TRAINING MODULE FOR LIFTING SUPERVISOR (TOWER CRANE)

Prepared for:

Jabatan Keselamatan dan Kesihatan Pekerjaan
Kementerian Sumber Manusia

Prepared by:

UKM PAKARUNDING

TRAINING MODULE FOR LIFTING SUPERVISOR (TOWER CRANE)

Prepared by:

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

Prepared for:

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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ABBREVIATIONS

DOSH	-	Department of Occupational Safety and Health
ERP	-	Emergency response plan
FMA	-	Factories and Machinery Act
FSWR	-	Flexible steel wire rope
FYK	-	Approved Firm (Firma Yang Kompeten)
HIRARC	-	Hazard Identification, Risk Assessment and Risk Control
OSHA	-	Occupational Safety and Health Act
OYB	-	Responsible Person (Orang Yang Bertanggungjawab)
PPE	-	Personel Protective Equipment
PTW	-	Permit to work
SWL	-	Sfe working load
WWL	-	Working load limit

(1) MODULE : Training Module for Lifting Supervisor (Tower Crane)

(2) OBJECTIVE : Provide a training for lifting supervisor for safe lifting operations at construction site

(3) LEARNING PERIODS: 3 day (2 days lecture and 1 day practical in related training center

(4) PRE-REQUISITE: Have attended Basic Rigging and Slinging Course

(5) SYNOPSIS:

A compulsory of attending the training is to determine the level of skills and provide better practical guidance to lifting supervisor in planning and monitoring the safe lifting operation of the construction site. Through this module the lifting supervisor will be able planning the lifting plan and know the risks inherent in the construction site especially the risks associated with lifting work. The ability to choose and assign members of the lifting team such as operator, rigger and signalman in performing lifting work which refers permit to work. With good planning and control by supervisors during lifting work, accidents involving tower cranes can be reduced.

(6) LIST OF TOPIC

Chapter 1 Legislations (0.5 hour)

Chapter 2 Responsibilities of Personnel in Lifting Operations (1 hour)

Chapter 3 Introduction to Lifting Works (1 hour)

Chapter 4 Introduction to Tower Cranes (0.5 hour)

Chapter 5 Load Charts (1 hour)

Chapter 6 Safe Lifting Works (1 hour)

Chapter 7 Lifting Plans (4 hours)

Chapter 8 Lifting Equipment (2 hours)

Chapter 9 Hitching Methods (2 hours)

Chapter 10 Tower Crane Accidents and Prevention (1 hour)

Chapter 11 Practical Training (6 hours)

TOTAL LECTURE: 14 hours

TOTAL PRACTICAL: 6 hours

(7) REFERENCES:

Akta Keselamatan dan Kesihatan Pekerjaan (AKKP) 1994 (Akta 514), dan Peraturan-Peraturan di bawah AKKP.

Bobby R. Davis, & Sydney Cheryl Sutton, A Guide to Crane Safety, N.C. Department of Labor Division of Occupational Safety and Health, 2004.

BS 7121-5:2006 Code of practice for safe use of cranes-Part 5: Tower cranes.

Code of Practice for Safe Use of Tower Cranes, Hong Kong, 2012.

David V. MacCollum, Crane Hazards and Their Prevention, American Society of Safety Engineer, 2005.

Guidelines for Creating Lifting Plan for Lifting Operations In Workplaces, Workplace Safety and Health (WSH) Council, Singapore, 2014.

Guidelines For Public Safety And Health At Construction Sites (1st Revision: 2007), Department of Occupational Safety and Health, Malaysia.

Hoisting and Rigging Safety Manual, Infrastructure Health & Safety Association, Canada, 2012

Laing O'Rourke, 2008. Guide to safe slinging and signalling.

MS 1803:2008 Cranes-Safety-Tower Cranes.

MS ISO 4306-3:2010 Cranes-Vocabulary-Part 3: Tower Cranes

SS 559: 2010 Code of practice for safe use of tower cranes.

CHAPTER 1

LEGISLATION

1.1 Introduction

Any action by the enforcement authorities, whether under OSHA or the FMA, should be in accordance with the existing legislative provisions. Similarly, any directive, action and decision to be taken by DOSH must be based on clear sources of authority and stipulations of the law, whether it be OSHA or FMA and the regulations contained therein. Any unauthorised action can jeopardise the work of DOSH or its enforcement officers, especially if the case is challenged in court.

For Malaysia, the major legislations enacted to address occupational safety and health issues at the workplace are the Occupational Safety and Health Act (OSHA) 1994 and the Factories and Machinery Act (FMA) 1967, as shown in Figure 1.1. Under these Acts, there are Regulations and Rules made by the Minister and which are enforced by the Department of Occupational Safety and Health (DOSH), Ministry of Human Resources.

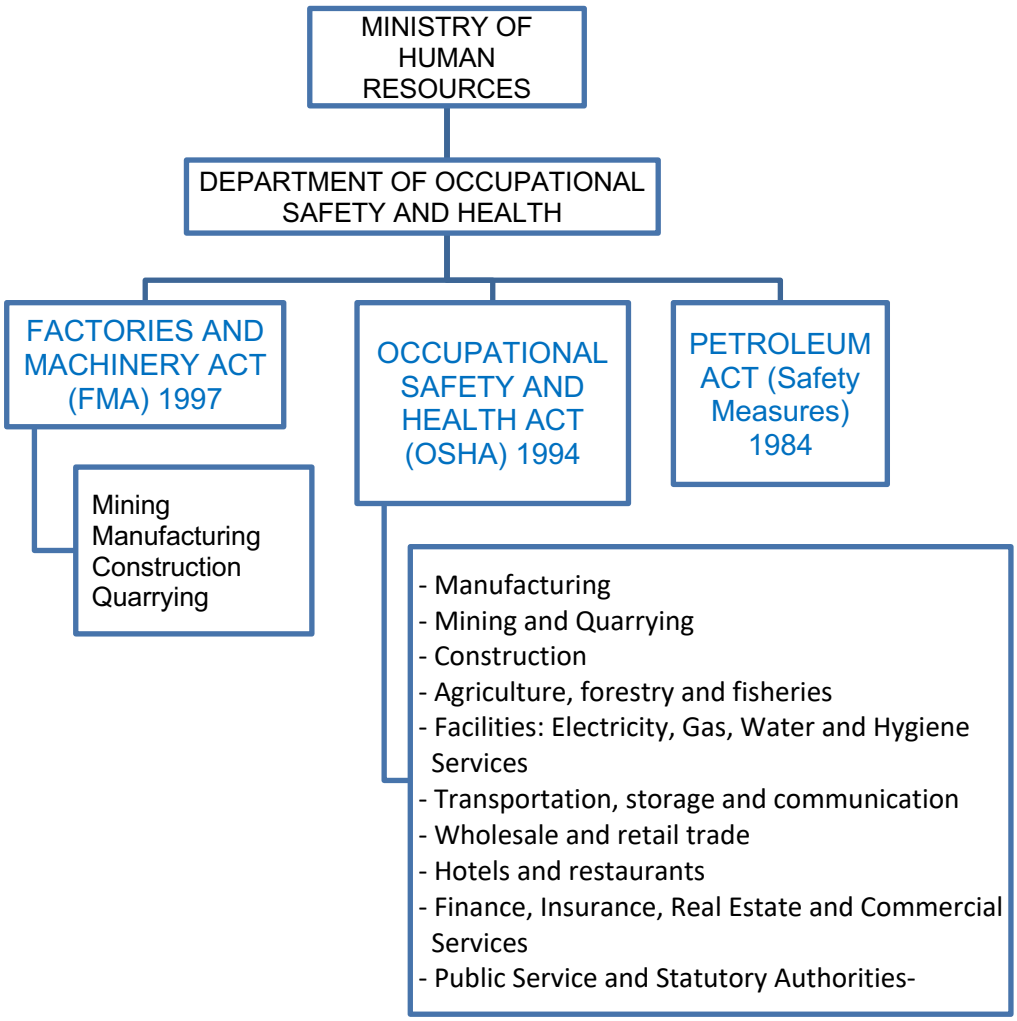


Figure 1.1 Acts that apply in Malaysia

DOSH enforces all three Acts. Before a further explanation is given about OSHA 1994 and FMA 1967 (both these Acts are widely used for tower crane issues), a little clarification should be made with regard to the Petroleum Act (Safety Measures) 1984.

1.2 Petroleum Act (Safety Measures) 1984 (Act 302)

In addition to OSHA 1994 and FMA 1967, DOSH also enforces the Petroleum Act (Safety Measures) 1984 (Act 302), which is aimed at ensuring safety in the transportation, storage and use of petroleum. The Act contains provisions relating to the transportation of petroleum by road and railway; the transportation of petroleum by water; the transportation of petroleum by air; the

transportation of petroleum through a piped system; the storage and handling of petroleum; the use of equipment, gadgets, materials, plants, building equipment, structures and installations; and existing equipment, gadgets, materials, plants, building equipment, structures and installations.

For the transportation of petroleum by road or railway, the owner or operator of the vehicle assigned to carry the petroleum shall take the necessary steps to ensure that the workers handle the petroleum according to the provisions under the Act and Regulations. When petroleum is transported by water, it should not be loaded or unloaded or removed except at a port or place prescribed by the Minister. The transporation of petroleum by air or through pipelines must be with the prior approval of the Minister. Furthermore, under the Act, a valid licence for the use of petroleum is required to store or operate any form of petroleum. There is also a requirement for containers or containers with petroleum to be labelled. The Act also requires residents in nearby areas to give the Minister notice within 24 hours in the case of any accident or loss of life or personal injury arising from a petroleum-related explosion or fire.

1.3 Occupational Safety and Health Act 1994 (OSHA)

The main purpose of this Act is to inculcate an attitude of concern for safety and health at the workplace, and to create effective safety measures through self-regulatory schemes, consultation, collaboration and involvement of employees, that are tailored to the industry or relevant organization. The long-term objective of this Act is mainly to produce a healthy and safe work culture among all employees and employers in Malaysia.

Aims of OSHA (Act 514)

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

1) To secure the safety, health and welfare of employees;
2) To protect employees and others against activities that involve risks;
3) To promote a safe and healthy workplace environment;

4) To provide occupational safety and health legislations with industrial codes of practice approved under the provisions of the Act (not limited to Acts and regulations).

Scope of Act 514

FOR EMPLOYEES:

in all sectors in Malaysia is as follows:

(a) Manufacturing
(b) Mining and quarrying
(c) Construction
(d) Agriculture, forestry and fisheries
(e) Facilities: Electricity, Gas, Water and Hygiene Services
(f) Transportation, storage and communication
(g) Wholesale and retail trade
(h) Hotels and restaurants
(i) Finance, Insurance, Real Estate and Commercial Services
(j) Public Service and Statutory Authorities

Except:

Work on ships (enshrined under the Merchant Shipping Ordinance 1952) and in the Armed Forces.

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

Summary of the Relevant Provisions:

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

It is the duty of the employer and self-employed person to ensure the safety, health and welfare of his employees while they are at work. The general duties of employers are summarised as follows:

Paragraph (1) and Paragraph (2);

(a) To provide a safe plant and system of work.

(b) To make an arrangements for ensuring the safety and absence of risks to health for the use or operation, handling, storage and transport plant and substances;
(c) To have and provide information, instructions, training and supervision in relation to safety and health.
(d) To provide safe means of access to and egress from the workplace
(e) To maintain a safe work environment for employees.

For the purposes of this section, “employees” include independent contractors and the employees of that independent contractor.

Section 16. Duty to formulate 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 17. General duties of employers and self-employed persons to persons other than their employees

It is the duty of the employer and the self-employed person to conduct his undertaking so as to ensure that other persons who are not his employees are not exposed to risks to their safety or health as a consequence of his undertaking.

Section 18. Duties of an occupier of a place of work to persons other than his employees

It is the duty of the occupier of non-domestic premises to ensure that the premises, plant or substances used by persons who are not his employees are safe. This duty includes any maintenance or repairs to the place and the access to and egress from that place.

Section 19. Penalty for an offence

A person who contravenes the provisions of section 15, 16, 17 or 18 shall be guilty of an offence and shall, on conviction, be liable to:

(a) A fine not exceeding RM 50,000.00; or

(b) Imprisonment for a term not exceeding 2 years; or

(c) Both.

Section 20. General duties of designers, manufacturers, importers and suppliers with regard to plants for use at work

It is the duty of a person who designs, manufactures, imports or supplies any plant to ensure that it is so designed and constructed as to be safe and without risks to safety and health.

In this case, a plant includes any tool or device or machine (tower crane). A designer or manufacturer or importer of tower cranes can be charged under this section if he commits a related offence.

"**So far as is practicable"**

The duties set out in sections 15, 17 and 18 of OSHA are so far as is practicable. The phrase "so far as is practicable" means by giving due consideration to and taking into account four factors that are provided for in section 3(1):

(a) the severity of the hazard or risk in question;

(b) the state of knowledge about the hazard or risk and any way of removing or mitigating the hazard or risk;

(c) the availability and suitability of ways to remove or mitigate the hazard or risk; and

(d) the cost of removing or mitigating the hazard or risk.

General Duties of Employees (Part VI)

Section 24. General duties of employees at work

Paragraph (1) sub-paragraph (a),(b),(c) and (d), and Paragraph (2)

(a) To take care of the safety and health of himself and of other persons.

(b) To co-operate with his employer and other persons in implementing the requirements of the Act.

(c) To wear the personal protective equipment provided.

(d) To comply with instructions and measures on occupational safety and health.

A person who contravenes the provisions of this section shall be guilty of an offence and shall, on conviction, be liable:

(a) To a fine not exceeding RM 1,000.00; or

(b) To imprisonment for a term not exceeding 3 months; or

(c) To 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:

(a) To a fine not exceeding RM 20,000; or

(b) To imprisonment for a term not exceeding 2 years; or

(c) To both.

Section 27. Discrimination against employee, etc.

(1) No employer shall dismiss an employee, injure him in his employment, or alter his position to his detriment by reason only that the employee:

(a) Makes a complaint about a matter which he considers is not safe or is a risk to health;

(b) Is a member of a safety and health committee established pursuant to this act; or

(c) Exercises any of his functions as a member of the safety and health committee.

The regulations under OSHA 1994 are as follows:

1. Occupational Safety and Health (Classification, Labelling and Safety Data 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 (Revoked);
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 Substances) Order 1999

1.4 Regulations and Special Orders under the Factories and Machinery Act, 1967

The Regulations and Orders under the Factories and Machinery Act, 1967 pertaining to the safety of machinery and the construction of buildings are as follows:

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 (Amended - 1983); and
5. Chief Inspector Special Order (To The Project Manager On the Management and Safe Operation of Tower Cranes) 2017.

In exercising the powers conferred on him by subsection 27(1) of the Factories and Machinery Act 1967 [Act 1391], the Chief Inspector of Factories and Machinery issued the following special orders:

Project managers must ensure that tower cranes:

(a) Have approved designs and comply with the requirements for design approval by the Department of Occupational Safety and Health;
(b) Have an installation permit and comply with the requirement for installation approval by the Department of Occupational Safety and Health; and
(c) Have a valid certificate of fitness.

The Regulations from No. 1 to No. 4 are indirectly related to the use of tower cranes, hence they are not described here. Meanwhile, the Chief Inspector Special Order (To The Project Manager On the Management and Safe Operation of Tower Cranes) 2017 is very relevant to the use of tower cranes at the sites of construction projects, and the special order makes it the primary duty of the project manager. The Order was made under the power of subsection 27(1) of the Factories and Machinery Act 1967.

The responsibilities of the project manager are as follows:

1. The project manager must ensure that the tower crane has:
   (a) An approved design and complies with the requirements for a design approval by DOSH;
   (b) A permit for its installation, and complies with the requirements for the approval of installation by DOSH; and
   (c) A valid certificate of fitness.

2. The project manager should ensure that during the operation, handling and maintenance of the tower crane:
   (a) The operator who is appointed is registered with the Department of Occupational Safety and Health to operate the crane;
   (b) The appointed lifting supervisor, signalman and rigger have relevant and adequate knowledge, experience and competency;

(c) A permit to work system is implemented;
(d) All the lifting gear is inspected and maintained according to the specifications of the manufacturer and good engineering practices;
(e) All safety devices are maintained to function properly at all times and are not easily disrupted; and
(f) Records relating to the use, inspection, maintenance and permit to work are kept at the construction site for checking purposes at any time..

The project manager must ensure that any person appointed by the occupier has a valid contract that is legally binding to:

(a) Carry out works to inspect, install, climbing, test, maintain and dismantle a tower crane;
(b) Conduct regular inspections on each tower crane at least once a month;
(c) Carry out works to inspect, install, climbing, test, maintain and dismantle a tower crane according to the specifications of the manufacturer and good engineering practices; and
(d) Perform repairs or modofications to the tower crane structure or components after obtaining the written approval of the Department of Occupational Safety and Health, and in accordance with the specifications of the manufacturer and good engineering practices.

Penalty:
“Any person who violates this special order shall be guilty of an offence and can be charged under section 8(g) of the Factories and Machinery Act 1967 (Act 139) and, if convicted, shall be liable to a fine not exceeding two hundred thousand ringgit or to imprisonment for a term not exceeding five years or to both”.

However, no specific Regulations have been made under either of the two Acts (OSHA 1994 and FMA 1967) regarding the correct use or operation of tower cranes at work sites. This can be found in the following guidelines and standards:

1. Guidelines of 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. Guidelines for the Prevention of Falling Objects at the Workplace, Department of Occupational Safety and Health, Ministry of Human Resources, Malaysia, 2007.
5. Standard Malaysia, MS 1803:2008: Cranes - Safety - Tower Cranes*;*
6. Standard Malaysia MS ISO 4310:2014 Cranes - Test code and procedures (First revision) (ISO 4310:2009, IDT);
7. Standard Malaysia MS ISO 4306-1:2014 Cranes – Vocabulary - Part 1: General (First Revision) (ISO 4306-1:2007, IDT);
8. MS ISO 9926-1: 2001 *Cranes-Training of Operators-General (ISO 9926-1:1990, IDT)*; and
9. MS 2203:2008: *Cranes-Training of Operators-Part 3: Tower Cranes* (ISO 9926-3:2005, MOD).

1.5 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.

Bibliography

Akta Keselamatan dan Kesihatan Pekerjaan 1994 dan Peraturan-Peraturan (Akta. 514).

Akta Kilang dan Jentera 1967, dan Peraturan-Peraturan (Akta 139).

Akta Petroleum (Langkah-langkah Keselamatan) 1984 (Akta 302).

Nota Operator Kren Menara, Institut Kemahiran Tinggi Belia Negara (IKTBN), Kementerian Belia dan Sukan, Bachok, Kelantan, 2004.

Nota Operator Kren Menara, Institut Kemahiran Tinggi Belia Negara (IKTBN), Kementerian Belia dan Sukan, Chembong, Negeri Sembilan, 2003.

Nota *Tower Crane Operator*, Gamuda Plant Operator School (GPOS), Shah Alam, Selangor, 2002.

Nota Operator Kren Menara, Beruntung Skill Training Centre (BSTC), Rawang, Selangor.

Peruntukan Utama Akta Keselamatan dan Kesihatan Pekerjaan 1994, Jabatan Keselamatan dan Kesihatan Pekerjaan (JKKP).

Lembaga Pembangunan Industri Pembinaan Malaysia, Akta 520.

CHAPTER 2

RESPONSIBILITIES OF PERSONNELS IN LIFTING OPERATION

2.1 Introduction

Responsibilities of the personnel involved are key elements in determining the safe of tower crane operation and lifting works. The personnel involved are project manager, competent person, lifting supervisor, crane operator, rigger and signalman. In determining responsibility between owners, contractors and tower crane operator, reference should be made to the Guidelines on Occupational Safety and Health in the Construction Industry (Management) 2017. The success or failure of a tower crane operation is depend on the team planning and team work. All crane operations such as lifting work must be performed by workers who are trained and competent team work as well as practice a safe systems and work culture. This safe operating system must be adhered and understood by all employees in the worksite before the commencement of any lifting operation.

