to the steps outlined by the manufacturer.
e) The counter jib shall be dismantled after all counter loads are removed
f) Dismantling A-frame
g) Dismantling Slewing Platform
h) The mast part is lowered one by one using a mobile crane

10.2 Dismantling Tower Crane

10.2.1 Lower the mast

The first step of dismantling is to reduce the height of the tower crane by removing the mast part one by one until its height can be reached by the mobile crane. Figure 10.1 shows the method of lowering the mast. The mast part is lowered by hoisting the tower crane which is being triggered using a telescopic cage, therefore the force should be balanced to ensure that the tower crane is stable.



(a) (b) (c)

Figure 10.1 Method of removing the mast: (a) The pin is removed from the mast, (b) The mast is raised using a hydraulic pump (c) The mast is removed from the tower pole part

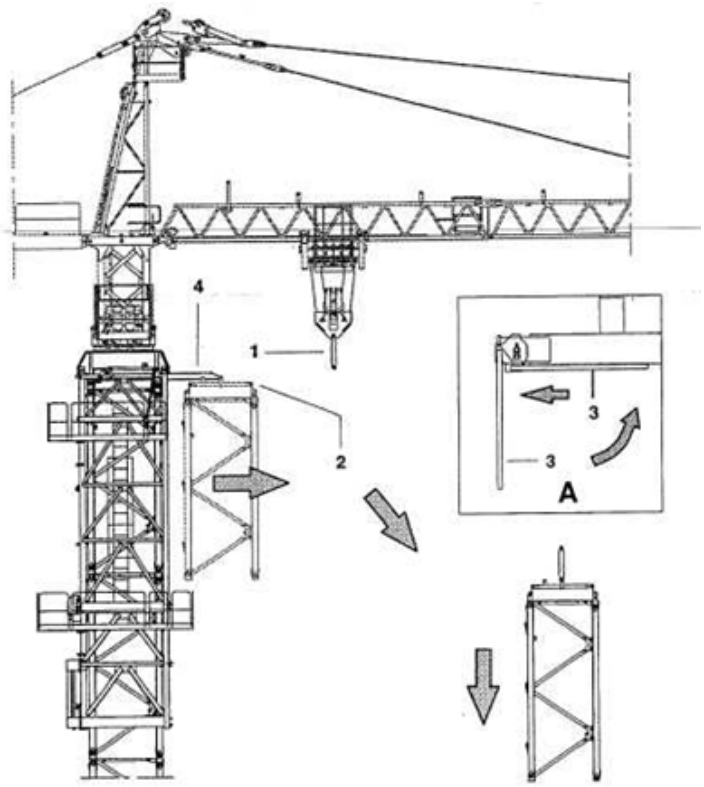
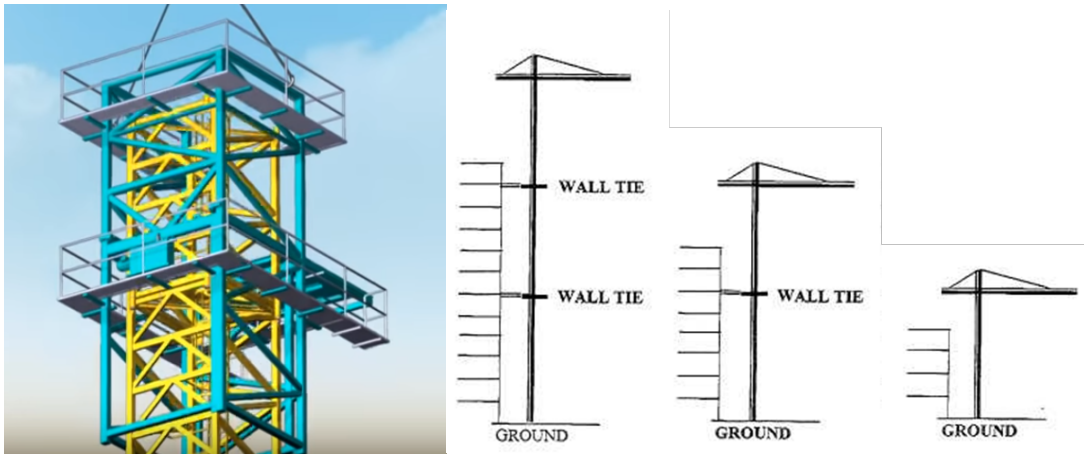


Figure 10.2 Method of lowering the mast

The same telescopic method when mounting is used to remove the mast portion of the tower crane. A hydraulic cylinder is used to reduce or increase the height of the tower using a telescopic cage. The telescopic cage becomes intermediary to trigger the fixed mast before the mast is removed during the dismantling (Figure 10.3).



(a) (b)

Figure 10.3 Telescopic Methods: (a) telescopic cage, (b) schematic description of telescopic method / dismantling method

10.2.2 Dismantling the lifting cables and wires

Upon reaching the appropriate height, cables and hooks should be removed prior to lowering parts of the tower crane component. The hook is lowered to the basement and the pin connecting between the lifting cable and the hook is disassembled (Figure 10.4). The cables are dismounted and rolled down or rolled wires first before being lowered using a moving crane.

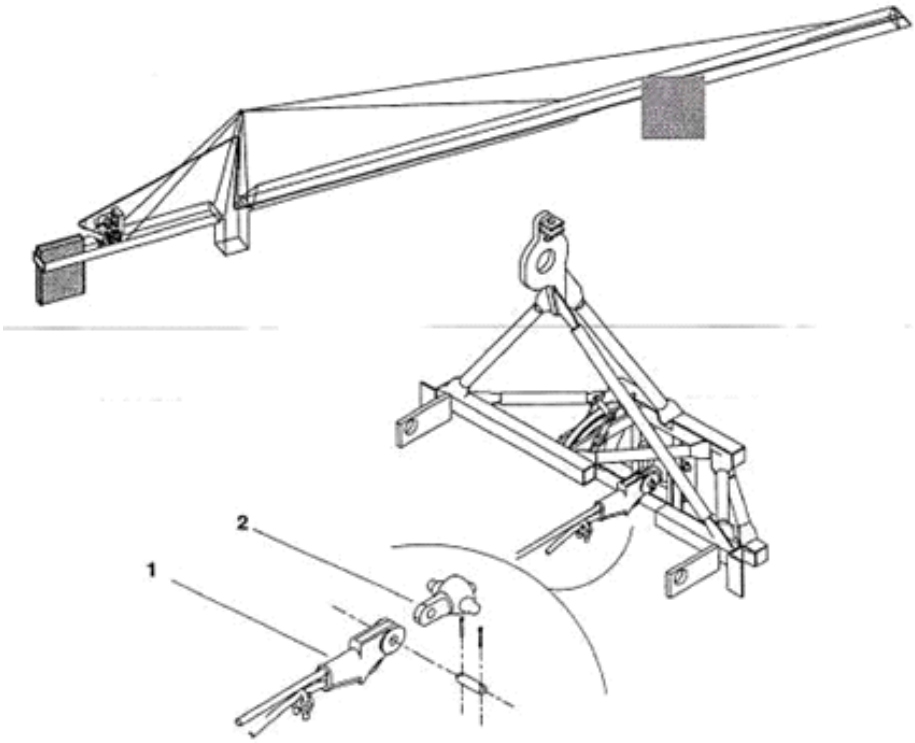
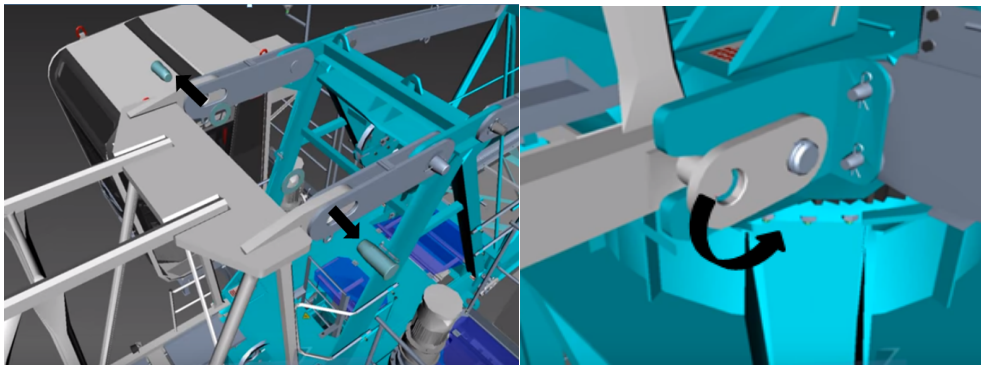


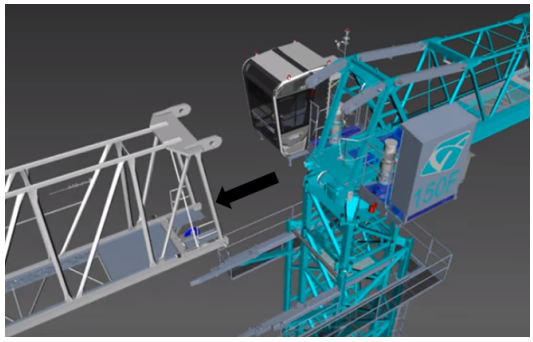
Figure 10.4 Dismantle the lifting cables and connecting wires

10.2.3 Dismantling the Boom

The tower crane boom needs to be lifted slightly using the mobile crane before the pin that connect the connector rod of the boom and the A-frame are opened (Figure 10.5 (a)). Then the pin connecting the boom with the slewing platform is opened (Figure 10.5 (b)). The balance of the boom should always be ascertained when lifted by the mobile crane and assisted with the tag line so as not to spin.