2.2 Responsibilities of Personnels During Lifting Operation

2.2.1 Project Manager

Project manager is the important personnel in a construction project management including selection and determination of contractual relationship with a contractor, including the tower crane contractor. Responsibilities of the project manager are subject to Special Order of Chief Examiner to Project Manager Related to the Management and Safe Handling of Tower Crane 2017. In carrying out its tasks, the project manager must ensure that a crane has:

(a) an approved design and complies with the requirements for a design approval by DOSH

(b) a permit for its installation, and complies with the requirements for the approval of installation by DOSH

(c) a valid certificate of fitness

2. The project manager should ensure that during the operation, handling and maintenance of the tower crane:

(a) the operator who is appointed is registered with the Department of Occupational Safety and Health to operate the crane
(b) crane operators have the crane operating certificate and still valid when he operates a crane
(c) the appointed lifting supervisor, signalman and rigger have relevant and adequate knowledge, experience and competency
(d) a permit to work system is implemented
(e) all the lifting gear is inspected and maintained according to the specifications of the manufacturer and good engineering practices
(f) all safety devices are maintained to function properly at all times and are not easily disrupted
(g) records relating to the use, inspection, maintenance and permit-to- work are kept at the construction site for checking purposes at any time

The project manager must ensure that any person appointed by the occupier has a valid contract that is legally binding to:

(a) Carry out works to inspect, install, climbing, test, maintain and dismantle a tower crane
(b) Conduct regular inspections on each tower crane at least once a month
(c) Carry out works to inspect, erection, climbing, test, maintain and dismantle a tower crane according to the specifications of the manufacturer and good engineering practices
(d) Perform repairs or modifications to the tower crane structure or components after obtaining the written approval of the Department of Occupational Safety and Health, and in accordance with the specifications of the manufacturer and good engineering practices
(e) Ensure that the work of checking, erection, climbing, testing, maintaining and dismantling the crane carried out by Approved Firm (*Firma Yang Kompeten,* FYK) and the Responsible Person *(Orang Yang Bertanggungjawab,* OYB*)* registered with DOSH and have a valid contracts. The work inspection by OYB must conducted at least once a month. The work of improvement or modification of the crane structure

must obtain the approval by DOSH and in accordance with the specifications of the manufacturer

2.2.2 Lifting Supervisor

Lifting supervisor is responsible for planning and supervising safe lifting operation using tower crane at worksite. Lifting supervisor is also responsible in ensuring all loads were lifted as per safety procedure, under allowable load limit and in accordance to the respective load chart of the specific tower crane. Among the responsibilities of a lifting supervisor are as follows:

Source: Safe lifting (2002)

(a) possesses the adequate theoretical knowledge, technical and practical training, plus the experience and knowledge in lifting operations
(b) prepares and plans for the lifting work
(c) coordinates and executes the lifting work according to plan
(d) brief all lifting workers (crane operator, signalman and rigger) regarding the lifting plan, risk controlling measures and safe lifting procedures prior to lifting operation
(e) identifies types and weight of the loads to be lifted
(f) ensures periodic inspections on the lifting appliances and lifting gear
(g) ensures safe working load (SWL) markings for all lifting appliances and lifting gear, and with valid test certificates
(h) ensures all crane operators are registered with DOSH, while the signalmen and riggers are adequately trained
(i) evaluates risk and prepare controlling measure accordingly to avoid risks
(j) determine the appropriate location/place for load loading/unloading
(k) ensuring an emergency response plan has been provided by the project owner/client or main contractor, and understood by all lifting work team
(l) If unsafe condition is reported, suitable steps must be taken to rectify the situation to ensure safe lifting operation

(m) ensure all lifting work is done which referred to permit-work-work (permit to work, PTW)

(n) to stop all works if lifting activities lead to unsafe condition

2.2.3 Tower Crane Operator

Tower crane operator must be responsible to handle crane safely based on orders and work system provided by the owner or tower crane contractor. The responsibilities of tower crane operator are as follows:

Source: Safe lifting (2002)

(a) to own a log book

(b) to perform daily inspection on crane system such as handling mechanisms, controlling switches, hydraulic hose, hydraulic oil level and various others

(c) to correctly respond to the signalman and rigger during lifting operation

(d) only giving lift to allowable loads in accordance to the load chart provided by crane manufacturer, and to ensure loads lifted do not exceed allowable load limits

(e) to ensure no lifting activities to be carried out without the risk assessment by authorised individual or parties

(f) understand hand signal and verbal communication codes when communicating using hand signal or walkie-talkie respectively

(g) understand emergency procedure and know how to react in the event of accidents during lifting operation

2.2.4 Rigger

Rigger is resposible to tie and release load from crane, and utilize lifting equipments and gears properly according to operation plan. Safety wear of a rigger must be complete and visually distinct (refer Figure 2.1). A rigger must be:

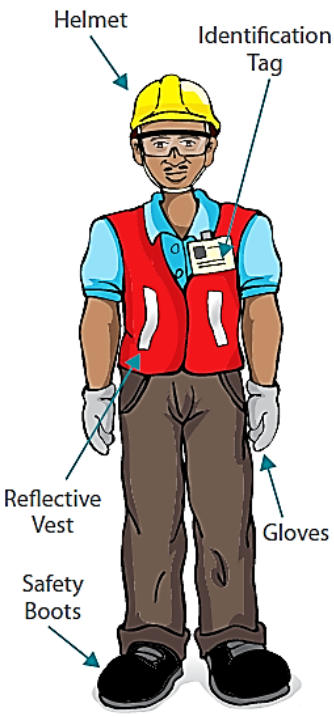


Figure 2.1 Rigger attire (Worker's Safety Handbook 2011)

(a) Adequately trained in slinging and hoisting, able to estimate load, and safe distance, and height of lifted load
(b) Able to select suitable lifting equipments and gears that is safe for the lifting operation
(c) Able to perform visual inspection on the lifting equipments and gears before use
(d) Avoid using damaged lifting equipments and gears
(e) Record defected lifting equipments and gears in suitable documents and report to lifting supervisor
(f) Understand hand signal and verbal communication codes when communicating using hand signal or walkie-talkie respectively
(g) Understand emergency procedure and know how to react in the event of accidents during lifting operation

2.2.5 Signalman

Signalman is responsible to give clear signals as a mean of communicating with the crane operator after rigging is completed and the load is ready to be lifted. Signalman is also responsible to coordinate safe crane movement with the crane operator. Safety wear of a signalman must be complete and visually distinct (Figure 2.2). A signalman must:

(a) Understand hand signal and verbal communication codes when communicating using hand signal or walkie-talkie respectively

(b) Able to give instruction to the crane operator and coordinate movement of crane and load safely

(c) Able to estimate safe distance between the lifted load and the surrounding objects during lifting operation

(h) Understand emergency procedure and know how to react in the event of accidents during lifting operation

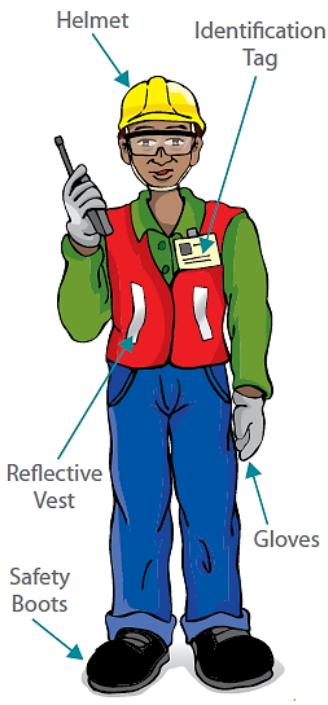


Figure 2.2 Signalman attire (Worker's Safety Handbook 2011)

Bibliography

Perintah Kilang dan Jentera (Kepada Pengurus Projek Berkenaan Pengurusan dan Pengendalian Selamat Kren Menara) 2017.

Guidebook for Lifting Supervisors, Workplace Safety and Health Council, Ministry of Manpower, Singapore, 2011.

Guidelines for Creating Lifting Plan for Lifting Operations In Workplaces, Workplace Safety and Health (WSH) Council, Singapore, 2014.

http://www.mytowercrane.com/safeliftingguide.htm [11 September 2017].

Safe Lifting, 2002 Occupational Safety & Health Council, Hong Kong, 2002.

BS 7121-5:2006 Code of practice for safe use of cranes-Part 5: Tower cranes.

Code of Practice for Safe Use of Tower Cranes, Hong Kong, 2012.

PN12040 Tower Crane-Code of Practice, Autralia, 2017.

SS 559: 2010 Code of practice for safe use of tower cranes.

CHAPTER 3

INTRODUCTION TO LIFTING WORKS

3.1 Introduction

The construction industry is one of the largest industries in the world and has been identified as one of the industries that are at risk of accidents. This is based on studies on the rate of accidents occurring on construction sites, workers' compensations, injuries and deaths. The construction industry also involves the wide use of cranes, particularly tower cranes, to help speed up the contruction of buildings. In the construction industry, the requirement to prepare a lifting operations plan is practised extensively as a useful approach in managing occupational safety and health, as the emphasis on these factors can eliminate or miinimize hazards at the workplace.

In lifting operations, it is important to form a lifting team comprised of the lifting supervisor, crane operator, rigger and signalman, as shown in Figure 3.1. Safe lifting operations require the commitment of the top management, the competence of the lifting team members, and the adequate use of lifting equipment. Lifting operations are under the responsibility of the lifting supervisor, who plans each lifting operation. The success of a lifting operation depends on the pre-operation briefing held between the supervisor and the workers who are involved. Most of the accidents that occurred in the past indicated that had there been planning, coordination and supervision of the works, the accidents and the loss of lives could have been prevented.

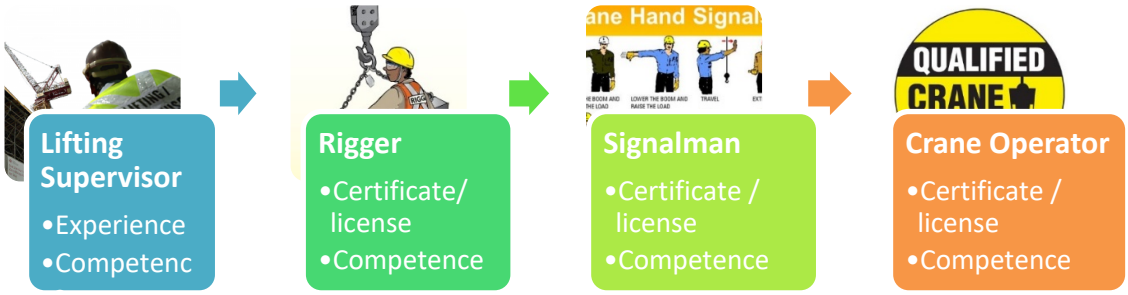


Figure 3.1 Lifting work team

This module was developed to provide better practical guidance to lifting supervisors when planning and supervising safe lifting works at construction sites. This training module also provides information regarding the hazards related to lifting operations, lifting plans, risk assessments, permit to work (PTW), safe lifting work procedures, and emergency response plans.

3.2 Management of Lifting Works

It is important to manage lifting works to ensure the proper and safe use of lifting equipment and that plans are in place for the safety of all parties on the construction site. Lifting work plans must be made by a competent person, namely the lifting supervisor who has been appointed by the project owner. Therefore, a safety and control system should be implemented by the lifting supervisor to cover the following:

(a) the planning of crane operations, including lifting works, installing, climbing, and dismantling a crane, and other related works
(b) the selection, preparation and use of cranes and lifting equipment that are suitable for the operation
(c) the provision of trained and competent personnel
(d) adequate supervision during the operation of the tower crane
(e) inspection and maintenance of the crane (including the crane components and lifting equipment) and the preparation of reports
(f) preventing the movement or use of the crane without the permission of the responsible party each time
(g) paying attention to the possibility of unsafe conditions during the crane operation or at the workplace. For instance, the weather may turn bad all of a sudden
(h) ensuring and safeguarding the safety of others, whether they are directly involved or not, during the operation of the crane
(i) providing a plan and procedure that must be followed in case of an emergency

The lifting supervisor must also conduct a Hazards Identification, Risk Assessment and Risk Control (HIRARC) at the construction site before the

commencement of the lifting works. After the existing hazards have been identified, a sequence of control measures must be used to eliminate or control those hazards and to reduce the risks. The lifting supervisor, together with the tower crane owner, can carry out a risk assessment to provide a detailed statement of the methods and controls for lifting works at the construction site. The management of the risks of lifting works will be discussed further in Chapter 7. The general role of the lifting supervisor and the procedures for carrying out lifting works are shown in Figure 3.2.

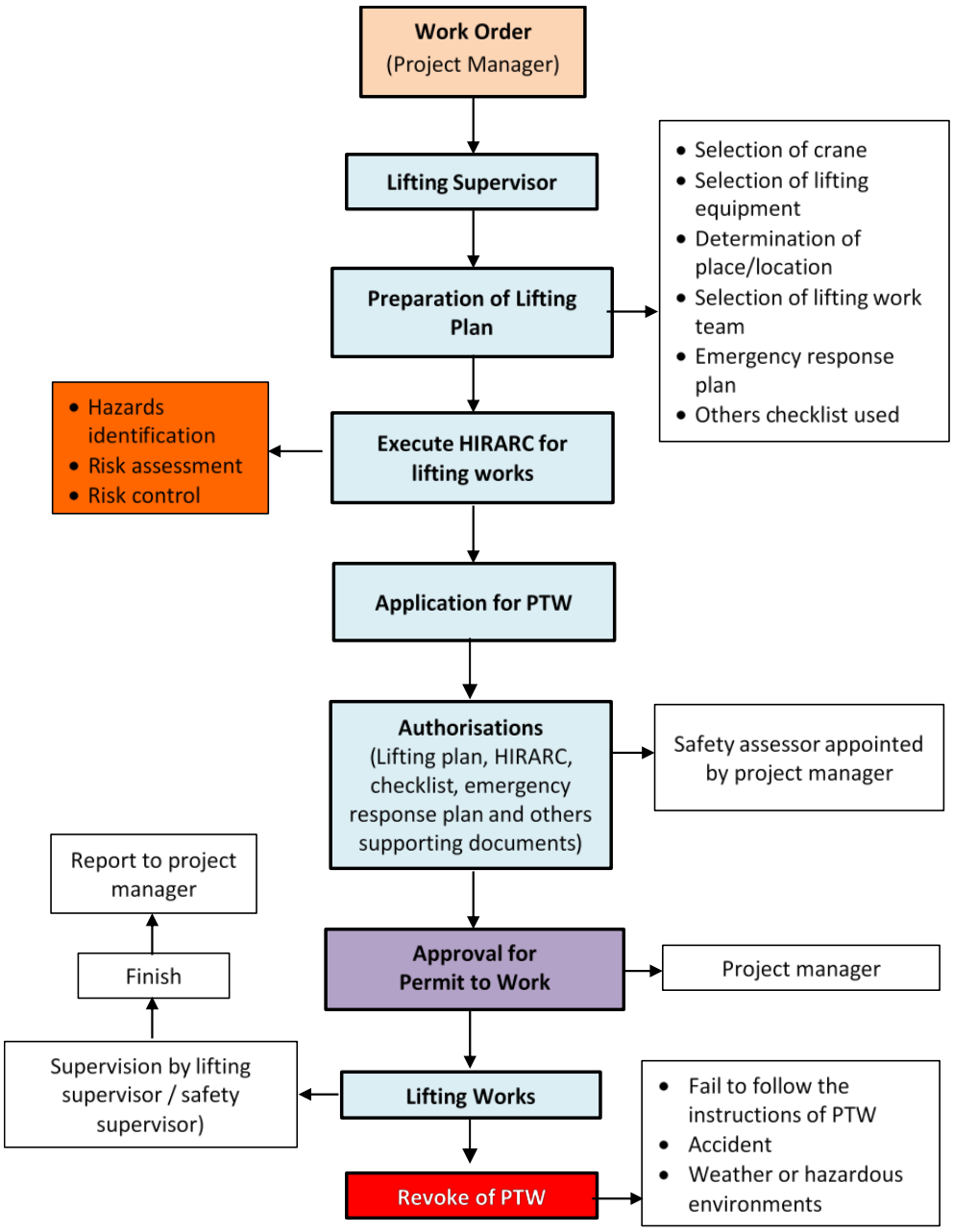


Figure 3.2 Flowchart of the role and procedures for lifting works

3.3 Lifting Categories and Control Methods

The lifts in lifting works can be categorized into three types, namely basic lifts, intermediate lifts and critical lifts.

3.3.1 Basic lifts

For basic lifts, the weight of the load can be easily estimated, and there are no significant hazards at the workplace or access routes to the crane or the workplace. For basic lifts, the lifting supervisor needs to:

(a) Visit the site where the lifting works are to be carried out to ensure that there are no significant hazards at the work area, including along the routes or where the crane is located

(b) Select the crane that is to be used depending on:
   i) the characteristics and weight of the load (including the lifting equipment)
   ii) the height to which the load is to be hoisted
   iii) the lifting radius
   iv) the capacity of the crane, as stated by the crane manufacturer

(c) Take into consideration the site for the crane operations, the access to and egress from the crane, and the suitability of the ground when it comes to self-elevating tower cranes

(d) Ensure that there are reports on the maintenance and inspections carried out on the crane to confirm that the crane is safe for use

(e) Select the lifting method, determine the centre of gravity of the load, and any protection that is to be used to prevent damage to the load

(f) Ensure that there are reports on the maintenance and inspection of lifting equipment or lifting gear within at least six months prior to their use to confirm that they are safe for use

(g) Check all lifting equipment and lifting gear before they are used

(h) Ensure that if one or more taglines are required to control the load, other personnel are instructed to handle the lines

3.3.2 Intermediate lifts

For intermediate lifts, it is necessary to calculate the weight of the load, and there is a high risk of hazards, whether in the work area or along the access route from the crane to the workplace. For intermediate lifts, the lifting supervisor should take into account the same matters mentioned for basic lifts, in addition to which he has to:

(a) Identify all the existing hazards in the area of operation, and visit the proposed location for the lifting works

(b) Prepare a risk assessment and a method statement that is specific to the worksite, detailing the control measures for the identified risks

(c) Communicate with other individuals or authorities (if necessary) to overcome the existing hazards by taking special action or measures to ensure the safe performance of the lifting works

(d) Take the appropriate action against the effects of lifting works on the external environment (such as buildings, traffic routes, etc.) or workers and the public, and give the proper notices to all the individuals concerned

3.3.3 Critical lifts

Critical lifts involve the complicated lifting of loads or persons, the use of two or more cranes, the lifting of loads beyond the permissible limit or the carrying out of lifting works at locations that are exposed to unusual hazards such as across or close to electric lines. For critical lifts, the lifting supervisor should take into account the matters mentioned for the normal and intermediate lifts, and should clearly know the following:

(a) weight and centre of gravity of the load

(b) area and wind speed

(c) connections or lifting points on the load that are appropriate for the load that is being used

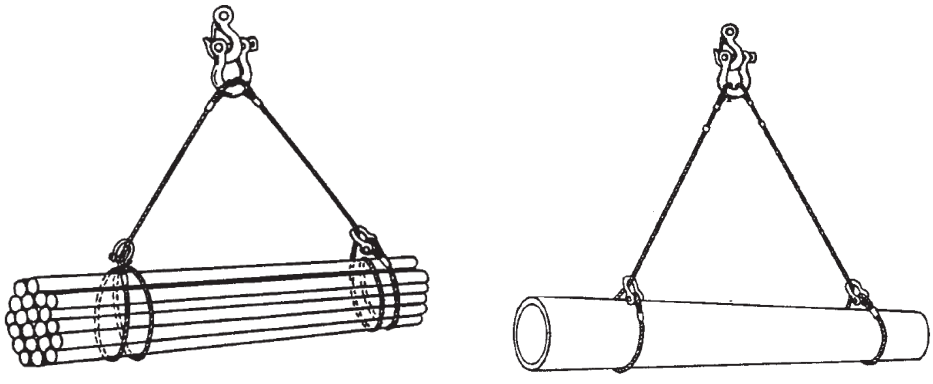
(d) method statement, including the access, ground conditions, crane installation and so on, as well as the proper sequence of work for lifting the load

3.4 Classification of Lifting Works

Lifting works can be classified as routine and non-routine lifting works. Both types of lifting works should have a carefully prepared lifting plan to identify the existing risks and the required level of control. The lifting plan can be planned on a daily, weekly or monthly basis.

3.4.1 Routine lifting works

Routine lifting works can be carried out under a basic lifting plan. This lifting plan must clearly define the load limit, the lifting method and the area of operation. For every load to be lifted, the lifting supervisor should conduct a risk assessment, which must be evaluated by the site safety supervisor and approved by the project manager before the lifting works can commence. Non-routine lifting works can also be carried out using the same documents, but they require more detailed information. The lifting plan has to be reviewed before the lifting works begin. Some examples of routine lifting works are shown in Figure 3.3.



(a) (b)

Figure 3.3 Examples of routine lifting works: (a) lifting of several metal rods, (b) lifting of cylinders (Hoisting and Rigging Safety Manual, 2012)

Among the factors involved in routine lifting works are:

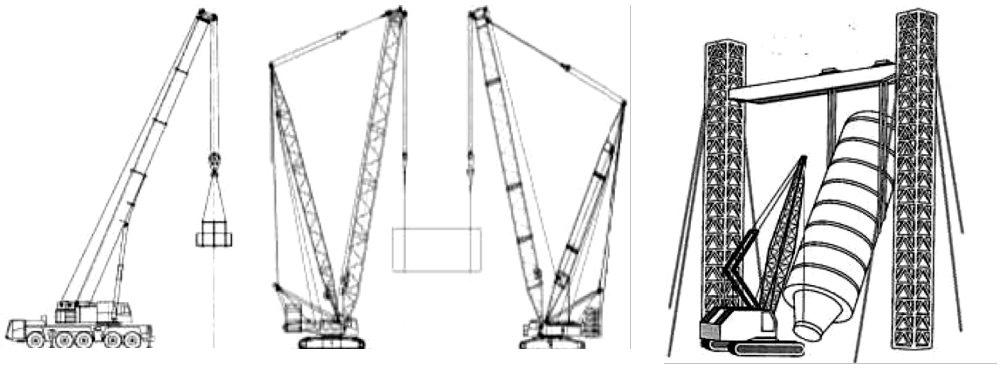
(a) lifting within the normal operating range of the crane
(b) lifting loads in an area that is not inconvenient/normal
(c) construction site is in suitable surroundings
(d) shape, weight and centre of gravity of the load have been identified

(e) repetitive lifting works using the same lifting equipment or lifting gear
(f) an equally competent crane operator
(g) the weight of the load to be lifted is below 75% of the load weight limit in the load chart
(h) the lifting equipment is specially assembled by a skilled rigger
(i) an appropriate lifting point is used
(j) a suitable lifting height
(k) standard hitching method

Note: In the case of repetitive or routine lifting works, the lifting work plan is only required at the beginning with regular observations.

3.4.2 Non-routine lifting works

Non-routine lifting works require more detailed lifting plans and factors compared to routine lifting works. These lifting plans, and any other requirements identified from those plans, must be approved by the project manager before the lifting works can be carried out. Some examples of non-routine lifting works are shown in Figure 3.4. Figures 3.5 and 3.6 illustrate the flowchart for the identification, planning and implementation of lifting works based on the Guidebook for Lifting Supervisors (2011).