(a) (b)



(c)

Figure 10.5 (a) The connector rod of boom and A-frame pin are opened; (b) Boom connection pins and slewing platforms are open (c) Boom is separated from the A-frame

10.2.4 Dismantling counter loads and counter jib

Crane loads are removed from the counter jib and lowered on the ground using the mobile crane. If there are multiple sets of weights, the lowest weighing load shall be issued first. Method of dismantling the counter load is shown in Figure 10.6 where the counter load is lowered using a mobile crane.

Figure 10.6 Methods of dismantling the counter weight

Before dismantling the counter jib, all counter loads must be lowered first. The counter jib is dismantled by unattached the jib balance pin from the slewing platform and lowered on the ground using the mobile crane as shown in Figure 10.7.

Figure 10.7 Lowering the counter jib

10.2.5 Dismantling the cabin

Cabin connections need to be removed before they are dropped using mobile cranes.

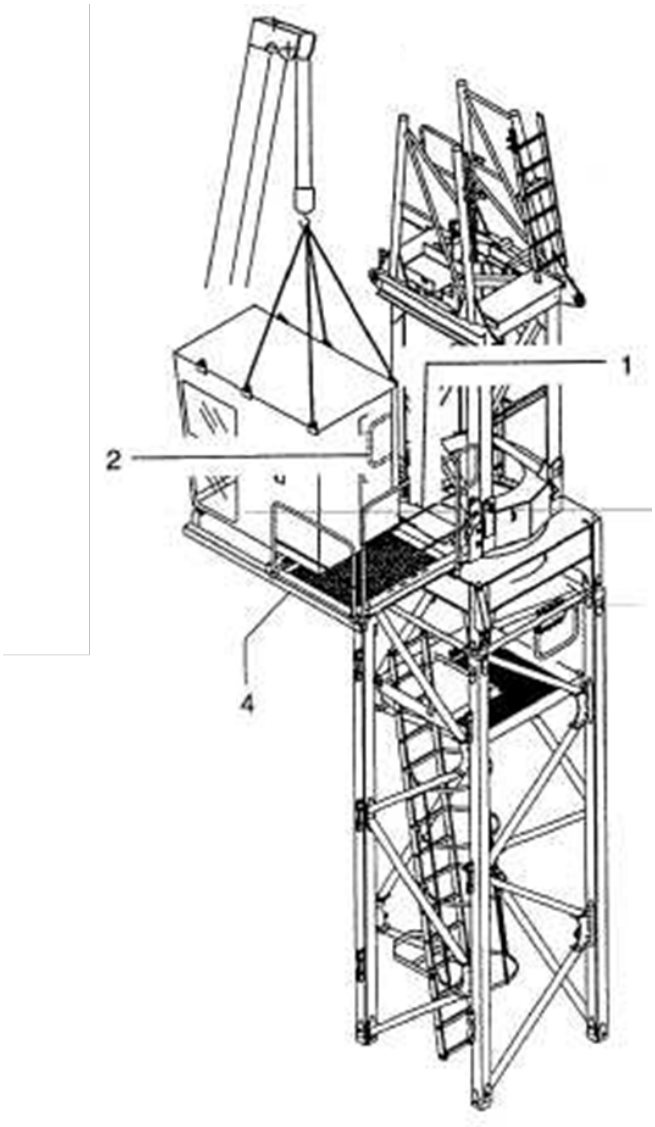


Figure 10.8 Dismantling the cabin

10.2.6 Dismantling the A-frame

The A-line dismantling step also requires the help of a mobile crane by connecting the hoisting rope to the A-frame. All bolt connections should be unlatched first before the A-frame is lifted from slewing platform (Figure 10.9). A-frame should be placed on the ground with the help of supporter so that it is in a horizontal position.

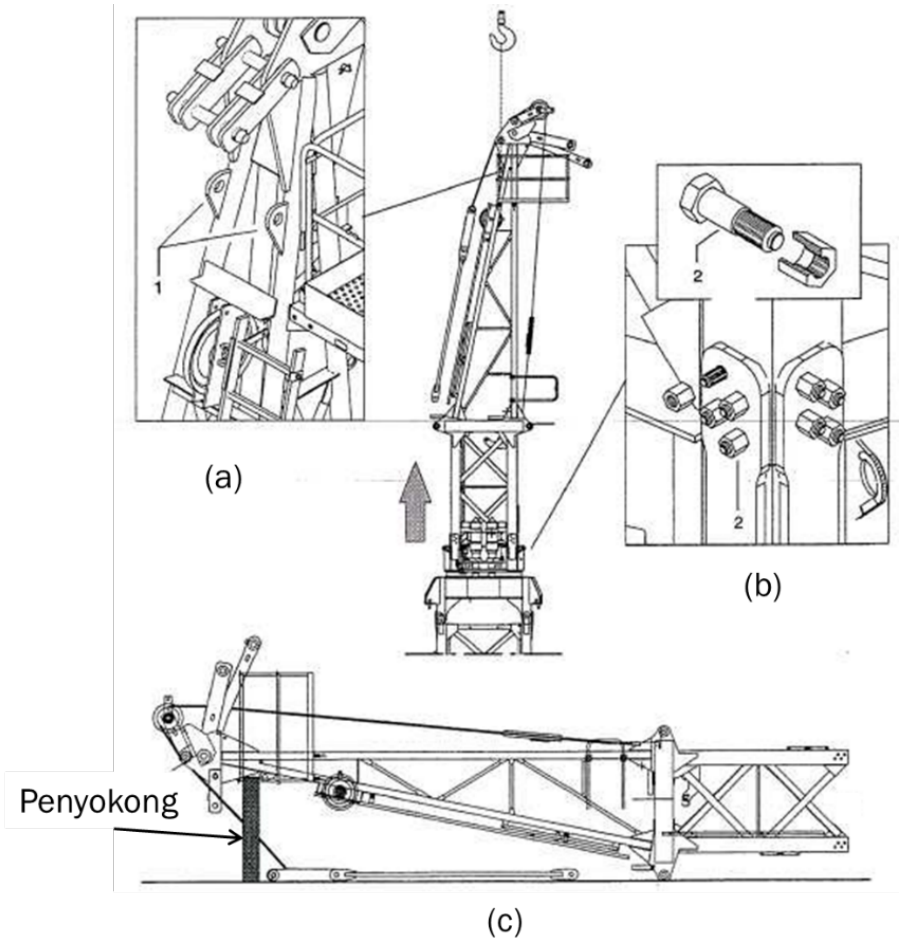


Figure 10.9 Methods of dismantling A-frame: (a) the mobile crane lifting rope is connected to the A-frame; (b) Connector bolts of the A-frame and slewing platform are unlatched; (c) A-frame is placed horizontally

10.2.7 Dismantling the slewing platform

Slewing platforms should be tied to the moving crane before the bolt between the mast and the slewing platform is unlatched. Steps to disassemble the slewing platform are shown in Figure 10.10.

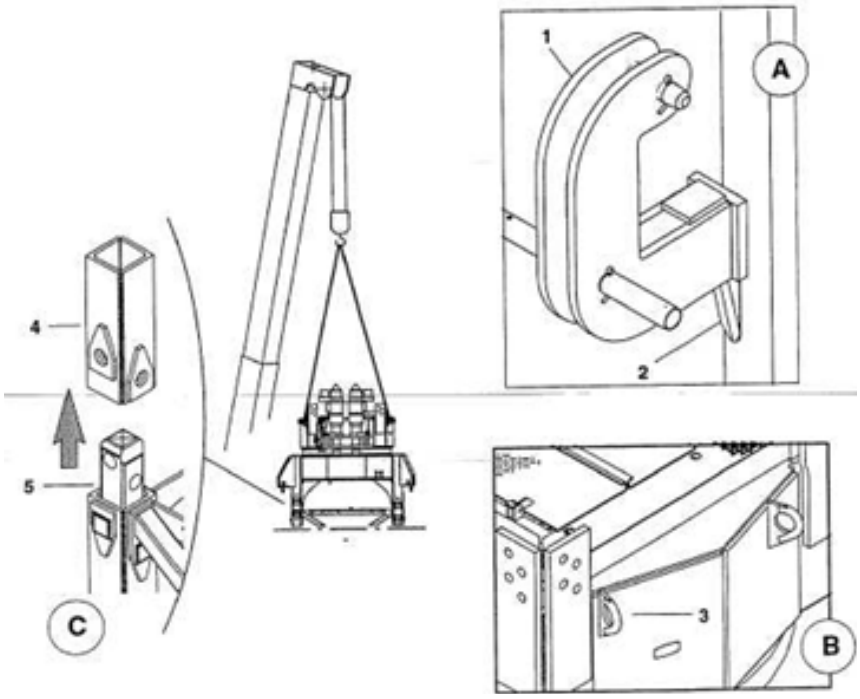


Figure 10.10 Steps of dismantling slewing platform

10.2.8 Lower the Mast

The mast part is lowered one by one and the mast must be tied to the mobile crane before the pin is removed. The lifting rope should be tied at least two corners of the mast before lifting using a mobile crane hook as Figure 10.11.

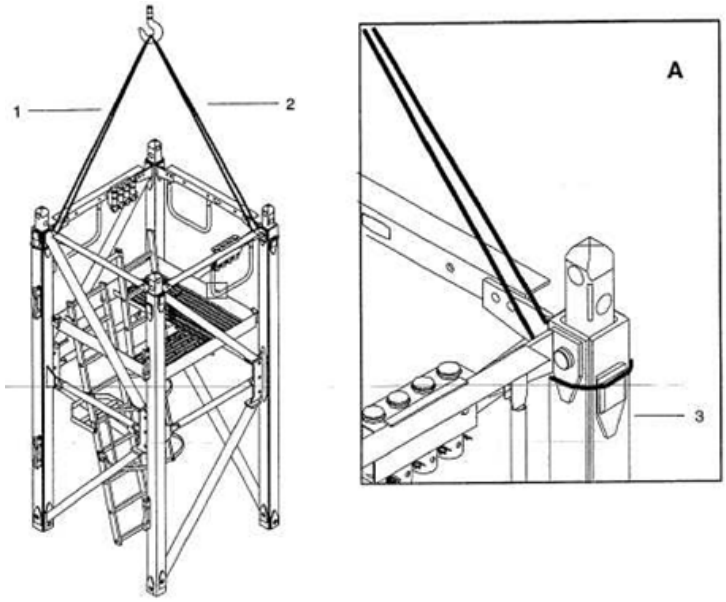


Figure 10.11 The method of binding lifting rope at the base of the mast during the dismantle

10.3 The use of Derrick cranes

This crane is specially designed for assembly and dismantling for all internal climbing type of tower cranes (Figure 10.12). It is installed on the roof of the building directly as it has no mast side. It is safe and suitable for the purpose of dismantling. If the derrick crane is used to dismantle the tower crane, the derrick crane owner should ensure that critical parts inspection is conducted by a competent inspector.

Figure 10.12 Derrick crane for tower crane dismantling work
(http://www.morrow.com)

10.4 Safety measures of dismantling tower cranes

Dismantling a tower crane is also a tough and dangerous operation. Accidental precautionary measures should be complied with at all times and always refer to the manufacturer's instructions of the crane. Things to be noted are:

- The space restriction by the crane structure itself, and other buildings that complicate the dismantling process.
- Choosing cranes such as type, size and crane position is determined at the start of the project.
- Equipment used to lower the crane structure is strong and sufficient.
- All lifting equipment, such as gears, need to be tested, scrutinized and checked by competent inspectors.
- The dismantled and lowered crane parts are safely placed on hooks or lifting devices before the bolt or pin lock is unlatched.

- It is recommended that the bolts used between the gear rings on slew and the top of the tower ring are deemed defective when the crane is transferred to another construction site and should be disposed of.
- Slew should be checked to see cracks on welding surface and flat surface when replaced and transferred to another construction site.

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CHAPTER 11

PERSONAL PROTECTIVE EQUIPMENT

11.1 Introduction

Personal protective equipment (PPE) means all equipment intended for use or to be held by persons at the workplace, and that protects them against risks to their health and safety. PPE is also related to any additional gear or accessories designed to meet those objectives. PPE must be worn when carrying out work at construction sites.

11.2 Types of Personal Protective Equipment

(a) Safety helmet

A safety helmet is one of the most commonly used PPE (Figure 8.1). The safety helmet serves to protect the head of the user against:

- The impact from a falling object by rebounding and deflecting the force
- Impact from the side and behind
- Fire, splashes from molten metal, high temperatures and electric shock (depending on the standard of the hard helmet chosen. However, standard hard helmets cannot function to protect the wearer against electric shock). A complete safety helmet must come with a shell, harness and headband.

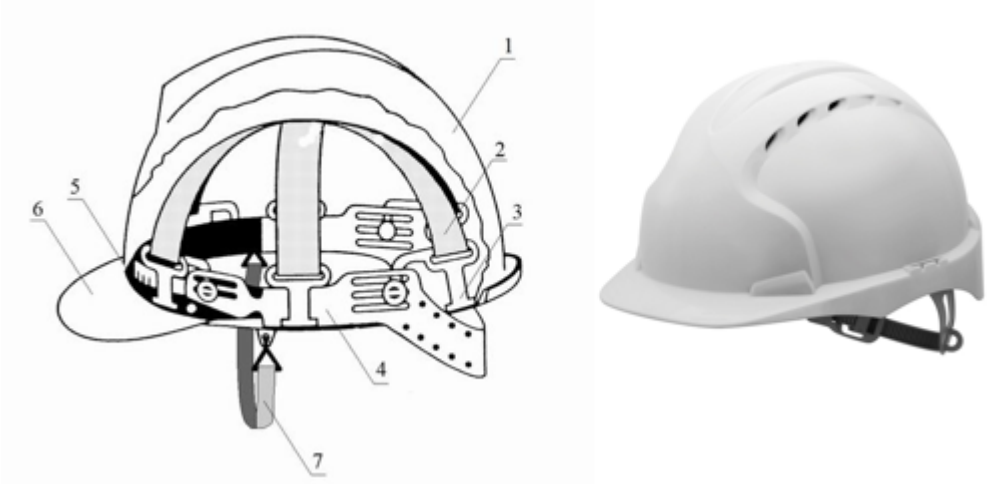


Figure 11.1 Safety helmet for the construction industry; 1 – shell, 2 – harness, 3 – harness adjuster, 4 – headband, 5 – sweatband, 6 – peak, 7 – chin strap

(b) Safety shoes

Safety shoes are designed to protect the feet against various injuries (Figure 8.2). Knocks, compression and piercings are the most common types of hazards that can cause foot injuries. The toecap protects the wearer from falling or rolling objects, as well as compression that can affect the feet in the workplace. Steel toecaps are the most popular and reliable form. Non-metallic toecaps are also commonly used because they do not conduct electricity, and are resistant to heat and cold temperatures, making them more comfortable for the wearer. To prevent injuries to the foot caused by the penetration of sharp or pointed objects, shoes that come with soles to withstand penetration should be selected.

The selection of suitable footwear should begin by identifying the risk factors that may occur in the workplace. The risk factors that should be identified are:

1) Based on the characteristics of the workplace
   - heavy items that can fall onto or injure the feet,
   - type, concentration and physical properties of chemicals (acids, alkalis, solvents, etc.),
   - ambient temperature and humidity.

2) Based on the condition of the worker:
   - working in a standing position
   - activities involving constant movement
   - climbing up ladders
   - moving on smooth surfaces
   - awkward working posture
   - working in an open space
   - working in a confined space (depending on the temperature)

Figure 11.2 Safety shoes

(c) Gloves

According to the hierarchy of control, the priority is to eliminate risks, followed by engineering aspects, and then the use of PPE such as the wearing of gloves (Figure 8.3). Gloves must be worn together with other PPE. Protective gloves are less effective as a control compared to other PPE. The selection of protective gloves should be based on the type of work, the wearer and the workplace environment. The following factors must be taken into consideration in the selection of gloves:

(a) The material being handled
(b) The risk of danger to the hands
(c) The type and period of contact
(d) The size of the hand and the comfort of the wearer
(e) The type of task

Figure 11.3 Safety gloves

(d) Reflective vests

The purpose of reflective vests (Figure 8.4) is to enable the wearer to be clearly seen in an environment that is compatible to the situation at the workplace. To ensure that the vests can be easily seen during the day, they must be in fluorescent colours (yellow, orange-red or red). The vests should be maintained according to the rules and instructions of the manufacturer. The proper selection and use of reflective vests are as follows:

(a) Reflective vests should be worn in dim workplaces so that the wearer can be easily seen

(b) The colour of the vest must be in contrast to the work environment so that the personnel will be clearly visible

(c) The selection of the appropriate vest should be determined through discussions with the employer.

(d) The vests should carry a valid label by the manufacturer, and be recognized by the authorities.

Figure 11.4 Reflective vest

(e) Safety glasses

Safety glasses (Figure 8.5), face shields, and welding helmets are used to protect the eyes and face. This type of protection needs to be worn when power tools are

being used or to prevent liquid from splashing onto the eyes or face. Glasses are the most widely used eye protection equipment.

Figure 11.5 Safety glasses

Figure 8.6 shows three types of eye protection devices, namely, a face shield, safety glasses, and goggles. The face shield provides the best protection against droplets and splashes of hazardous substances.

Figure 11.6 Glasses with a direct and indirect ventilation system

(f) Ear protection devices

Earplugs and ear muffs are ear protection devices (Figure 8.7) that are used to protect the hearing of the wearer. Ear muffs are more comfortable and effective in reducing noise, while earplugs are more effective in terms of their use, although

some workers find them uncomfortable.

Figure 11.7 Ear protection devices

(g) Safety harness

A safety harness (Figure 8.8) is a protective equipment that is designed to protect a person who is performing a climbing activity or is coming down from a height. The harness connects a moving object to a stationary object, and it is usually designed with a rope and cable, together with a lock that can be easily opened (Figure 8.9). Figure 8.10 shows the correct way to use a harness when climbing a tower crane.

Figure 11.8 Safety harness

Figure 11.9 Safety rope

Figure 11.10 Correct method of use and climbing (https://www.123rf.com/photo_13536201_worker-builder-at-facade-construction-works.html)

CHAPTER 12

GENERAL SAFETY

12.1 Risk management of the tower crane operation

1) Risk management must be carried out by the owner of the project or the owner of the tower crane or any responsible party and the responsible party must provide a complete report on the risk management. Risk management is important for identifying all hazards associated with tower crane operations, assessing the probability of accident being exposed to hazards and determine the appropriate steps to control the risk. There are three basic steps for risk management:

a) Step 1 - Hazard Identification. The responsible party must identify potential dangers or hazards in relation to use and tower crane operations such as tower crane sites, tower crane and personal equipment involved in lifting operations;

b) Step 2 – Risk Assessment. Assessments are made based on the bad potential otherwise the dangers that may result from the use and operation of the tower cranes. Associated engineering expertise is required when making this assessment;

c) Step 3 - Risk Control. The proper control must be identified and implemented so that the predicted risk can be prevented. Risk controls include setting the appropriate place, the radius of the tower crane operation, crane operator and other qualified personnel.