(a) (b) (c)

Figure 3.4 Examples of non-routine lifting works: (a) lifting an excessive load, (b) lifting using two cranes, (c) a complex lift

Among the factors involving non-routine lifting works are:

(a) the use or two or more lifting equipment

(b) lifting of loads in a sensitive, difficult or confined area

(c) lifting works are resumed by different individuals

(d) lifting a machine without a lifting point

(e) in an environment that may influence the performance of the equipment

(f) difficult to estimate the weight of the loads and/or the centre of gravity

(g) hitching method that is not according to the standard

(h) load is lowered or raised from a confined space

(i) weight of the load is more than 75% of the load weight limit in the load chart

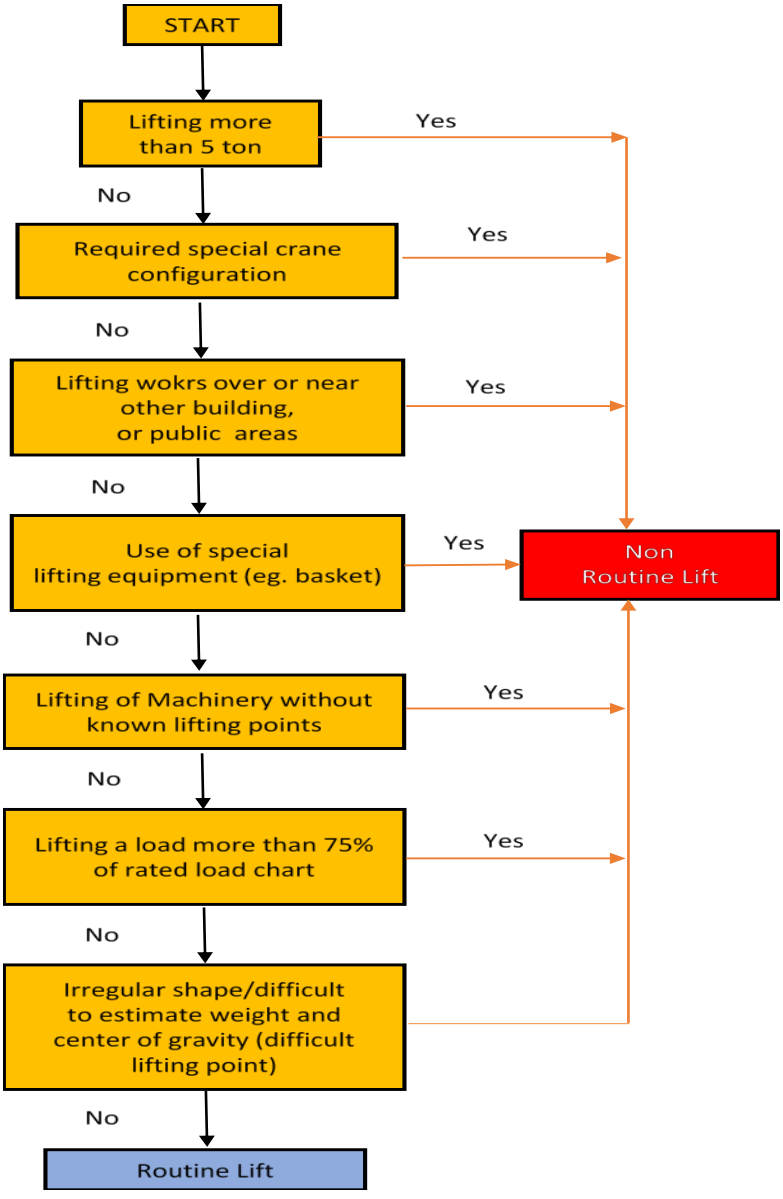


Figure 3.5 Identification of routine or non-routine lifting works

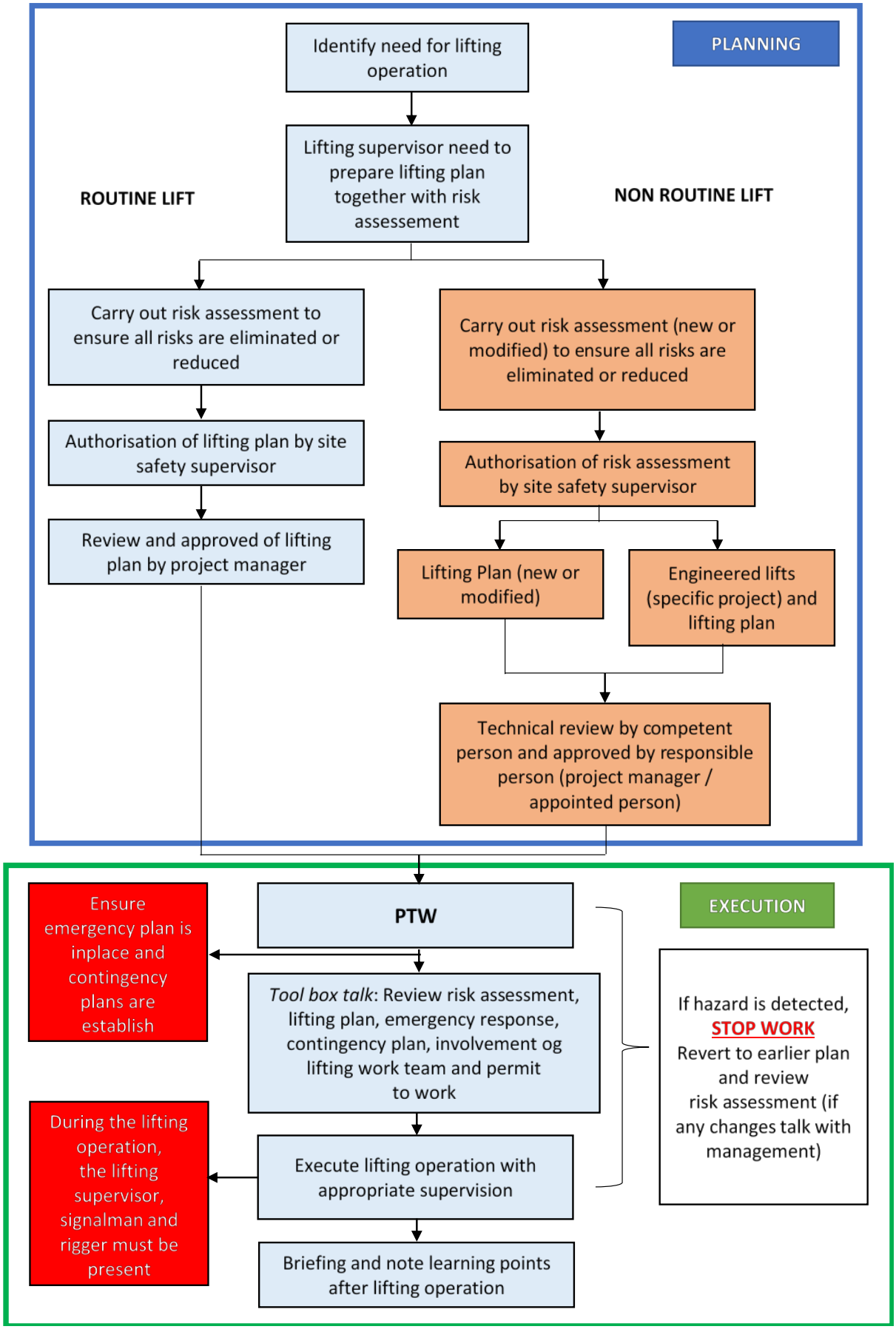


Figure 3.6 Flowchart on planning and implementation of lifting works

Bibliography

BS 7121-5:2006 Code of practice for safe use of cranes-Part 5: Tower cranes

Code of Practice for Safe Use of Tower Cranes, Hong Kong, 2012.

Guidebook for Lifting Supervisors, Workplace Safety and Health Council, Ministry of Manpower, Singapore, 2011.

Guidelines for Creating Lifting Plan for Lifting Operations In Workplaces, Workplace Safety and Health (WSH) Council, Singapore, 2014.

Hoisting and Rigging Safety Manual, Infrastructure Health & Safety Association, Canada, 2012

http://www.mytowercrane.com [11 September 2017]

In Jae, S. 2015. Factors that Affect Safety of Tower Crane Installation/Dismantling in Construction Industry. Safety Science 72:379-390.

Laporan dan fail siasatan Jabatan Keselamatan dan Kesihatan Pekerjaan (JKKP), Kementerian Sumber Manusia, Putrajaya.

Ronald G. Garby, PT's Crane & Rigging Handbook, IPT Publishing and Training Ltd., 2005.

Safe Lifting, 2002 Occupational Safety & Health Council, Hong Kong, 2002.

CHAPTER 4

INTRODUCTION TO TOWER CRANE

4.1 Introduction

Tower cranes come in various sizes, weights and loading capacities depending on the job type and requirements. Tower crane used at site construction as a lifting equipment for working conditions based on height of the building and ability to lift construction material in certain capacity. Generally, cranes that are properly maintained can be safely used in long term for 20 to 25 years.

The selected tower crane must be suitable for a purpose of work such as for lifting, lower or moving loads, and environmental conditions. Accidents can occur if crane selection is not properly made. The factors are need to consider in choosing a tower crane are as follows:

(a) the weight and dimensions of the load
(b) the height of lifting and distance/load movement area
(c) the number and lifting frequency
(d) the time frame for which the crane is used
(e) work place conditions, including soil condition for erection of tower crane and available space for crane access, construction, operation and dismantle
(f) any special operating requirements or prescribed limits including the presence of other cranes nearby

Discussions between crane owners, project owners, architects, consultants and project managers must be made early to ensure that the selected cranes are appropriate. Additionally, replacement or modification of crane/structure should be reported to DOSH, recorded, and stored as reference by the responsible party. Replacement of crane/structure should be in accordance with the specification set by manufacturer or crane designer.

The tower crane can be installed statically, can move or use the rail to move. During construction of the building crane is installed static. The base of the crane site must be designed by a Registered Engineer and must be approved by a Professional Engineer with a Practice Certificate before the work is done on the ground. Whereas, for the tower cranes installed on the rail, it must be able to move on the rail that was installed and designed by a Professional Engineer with Practice Certificate.

Tower cranes are mostly found at major construction sites. These cranes are usually mounted at permanent sites in the construction area concerned. Each type of tower crane has its own advantages and disadvantages, and the best type of cranes should be chosen to carry out the related work. Tower cranes are designed using high-strength iron shaped into a tower. They are used for construction sector as shown in Figure 4.1

(a) (b)

Figure 4.1 Example of a tower crane in contruction site: (a) luffing, (b) hammerhead

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 erection and dismantling the tower crane. It is also

meant to facilitate the transportation of the crane from one construction site to another.

Apart from tower crane, there are also several other cranes used in the construction sector such as mobile cranes, crawler cranes and Derrick cranes.

(a) Mobile crane

A mobile cranes (refer Figure 4.2) have wheels at their base like trailers, are among the cranes that are frequently used in the construction sector because of their nature as such. They are usually used in highway maintenance, construction of bridges and buildings, and on various other construction sites. The range for this type of crane is normally around 400 feet.

Figure 4.2 Mobile crane

(b) Crawler crane

A crawler crane (refer Figure 4.2) 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 4.3 Crawler crane (www.technicbricks.com)

(c) Derrick crane

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 (refer Figure 4.4). 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, to lower the crane structure involved in accidents or lower the load on a limited area.

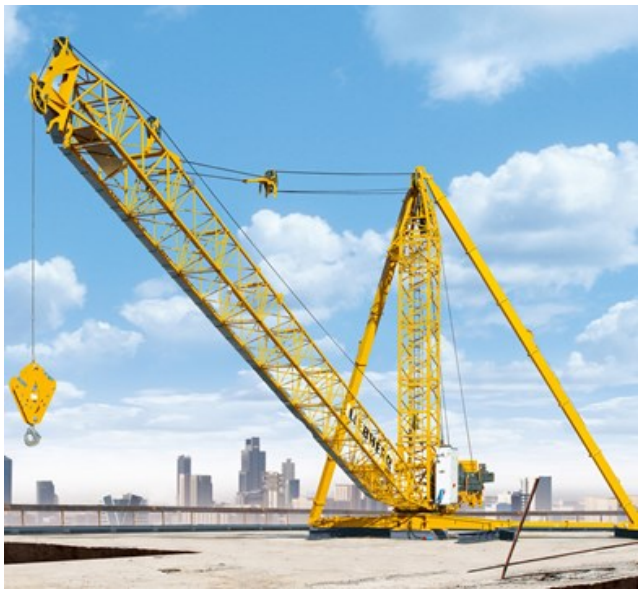


Figure 4.4 Derrick crane (www.liebherr.com)

4.2 Foundation and Types of Tower Cranes

A tower crane is fitted on concrete foundation and supported by beams. While a slewing platform, lifting equipment, jib and others component are mounted on the tower. For tower cranes that are installed by external climbing, the top part of the tower frame is fastened to any nearby building structure. While for tower cranes that are installed by internal climbing, ramps and beams are fastened to the base of the tower. The tower crane is mounted on a concrete base and supported by a pile. Whereas for platform slu, lifting equipment, jib and other components are installed on top of the tower. For exterior mounting tower cranes, external frames are tied to the structure of the building near the top of the tower. Whereas, for tower cranes mounted internally, ramps and beams are tied to the tower site. Before a tower crane is installed, safety inspections in a crane site should be carried out (personnel appointed by FYK) which should considered and planned according to the procedures that have been issued by a competent party or Professional Engineer with a Practice Certificate. 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.

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. 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 as shown in Figure 4.5. This type of mounting crane is suitable for open areas,

and should be placed at the front or in any place that can provide space to the boom to rotate or moved.

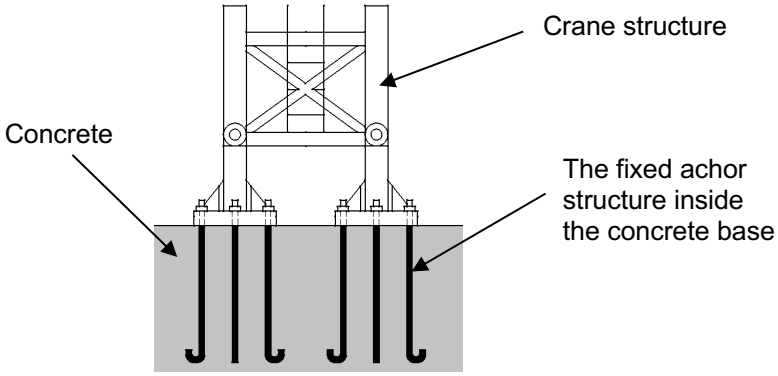


Figure 4.5 Installation of crane with in-situ cast base

(ii) Own base is the base of the crane which constructed by placing ballast at the crane base with the chassis as the weight as shown in Figure 4.6

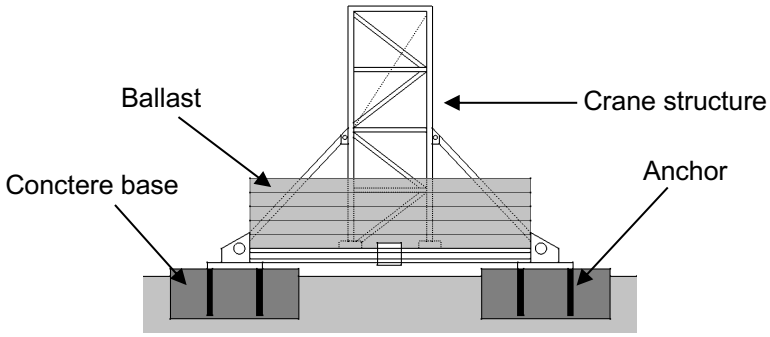


Figure 4. Installation of crane with own base

(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) External 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 as shown in Figure 4.7.

Rajah 4.7 Installation of crane with external supported static crane (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. The crane can be adjusted from one level of the building under construction to a higher level as shown in Figure 4.8.

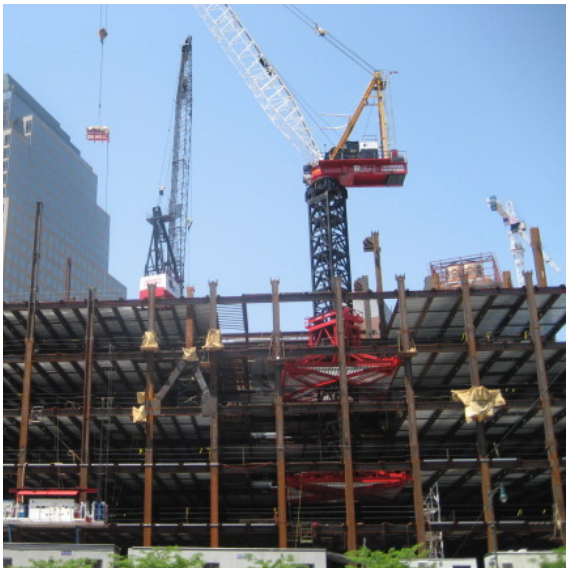


Figure 4.8 Installation of crane with internal climbing crane (www.dcm.milgromandassociates.com)

(c) Travelling rail

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 as shown in Figure 4. 9.

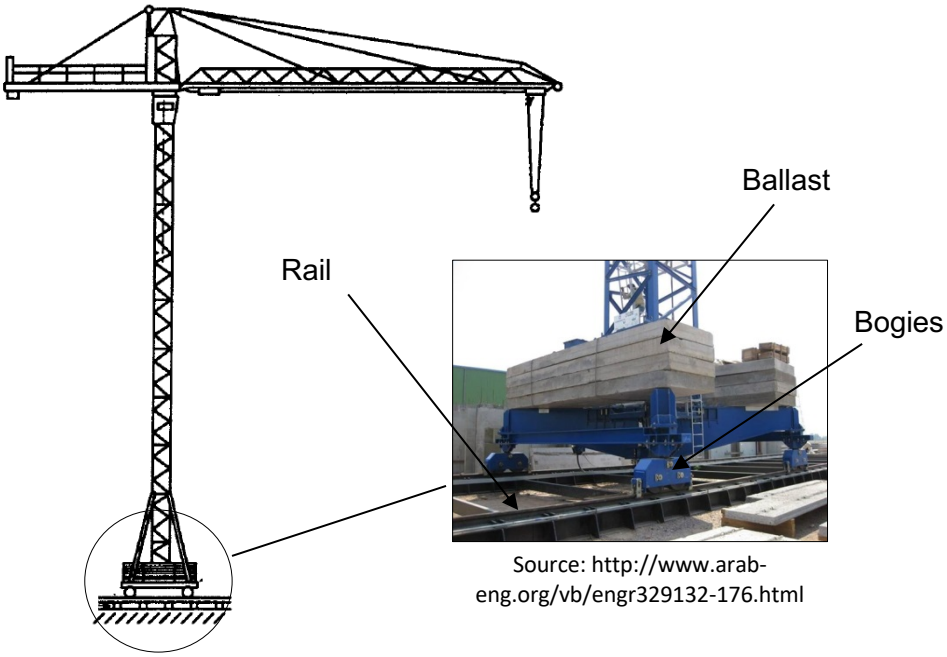
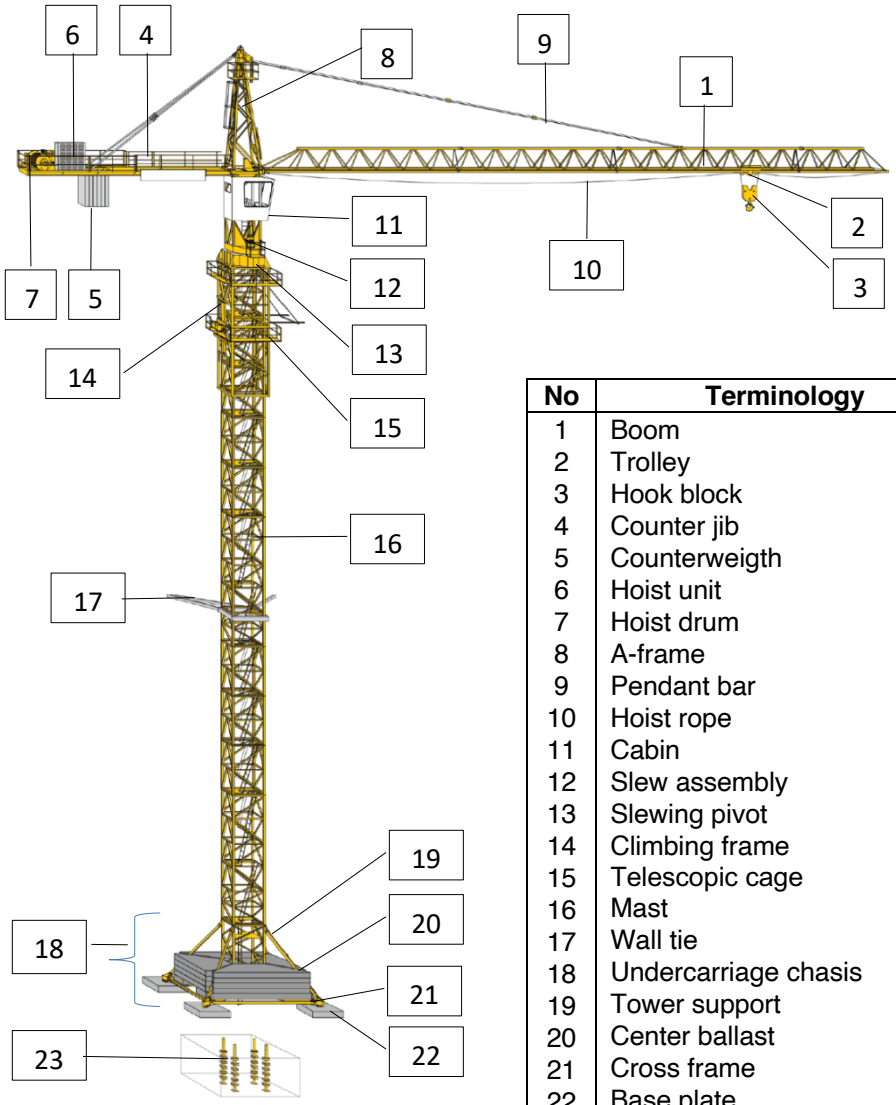


Figure 4.9 Tower crane with travelling rails base (Environmental, Health and Safety (EHS) Departments, US)

The design of tower crane is depend on its suitability for the work requirements. There are four types of tower cranes designed to lift, lower and move loads on construction sites. These tower crane are saddle top hammerhead, topless hammerhead, luffing and self erecting.

4.2.1 Saddle top hammerhead tower crane

This type of tower crane is adapted for industrial projects that have certain criteria, such as a wide load area, and it is driven by electrical power. If the area or site meets the specified criteria, then the hammerhead tower crane would be suitable for use as shown in Figure 4.10.



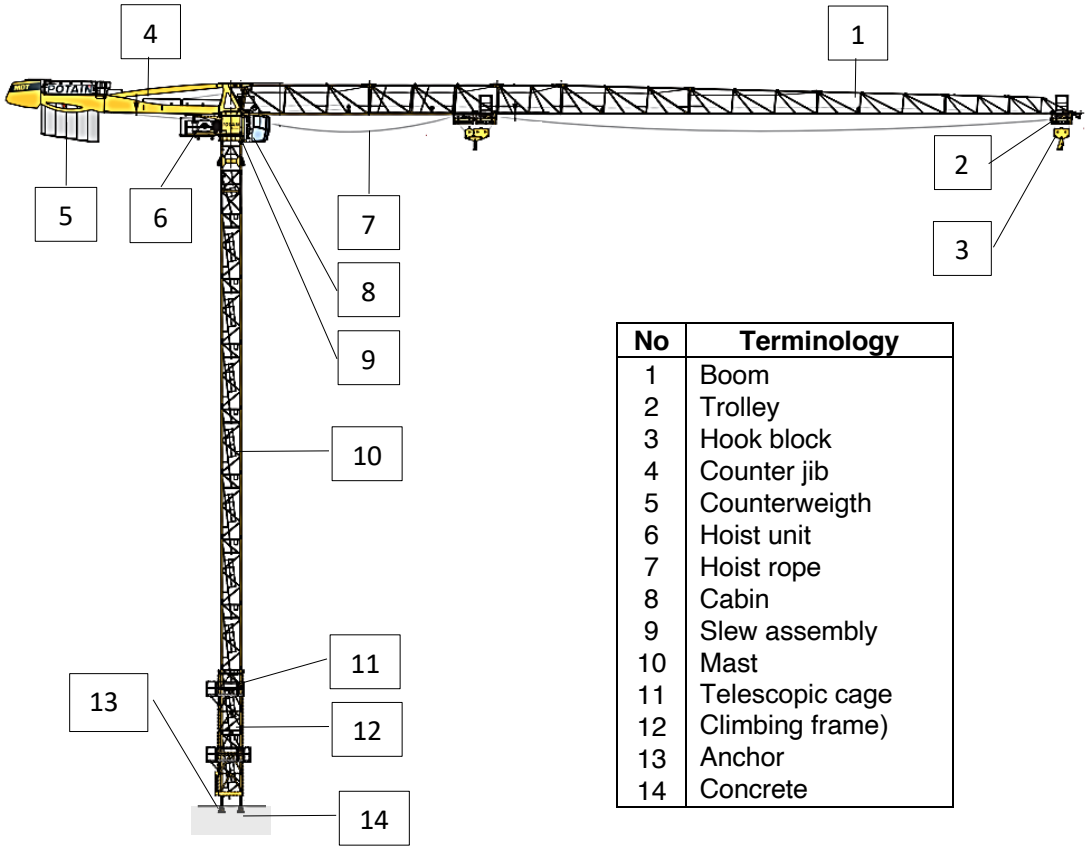
No	Terminology
1	Boom
2	Trolley
3	Hook block
4	Counter jib
5	Counterweigth
6	Hoist unit
7	Hoist drum
8	A-frame
9	Pendant bar
10	Hoist rope
11	Cabin
12	Slew assembly
13	Slewing pivot
14	Climbing frame
15	Telescopic cage
16	Mast
17	Wall tie
18	Undercarriage chasis
19	Tower support
20	Center ballast
21	Cross frame
22	Base plate
23	Anchor

Figure 4.10 Design of a hammerhead tower crane (saddle top) (www.morrow.com/crane101)

4.2.2 Topless hammerhead tower crane

This type of crane, which is powered by electricity, is suitable for use on construction sites with criteria such as wide rotation span, limited load capacity, and narrow/limited construction space. The topless hammerhead tower crane resembles a saddle top hammerhead except that it does not have an A-frame like other tower cranes, and it is more suitable for use at construction sites with narrow spaces or that are in close proximity to airports. The colliding between hammerhead (topless) cranes is also rare when they are mounted closely if the

crane's position is in different heights. The design and terminology for this type of tower crane are shown in Figure 4.11.