2) Employers are responsible for conducting risk assessments at work or on the work performance. When planning a work method, appropriate and adequate assessment should be conducted and recorded to reduce the risk at work or the work that has been done. Flow chart for Hazard Identification, Risk Assessment and Risk Control (HIRARC) is shown in Figure 12.1.

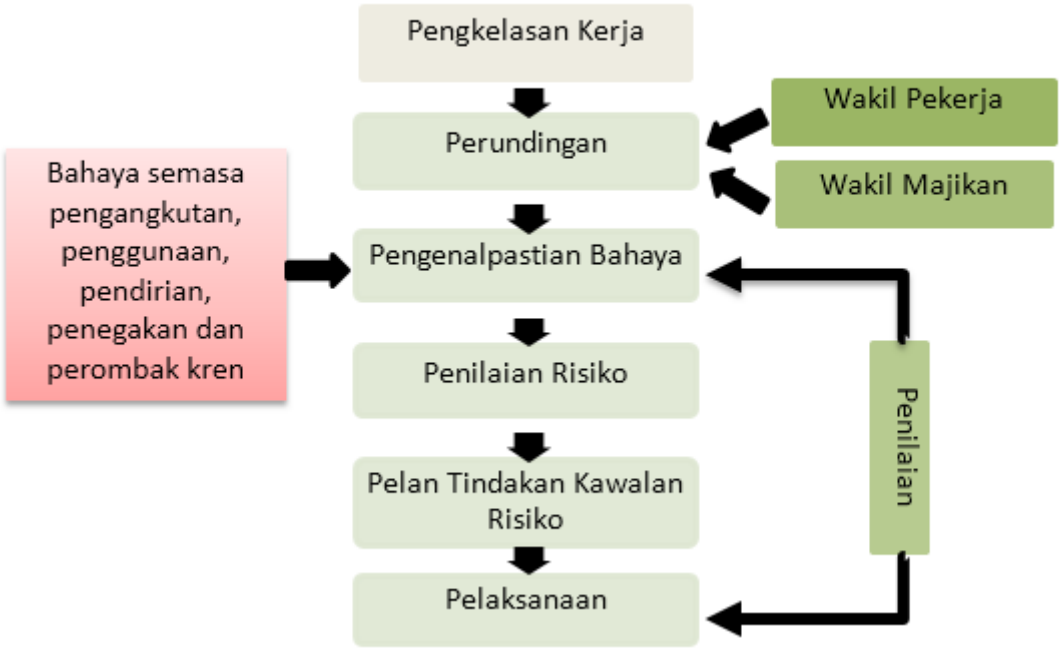


Figure 12.1 Flowchart for HIRARC process

12.2 Hazards Identification

1) Employers must identify and assess all significant risks or hazards, situations and dangerous events, and making evaluation and planning actions to eliminate or reduce the risk in reference to provisions in MS1803: 2008 and MS ISO 12100, pertaining to the necessary risk assessment to mitigate or eliminate risks associated with hazardous elements.

2) List of hazards, hazards and dangerous occurrences associated with tower crane operations refers to MS1803: 2008 and EN 1050: 1996 (Appendix C):

   a) Mechanical hazards are caused by machine parts or work sheets, e.g. shape or lack of mechanical strength;
      i. Destruction hazard
      ii. Strain hazard
      iii. Cutting or breaking hazard
      iv. Release hazard
      v. Falls or trap hazard
      vi. Impact hazard

vii. Injection or release hazard (crane with hydraulic system).

b) Electrical hazards caused by;
   i. People in contact with live electricity (direct contact);
   ii. The person in contact with the turned on electric transmission due to system failure (indirect contact);
   iii. The use of live transmission under high voltage
   iv. Heat hazards that cause burns, burns and other injuries due to possible touch between people with objects or substances with high or low temperature objects, with fire or explosion;
   v. Health injury from heat or cold working environment.

c) Hazards produced by the sound;
   i. Loss of hearing
   ii. Speech communication disturbances

d) Hazards generated by materials and materials processed or used by machinery:
   i. Fire and explosion hazard

e) The hazards generated by the abandonment of ergonomic principles in the design of the machinery:
   i. Incorrect posture or excessive work
   ii. Inadequate consideration of the anatomy of the legs, arms and arms
   iii. Ignoring the use of personal protective equipment
   iv. Insufficient local lighting
   v. Human errors, human behaviours
   vi. Design, location or introduction of inadequate manual controls
   vii. Inadequate visual design or location

f) Unexpected start of operation / operation, over operation / speed (or system does not work or anything similar to it) are caused by:
   i. Failure / system control disruption
   ii. Other external influences (gravity, wind, etc.)

iii. Errors in the software
iv. Errors made by crane operators (due to the incompatible of machinery with human characteristics and abilities).

g) Power failure
h) Control circuit failure
i) Break-up during operation
j) The object or liquid falls
k) Loss of stability / over turn on the machinery
l) Slipping, trapped and fallen people (related to machinery).

12.3 Risk Assessment

1) The risk assessment for tower crane operations varies according to some of the following phases:
   a) Cranes use: Risk identification and evaluation at crane use rates involves the following factors:
      i. The lifting person
      ii. The stability of the crane
      iii. Failure of lifting equipment
      iv. Condition of the weather
      v. Exceeds the allowed capacity
      vi. Binding and lifting instructions
      vii. Inspection and maintenance of cranes
      viii. The efficiency of the crane operator and the person involved
      ix. Failure of electrical and mechanical systems
      x. Unauthorized entrance or exit

   b) Installation, erection and dismantling of cranes: Identification and assessment on the enforcement stage, erection and crane dismantling involve the following factors:
      i. Delivery cranes to site
      ii. Traffic management

iii. Lifting cranes or cranes components from lorries
iv. The usage of mobile cranes
v. Condition of the ground
vi. Condition of the weather
vii. Public passage
viii. Lifting across people or other structures
ix. Stability and load forces
x. Permit for crane erection
xi. Site base design and support strength
xii. Efficiency, training and supervision
xiii. Falls from high altitude
xiv. Use of personal protective equipment
xv. Materials from high altitude
xvi. Entrance facilities

2) Other risks that may cause injury to people involved with the tower crane operation or person around the crane are:
   a) Crane crashed;
   b) Structural failure or crane component;
   c) Collision of cranes or loads with other structures
   d) Falling from altitude (from buildings, cranes and others);
   e) Fall objects
   f) Electric shock

3) The tower crane may or may fall when the crane instability occurs due to overload and is influenced by several other factors including:
   a) The use of incorrect crane weighing weight
   b) Installation of wrong crane support arm;
   c) Bolt flash on incorrect crane structure (mast or boom);
   d) Incorrect crane site base design

4) Failure of the crane structure is included in the failure of any crane component, such as mast, boom / jib, hydraulic components, wire rope, pulley, hook and other related components. The main cause of these structural failures is overloaded on the crane structure, and this failure may occur without warning.

5) The person carrying out activities related to the work of lifting, erecting, ascending and dismantling the tower crane also have the risk of falling from altitude.

6) Falling objects may be due to load lifting activities, erection work, improvements and improper crane dismantle. Falling objects can cause injury or death risk to workers and the public.

7) Examples of risk assessments provided in Appendix D and the sample risk assessment form are provided in Appendix E.

12.3.1 The Risk of Crashing Between Cranes

1) Cranes or load collisions with other structures may occur when they are errors during communication, crane movement or insufficient space between cranes with other structures such as other tower cranes or adjacent buildings, as well as relief over overlapping zone areas between 2 or more cranes (Figure 12.2).

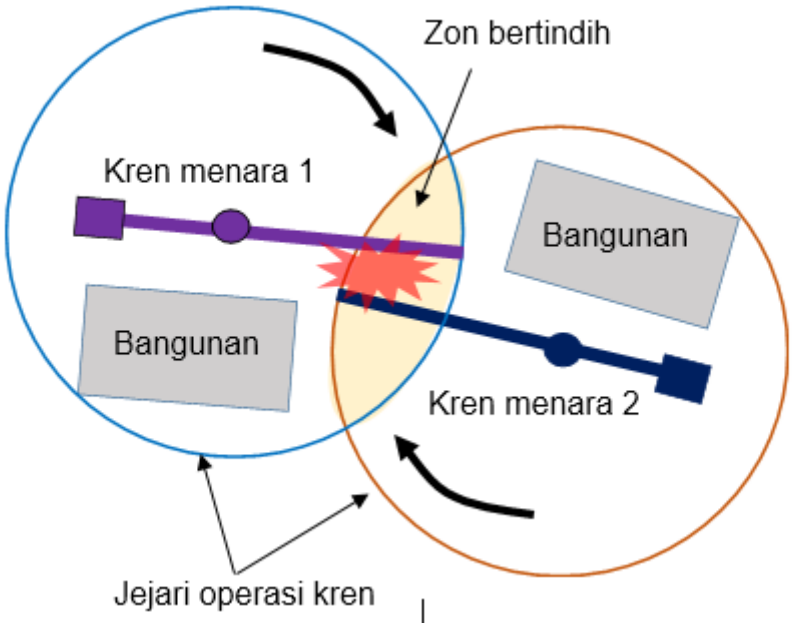


Figure 12.2 Schematic collision between two tower cranes

2) In order to reduce the risk of injury from collisions between cranes and other structures, the Competent Person should ensure:
    a) Placement of cranes and spaces between tower cranes that may collide with other structures should be planned in advance to ensure cranes are in place (Figure 12.3)
    b) The Competent Person should plan a safe working method during placement and crane operation
    c) Persons involved in crane operations and other structures should be provided with adequate training to ensure that the procedures are properly implemented
    d) The communication method between the crane operator and the load fastener or signaller is aligned and understood accurately.

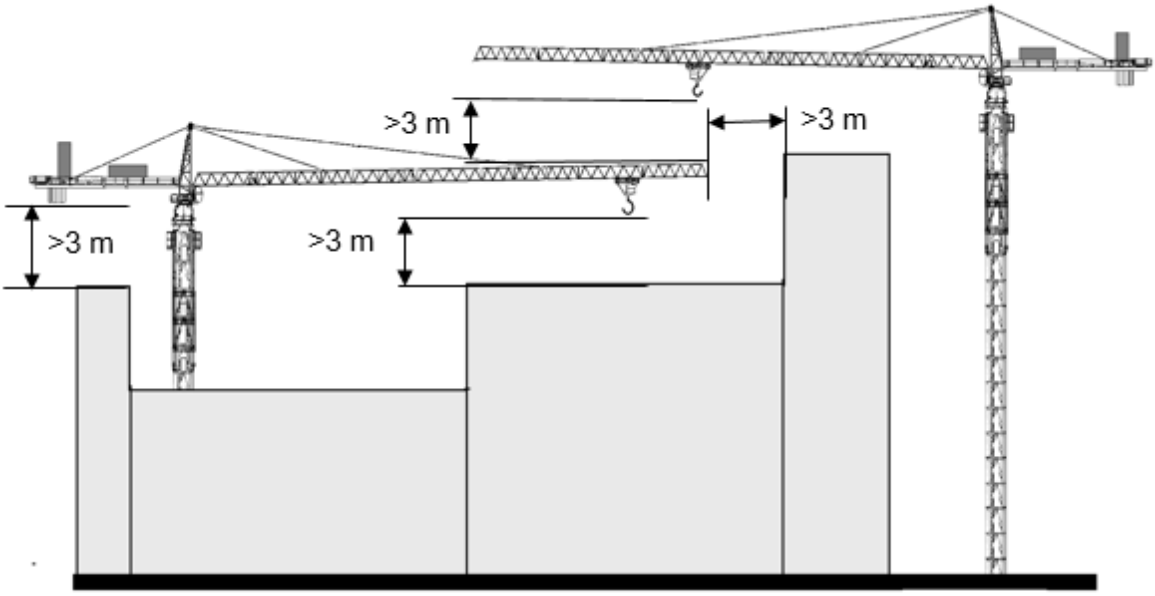


Figure 12.3 Safe distance between two tower cranes during operation

12.3.2 Operation near Pole and Electric Cable

1) People involved with the crane operation may be exposed to the risk of electric shock by contact with power lines, power tools, and other electrical power:
    a) The contact with the upper electric line can create an electrical shock hazard when handling cranes as it is difficult for crane operators to see electric lines and estimate the distance from the crane.

b) Before placing a crane around the upper electrical line, discussions on work and the associated risks need to be made between the contractor and the person involved with the crane operation.

2) When cranes are to be used in an electrical line environment on the following precautions should be noted by designated person, crane operator and others working with the crane, namely:
   a) Each crane has different operating characteristics in determining the safe operating distance from the electrical conductor, if the active power line seek advice from electrical utilities party such as Tenaga Nasional Berhad (TNB) before the commencement of work
   b) Any crane operation should be supervised by a competent person
   c) Make sure the load and crane do not approach the nearest power line
   d) Crane operator or anyone at risk should be advised to take appropriate action in the event of contact with electrical conductor
   e) The crane cannot be used to remove the material from the power line or enter the power line danger zone, unless approved by electrical utility company engineers or TNB
   f) If the electricity line is to be disconnected, have the discussions with the online controllers as early as possible before the work is done.

3) The distance between the worker / workplace and the nearby electricity current must be secured by the Competent Person or person appointed to ensure the safety of the worker and the people around. Following is the recommended range of voltage and distance range when doing work near the electric current:
   a) 0 - 33,000 voltage (distance 3.0 m)
   b) 33,000 - 132,000 voltage (distance 6.0 m)
   c) Over 132,000 voltages (refer to electrical utility company)

4) If the crane or load is touched by the aerial electrical conductor, the crane operator or the person involved should immediately notify the Competent Person (security supervisors, site supervisors) to warn about the dangers to the people around them. If a person or something comes in contact with the electric line above, the following must be done:

a) If it is touched / close to the wires broken, move and stay away as soon as possible until the line is confirmed safe
b) Always think that the electricity line is active, though it does not trigger a spark, or if it looks like no current
c) It needs to remember that, even if the electricity line is off, it can switch on either automatically after a while or after a few minutes or hours if the online owner does not realize that the line has been damaged.
d) Need to remember that if the active wire touches the surrounding area (the ground) it may become active. Keep the safe distance from the wire or anything that can touch it
e) If necessary, call emergency services from responsible parties such as TNB.

12.4 Risk Control

Based on the risk assessment, the employer shall prepare and implement the procedures and practices of risk or hazard control for all works or operations related to the tower crane. Employers should also refer to Appendix F, Occupational Safety and Health Guidelines in the Construction (Management) Industry 2017 which provides the principles for risk control. It shall include but not limited to the following:

(a) Avoid risk
(b) Assessing the inevitable risks
(c) Reducing the existing risks
(d) Customizing work for individuals, such as workplace designs, selection of work equipment, selection of working method, production and others
(e) Adapt to technological advances in machinery or systems
(f) Develop an overall risk prevention policy covering technology, work organization, working conditions, social relationships and the influence of factors related to the work environment
(g) Give priority to collective protection measures from individual protection measures
(h) Giving appropriate and easy-to-understand instructions to employees
(i) Device inspection and safety movement limitation, lifting equipment, and critical components such as jib, pulley, wire rope and others should be monitored and evaluated periodically, for example monthly, quarterly or annually
(j) Safety checks on employee health should be monitored and evaluated periodically, for example monthly, quarterly or annual

(k) Employers must ensure that every employee involved in the lifting operation has undergone a safety training course and related techniques (signals, bonds etc.) and pass the exam

(l) Ensure clear and easy-to-understand communications between crane controller, signaller or load fastener such as using walkie-talkie or phone or hand gesture

(m) the responsibility of each employee must be explained and set as the person who manages the lifting operation, a maintenance person, a security supervisor, or other employee in connection with the use and operation of the crane.

12.5 Risk Planning and Coordination of Tower Crane Use

Careful risk planning is important to ensure safe tower cranes. Effective planning will help identify ways to protect those who:

(a) Assembling, erecting, directing the work and dismantling the tower crane

(b) Directly involved in lifting operations such as crane controllers

(c) In an area adjacent to a tower crane, including public places

(d) Regarding the use of electricity, ensure the supply and electrical equipment are installed and used in a safe manner especially for those who work near the power supply

(e) Determine the crane requirements, including loading and access space for lifting, at the stage of project preparation;

(f) Reducing the number of tower cranes at the project site to reduce the possibility of collisions between cranes and other objects

(g) Ensuring that every tower crane can be installed at an acceptable distance from other tower cranes and concrete placement booms

(h) Ensuring the crane machine platform remains at a safe distance above the building

12.6 Safe Design and Registration of Tower Cranes

12.6.1 Stability of the Tower Crane

1. The correct design will determine the stability of the tower crane. Stability is an important safety issue for the tower crane. Failure to maintain stability can lead to serious events caused by mechanical or structural failure, or crashed cranes. The tower crane needs to be designed to be stable, and without the risk of

overturning, falling or moving unexpectedly during the assembling and dismantling of the crane, and in all operating conditions. All tower crane designs must be approved by JKKP. The design of the tower crane and any part of it shall be in accordance with specifications specified in MS 1803: 2008-Cranes-Safety-Tower Cranes standards.

2. The stability of a tower crane must take the following factors into account : -
   a) Moment stabilization
      i. Load chart: used to identify the amount of load that can be safely lifted by the crane. Load chart must be written in Malay or English and in metric unit. The load chart must be easily seen by crane operators to ensure no overloading. The load capacity must not exceed the load chart except; during a crane test conducted by a competent authority in a state of emergency or only during an emergency.
      ii. Counterweight: is very critical as a stabilizer agent. Light counterweights will cause the jib / boom to reverse in the direction of the load. If it is too excessive, jib / boom will be overtaken and upside down.
   b) Reversal of moment caused by excessive load
   c) Site base designed for the installation of a crane
   d) Design, number and location of connection
   e) Wind condition

12.6.2 Tower Crane structure

1) The tower crane must be designed in accordance with accepted engineering principles and relevant technical standards.

2) The tower crane designs shall be approved by the Lifting Machine Unit, Design Section, Industrial Safety Division, DOSH and according to the guidelines of the department / section.

3) The design and size of the tower crane must take the height of the tower, wind speed, site type, boom length and load capacity factors into account.

12.6.3 Factor of Tower Crane Structure Failur

Structural failure due to failure of crane components such as jib / boom or wire rope. Excessive loading is one of the causes of crane failure. All tower cranes used must take the factors that affect crane structure failure below into account to ensure the structure of the tower cranes is safe:

(a) Counterweight loadings

(b) installation / type of tower crane bolts

(c) Crane connection part during installation

(d) Design of tower crane site base

12.6.4 Letter of Certification

All tower cranes used must be registered with JKKP and require a valid eligibility certificate to operate i.e. Machine Lifting Certificate (PMA). The PMA is based on the rules provided in the definition of "lifting machine" under Act 139, Factory and Machinery Act, 1967, (Amendment) 2006, Section 3 (e). Certificate of registration of tower crane must be displayed at the relevant project site.