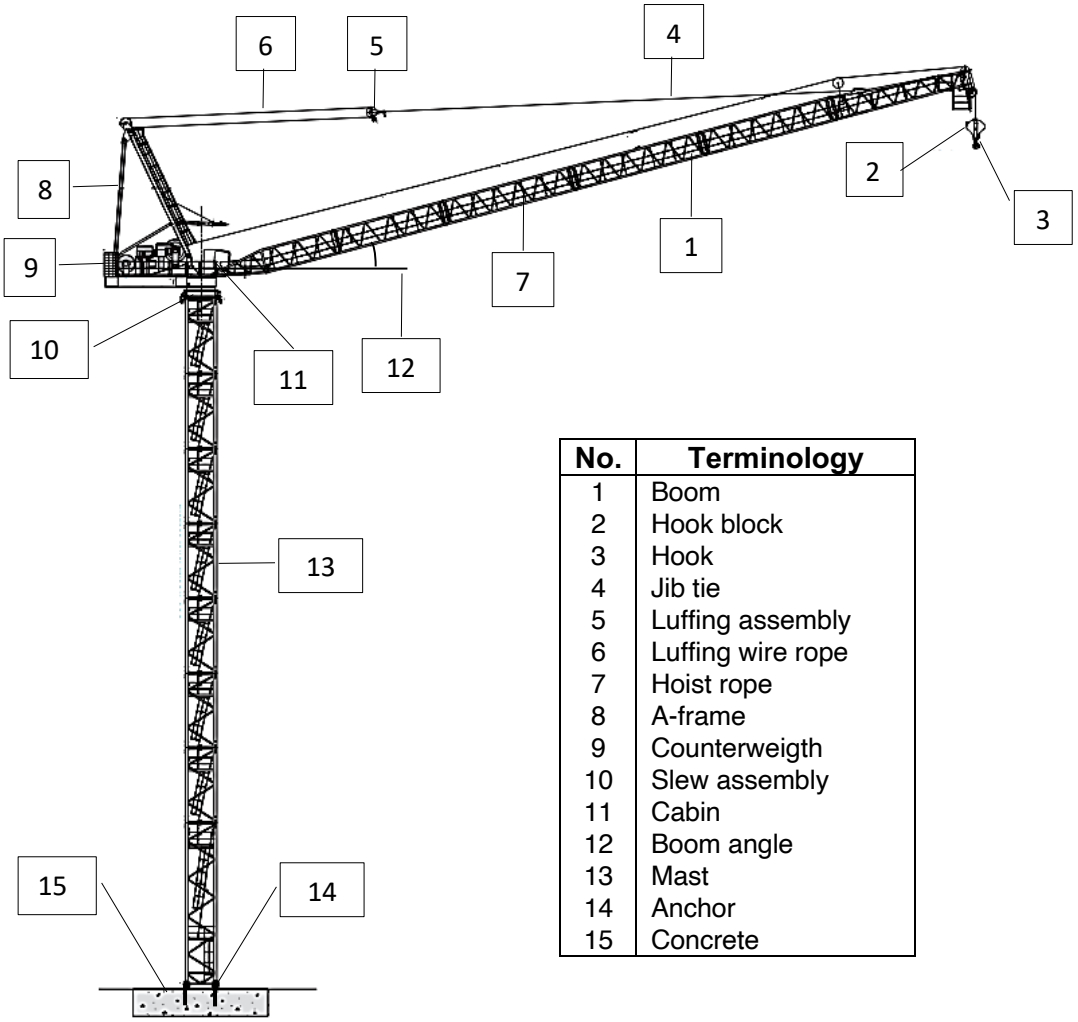


No	Terminology
1	Boom
2	Trolley
3	Hook block
4	Counter jib
5	Counterweigth
6	Hoist unit
7	Hoist rope
8	Cabin
9	Slew assembly
10	Mast
11	Telescopic cage
12	Climbing frame)
13	Anchor
14	Concrete

Figure 4.11 Design of a hammerhead tower crane (topless) (www.nftcrane.com)

4.2.3 Luffing tower crane

This type of tower crane, which is able to lift heavy loads and is powered by electricity, can be adapted for industrial projects with criteria such as limited rotation span. If the area or site meets the specified criteria, then the luffing tower crane is suitable for use as shown in Figure 4.12.



No.	Terminology
1	Boom
2	Hook block
3	Hook
4	Jib tie
5	Luffing assembly
6	Luffing wire rope
7	Hoist rope
8	A-frame
9	Counterweigth
10	Slew assembly
11	Cabin
12	Boom angle
13	Mast
14	Anchor
15	Concrete

Rajah 4.12 Design of luffing tower crane (www.morrow.com/crane101)

4.2.4 Self erecting tower crane

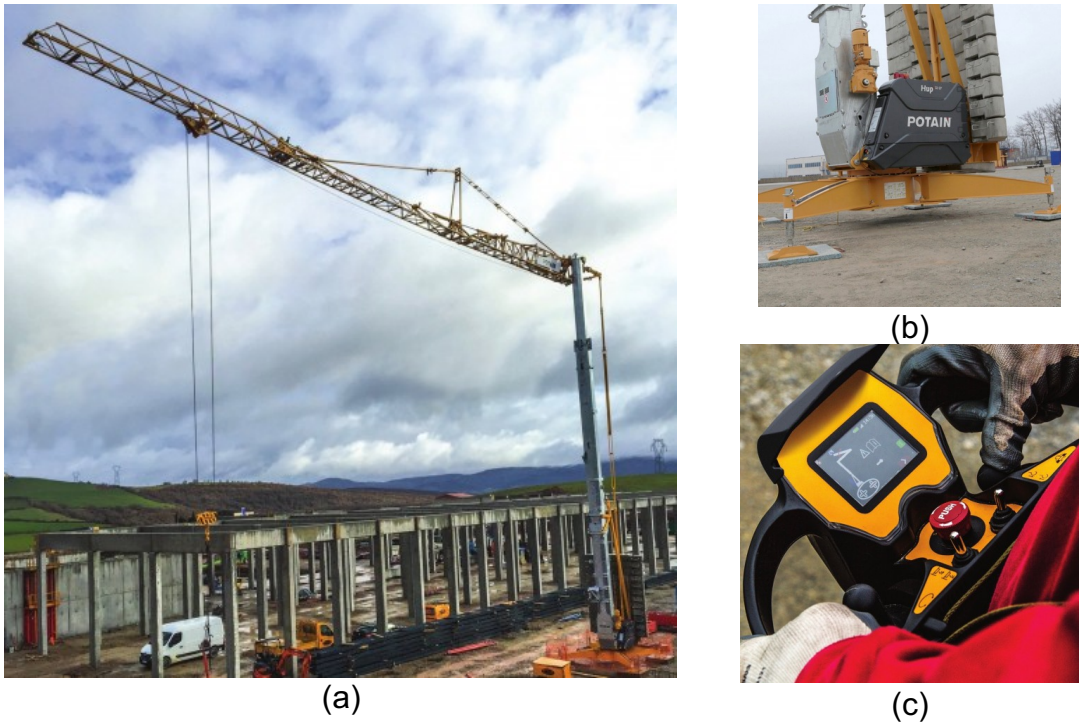
This type of crane can be operated in various configurations or selections of lifting operations for the construction of low and medium-rise buildings. The crane consists of a single mast that can be adjusted to increase the height of the crane, four jib structures, a crane base stabilized with a ballast and operated by remote control, as shown in Figure 4.13. Some of the advantages of this crane are:

(i) speed at which the load is lifted is automatically adjusted according to the load capacity

(ii) precise handling and efficient response to the movement of the crane and the load swing

(iii) uses electric power

(iv) installation of the crane is automatic, no additional mast is required, and a shorter time is required for the installation



(a) (b) (c)

Figure 4.13 Potain Hup 31-27 self-erecting tower crane model (a) crane design, (b) site installation, (c) operating a crane by remote control (www.bultenmaterieel.com)

4.3 Tower Cranes Safety Device

The tower crane must be equipped with a safety device (refer Table 4.1) that acts automatically when the specified limit is exceeded. This is important to avoid a damage to the crane or be able to cause an accident if the crane operator makes a mistake during the crane operation. Among of the safety switches that need to be installed are:

(i) hoist limit switch

(ii) slewing limit switch

(iii) trolley limit switch

(iv) luffing limit switch

(v) moment cut out switch

(vi) maximum safe working load cut out switch

Table 4.1 Function of the limit and safety device for crane operation

Device/Swicth	Funtion
Hoist limit switch	To prevent the block from colliding with the jib/boom
Slew limiter	Hammerhead and Luffing cranes can only rotate 2½ rounds, i.e. a radius of 900 degrees (360 x 360 x 180; radius degree units). It prevents the electric cables from snapping due to the rotation of the crane.
Trolley limit switch	To limit the movement of the block so as not to exceed its limit (either backward or forward)
Boom limit switch (luffing)	To limit the movement of the boom so as not to exceed its limit (either upper or lower)
Travel limit switch	For cranes that use rails or for mobile cranes.
Zone protection and anti-collision devices	Works by predicting of possible collisions. When the system detects a warning, it will control and operate the crane effectively
Load Limiter	
Moment breaker	To limit the load that is to be hoisted. If the load exceeds the limit, a siren will go off
Maximum safe working load breaker	To limit the movement of wire rope not to exceed the maximum distance when the load moves out of the boom

Before the operation of the tower crane commences, all security switches are ensured in good and functional condition. The position of the safety switchs on the tower crane are shown in Figure 4.14 and 4.15.

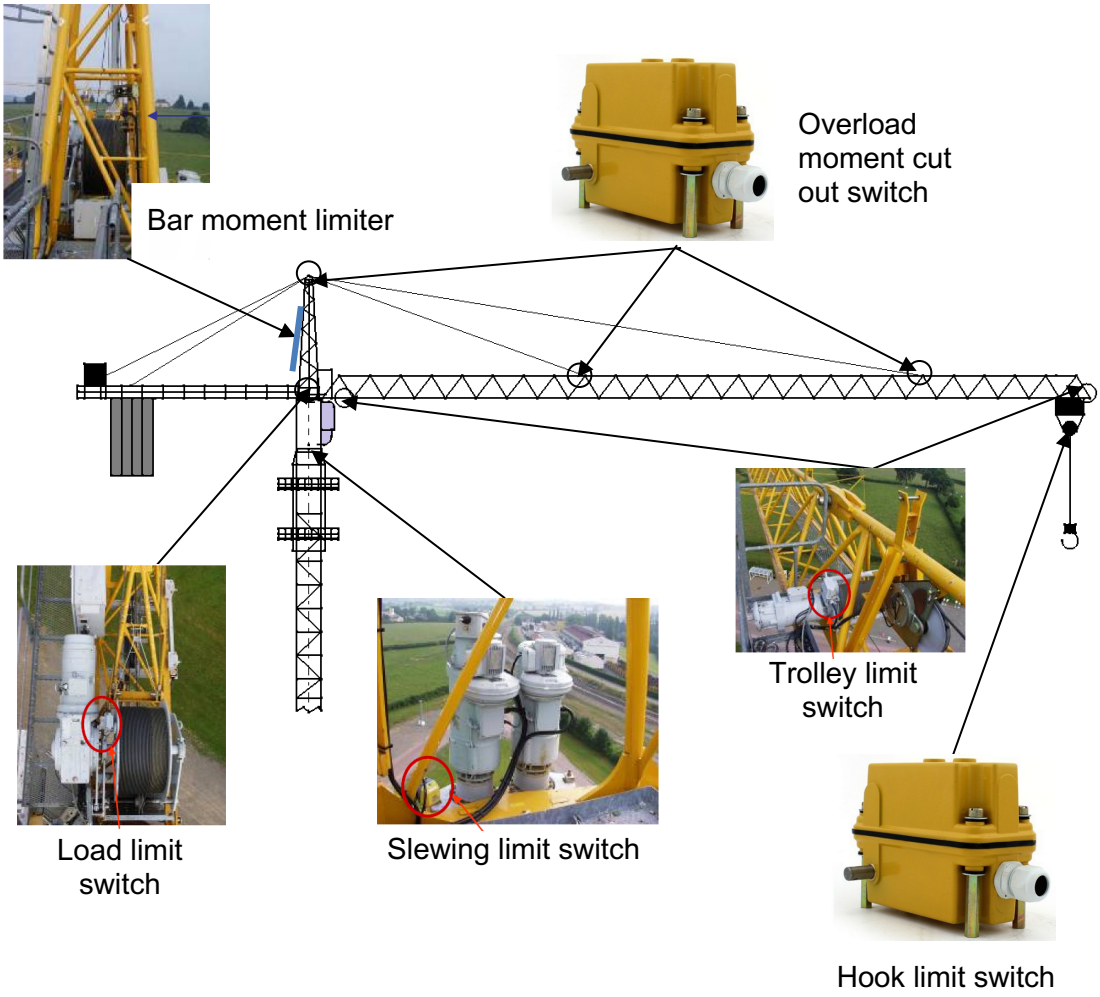


Figure 4.14 Position of safety switches on tower cranes (www.manitowoc.com)

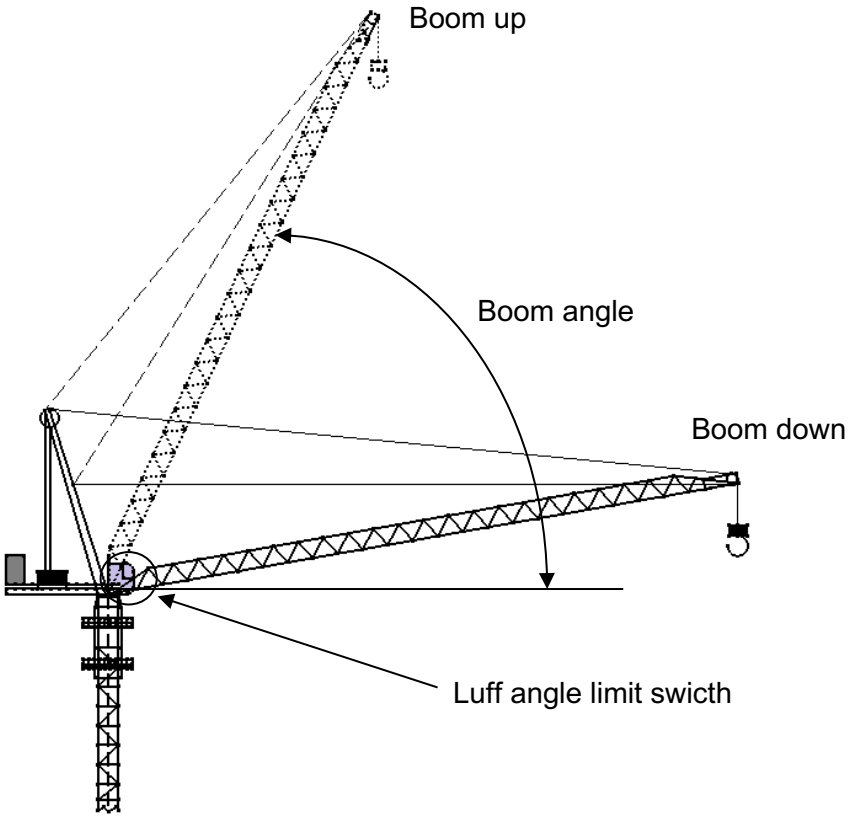


Figure 4.15 Position of boom limit switch movement (luffing tower crane)

Figure 4.16 shows an example of a load moment indicator in the cabin of a tower crane for limiting the load to be lifted, while Figure 4.17 shows the protection zone and anti-collision system or control for cranes.

(a) (b)

Figure 4.16 Screenshot of safe working load indicator: (a) hammerhead tower crane, (b) luffing tower crane (www.ccnmag.com)

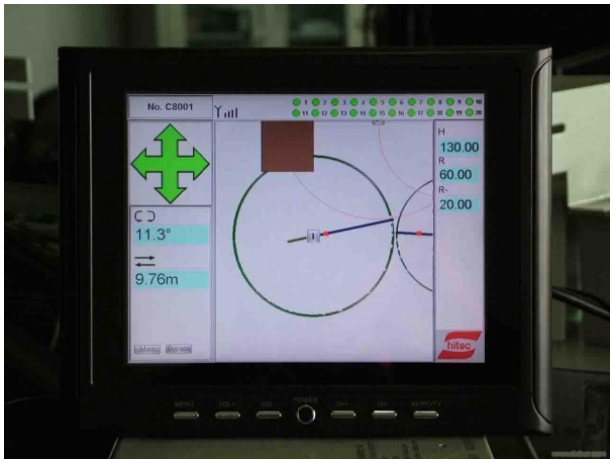


Figure 4.17 Screenshot of protection zone and anti-collision system (www.ccnmag.com)

4.4 Inspection and Maintenance of the Crane Tower

Tower cranes are machines that should be carefully maintained and inspected because they involve safety. A form of scheduled inspections has been implemented to facilitate tower crane operators in conduction pre- and post-operation inspections. The scheduled inspections have been grouped into two forms, there are:

(a) Logbook

The logbook must be in the operator's cabin of every tower crane machine to enable an operator to conduct scheduled inspections before and after operating the tower crane or when maintenance is performed on the tower crane. The contents of the logbook are as follows:

(i) operator name and qualification
(ii) permit for a Lifting Machine (*Perakuan Mesin Angkat*, PMA) certificate
(iii) maintainance of components/equipment
(iv) repairing of components/equipment
(v) reports of accidents or dangerous occurrences
(vi) report of damage

(b) Pre-Post Operation Form

A tower crane operator must perform a pre-post operation inspection before and after the operation of a tower crane in the interest of safety and to facilitate the operation of the tower crane. Example of the pre-post operation inspection form is shown in Table 4.2.

Table 4.2 Pre-post operation inspection form

Tower Crane Inspection Item	Condition		Note
	Good	Not good	
1. Check the crane foundation			
2. Main switch of the crane			
3. Earthing			
4. Mast structure			
5. No. of Perakuan Mesin Angkat (PMA)			
6. Pin/bolt/nut on crane mast			
7. Stairs			
8. Platform			
9. Slewing ring			
10. Hoisting motor			
11. Counterweight			
12. Sheave			
13. Grease			
14. Hon			
15. Crane structure			
16. Cabin			
17. Slewing brake			
18. Fire extinguisher			
19. Cabin mirror			
20. Logbook			
21. All safety devices			
22. Load chart			
23. Gear oil			
24. Distance indicator			
25. Crane manual			

Bibliography

Environmental, Health and Safety (EHS) Departments, US

http://www.morrow.com/crane101 [13 Ogos 2017]

http://www.technicbricks.com [19 Julai 2017]

Nota Operator Kren Menara, Institut Kemahiran Tinggi Belia Negara (IKTBN), Kementerian Belia dan Sukan, Bachok, Kelantan, 2004.

Nota Operator Kren Menara, Institut Kemahiran Tinggi Belia Negara (IKTBN), Kementerian Belia dan Sukan, Chembong, Negeri Sembilan, 2003.

Nota Tower Crane Operator, Gamuda Plant Operator School (GPOS), Shah Alam, Selangor, 2002.

Occupational Safety and Health Program, A Guide to Cranes and Derricks, US

Shukri, A.F.A. 2010. Malaysia Construction Experience in Deployment of Crane Services for Construction Project. Thesis Master of Science, Universiti Teknologi Malaysia.

Ronald G. Garby, PT's Crane & Rigging Handbook, IPT Publishing and Training Ltd., 2005.

Zrnic, N. D., Bosnjak, S. M., Gasic, V. M., Arsic, M. A. & Petkovic, Z. D. 2011. Failure analysis of the tower crane counter jib. *Procedia Engineering* 10: 2238-2243.

Crane Safety Inspection and Lifting Gears, Beruntung Skill Training Centre (BSTC)

http://www.liebherr.com [28 April 2017]

http://www.ccnmag.com [15 Jun 2017]

http://www.dcm.milgromandassociates.com [15 Jun 2017]

http://www.nftcrane.com [24 Jun 2017]

BS 7121-5:2006 Code of practice for safe use of cranes-Part 5: Tower cranes.

Code of Practice for Safe Use of Tower Cranes, Hong Kong, 2012.

PN12040 Tower Crane-Code of Practice, Autralia, 2017.

SS 559: 2010 Code of practice for safe use of tower cranes.

MS ISO 4306-3:2010 Cranes-Vocabulary-Part 3: Tower Cranes

MS 1803:2008 Cranes-Safety-Tower Cranes

CHAPTER 5

LOAD CHARTS

5.1 Introduction

A load chart is a table that is provided by crane manufacturers giving information on the hoisting capacities of cranes. The proper use of the load chart is one of the basic competencies of a crane operator. Individuals involved in hoisting operations need to understand how to read and use a load chart correctly. Nevertheless, tower cranes have been fitted with safety devices and switches that automatically indicate any excess loading weight or moments on the crane for safety purposes. If the load chart is wrongly read or the capacity of the crane is over-estimated, accidents can occur due to damage to the crane structure and the lifting equipment leading to injury/death to other workers and members of the public.

5.2 Understanding the Load Charts of Various Crane Models

Load charts list the hoisting capacities of cranes for various boom lengths and load ranges, as shown in Figures 5.1 and 5.2. To ensure a crane operates within a safe load range, the following points should be noted:

(i) The values shown in the load chart for a crane refer to the maximum load for the crane concerned (including the lifting equipment). These values apply to a crane that is in an “as new” condition and is installed according to the manufacturer’s specifications.

(ii) A load chart assessment only applies to a crane that has been maintained in good condition, as specified by the crane manufacturer. The boom is one of the critical elements in a crane, and it must be in perfect condition at all times.

(iii) Crane operators must understand load charts for the safe handling of loads. A copy of the load chart must be displayed in the crane operator's cabin.