12.7 Safety Measures During Cranes Installation and Dismantling

Installing, erecting and dismantling a tower crane is a complicated process and takes a long time, and dangerous events may be exposed to operators, people around and crane structures. Therefore, every activity involving tower crane security factor should be taken into account as the risk is high, and need to be done by a competent firm / person.

12.7.1 Safety measures during installation

At the beginning of the tower crane installation, it is assisted by the moving crane. At this stage the most important thing is the process of lifting mast / boom cranes either from the vehicle or to be installed. Among the important things to be taken into consideration during the process of assembling and dismantling the tower cranes are:

- Type of sling used to lift tower crane structure (recommended synthetic fabrics type of sling)

- The binding and binding angle of the crane main structure such as boom and counter jib should be emphasized so that it is not bent and always stable during lifting.
- All workers involved must wear personal protective equipment.
- For steel and painted structures, the bound parts are covered with sacks or fabrics if other types of slings are used.

12.7.2 Safety Measures during Installation

(a) Luffing tower crane

In the process of installing luffing tower cranes, some security measures need to be emphasized such as:

i. Submit a checklist and other relevant documents to DOSH to obtain approval if using the used tower crane.

ii. Invite JKKP to come to monitor the site of the tower crane site and inspect all components of the crane that will be used before the install process is started.

iii. Project engineers should examine the base site of the tower cranes to ensure that tower crane sites are built according to the specifications of professional engineers and manufacturers prior to installation of concrete.

iv. Inspect all state of the structure, pin, pulley, bolt, moving components and electrical systems.

v. Ensuring the process of installing tower cranes is made according to manufacturer's instructions.

vi. Checking all components of the mast pole is vertical when the installation starts.

vii. Assemble the supporting cage along with a complete hydraulic system before it is mounted on a tower crane pole.

viii. Install power system on machine deck.

ix. Connecting the hydraulic system and electrical system properly.

x. For the main boom assembly, bind the lifting cord on the ground and slowly lift with good stability and connect to the top of the tower crane.

xi. To install the luffing cord, connect the luffing cord to the luffing pulley and lock the thimble at the top of the tower crane.
xii. Tense the luffing cable and remove the cable that lifts the boom slowly.
xiii. Correct the balancer and tighten the balancing position
xiv. Connect the lifter cables through all the pulleys and lock using anti-twist hoisting thimbles
xv. Install all security switches and test all switch functions
xvi. Test the crane at no load conditions
xvii. Determine the maximum switch size, momentum and speed limiter at state with load.
xviii. Invite JKKP to make final inspection and load test.

(b) Hammerhead tower crane

In the process of installing a hammerhead type crane, several safety precautions need to be emphasized:

i. Request monitoring from project engineers to ensure the base of the tower crane site is built to the specification of professional engineers and manufacturers.
ii. Examine the conditions of tower crane structure, pins, pulleys, bolts, moving parts and electrical systems.
iii. Ensure that the process of installing the tower cranes is made according to the manufacturer's instructions.
iv. Checking all components of the mast pole is vertical when the installation starts.
v. Assemble the cage along with a complete hydraulic system before it is mounted on a tower crane pole.
vi. Ensure that slew base is installed along with operator cabins, catwalk platform and handrails before being lifted.
vii. Assemble the counter jib on the ground before it is lifted.
viii. Installing the balancer at the counter jib according to the specifications specified.
ix. For the main boom assembly, bind the lifting cable on the ground along with the binder rod, the pulley section and the load indicator board. Then,

lift the main bum slowly with good stability and connect it to the top of the tower crane.

x. Adjust the balancer and tighten the balancing position

xi. Connect the lifter cables through all the pulleys and lock using anti-twist hoisting thimbles

xii. Test the crane at no load conditions

(c) Derrick crane

In the process of installing a derrick type crane, several safety precautions need to be emphasized:

i. Inspect derrick cranes with professional engineers whether the load distribution can be on roof slap beams.

ii. Collect all required documents to be sent to JKKP for approval.

iii. Using building elevator space and labour energy to lift up derrick cranes on the roof of the building

iv. Use a stiff leg crane to install a derrick crane onto the slab.

v. Connects all electrical connections and derrick crane commissions.

vi. Run an in-house load test.

vii. Invites JKKP for final inspection and load test.

viii. Derrick cranes can only be operated by qualified and capable operators.

ix. Create safe lifting methods with security officers before actual lifting works are carried out.

12.7.3 Security measures during dismantling

a) Luffing tower crane

In the process of dismantling a luffing type crane, several safety precautions need to be emphasized:

i. Send all relevant documents and construction site sketches to JKKP for approval of the dismantling of the tower crane.

ii. Check PMA and tower crane serial number before dismantling

iii. Examine the checklist for maintenance of the last month's crane conditions before being dismantled.

iv. Check all brake systems, lift cable systems and luffing systems.

v. Check out any obstacles in the construction site area to facilitate the process of dismantling.
vi. Disconnect lift cable system and luffing safety device
vii. Lower the main jib around 15 degrees until the jib is supported by the cables, and disconnects the lifting system and the luffing cord and rolls on the drum.
viii. Remove all equilibrium point instruction manuals before dismantling the boom.
ix. Disconnect the crane's main power connection.
x. Disconnect all cable limitation switches.
xi. Bind the lifting cables to the main jib and lift the main jib as high as 2 feet and wait 10 minutes to ensure the brake and crane hydraulic system to move steadily. Then open all pin connections and slowly lower the main jib on the ground.
xii. Bind the lifting cable to the counter jib and lift the jib as high as 100mm and disconnect all pin connections, then lower the balancing jib on the ground slowly.
xiii. Bind the lifting cables at the balance point of the slew base and disconnect all pin connections, then slowly lower the slew base on the ground.
xiv. Bind the lifting cables to the balanced mast point and disconnect all pin connections, then lower the mast on the ground slowly.
xv. Using suitable mobile cranes depends on the height and width of the site during the dismantling.

b) Hammerhead tower crane

In the process of dismantling a hammerhead type crane, several safety precautions need to be emphasized:

i. Send all relevant documents and construction site sketches to JKKP for approval of the dismantling of the tower crane.
ii. Check PMA and tower crane serial number before being dismantled
iii. Examine the checklist for maintenance of the last month's crane conditions before dismantling.
iv. Check all brake systems, cabling systems and trolleys.

v. Inspect any obstacles in the construction site area to facilitate the process of dismantling.
vi. Disconnect the roll limiting switch
vii. Disconnect the cable and rewind the cable on the hoisting drum.
viii. Disconnect the cable on the pulley and rewind the cable on the hoisting drum.
ix. Lock the trolley part to dismantle the main jib.
x. Disconnect all crane main power connections.
xi. Disconnect all control cables and limit switches.
xii. Move half of the balancer to balance the tower crane and dismantle the main jib along with the binding pole and trolleys.
xiii. Transfer all balances from the counter jib
xiv. Dismantling counter jib
xv. Dismantle and lower the cathead (A-frame)
xvi. Dismantle the slewing platform
xvii. Dismantle the entire mast part and site.
xviii. Using suitable mobile cranes depends on the height and width of the site during the dismantling.

12.7.4 Safety measures during the process of erecting the tower pole

In the process of erecting a tower crane, several safety precautions need to be emphasized:

i. Check the last month's maintenance checklist of the tower crane before the erecting process is carried out.
ii. Request a project engineer's view to ensure the column / collar is in a strong state and capable of supporting the torque and bending of the tower crane.
iii. Install the binder collar set on the mast, wall tie beam and check the horizontal position.
iv. Checking hydraulic jacking up system.
v. Arrange the mast parts and mount the platform at the mast according to specifications when they are above the ground before jacking up.
vi. Extend the length of the main power cable if required.
vii. Checking roll system, trolley cable, brake system and end bulldog clip for climbing purposes.
viii. Check all roll restraint switches.

ix. Using concrete blocks to balance the tower crane during the jacking-up process is made.
x. Jacking up the towers at appropriate altitudes.
xi. Tighten all bolt / pin and nut connections.
xii. Resets the roll restriction after the process of jacking up.
xiii. Test tower crane with load.

12.8 Responsibilities of Tower Crane Management at the Site of Construction

Those responsible for tower crane management at the site must ensure that:

i. The tower crane is vertical and dismantled by a competent person who has training and experience. Companies should provide written procedures for each type of tower crane and this procedure should refer to the manufacturer's instructions.
ii. A thorough examination of the crane should be carried out after enforcement by a competent person.
iii. Only competent people can handle cranes.
iv. Pre-use checks are performed by the crane operator at the beginning of each shift to ensure that the crane does not suffer any damage or failure and is safe to use.
v. Internal checks are carried out by crane operators, usually on a weekly basis, and records of these checks are kept.
vi. Lifting operations need to be properly designed and supervised accordingly.

12.9 Safety Factors and Failure of Tower Cranes at Construction Sites

12.9.1 Risks involving tower cranes

There are five risks involving tower cranes:

a) Structural failures
b) The tower crane falls
c) Accidents with other tower crane movements
d) Load objects fall
e) Fall from altitude

12.9.2 Safe design for tower cranes

In ensuring the safety of the tower cranes, a secure design should be made, including:

a) Load Chart Standards and balancer need to be complied for crane stability
b) Base and site
c) Cranes fasteners are safe for use and safety steps from manufacturer must be complied with
d) Wind and weather controls should be adhered to in accordance with established standards

12.9.3 Safety limiting indicator

Indicators can:

a) Stop the crane movement if the crane movement exceeds the specified limit
b) Dependency of the tool
c) Freight limitation
d) Movement limiter tool
e) The allowed working radius
f) Dual braking system

12.10 Examples of hazards at construction sites are:

a) Collision between cranes, other objects and structures

The tower crane placement should take the dangers into account (Figure 12.7) such as:

- Power flow in the upper area
- Nearby structures
- Other cranes or concrete placement booms (including on adjacent site)
- Flight pitch environment and aviation flight path.
- The boom of concrete placement works in the radius of the tower crane operation
- Tower crane located on the adjacent site operating in the same airspace.
    - Crashes between cranes or other structures / objects may cause injury to persons who are around cranes from:
        - Fallen loads
        - Cranes collapse
        - Failed on crane components, such as boom parts

- The risk of injury from collisions between tower cranes and other structures is greater where crane crew cannot communicate directly.

12.11 Ways to minimize the risk of injury from collisions between cranes and other structures :

- The location / space where the tower crane may collide with another structure, the associated procedures need to be documented, such as safe working method statements need to be established early in the planning to ensure that the controls are in the proper place to reduce the risk of injury from collision.
- This procedure should identify the Competent Person for the implementation of the safe working method statement. Everyone involved in the tower crane and other structures should be trained in the procedure.
- This procedure needs to handle the following issues:
  - Crane placement to provide space for cranes / other machinery to operate in the crane operation radius.
  - Placement of cranes and other machinery with counterweights so counterweights do not collide during slewing operations.
  - Communication method between crane crew and other crane operator.
  - Scheduled the work to reduce the time of cranes and other machinery required to work in the same area, or at the same altitude.
  - Procedure of raising the tower crane to ensure cranes remain as far from any structure or other machinery.
  - Frequency of meetings to monitor and review the effectiveness of control measures and on who should attend the meeting.

b) Location of access / entrance area

These considerations should be taken into account when placing the tower crane:

- Common access areas for workers and others in the workplace.
- Public access areas such as pedestrian paths, roads and pathways between buildings around the crane.

c) Working near the Overhead Powerlines

- Contact with overhead electrical lines can cause a risk of electric shock during handling of machinery (Figures 12.8 and 12.9). It can be very difficult for crane operators to see electric lines and estimate distance from them.
- Prior to erecting a tower crane around the upper electrical line, consultancy on work and associated risks would have to take place between the main contractor and the tower crane operator.
- When cranes and machinery that involve high range are to be used in electrical line environments the following steps are required:
  a) the operation is properly planned by a competent person
  b) should be supervised by a competent person
  c) performing work in a safe way
- There are two options for working near the overhead electric line:
  a) Power supply to electric line is switched off, or
  b) Is outside the exception zone
- If electrical lines are to be switched off, talk to the person who controls the line as early as possible when planning a job. Switching off the power supply can take time and depends on the situation, and can slow down the work.
- If the crane or load is touched by the aerial conductor, immediately inform the electrical supervisor of the situation and, the Safety Officer will remain in place to warn about the hazard of electric shock (Figure 12.9).

12.12 Measures to be followed and performed by crane operators:

a) Stay in the cabin or crane until electricity is disconnected
b) Warn others (signalman) to stay away from cranes and not to touch any part of the crane, rope or load.
c) Without anyone approaching the crane, handle the crane (boom) in any way to decide on the touch.
d) When unable to move or break the conductor's aerial conductor with the crane, stay in the cabin or on the crane, and wait until the condition is confirmed safe.

e) If necessary to get out of the cabin or crane due to fire or other reasons, to avoid electric shock, jump away from the crane (except the tower crane), and not touch the crane and ground at the same time.

f) When moving from the crane, slowly go through the affected area to avoid contact with other high voltage capabilities (see Figure 9.7). The action recommended by the competent person shall be completed / recovered before the crane is re-operated.

12.12.1 Electrical power and working distance near the electric current

Table 11.1 shows the range of voltage and safe distance of machinery position recommended by several countries from the electrical current during construction work.

Table 11.1 Total voltage and safe distance from the electric current (overhead powerlines)

Voltage (v)	**Distance from Recommended Electric Current (m)**		
	Australia	Hong Kong	Ireland
0 – 33,000	3.0	3.0	3.0
33,000 – 132,000	3.0	6.0	4.5
132,000 – 330,000	6.0	7.0 (275 kV)	6.0
Above 330,000	8.0	7.0 (400 kV)	8.0
Source	*Work Near Overhead Power Lines, Code of Practice, Australia, 2006*	*Avoiding danger from overhead power lines Guidance Note GS6 (Fourth edition), Hong Kong, 2013*	*Code of Practice for Networks Avoiding Danger from Overhead Electricity Lines, Health and Safety Authority, Ireland, 2008*

12.12.2 Emergency procedures if collided with electricity current

If someone or something comes in contact with the above electric lines, things to do are:

a) Never touch the electrical current

b) Assume that electricity lines are active, even if they do not trigger sparks, or if they appear to die

c) It should be noted that, even if the electricity line is dead, it can be restarted either automatically after a few seconds or after several minutes or hours if the line owner does not realize that the line has been damaged

d) If possible, call TNB's emergency services / parties

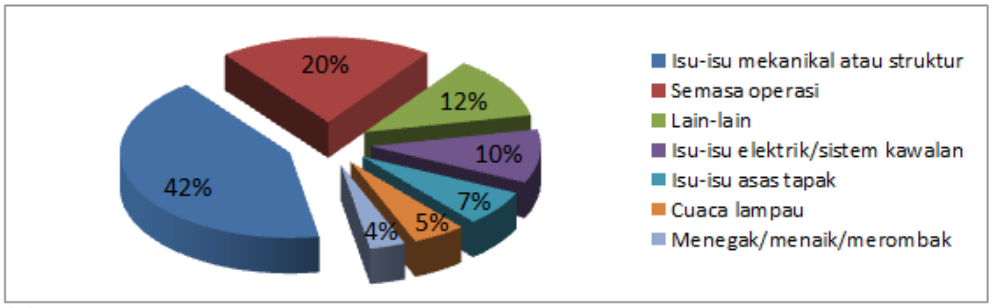
e) If you are touched / close to the broken wires, move and stay away as soon as possible until the line is confirmed safe

f) Should remember that if the active wire touches the surrounding area (the ground) it may be activated. Keep the safe distance from the wire or anything that can touch it.

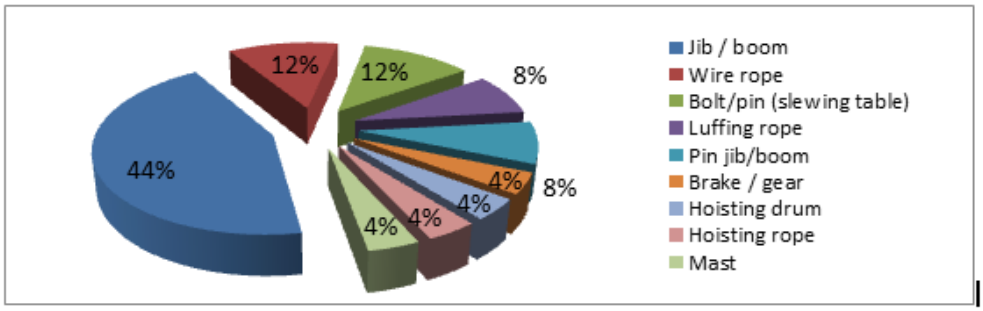
12.13 Last Accidents and Incidents (Lessons Learned)

12.14 The cause of the accident

Accidents involving tower cranes are largely due to mechanical, electrical, crane structure, operator / rigger / signalman problems and so on. Figure 12.14 shows the percentage of factors causing the crane tower accidents in Malaysia.



(a)



(b)

Figure 12.4 (a) Percentage of factors causing tower crane accidents and (b) percentage of factors from mechanical / structural issues *(Abdullah & Wern 2010;*

Fail siasatan JKKP; http://www.dosh.gov.my)

12.15 Working at high altitude

Working at high altitudes is a very dangerous situation if the safety measures and protection from falls are not taken into account (Figure 12.15). The higher the workplace, the higher the risk can be. Protection from falling is a topic that has several aspects. Federal DOSH and government regulations on security of falling have outlined better and safer guidance for employee protection against falling as set out in the "Guidelines for the Prevention of Falls at Workplaces" set by the JKKP.

In the construction industry, it is the employer's responsibility to prevent falling events by maintaining a safe working environment through proper education, use of fall protection equipment, and training.

Figure 12.5 Safety protection from falling *(http://simplifiedsafety.com; https://www.ihsa.ca)*

Before working at a certain height, you must go through the following steps:

- Avoid working at altitude if there is another way to do so
- If working at altitude (inevitably), avoid falling by using / wearing proper protective equipment
- Reduce the distance and falling events by using proper equipment when the risk is inevitable.
- Ensure the protection equipment used is appropriate, stable and strong enough to work, maintain and check regularly

- Make sure you do not exceed the load or act recklessly when working in high places
- Take precaution when working on or near a brittle surface
- Protect the object from falling
- Consider emergency evacuation and rescue procedures in the event of a fall.