Radius and Capacities

Hook Reach	Maximum Capacity – Radius	ft / m	13* / 4*	66 / 20	98 / 30	107 / 32.5	115 / 35	123 / 37.5	131 / 40	139 / 42.5	148 / 45	156 / 47.5	164 / 50	172 / 52.5	180 / 55	189 / 57.5	197 / 60	205 / 62.5	213 / 65
213 ft / 65m	26,460 lbs – 127 ft / 12 000 kg – 38.8m	lbs / kg	26,460 / 12 000	26,460 / 12 000	26,460 / 12 000	26,460 / 12 000	26,460 / 12 000	26,460 / 12 000	25,245 / 11 450	22,155 / 10 410	20,945 / 9 500	19,160 / 8 690	17,550 / 7 960	16,115 / 7 310	14,795 / 6 710	13,625 / 6 180	12,520 / 5 680	11,530 / 5 230	10,580 / 4 800
197 ft / 60m	26,460 lbs – 136 ft / 12 000 kg – 41.4m	lbs / kg	26,460 / 12 000	26,460 / 12 000	26,460 / 12 000	26,460 / 12 000	26,460 / 12 000	26,460 / 12 000	26,460 / 12 000	24,440 / 11 540	23,345 / 10 590	21,495 / 9 750	19,820 / 8 990	18,320 / 8 310	16,955 / 7 690	15,720 / 7 130	14,550 / 6 600		
180 ft / 55m	26,460 lbs – 144 ft / 12 000 kg – 43.8m	lbs / kg	26,460 / 12 000	26,460 / 12 000	26,460 / 12 000	26,460 / 12 000	26,460 / 12 000	26,460 / 12 000	26,460 / 12 000	26,460 / 12 000	25,395 / 11 520	23,415 / 10 620	21,625 / 9 810	20,020 / 9 080	18,520 / 8 400				
164 ft / 50m	26,460 lbs – 150 ft / 12 000 kg – 45.8m	lbs / kg	26,460 / 12 000	26,460 / 12 000	26,460 / 12 000	26,460 / 12 000	26,460 / 12 000	26,460 / 12 000	26,460 / 12 000	26,460 / 12 000	26,460 / 12 000	25,065 / 11 370	23,150 / 10 500						
148 ft / 45m	26,460 lbs – 148 ft / 12 000 kg – 45m	lbs / kg	26,460 / 12 000	26,460 / 12 000	26,460 / 12 000	26,460 / 12 000	26,460 / 12 000	26,460 / 12 000	26,460 / 12 000	26,460 / 12 000	26,460 / 12 000								
131 ft / 40m	26,460 lbs – 131 ft / 12 000 kg – 40m	lbs / kg	26,460 / 12 000	26,460 / 12 000	26,460 / 12 000	26,460 / 12 000	26,460 / 12 000	26,460 / 12 000	26,460 / 12 000										
115 ft / 35m	26,460 lbs – 115 ft / 12 000 kg – 35m	lbs / kg	26,460 / 12 000	26,460 / 12 000	26,460 / 12 000	26,460 / 12 000	26,460 / 12 000												
98 ft / 30m	26,460 lbs – 98 ft / 12 000 kg – 30m	lbs / kg	26,460 / 12 000	26,460 / 12 000	26,460 / 12 000														

*Minimum hook reach.

The maximum weight lifted by the crane at a hook/ boom distance, 55 m

1-PART OPERATION

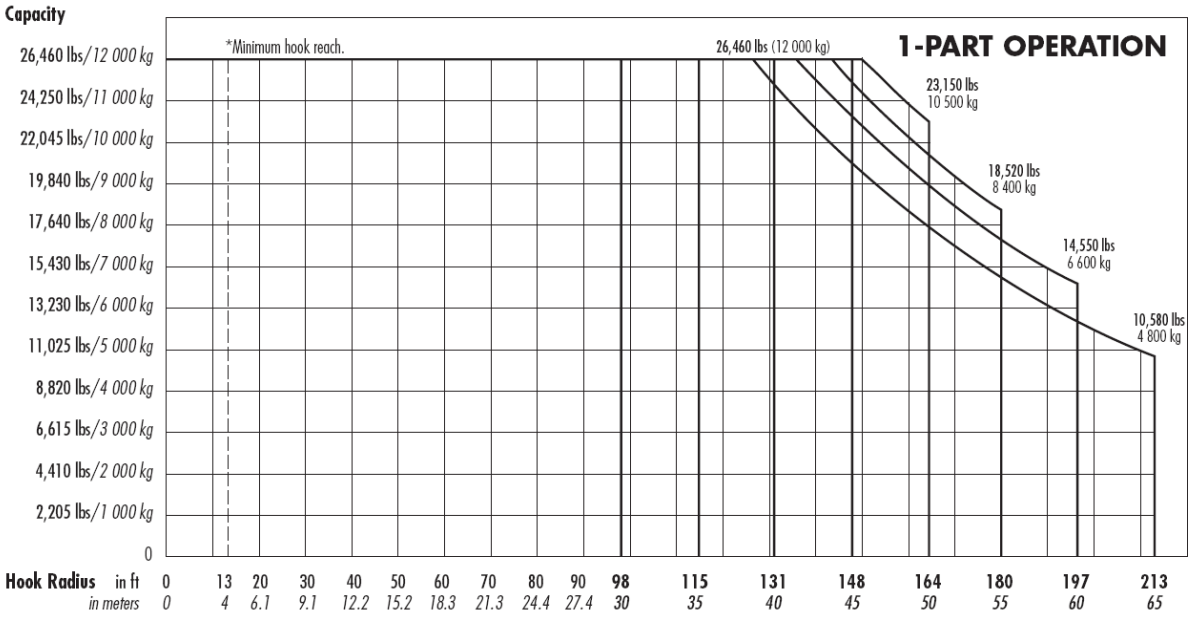


Figure 5.1 Load chart for a luffing crane (single-wire rope reeve) (Lift Director-Tower Cranes Load Chart Manual, 2013)

Radius and Capacities

2-Part Operation

Hook Radius	Jib Tip Radius	Maximum Capacity – Radius	ft / m	33 / 10	49 / 15	66 / 20	82 / 25	98 / 30	115 / 35	131 / 40	148 / 45	164 / 50	180 / 55	197 / 60	213 / 65	230 / 70	246 / 75
246 ft 75m	252'-0" 76.8m	22,050 lbs – 104 ft 10 000 kg – 31.6m	lbs kg	22,050 10 000	22,050 10 000	22,050 10 000	22,050 10 000	22,050 10 000	19,670 8 920	16,670 7 560	14,370 6 520	12,540 5 690	11,050 5 010	9,790 4 440	8,730 3 960	7,830 3 550	7,050 3 200
230 ft 70m	235'-7" 71.8m	22,050 lbs – 117 ft 10 000 kg – 35.6m	lbs kg	22,050 10 000	22,050 10 000	22,050 10 000	22,050 10 000	22,050 10 000	22,050 10 000	19,180 8 700	16,600 7 530	14,530 6 590	12,850 5 830	11,460 5 200	10,270 4 660	9,260 4 200	
213 ft 65m	219'-2" 66.8m	22,050 lbs –129 ft 10 000 kg – 39.2m	lbs kg	22,050 10 000	22,050 10 000	22,050 10 000	22,050 10 000	22,050 10 000	22,050 10 000	21,500 9 750	18,650 8 460	16,380 7 430	14,530 6 590	12,990 5 890	11,680 5 300		
197 ft 60m	202'-9" 61.7m	22,050 lbs – 139 ft 10 000 kg – 42.4m	lbs kg	22,050 10 000	22,050 10 000	22,050 10 000	22,050 10 000	22,050 10 000	22,050 10 000	22,050 10 000	20,460 9 280	17,990 8 160	16,000 7 260	14,330 6 500			
180 ft 55m	186'-0" 56.7m	22,050 lbs – 148 ft 10 000 kg – 45m	lbs kg	22,050 10 000	22,050 10 000	22,050 10 000	22,050 10 000	22,050 10 000	22,050 10 000	22,050 10 000	21,910 9 940	19,310 8 760	17,200 7 800				
164 ft 50m	169'-7" 51.7m	22,050 lbs – 155 ft 10 000 kg – 47.3m	lbs kg	22,050 10 000	22,050 10 000	22,050 10 000	22,050 10 000	22,050 10 000	22,050 10 000	22,050 10 000	22,050 10 000	20,500 9 300					
148 ft 45m	153'-3" 46.7m	22,050 lbs – 148 ft 10 000 kg – 45m	lbs kg	22,050 10 000	22,050 10 000	22,050 10 000	22,050 10 000	22,050 10 000	22,050 10 000	22,050 10 000	22,050 10 000						
131 ft 40m	136'-10" 41.7m	22,050 lbs – 131 ft 10 000 kg – 40m	lbs kg	22,050 10 000	22,050 10 000	22,050 10 000	22,050 10 000	22,050 10 000	22,050 10 000	22,050 10 000							
115 ft 35m	120'-5" 36.7m	22,050 lbs – 115 ft 10 000 kg – 35m	lbs kg	22,050 10 000	22,050 10 000	22,050 10 000	22,050 10 000	22,050 10 000	22,050 10 000								

The maximum weight at a distance of 55 m

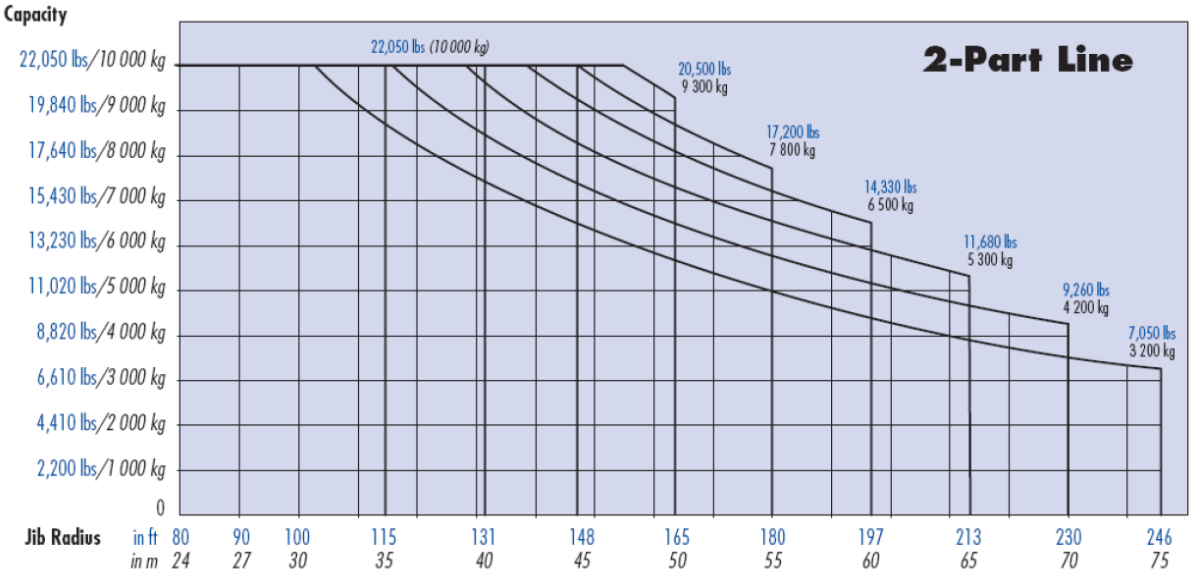


Figure 5.2 Load chart for a hammerhead crane (double-wire rope reeve) (Lift Director - Tower Cranes Load Chart Manual, 2013)

5.3 Use of Load Charts for Different Types of Cranes

Every type of crane has its own load chart. Personel involved need to know how to use these different load charts in order to avoid failure in the lifting equipment and to the crane structure.They must discipline themselves and to ensure that they do not exceed the load limit specified in the load chart or by the crane manufacturer without supervision by a responsible person during load hoisting operations. Examples of trolley configurations, maximum load

weight and specifications for Kroll K180 hammerhead tower crane model are shown in Figures 5.3 and 5.4.

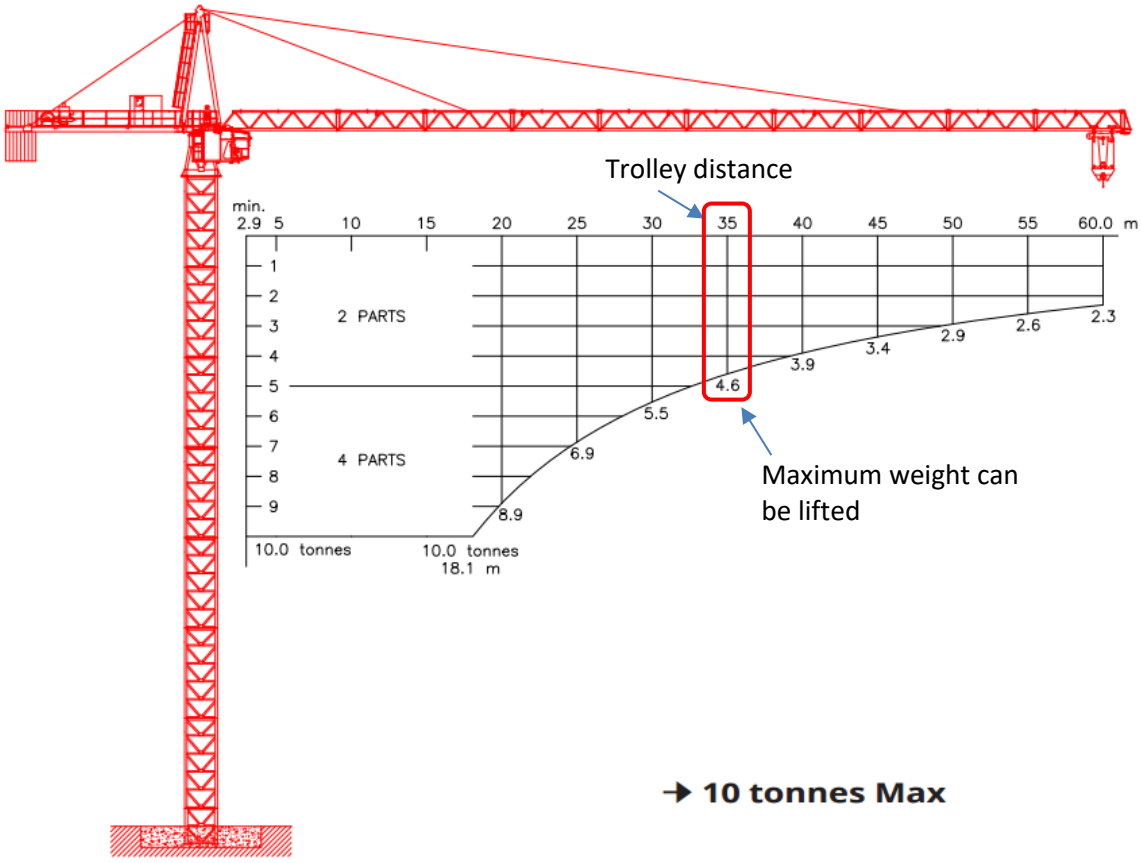


Figure 5.3 Trolley configuration and a safe load weight (www.krollcranes.dk)

TROLLEY SPEEDS			TROLLEY WIRE	
	0 - 10 t	0 - 70 m/min	Diameter	10 mm
			Safety Factor	5
			MBL	87 kN
	SLEW DRIVE			POWER
	Motor			SUPPLY
	2 x 7 kW			400 - 480 V, 50/60 Hz
SLEW SPEEDS			Consumption	50 kVA
	0 - 10 t	0 - 0.7 rpm	Main Fuse	80 A
			Recommended Genererator Size	125 kVA
	UNDERCARRIAGE			SUPPLY CABLE
	Motor			
	2 x 5.5kW			
TRAVEL SPEEDS			Cable Length	Cable Type
	0 - 10 t	0 - 20 m/min	0 - 175 m	4 x 16 mm²
			175 - 250 m	4 x 25 mm²

Figure 5.4 Specifications for hammerhead tower cranes (www.krollcranes.dk)

Examples of configurations for boom distance, luff angle and specifications for Potain MR605 luffing tower cranes model are shown in Figures 5.5-5.7.

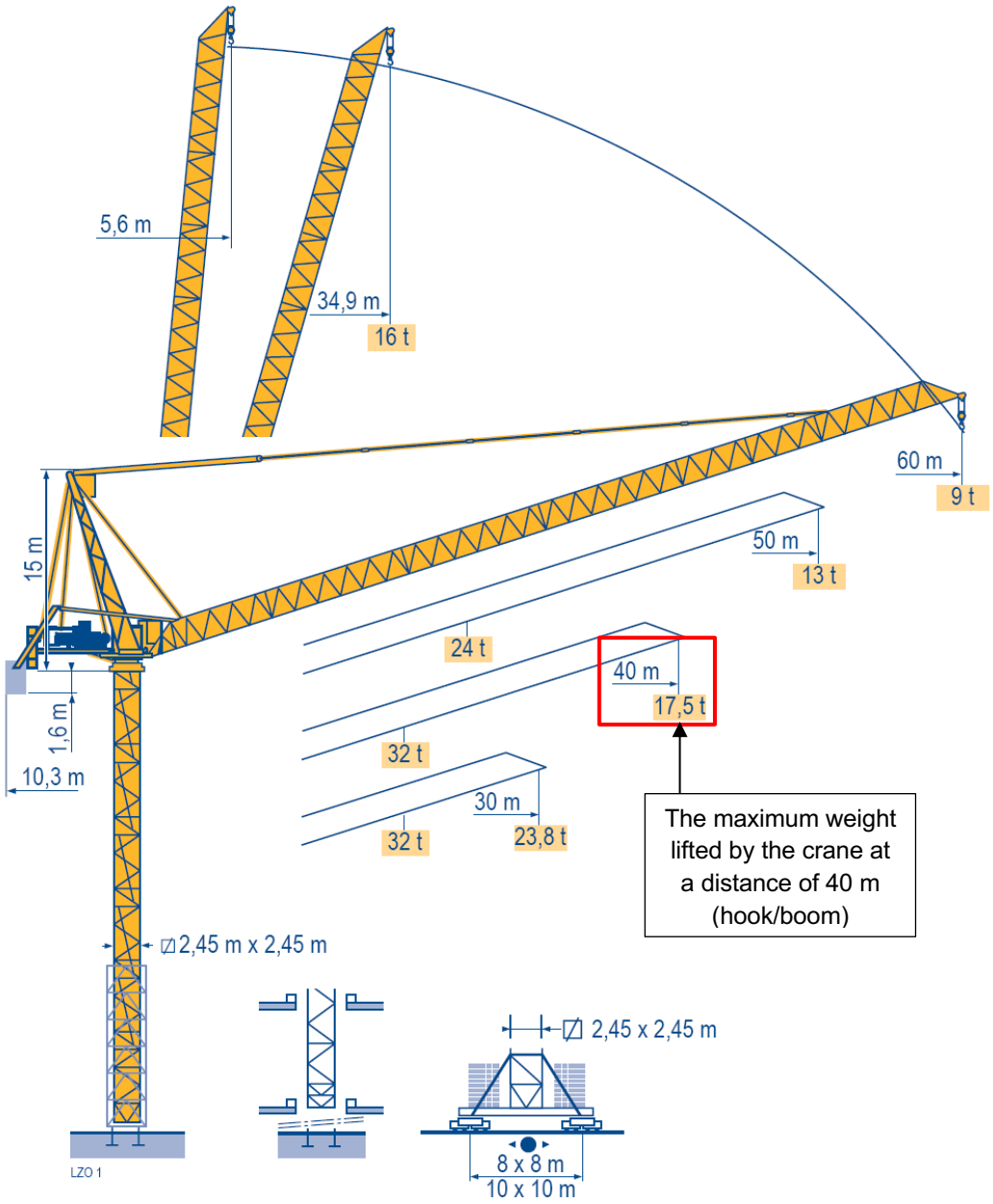


Figure 5.5 Configurations for boom distance and safe load weight for luffing tower cranes luffing (www.bigge.com)

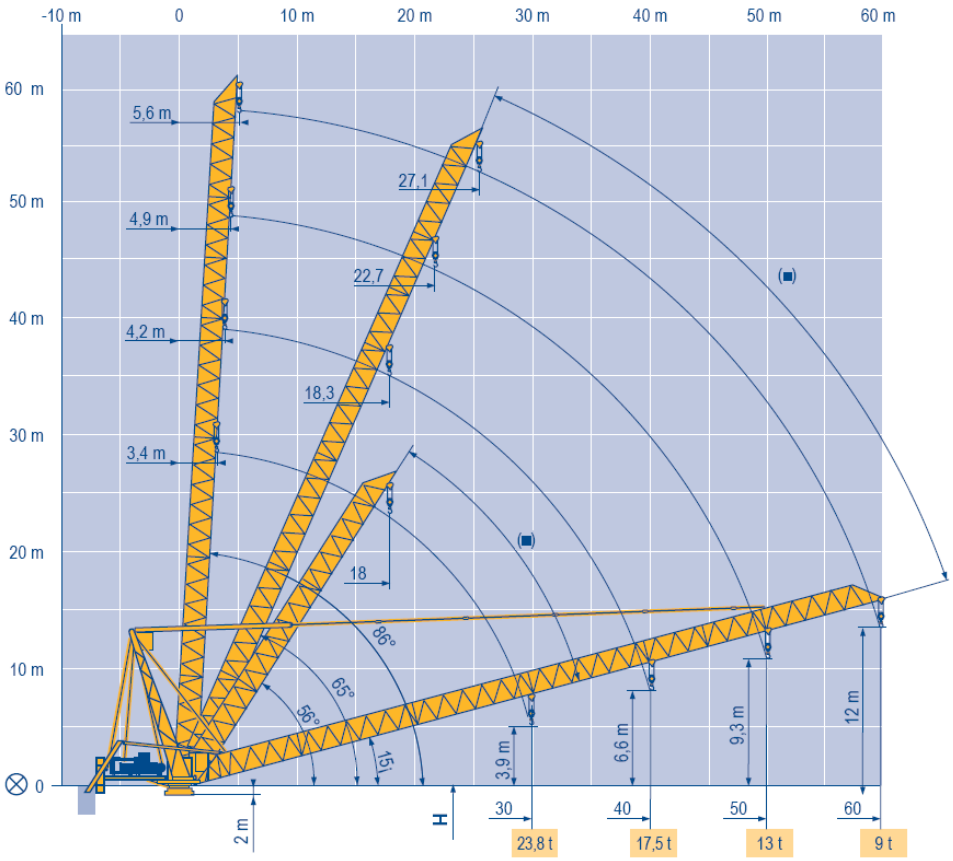


Figure 5.6 Configuration of luff angle luffing tower crane (www.bigge.com)

MR 605 B H32 50 Hz										ch - PS hp	kW	
	180 LBR 80 L 1090	m/min	3,8/38	6/60	9,5/95	15,2/152	1,9/19	3/30	4,75/47,5	7,6/76	180	132	1090 m
		t	16	10,1	5,9	3,25	32	20,2	11,8	6,5			
	90 VBR		3 min 17 s								90	66	
	R - 13,2	tr/min U/min rpm	0 → 0,67								3 x 6	3 x 4,4	
	Y 800 A J 850 A	m/min											

CEI 38	IEC 38	kVA
400 V (+6% -10%) 50 Hz		270 kVA

MR 605 B H32 60 Hz										ch - PS hp	kW	
	215 LBR 80 L 1090	m/min	4,6/46	7,2/72	11,4/114	18,2/182	2,3/23	3,6/36	5,7/57	9,1/91	215	158	1090 m
		t	16	10,1	5,9	3,25	32	20,2	11,8	6,5			
	108 VBR		2 min 44 s								108	79	
	R - 15,8	tr/min U/min rpm	0 → 0,8								3 x 7,2	3 x 5,3	
	Y 800 A J 850 A	m/min											

CEI 38	IEC 38	kVA
480 V (+6% -10%) 60 Hz		325 kVA

Figure 5.7 Specifications for a luffing tower crane (www.bigge.com)

Examples of the load chart and specifications for a CTT182-8 topless hammerhead tower crane are shown in Figures 5.8 and 5.9.