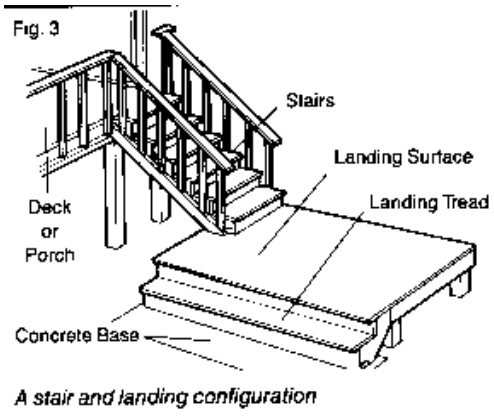
12.15.1 Access and fixed platform

For access and platforms that are permanently installed such as stairs or ramps, and others shall comply with the Act and the requirements of the Local Authorities. The requirements and standards for access and platform vary depending on the use and place to be installed for example:

- All entry and stairs must have a minimum head release of 2.1 metres vertical of the steps
- The door should not open directly to the stairs or the road. A landing or platform level is required.
- For open stairs and ramped steps, the minimum width is 685 mm.
- When enclosed between walls, etc., the minimum width is raised to 815 mm, and the minimum width is 1 metre.
- The barrier should be installed for all exposed edges.

Examples of access and permanent platforms are shown in Figure 12.16.

Handrails, guardrails and toeboards (http://www.nzmachinery.com/news_nc1_7)



A stair and landing configuration

Stairway and ramp landings (http://fieldshomecenter.com)

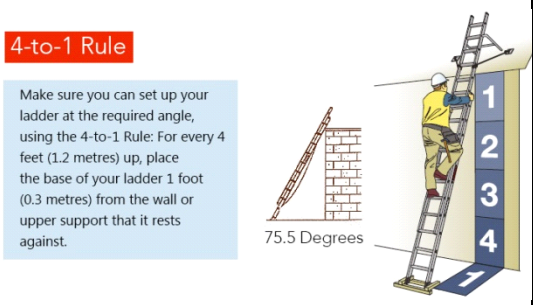
	
Stairways (http://www.howtospecialist.com)	*Fixed rung ladders (http://speeddemon2.com)*

Figure 12.6 Some access and fixed platform types at work

12.15.2 Access and non-fixed platform

All types of stairs (ladder, trestles, stairwells, etc.) and work platforms shall comply with the relevant Malaysian Standard or other accepted International Standards. For those that do not have the Standard sign, it is used for light work only and is not suitable for use at work.

Example temporary access and platforms used at work sites are shown in Figure 12.17.

	
Perimeter perlindungan (https://www.peri-usa.com)	*Single and extension ladders (http://chainsawjournal.wpengine.netdna-cdn.com)*

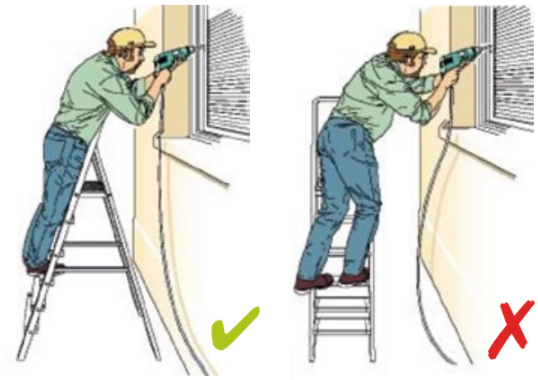
	
Cantilevered temporary work platforms (http://www.superiorscaffold.com/blog/page/7/)	*Foldable/portable step ladders (Best practice guidelines for working at height in New Zealand, 2012)*

Figure 12.7 Some of the temporary access and platform examples

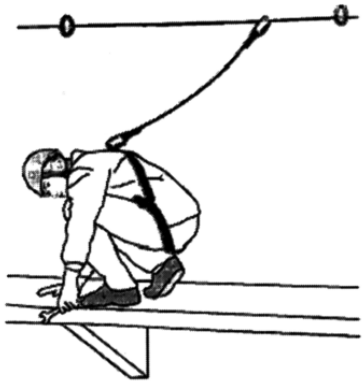
12.15.3 Safety bands, belts and harnesses

In the construction industry, selection, checking, rigging, and use of all belts, harnesses, safety ropes and catching devices shall comply with the acceptable international standards. The main points to note are:

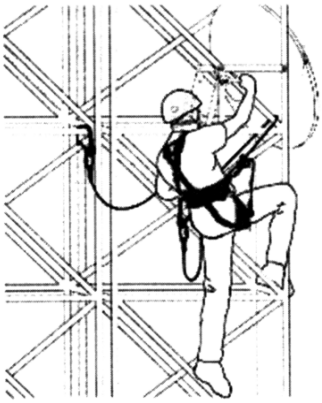
- Assessment of work methods should be carried out to select the most suitable method of work and catching device.
- All equipment should always be inspected and tested to ensure that it complies with MS Standard or other acceptable International Standards.
- Equipment should be given detailed visual inspection by a trained person whenever it is used.
- Always ensure that the equipment used is consistent with manufacturer's instructions.
- Binding of static straps, anchored straps and restrictions are skilled operations that need to be run by trained people.
- Person who uses the equipment must be trained or supervised to ensure that the belts or harnesses are mounted and properly aligned with anchored rope.

- When a person is wearing a safety rope moving around, the rope can move across the working area and stuck around the barrier. This can cause the rope to jerk or jam, and become unbalanced. These ropes can also be stuck on objects such as roof tile or loose bolts, causing them to fall and other hazard events.
- For work operations such as gas cuffing, grit blasting, or usage of sharp cuffing tools, precautions should be taken to prevent wear and damage to the equipment. Protective devices such as short steel lanyards wires, protective covers around straps, or other measures.

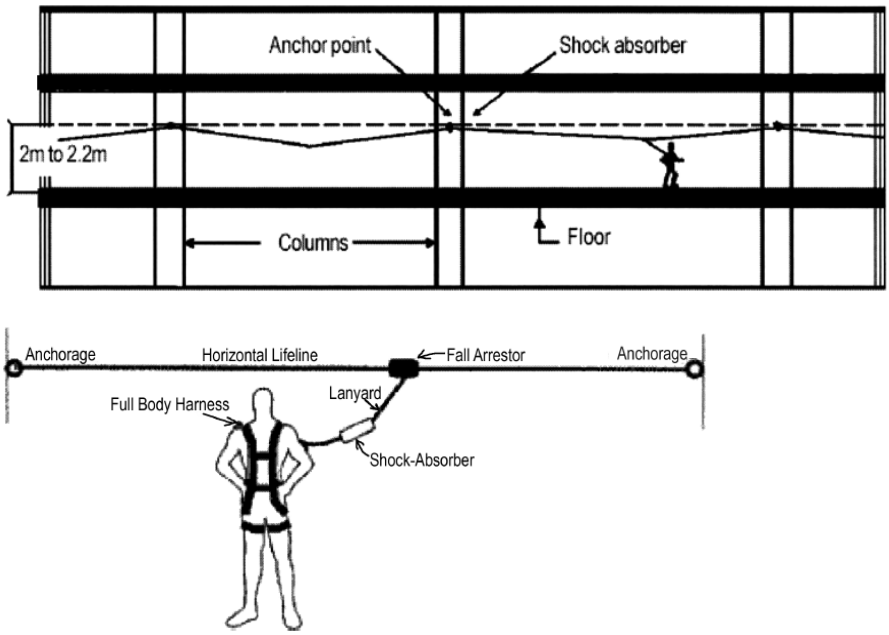
Some examples of safety rope, belts and harness equipment and the methods used are shown in Figure 12.18



(a) Travel-restriction systems



(b) Work-positioning systems



(c) Static line and anchorage techniques

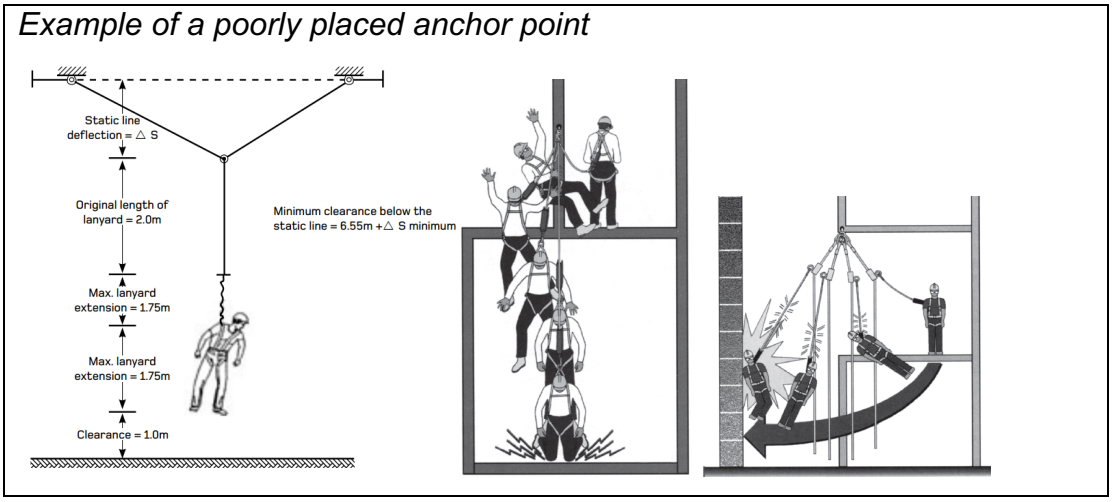


Figure 12.8 Several types of safety rope, belt and harness equipment and methods used *(Guidelines for the Prevention of Falls at Workplaces, 2007; https://www.ihsa.ca)*