Specifications:

- Maximum boom length: 65 meters
- Capacity at maximum length: 2 tons
- Maximum capacity: 8 tonnes

Figure 5.8 Load chart for topless hammerhead tower crane (www.bigge.com)

			t	m/min	kW	
	37 AFC 40 (Variant)		4	0 ➔ 44	37	510 m, max 255 m
			3	0 ➔ 57		
			2	0 ➔ 82		
			1,5	0 ➔ 105		
			1	0 ➔ 132		
			8	0 ➔ 22		
			6	0 ➔ 28		
			4	0 ➔ 41		
			3	0 ➔ 52		
			2	0 ➔ 66		

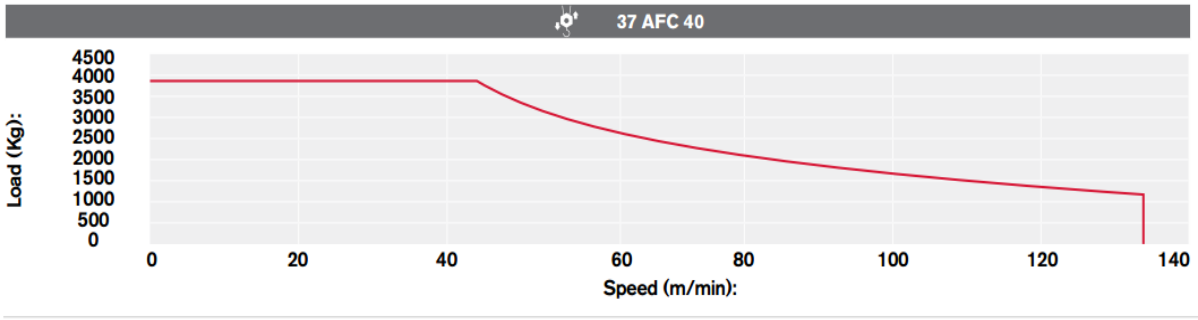
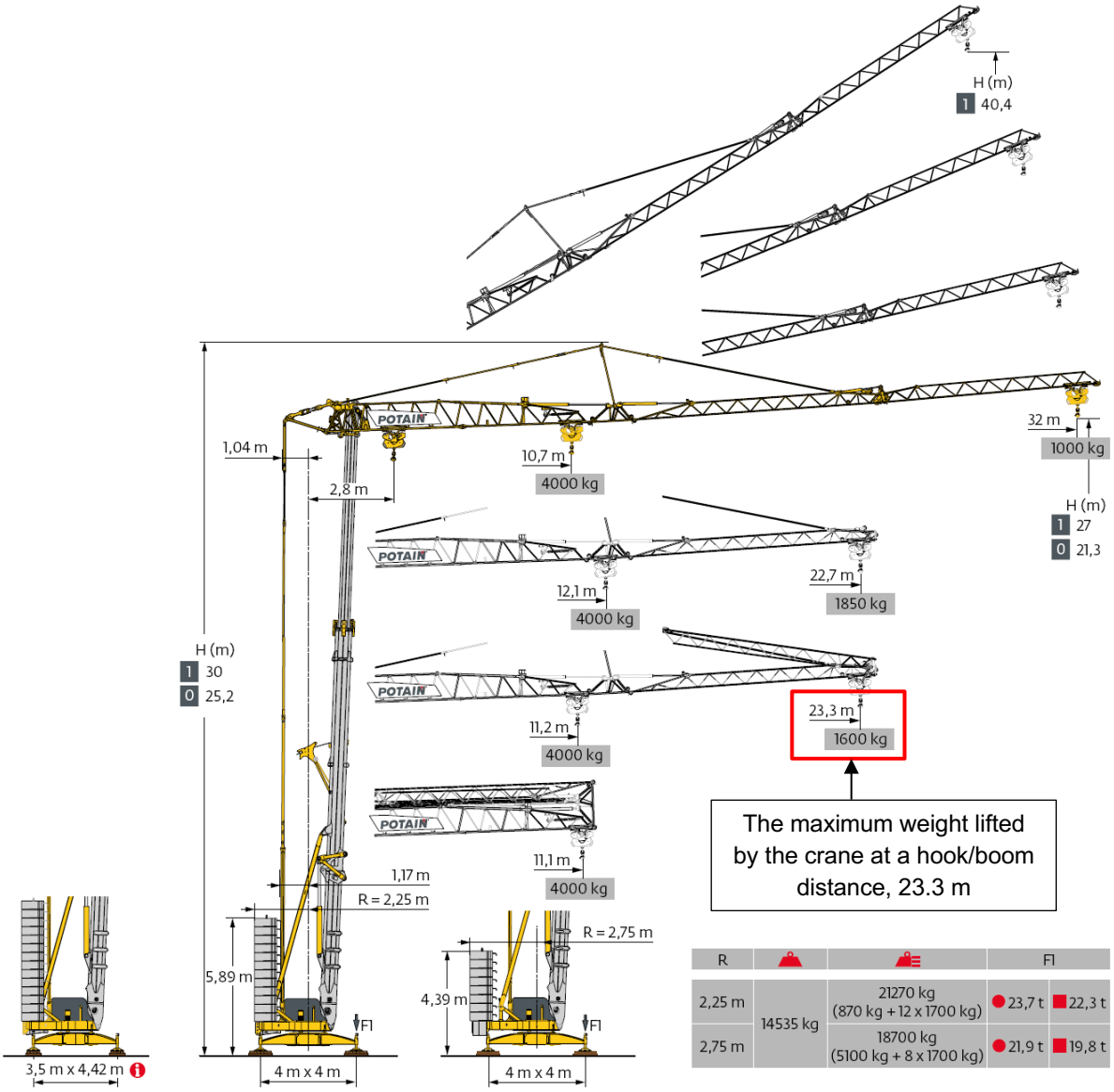


Figure 5.9 Specifications for the speed of load lifting (www.bigge.com)

Examples of the load chart and erection process for a Hup 32-27 self erecting tower crane model are shown in Figures 5.10 and 5.11.



R			Fl	
2,25 m	14535 kg	21270 kg (870 kg + 12 x 1700 kg)	● 23,7 t	■ 22,3 t
2,75 m		18700 kg (5100 kg + 8 x 1700 kg)	● 21,9 t	■ 19,8 t

Figure 5.10 Load chart for self erecting tower crane (www.manitowoccranes.com)

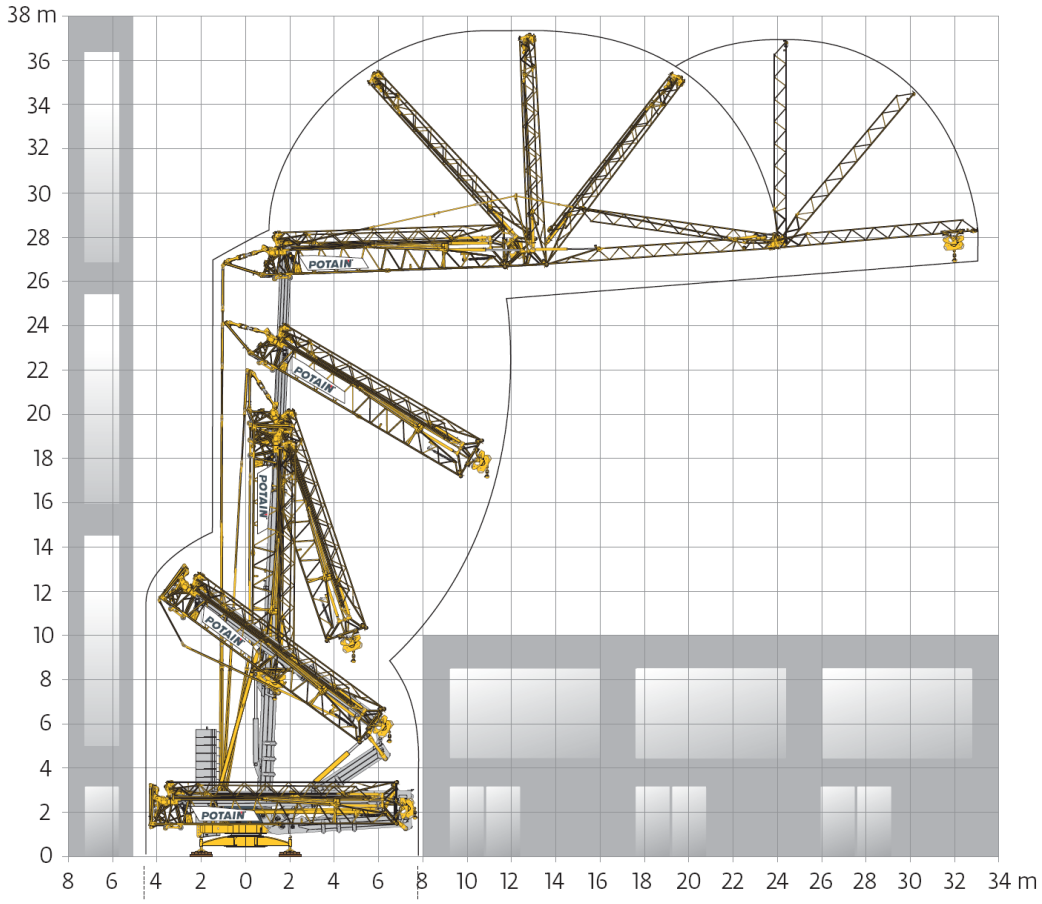


Figure 5.11 Erection movement for self erecting tower cranes (www.manitowoccranes.com)

Bibliography

Bobby R. Davis, & Sydney Cheryl Sutton, A Guide to Crane Safety, N.C. Department of Labor Division of Occupational Safety and Health, 2004.

Crane Manual, (Operations, maintenance and safety), The Deeside Railway Crane Manual, 2007.

Guidelines for Creating Lifting Plan for Lifting Operations in Workplaces, WSH Council, 2014.

Crane Safety Inspection and Lifting Gears, Beruntung Skill Training Centre (BSTC)

https://www.bigge.com/crane-charts/Comedil-CTT182-8.pdf. [23 March 2017]

https://www.cranehunter.com/how-to-read-crane-load-chart. [23 March 2017]

https://www.favellefavco.com/main-tower-model-luffing.php. [23 March 2017]

https://www.krollcranes.dk/media/Data_Sheet_K180-10t.pdf. [23 March 2017]

https://www.krollcranes.dk/media/k180-m22-us.pdf [23 March 2017]

https://www.manitowoccranes.com [26 September 2017]

https://www.technicbricks.com [20 September 2017]

James Headley, How To Use Load Charts, Crane Institute of Maerica Publishing and Products, Inc., U.S. 2011.

Lift Director-Tower Cranes Load Chart Manual, National Commission for the Certification of Crane Operators, 2013.

Nota Operator Kren Menara, Institut Kemahiran Tinggi Belia Negara (IKTBN), Kementerian Belia dan Sukan, Bachok, Kelantan, 2004.

Nota Operator Kren Menara, Institut Kemahiran Tinggi Belia Negara (IKTBN), Kementerian Belia dan Sukan, Chembong, Negeri Sembilan, 2003.

Nota Tower Crane Operator, Gamuda Plant Operator School (GPOS), Shah Alam, Selangor, 2002.

CHAPTER 6

SAFE LIFTING WORKS

6.1 Hazards During Lifting Works

Accidents involving lifting works can be due to several factors such as failure of the structure, crane components and lifting equipment or lifting gear. However, the results of investigations into the accidents that have occurred revealed that the main causes can be attributed to weak planning, supervision and coordination of lifting works. Given below are some of the causes of failure that result in accidents during lifting works:

(i) the absence of or a poor risk assessment prior to the lifting works

(ii) weak implementation of control measures against existing risks

(iii) a poor lifting plan or the absence one that is suitable for each lifting work

(iv) a poor permit to work system or the absence of one to manage the lifting works

(v) maintenance of lifting equipment (lifting gear, wire rope, pulley and so on) and safety devices that are not functioning properly

(vi) weak control over safety at the construction site (such as failure to maintain a “danger zone” with guards/barriers so that workers who are not involved in the lifting works are prevented from entering the lifting zone)

6.2 Preventive Measures for Safe Lifting Works

Planning for the safe operation of tower cranes involves the implementation of a comprehensive risk assessment, a clear statement of safe work methods/procedures, a good hoisting plan, the use of suitable lifting equipment and lifting gear, a competent lifting team, and the adoption of a permit to work (PTW) system to ensure hoisting works are safely conducted. Figure 6.1 shows the safety guidelines issued by DOSH for hoisting works.

To ensure the safe operation of cranes, the parties involved in hoisting, works, such as lifting supervisors, operators, riggers and signalman, should take the following matters into consideration:

(i) safe work zones
(ii) operators, riggers and signalman must be competent
(iii) safety devices and limiters must be functioning during crane operations
(iv) safe load indicators are installed in cranes
(v) lifting equipment and lifting gear are in good condition, and are marked with the working load limit (WLL)
(vi) safe access and egress to the crane or the place where hoisting works are being conducted
(vii) the load does not collide with any object while it is being lifted
(viii) the load is not lifted over any building or persons (refer to Figure 6.2(a))
(ix) the load is lifted slowly to ensure the stability of the load (refer to Figure 6.2(b))
(x) the height and length of the tower crane boom
(xi) refer to the load chart for the luff angle and position of the trolley
(xii) reeving of wire rope on hoisting pulley (refer to Figure 6.3)
(xiii) adding of counterweigth (refer to Figure 6.4)
(xiv) permissible load radius
(xv) detailed knowledge of the load to be lifted (load weigth and shape)
(xvi) identifying the centre of gravity/hoisting point of every load to be lifted

In addition, when the tower crane is not in operation, the crane operator must ensure that the hook block/trolley is placed at the closest distance to the mast and the hook is raised to the highest position. Meanwhile, in bad weather, except for cranes that are close to buildings or structures, the brakes must be released to enable the boom to rotate freely (refer to Figure 6.2(c)).

Figure 6.1 Guidelines for safe lifting works (www.dosh.gov.my)

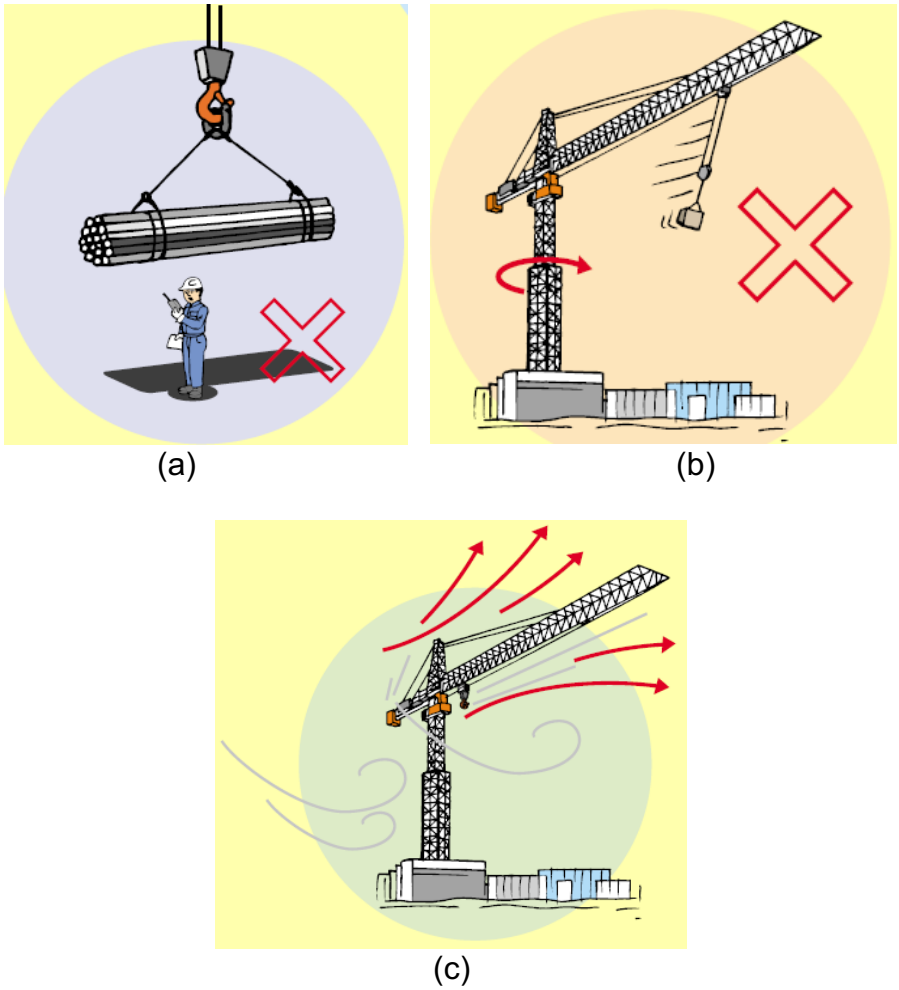


Figure 6.2 Crane operation situations: (a) load cannot be lifted over or across people, (b) crane should be moved at a slow speed, (c) position of the hook block and release of the brake during severe weather (Safe Lifting, 2002)

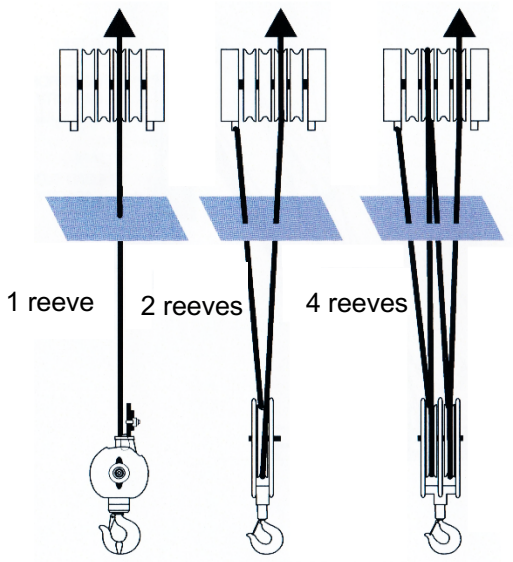


Figure 6.3 Types of wire rope reeving to the pulley at the hook block (How To Use Load Charts, 2011)

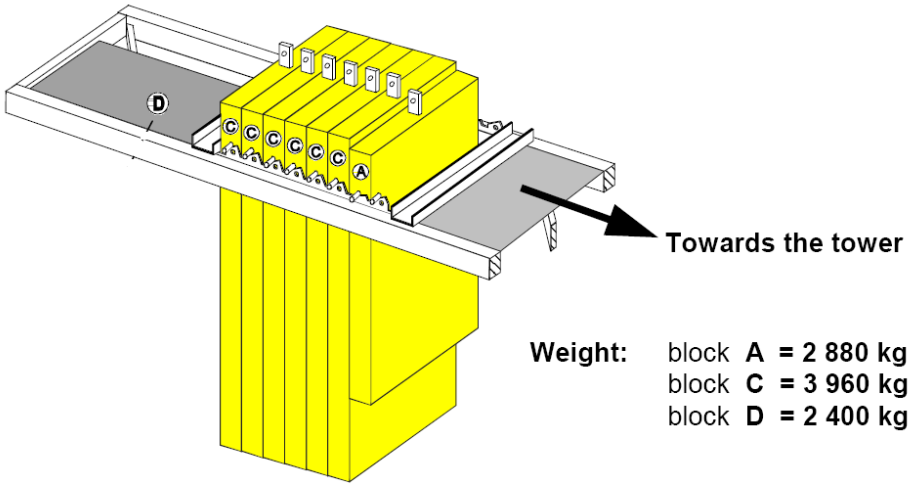


Figure 6.4 Position of counterweight on a tower crane (Lift Director-Tower Cranes Load Chart Manual, 2013)

6.3 Permit to Work

A permit to work system is a system for managing and controlling several types of hazardous works, including lifting operations. The lifting supervisor, who is coordinating the lifting operations, has to apply to the project manager to conduct the lifting operations. The scope and conditions for the lifting operation that is to be carried out must be stated in the permit to work (PTW) application. The project manager is responsible for conducting an inspection to confirm that appropriate control measures have been taken to reduce any risk of expected hazards. Once it is confirmed that the safety measures have been taken, the application will be approved by the project manager. The contents that must be in the PTW (guide to contents in PTW issued by DOSH, as shown in Figure 6.5) are as follows:

(a) Identification of hazards

(b) Risk assessment

(c) Required control measures for the eradication of hazards and the level of risk

(d) Determining the persons who are at risk, and they being not limited to:

  (i) lifting supervisor

  (ii) signalman

  (iii) rigger

(iv) crane operator
(v) persons who inspect, erect, climb, test, maintain and dismantle the tower crane
(vi) construction workers
(vii) members of the public

(e) Prepare a PTW in writing to include the following:
(i) level of competence, skills and expertise in all lifting operations
(ii) list of segregation/precautionary measures before lifting works are carried out
(iii) list of prohibited activities
(iv) list of lifting equipment and machines to be used
(v) list of personal protection equipment to be used
(vi) list of the planned work sequence on identifying the hazards/control measures for eradicating the hazards
(vii) emergency action plan
(viii) list of the personnel and the relevant authorised personnel involved in the application, assessment, issuing, monitoring and cancellation of the PTW

(f) Hold a briefing for members of the lifting team regarding the hazards and control measures that should be taken
(g) Ensure the individuals in the lifting team understand and comply with the PTW
(h) The PTW must be displayed at the workplace for the reference of the workers who are involved, and a copy must be kept for the reference of DOSH
(i) Ensure the work area is clean and safe
(j) Ensure all the safety devices on the crane are functioning properly

The lifting supervisor must ensure that the PTW is issued by the project manager before the commencement of lifting works. Table 6.1 shows an example of the workflow for the application and approval of the PTW based on the Guidebook for Lifting Supervisors (2011). A sample of the permit to work form is shown in Annex B. In addition, the project manager must prepare a

management system to be implemented by the lifting supervisor for lifting works for the purpose of:

(a) ensuring all the lifting equipment have had their capacities determined, and have been inspected and properly maintained

(b) ascertaining and ensuring that all the safety devices on the crane are functioning and are well-maintained, and have not been disturbed

(c) records in relation to the use, inspection and maintenance must be kept together with the tower crane, and must be available on request

All the information in this management system must be documented and can be checked, when required, either by the lifting supervisor or DOSH.

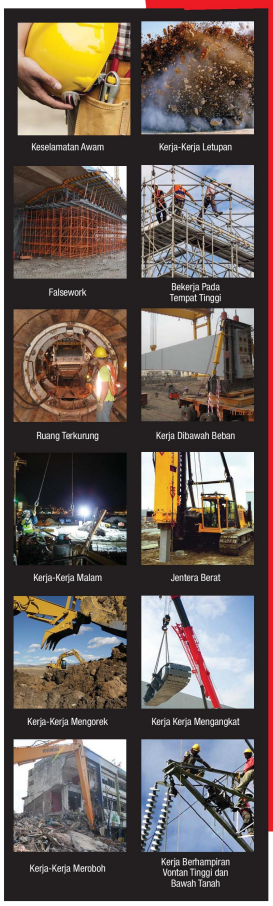
Table 6.1 Workflow for the application and approval of a permit to work for lifting works

Work process	Action
Application	The lifting supervisor duties • Assess a risk • Prepare a lifting plan • Submit a lifting plan, HIRARC, checklist and emergency response plan to project manager
Validation	• Project manager appoints a safety assessor (such as an officer of Occupational Safety and Health or a competent person) • Verification of PTW application, lifting plan, HIRARC, checklist and emergency action plan by safety assessor or authoritative person)
Approval	• Submission of verification documents by safety assessor to project manager • Review and approval by project manager • PTW issued to lifting supervisor
Monitoring	• Safety and Health Officers are constantly monitoring safe work operations • Lifting supervisor need to follow instructions in PTW • Lifting supervisor should inform the project manager after the lifting operation is complete
Revoke	• The project manager may cancel the PTW if the lifting team fails to comply with the instructions in PTW

No

KERJA – KERJA YANG MEMERLUKAN PERMIT
PERMIT TO WORK (PTW)

KANDUNGAN DALAM PERMIT TO WORK (PTW)



1. **Pengenalpastian bahaya.**
2. **Penilaian risiko.**
3. **Langkah kawalan yang perlu untuk menghapuskan bahaya dan tahap risiko.**
4. **Menentukan siapa yang berisiko.**
5. **Menyediakan PTW secara bertulis yang merangkumi:**

   - Tahap kecekapan dalam semua operasi dan apa-apa kemahiran dan kepakaran;
   - Senarai pengasingan/ langkah berjaga-jaga sebelum kerja;
   - Senarai aktiviti yang dilarang;
   - Senarai peralatan dan jentera;
   - Senarai peralatan perlindungan diri yang akan digunakan;
   - Senarai turutan kerja seperti dirancang dengan mengenal pasti bahaya/ langkah kawalan untuk menghapuskan bahaya;
   - Pelan tindakan kecemasan;
   - Senarai personel yang terlibat- authorised personel yang berkaitan dengan pengeluaran PTW;

6. **Mengadakan taklimat kepada mereka yang beroperasi dibawah PTW terhadap bahaya dan langkah-langkah kawalan yang perlu diambil.**
7. **Memastikan sesiapa yang menjalankan kerja memahami tentang PTW dan mematuhinya**
8. **PTW hendaklah dipamerkan di kawasan kerja untuk rujukan pekerja dan satu salinan hendaklah disimpan untuk rujukan JKKP.**
9. **Memastikan kawasan kerja bersih, selamat dan semua peranti keselamatan berfungsi dengan baik**

Boleh melayari website JKKP
http://www.dosh.gov.my/index.php/ms/construction-safety

BAHAGIAN KESELAMATAN TAPAK BINA
JABATAN KESELAMATAN DAN KESIHATAN PEKERJAAN MALAYSIA
ARAS 1, 3, 4 & 5 BLOK D4, KOMPLEKS D
PUSAT PENTADBIRAN KERAJAAN PERSEKUTUAN
62530 PUTRAJAYA.

Figure 6.5 Guide to contents and works that require a permit to work (www.dosh.gov.my)

6.4 Calculation of Weights of Various Types of Materials

Information regarding the weights of building materials can be obtained in various ways, such as:

(a) Checking the label on the material
(b) From a supervisor or individual who has better knowledge
(c) From the catalogue that is delivered together with the material
(d) From business records or operating manuals that may be able to provide clearer information on the weight of a component or material
(e) Through calculations

If the size of the material is known, the weight of the material can also be calculated from information regarding the density of the material concerned, as shown in Table 6.2. The lifting supervisor, signalman and rigger are responsible for ensuring that small materials such as stones, bricks, tiles, blackboards or other objects are hoisted in a strong and solid container, and are securely wrapped (for example, in plastic). The project manager is responsible for ensuring that the lifting team that is handling the load, including the lifting supervisor, operator, signalman and rigger have received sufficient training in terms of the principles of lifting operations, the weight of the load, and the appropriate lifting distance.

Table 6.2 Typical weights of building materials

MATERIALS	WEIGTHS
Aluminium	2.7 ton/m^3
Bricks, clay	1.6 ton/m^3
Cast iron	7.2 ton/m^3
Cement	50 kg/bag
Concrete, wet or set	2.4 ton/m^3
Concrete panel (Steel reinforced	3.0 ton/m^3
Petrol	0.7 ton/m^3
Diesel	0.8 ton/m^3
Earth	1.8 ton/m^3
Glass	2.6 ton/m^3
Hardwood	1.1 to 1.4 ton/m^3
Lead	11.3 ton/m^3
Road metal, Crushed rock	1.9 ton/m^3
Dry sand	1.7 ton/m^3
Wet sand	1.9 ton/m^3
Softwood	0.6 ton/m^3
Steel	8.0 ton/m^3
Mild steel	7.84 ton/m^3
Water	1.0 ton/m^3 (1000 liter/m^3)
Scaffold fittings (4.9 mm thick) (Frame)	0.5 kg/m; AST Rigging Handbook, 1.5 kg/m (for Australia Scaffold)
Scaffold tubes) (tubes turbular type) (Steel)	4.41 kg/m
Scaffold planks	7 kg/m
Steel H-beam	45 kg/m
Steel pipe (20 mm thick)	2.4 tan/m^3 (from materials catalog)

Source: PN12040 *Tower Crane-Code of Practice*, Australia (2017)

6.5 Estimation of the Maximum Load that can be Lifted

To determine the maximum load that can be safely lifted by a crane, the weight of the lifting equipment (wire rope, sling, etc.) and the lifting gear (hook, spreader beam, hook block, etc.) must be subtracted from the maximum load to be lifted. The lifting supervisor must take into account the entire load to be lifted and record it on the relevant form. An example of the calculation for the maximum weight that can be lifted and the weight estimation computation form are shown in Figures 6.6 and 6.7.

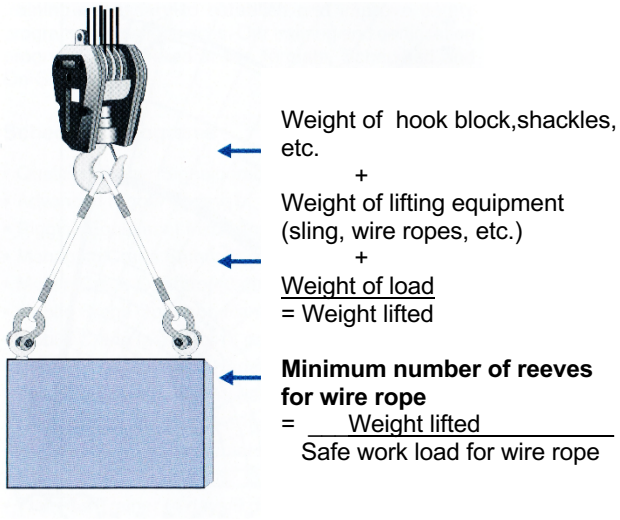


Figure 6.6 Calculation of maximum load that can be lifted (How To Use Load Charts, 2011)

A	Lifting machine:	AC-100 (100 ton)	
	Counterweight:	25 ton	
	Lifting gear:	4 x 8.5 ton shackle	
		4 x 5 ton x 8 m webbing sling	
B	**Crane details:**		Unit
	Crane	AC-100 (100 ton)	
	Configuration	Main boom	
	Boom length	33.7	m
	Working radius	14	m
	Corresponding SWL:	18000	kg
C	**Load details:**		
	Description	Electrical equipment, transformer with estimated load of 8500 kg	
	Lifting point	Transformer have 4 lifting points, using 4 wire sling and webbing sling connected to hook block	
	Dimension	L 5.25 m x W 3.5 m x H 2.38 m	
	Center of gravity	~~o~~ Given ~~o~~ Calculated ○ Unknown	
D	**Load calculation:**		Unit
	OLD transformer weight:	8500	
	25% add on:	3400	
	Lifting gear weight:	100	
	Hook blocks weight:	700	
	Total weight:	12700	
	Safety factor:		**1.42**
	Crane capacity usage (Load/SWL):		**70.56%**

Figure 6.7 Load estimation computation form for lifting operations (Guidelines for Creating Lifting Plan for Lifting Operations in Workplaces, 2014)

6.6 Determination of the Centre of Gravity of a Load

Before a load is hoisted, the lifting point/centre of gravity of the load must be maintained below the hook and the hitch point of the sling, as shown in Figure 6.8. Otherwise, the load that is being lifted will move until the lifting point/centre of gravity is below the hook, and this can pose a danger to workers who are near the load (see Figure 6.9). The centre of gravity depends on the shape and weight of the load, and if there is any doubt with regard to the determination of the centre of gravity, the lifting supervisor should consult or seek the advice of a registered engineer or related parties.

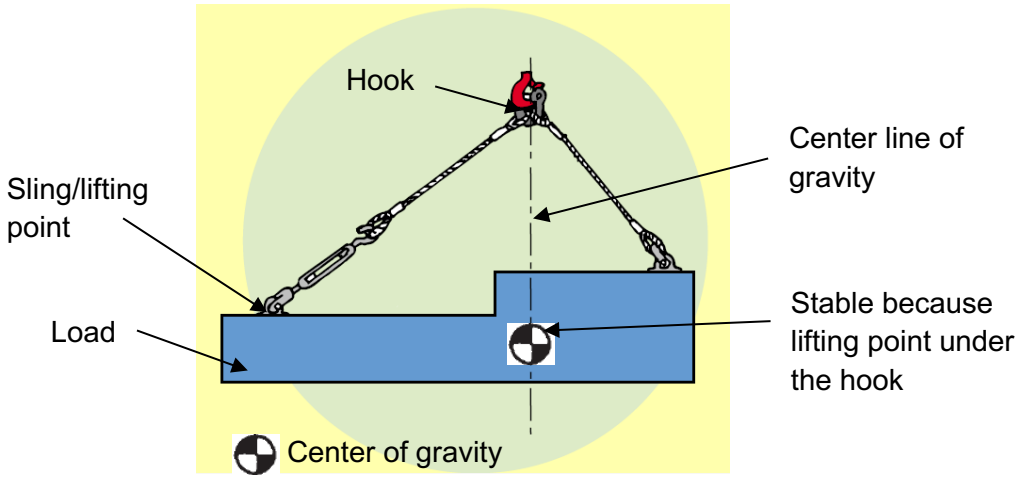


Figure 6.8 Position of centre of gravity from the hook (Safe lifting 2002)

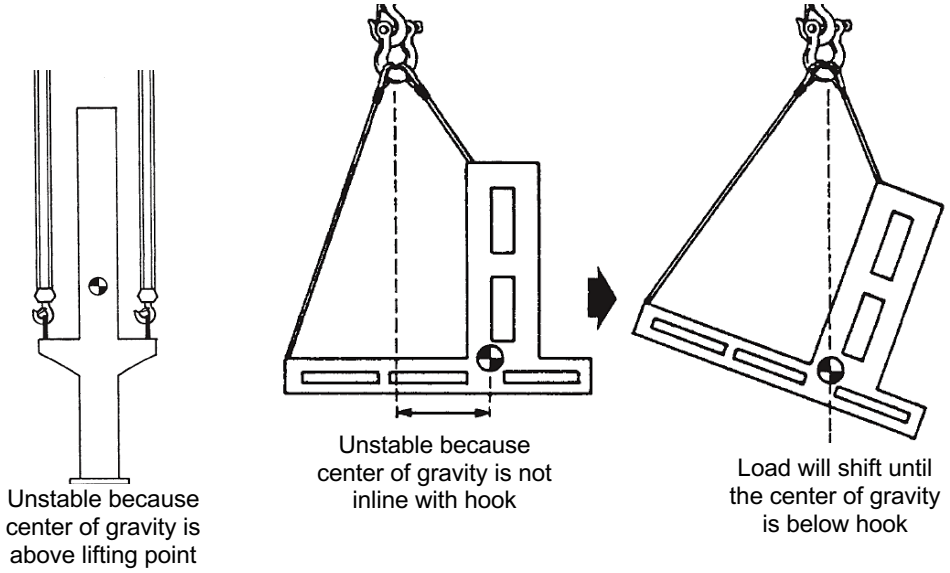


Figure 6.9 Position of centre of gravity from the hook and lifting point (Hoisting and Rigging Safety Manual 2012)

6.7 Permissible Working Load

The safe working load (SWL) or permissible working load for a tower crane refers to the specifications of the load on the hook for a certain reach, with the use of the appropriate wire rope, boom length and crane height as well as location of the site for the lifting of the load. Each piece of equipment that is involved in the lifting work has its own SWL. Therefore, the load to be lifted must be lower than the SWL of the tower crane system, while taking into account dynamic effects such as knocks and impacts caused by jerking movements during lifting. Reference should be made to the crane manufacturer's handbook for the appropriate specifications of the machine/equipment in order to determine the usage limit or permissible load limit for each machine/equipment.

6.8 Luff Angle (only for luffing tower cranes)

The luff angle is the angle between the horizontal line of the slew-boom platform pin and the line of tilt of the boom (Figure 6.10). The maximum luff angle for a luffing tower crane is determined by the crane manufacturer. The maximum luff angle of some cranes can be up to 86^{o}. Therefore, every luffing crane should be installed with a luff limiter switch to stop the boom from moving once the maximum luff angle is exceeded. This is to prevent the occurrence of over-luffing. In addition, the crane operator must exercise caution when a large luff angle is used during the lifting of a load because this will expose the load to the risk of collision with the mast. The sudden release of the load at a large luff angle position can also cause the boom to bounce backwards and hit the jib counter.

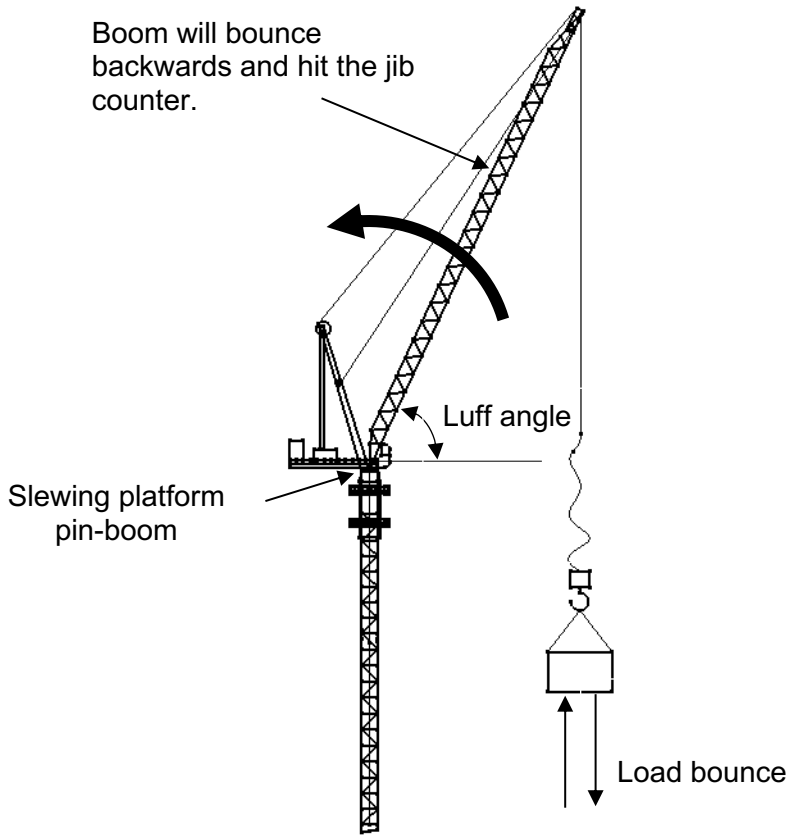


Figure 6.10 Effect of luff angle on the stability of a tower crane

6.9 Distance of Load Radius

The reach distance will be displaced forward whenever the crane lifts a heavy load from ground level because then, the wire rope hoist will be stretched and will cause the boom and mast to lean forward, as shown in Figure 6.11. Therefore, the operator plays an important role in determining the lifting of a load for a large range of reach distances by taking into account the height of the mast and the length of the crane boom.

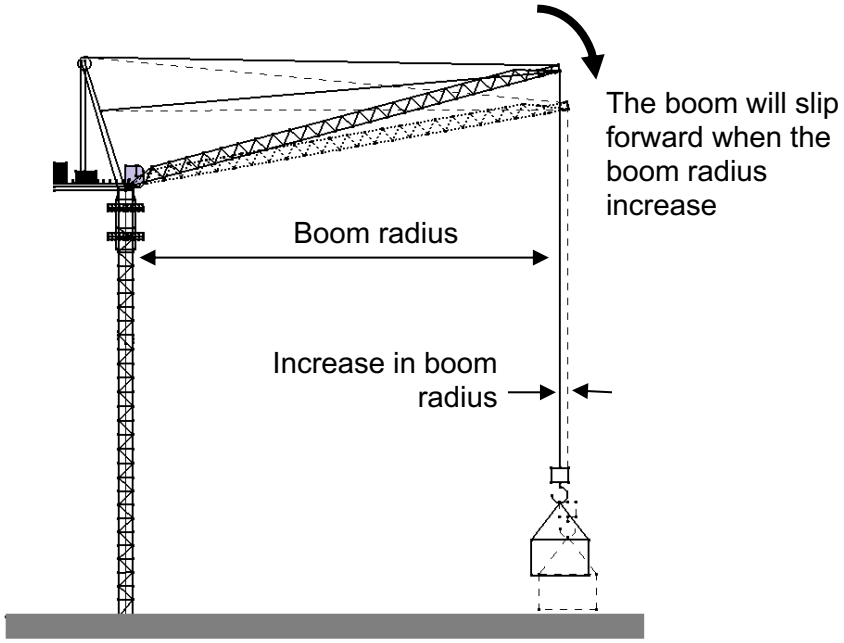


Figure 6.11 Increase in boom range during lifting of load

6.10 Handling of Loads Close to Where People are Working and Public Routes

If loads are to be handled close to where people are working, the following precautions should be taken:

(a) It should be ensured that the place where the load is to be lowered, raised and shifted to is safe

(b) The hoisting crew (operator, signalman, rigger, lifting supervisor) will need to plan a safe route for the load to avoid lifting it over or across workers

(c) All workers must stay away from the route along which the load is to be lifted

(d) Written approval must be obtained from the local authority if any hoisting work or part of the crane is to extend beyond the construction site

(e) In danger zones where hoisting works are being carried out, warning signs (see Figure 6.12) or warning lights should be erected to direct the public or traffic away from the construction site

(f) Avoid lifting loads across highways, railway tracks, rivers or public places that can be accessed by the public

Figure 6.12 Examples of a warning sign during crane operations (MS 1803:2008)

6.11 Control of Tower Crane Operations

Before commencing a crane operation, the operator must ensure the following:

(a) He has a clear view of the load and the zone of operation. If not, the crane operator will have to follow the instructions of a signalman who has a clear view

(b) Safety devises that warn of danger should be clearly visible to the operator

(c) Hand and flag signals by a signalman must be clearly visible

(d) The signal codes that are conveyed verbally must be clearly audible, especially when communicating by telephone or two-way radio (walkie-talkie)

(e) Ensure that hoisting activities do not cause damage to crane components and the material being hoisted

(f) Ensure that the operator has a clear view of the load and wire rope hoist, and is not obstructed by any object

(g) Ensure that the wire rope hoist is vertical throughout the hoisting work
(h) The load must be lifted clearly from the surface of the ground/area
(i) The rigging and counterweight of the load must be inspected before the hoisting work
(j) The load should not be left suspended unless a site safety officer or lifting supervisor is present during the period when it is suspended
(k) Ensure the brake locks for the hoist and boom (luffing crane) can function during an emergency

6.12 Weather Conditions

Generally, cranes are designed to operate in normal wind speed conditions, and they should not be operated during strong winds. An anemometer or tool for measuring wind speed must be installed in a suitable position on the tower crane. During the operation of the tower crane, the maximum wind speed as recommended by the crane manufacturer must be complied with. Besides strong stormy/windy conditions, other weather conditions can also invite the risk of accidents. The crane operator must stop operating the crane during severe weather conditions such as heavy rain, lightning or situations that are hazardous for the operator (haze, mist, excessive heat and so on) and for the stability of the crane (earthquakes, landslides, floods and so on).

6.13 Use of Personal Protective Equipment

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. All employees or visitors must be informed of personal safety requirements and the use of personal protective equipment provided.

Personal protective equipment should be checked before and after use to ensure that the equipment is safe to use or replace if any damage. Every

inspection and repair done on such equipment should be recorded and stored in the appropriate place. The personal protective equipment used at the construction site is as follows:

(a) safety hat
(b) safety shoes
(c) gloves
(d) light reflective vests
(e) safety glasses
(f) ear protection devices
(g) safety harness

6.14 Access to and Egress from the Crane or Construction Site

During hoisting works, the project manager or lifting supervisor must ensure the following:

(a) The access/egress area or routes for workers and other persons to the crane or construction site are controlled and safe for use,
(b) The access/egress area or routes for the public, such as walkways, roads and paths between buildings around the crane are monitored and the relevant warning signs have been erected,
(c) Only individuals who have been granted permission by the project manager can board or leave the crane,
(d) Workers must be instructed to use the correct access routes and practise the proper safety procedures during an emergency.

6.15 Fire Extinguishers

Lifting supervisors must plan the placement, use and maintenance of fire extinguishers according to the advice of the Fire Authority after conducting a risk assessment. Individuals must be trained in the use of the fire extinguishers. Fire extinguishers should be located in the crane cabin and in areas that are easily exposed to fires.

Bibliography

BS 7121-5:2006 Code of practice for safe use of cranes-Part 5: Tower cranes

Code of Practice for Safe Use of Tower Cranes, Hong Kong, 2012.

Guidebook for Lifting Supervisors, Workplace Safety and Health Council, Ministry of Manpower, Singapore, 2011.

Guidelines for Creating Lifting Plan for Lifting Operations In Workplaces, Workplace Safety and Health (WSH) Council, Singapore, 2014.

Guidelines For Public Safety And Health At Construction Sites (1st Revision: 2007), Department of Occupational Safety and Health, Malaysia.

http://www.dosh.gov.my [24 Ogos 2017]

http://www.manitowoc.com [21 Julai 2017]

http://www.mytowercrane.com/safeliftingguide.htm [11 September 2017].

MS 1803:2008 Cranes-Safety-Tower Cranes.

PN12040 Tower Crane-Code of Practice, Autralia, 2017.

Ronald G. Garby, PT's Crane & Rigging Handbook, IPT Publishing and Training Ltd., 2005.

Safe Lifting, Occupational Safety & Health Council, Hong Kong, 2002.

SS 559: 2010 Code of practice for safe use of tower cranes.

CHAPTER 7

LIFTING PLAN

7.1 Introduction

A lifting plan is important for ensuring that the load is lifted safely and according to the planned lifting schedule. The lifting supervisor, crane operator, rigger and signalman are responsible for planning the lifting works. For lifting works that involve difficult lifts, the lifting team will need additional information such as details of the construction site. When preparing the lifting plan, several checklists have to be taken into consideration to ensure the lifting works are carried out according to safe procedures. Among the checklists are the following:

(a) A list of the contents of the lifting plan such as a lifting analysis report, a copy of the load chart of the crane, a copy of the inspection report on the lifting equipment, etc.
(b) Planning of the lifting work
(c) An analysis of the placement of the crane
(d) An analysis of the capacity of the crane
(e) Computation of the load to be lifted
(f) Information on the lifting equipment and the hitching method
(g) A list of the personnel in the lifting team

In addition, attention should also be given to the following matters when planning the lifting work:

(a) The size, shape and weight of the load to be lifted (location to which the load is to be raised and lowered)
(b) Selection of the sling and the hitching method
(c) Selection of a suitable crane for the operation, and ensuring a safe distance between the load and the crane structure
(d) Selection of suitable lifting equipment and lifting gear
(e) Position of the crane and location of the load before, during and after the lifting operation

(f) Suitability of the site for the lifting works, including the safe distance and space
(g) Complete information regarding the individuals or parties who prepared the lifting plan
(h) Surrounding circumstances that may obstruct lifting operations

7.2 Lifting Work Briefing and Induction

The lifting supervisor is reponsible for giving a briefing on safety to all the personnel involved in the lifting work to ensure that they understand and comply with the contents of the PTW before the lifting work begins. The briefing should be delivered in Malay or English. A copy of the lifting work plan and the relevant supporting documents should be given to all the personnel involved in the lifting work. When there is a change in the lifting team, the new members must be briefed on the lifting plan and other related issues.

During the induction to the lifting work at the construction site, the site safety supervisor or a representative of the main contractor can be called to share his views with the lifting team regarding the possible occurrence of any accident or risk. The practical use of communication codes or signals (for example, hand and flag signals, as shown in Annex A) that have been effective among members of the lifting team should be repeated at each induction session to ensure that the information that is conveyed is clear and precise.

The attendance of every member of the lifting team at both the briefing and induction sessions must be recorded (every team member must sign an attendance form, and this will be kept by the lifting supervisor). Examples of the attendance and safety briefing forms, lifting work plan, and permit to work are shown in Figure 7.1-7.3.

Toolbox Safety Talks

Working Near Cranes

1) What are the hazards/injuries involved with working near cranes?
   a. Struck by loads or equipment
   b. Being caught in between moving equipment, materials, and power lines leading to lacerations, fractures, and death

2) What hazards should be recognized?
   a. Your positioning
   b. Falling objects
   c. Hoist block sheaves
   d. Suspended loads
   e. Communication
   f. Radius of the crane
   g. Pre-shift inspections

3) What safe practices should be used when working near a crane?
   a. Barricade the swing radius of the crane. Use a spotter if necessary
   b. Never ride the hook
   c. If you have to enter the cranes swing radius, be positive that the operator is aware of your presence
   d. Know proper hand signals and maintain communication
   e. Never walk under suspended loads
   f. Always wear a hard hat
   g. Keep clear of lower block sheaves

4) What additional safe practices should be mentioned?
5) How do we maintain communication with the operator? Can it be improved?
6) What is the swing radius of the crane on our site?
7) Do we have the swing radius barricaded properly?
8) Has anyone had an incident or near miss while working near a crane?
9) Who here has ever taken a ride on the cranes hook?

Make Time for Safety, Everyday! – Yes, production is important, ***but the focus must be on Safe Production!*** Keep that in the back of your mind. Don't take risky chances and stay out of harm's way. Nobody goes to work thinking *'I'm going to get hurt or killed on the job, today!'* But every day 15,000-17,000 workers suffer disabling injuries on the job and another 11-17 are killed. ***What are you doing to make sure it doesn't happen on your shift?***

Keep stoking the fire; we can't let the 'Safety Train' run out of steam!

Date Presented: _____ **Presented By:** _____

Attendance Sheet

Figure 7.1 Safety briefing form for crane operations (www.rockwoodcasualty.com)

Samples of several forms and checklists for lifting plan requirements can be seen in Annexes B, C, D and E.

LIFTING PLAN			
1. GENERAL			
Project/Package			
Location of Lifting Operation			
Contractor carrying out the lifting operation		Date/Time: Validity Period:	
2. DETAILS OF THE LOAD/S			
Description of load/s			
Overall dimensions			
Weight of load	kg/tonne	□ Known weight	□ Estimated weight
Centre of gravity	□ Obvious	□ Estimated	□ Determined by drawing
3. DETAILS OF THE LIFTING EQUIPMENT/LIFTING GEARS			
Type of lifting equipment			
Maximum SWL as certified on the chart		Date of last certification	
Max boom/Jib length	m	Fly jib/offset	
Intended load radius	(Distant between the load and the crane)	SWL at this radius	
Type of lifting gears	Sling/webbing/chains/shackles/spreader beam/receptacle		
Combined weight of the lifting gears	kg/tonne	Certification of lifting gears	□ Yes □ No
4. AUTHORIZATION			
	Prepared by:	Reviewed by:	Approved by:
Signature			
Name			
Designation			
Date			

Figure 7.2 Form for lifting plan for the use of a crane

PERMIT TO WORK (PTW)			
LIFTING WORK			
Project			
Location			
Duration of work permit	From:	To:	
Name of contractor			
Work activity			
Permit no			
CONTACT INFORMATION			
	Name	**Company**	**Phone number**
Designated Lift Leader			
Qualified Crane Operator			
Designated Rigger			

PART A: CONTROL POINT (Please mark √ for comply or X for not comply	
1. Crane permit valid	
2. Sling in good condition and with valid certificate	
3. Crane operator is competent	
4. Load chart shall be available	
5. Load indicator/safety devices been installed and functional	
6. Area of lifting radius must be verify	
7. Tag line used	
8. Walkie talkie used as mode of communication	
9. Using of suitable PPE such as safety vest, glove and safety shoe	
10. Good platform – crane sitting on stable and even ground	
11. Full extended of outrigger	
12. No overhead electrical cable or lining at the lifting radius	

PART B: REMARK

PART C: APPROVAL			
Applicant Receiving Authority	Verification Contractor Safety Department	Approval Approval Authority	Sign Off Approval Authority
Sign:			
Name:			
Date:			
Company:			

PART D: RENEWAL

1. Applicant by Sub Contractor/Site Supervisor must read and understand this certificate and undertake work in accordance with the condition on it.
2. Verification by Contractor Safety and Health Department.
3. Endorsement by Contractor Safety Office with Clients Safety Health Officer cross-checked above condition.
4. Approval by Person In Charge.
5. Attached toolbox record and layout of working area if necessary.
6. Attached HIRARC in high-risk work.

Figure 7.3 Permit to work form

7.3 Risk Management

Risk management is important in order to identify all hazards associated with tower crane or lifting operations, for assessing the probability of accident or injury or dangerous occurrence due to exposure to identified dangers and the determination of appropriate measures to control risks. There are three basic steps for a risk management:

(a) Hazards identification

The identification of the potential hazards that might occur from the use and operation of the tower crane, such as from the tower crane foundation, the tower crane equipment, and the personnel involved in the lifting operation, and other hazards associated with lifting operations are poorly maintained wire rope, broken safety device, improper rigging method, and so on.

(b) Risk assessement

The estimation of the hazard risk level identified in terms of the severity of any injury or damage in case of accident, and the possibility of such occurrence. For example, the risk level of workers working under a suspended pre-disposal component should be assessed as a high risk because of the consequences of the load that causing injury or death of workers.

(c) Risk control

The appropriate control must be identified and implemented so the predicted risk can be avoided. Examples of suspended components or loads, the appropriate risk control measures are to place an "unsafe zone" to prevent workers from working directly under suspended loads. Exclusion zones also need to be isolated to prevent any unauthorized entries. These risk controls are including of cranes setting, lifting equipment or appropriate loads, tower cranes radius operation, cranes operator carelessness and other personnel involved.

When planning a method of work, an appropriate and adequate assessment should be conducted and recorded to eliminate or reduce the risk from the work. The flowchart for the Hazard Identification Risk Assessment and Risk Control (HIRARC) process tin order to identify hazards and control risks for workplace safety is shown in Figure 7.4.

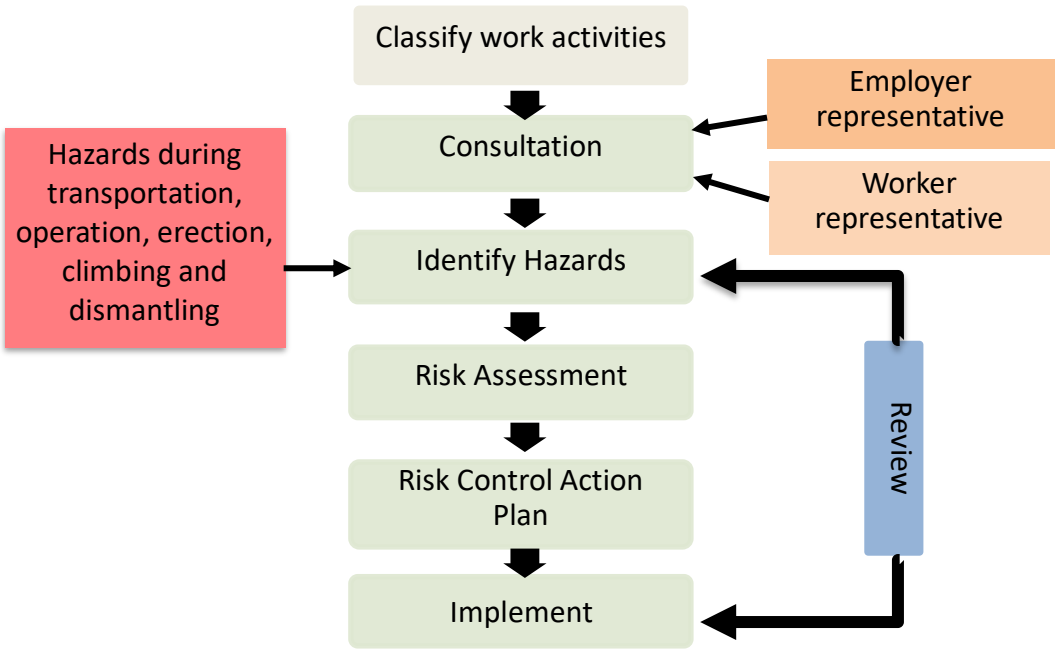


Figure 7.4 Flowchart for HIRARC process

7.3.1 Hazards Identification

The hazards of tower crane operations or hoisting work should be identified and all the significant risks or dangers, situations and hazardous incidents should be evaluated, and an assessment and planned action should be taken to eliminate or reduce the risks concerned by referring to the provisions in MS1803:2008 and MS ISO 12100 pertaining to the necessary risk assessment to mitigate or eliminate risks associated with hazardous elements.

A list of the hazards, hazardous situations and events related to tower crane operations is referred to in MS1803:2008 and EN 1050:1996 as follows:

(a) Mechanical hazards due to machine parts or work pieces, for example, the shape or inadequacy of mechanical strength, such as:
    (i) crushing hazard
    (ii) shearing hazard
    (iii) cutting or severing hazard
    (iv) entanglement hazard
    (v) falling or trapping hazard
    (vi) impact hazard
    (vii) injection or ejection hazard (cranes with hydraulic systems)
(b) Electrical hazards due to:
    (i) contact of persons with live electric current (direct contact)
    (ii) contact of persons with electric current that has become live due to system failure (indirect contact)
    (iii) the use of a live current under high voltage
    (iv) thermal hazards resulting in burns, scalds and other injuries because of possible contact of persons with objects or materials at extremely high or low temperatures, with flames or explosions.
    (v) damage to health by hot or cold working environment.
(c) Hazards generated by noise, such as:
    (i) hearing loss
    (ii) interference with speech communication
(d) Hazards generated by materials and substances processed or used by machines, such as:
    (i) fire and explosion hazards
    (ii) hazards generated by neglecting ergonomic principles in machine designs, namely:
    (iii) wrong posture or excessive work
    (iv) poor vision from driving position
    (v) inadequate consideration of the anatomy of the foot, hand and arm
    (vi) neglecting the use of personal protection equipment
    (vii) inadequate local lighting
    (viii) human error and behaviour
    (ix) inadequate design, location or identification of manual controls
    (x) inadequate design or location of visual display unit

(e) Unexpected start-up of work/operations, excessive operation/speed (or system malfunction or anything similar to it) arising from:
  (i) other external influences (gravity, wind, etc.)
  (ii) failure/disruption of the control system
  (iii) software errors
  (iv) errors made by the crane operator (due to mismatch of machinery with the characteristics and abilities of individuals)
(f) Failure of the power supply
(g) Failure of the control circuit
(h) Break-up during operation
(i) Falling objects or fluids
(j) Loss of stability/overturning of machinery
(k) Slips, traps and falls of persons (related to machinery)

7.3.2 Risk assessement

The risk assessment carried out by lifting supervisor is part of the planning process that should be identify the hazard associated with the proposed lifting operation. Assessment of risk need to assess the risks involved and the nature and steps required to reduce these risks. Lifting supervisor should also concern about the considerations hazard which identified on the overall site risk assessment.

The generic risk assessments may be insufficient because most of the sites have their own hazards and should consider in a separate specific site assessments. Risk assessment results need to be written and used in the preparation of risk controls for the site. The risk assessment with the manufacturer's instructions, is then used to make detailed risk controls for the transport, collection, installation, use and dismantle of the equipment at the construction site. The risk assessment for tower cranes is as follows:

(a) Crane operations: Risk identification and assessment during crane operation involves the following factors:
  (i) the persons doing the hoisting

(ii) the stability of the crane
(iii) failure of lifting equipment
(iv) weather conditions
(v) exceeding the permitted rated capacity
(vi) hitching and hoisting instructions
(vii) inspection and maintenance of cranes
(viii) competence of crane operators and the persons involved
(ix) failure of electrical and mechanical systems
(x) access and egress roads that are obstructed

(b) Erecting, climbing dan dismantling: Identification and assessment during erection, climbing and dismantle of cranes involve the following factors:
(i) delivery of the crane to the site
(ii) traffic management
(iii) lifting the crane or crane components from the lorry
(iv) use of movable cranes
(v) earth conditions
(vi) weather conditions
(vii) public walkways
(viii) lifting over persons or other structures
(ix) stability of the load being lifted
(x) permit to erect the crane
(xi) design of the base and strength of the support
(xii) expertise, training and supervision
(xiii) falls from a height
(xiv) use of personal protection equipment
(xv) materials from high places
(xvi) entry facilities

(c) Other risks that can cause accidents in relation to tower cranes are as follows:

(i) crane toppling over
(ii) failure of the crane structure or component

(iii) crane or load colliding into other structures
(iv) falls from a height (from buildings, cranes, etc.)
(v) hit by objects (falling objects, etc.)
(vi) electric shock

A tower crane can become unstable as a result of extreme hoisting works and other factors such as:

(i) use of incorrect counterweight
(ii) installation of a collar that is not in accordance with the specifications given by the crane manufacturer
(iii) wrong torque for bolts and nuts on the mast or boom
(iv) crane base not installed according to the specifications of the crane manufacturer

(d) The following risks can lead to accidents during hoisting works:

(i) mechanical hazards and dangerous occurrences
- loads falling while being hoisted
- hoisting of an unstable load
- unexpected movement of the load
- collision with more than one crane
- collision between loads being hoisted

(ii) walkway for workers when placing/installing supports for the load
(iii) mechanical strength of crane components/parts or lifting equipment that is not in accordance with the manufacturer's specifications
(iv) design of crane pulley that is not strong or is not in accordance with the manufacturer's specifications
(v) drum design or specifications that are not in accordance with the manufacturer's specifications or that are not compatible with the crane
(vi) failure of the brake control system while the load is being raised, lowered or shifted
(vii) installation, testing, usage and maintenance conditions that are not in accordance with the manufacturer's specifications
(viii) electrical hazards such as lightning

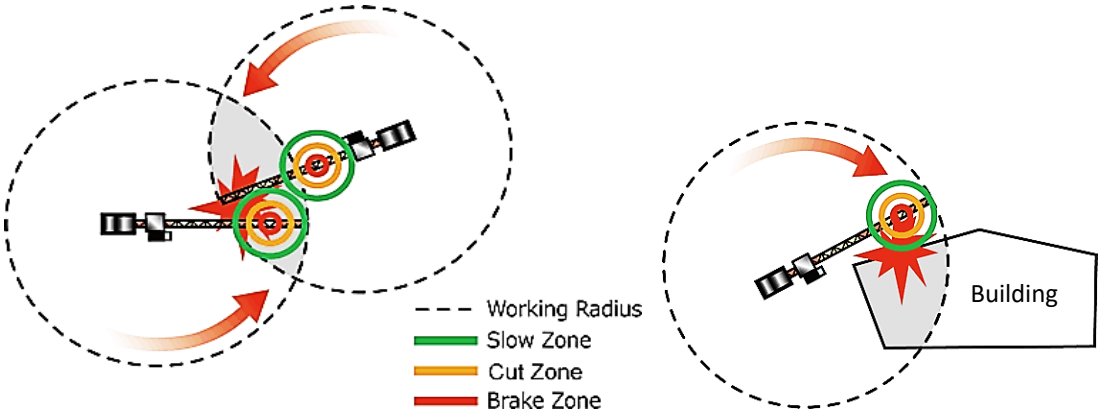
(ix) hazards generated by ignoring ergonomic principles at the workplace such as inadequate visibility for crane operators while handling cranes

(x) hazards of the load slipping or displacement of any part of the load

Examples of risks during tower crane operations

(a) Risk of collision between cranes

Collisions between cranes or loads with other structures can occur when there are errors in communication and crane movements or when there is insufficient space between the crane and other structures such as other tower cranes or adjacent buildings, and also when the operating zones of two or more cranes overlap, as shown in Figure 7.5.



Figures 7.5 Collisions and operating zones of tower cranes (www.opticrane.com)

To reduce the risk of injury from collisions between cranes and other structures, those who are responsible should ensure:

(i) The location of the crane and the space between the tower crane and other structures are planned in advance to ensure that the crane is sited in the correct place

(ii) The responsible persons must plan work methods that are safe during the placement and operation of the crane

(iii) The persons who are involved in the operation of the crane and other structures must be given adequate training to ensure the procedures are implemented correctly

(iv) The method of communication between the crane operator and the rigger or signalman must be precisely coordinated and understood

(b) Operating close to electric poles and cables

Individuals who are involved in the operation of a crane may be exposed to the risk of electric shock through contact with power lines, power tools and other electric power sources, namely:

(a) Contact with overhead electric lines can give rise to the risk of electric shock when operating a crane because it is difficult for the crane operator to keep the electric lines in view and to estimate their distance from the crane,

(b) Before siting a crane in an area where there are overhead electric lines, discussions regarding the work and the related risks must be held between the contractor and those involved in the operation of the crane.

When the crane is to be used in an area where there are electric lines (see Figure 7.6), the following precautions must be taken by the lifting supervisor, crane operator and other persons working with that crane:

(a) Every crane has different operating features for determining the safe operating distance from electric conductors. If the power line is live, seek the advice of the electric utility company, such as Tenaga Nasional Berhad (TNB) before commencing work,

(b) Any crane operation must be monitored by a competent person,

(c) Ensure the load and crane do not get too close to the nearest power lines,

(d) The crane operator or anyone at risk should be advised to take the appropriate action should they come in contact with electric conductors,

(e) Cranes should not be used to remove materials from below power lines or to enter into the danger zones of power lines without the approval of an engineer from the electric utility company or TNB,

(f) If electric lines are to be disconnected, discussions should be held as soon as possible with the party controlling the lines before works are carried out.

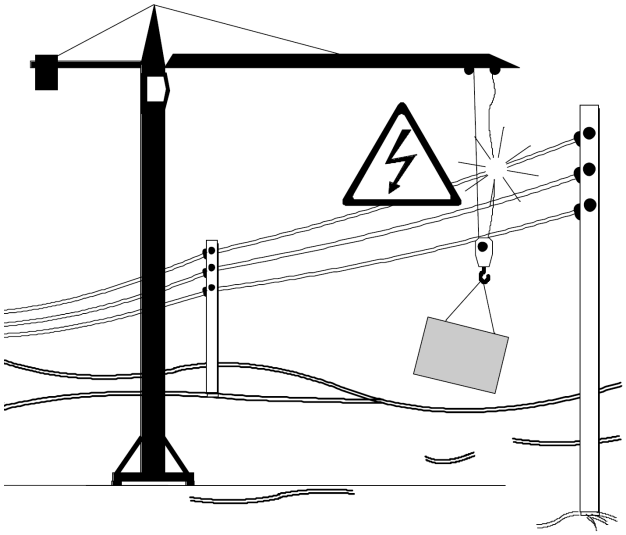


Figure 7.6 Operating a crane close to electric cables
(Tower Crane Refence Manual 2014)

The person responsible or the person appointed to ensure the safety of workers and people in the vicinity must make sure that the workers/worksite are at a safe distance from nearby electric lines. The voltage range and safe distance when working close to overhead power lines are shown in Table 7.1.

Table 7.1 Total voltage and safe distance from overhead power lines

Voltan (V)	**Recommended distance from electric current (m)**			
	Malaysia	Australia	Hong Kong	Ireland
0-33,000	3.0	3.0	3.0	3.0
33,000-132,000	6.0	3.0	6.0	4.5
132,000-330,000	Refer TNB	6.0	7.0 *(275 kV)*	6.0
Atas 330,000	Refer TNB	8.0	7.0 *(400 kV)*	8.0

Sources: Work Near Overhead Power Lines, Code of Practice, Australia, 2006; Avoiding danger from overhead power lines Guidance Note GS6 (Fourth edition), Hong Kong, 2013 dan Code of Practice for Networks Avoiding Danger from Overhead Electricity Lines, Health and Safety Authority, Ireland, 2008

If a crane or load comes in contact with an aerial electric conductor, the crane operator or persons involved must immediately notify the responsible persons (safety supervisor, site supervisor, lifting supervisor) so that people in

the vicinity can be warned of the hazard. If an individual or object comes in contact with a cable or aerial electric conductor, the following steps should be taken:

(a) Remain in the cabin until the electricity is disconnected
(b) If you have touched/are close to a damaged wire, move and distance yourself as fast as possible until the line is confirmed to be safe
(c) Warn other workers, such as the signalman, to stay away from the crane and not to touch any part of the crane, wire rope or load
(d) Assume that the electric line is live even if it does not emit sparks or appears to be dead
(e) It must be remembered that even if an electric line is dead, it can become live again either automatically after several seconds or after several minutes or hours if the owner of the line is not aware that the line is damaged
(f) It must be remembered that if a live wire touches the surrounding area (ground), it may become live as well. Stay at a safe distance from the wire or anything that may have come in contact with it
(g) If necessary, call the emergency services of the electric utility company or TNB

7.3.3 Risk control

After the risk identification and assessment is carried out, a lifting supervisor or relevant party should ensure that the complete risk control method and the details of the safe working system for lifting operations are provided. Individuals who are responsible may consult with persons which have special knowledge and experience to assist the planning process of tower crane opeation. The risk control methods are as follows:

(a) The task to be achieved and the order to be executed
(b) Cranes configuration when not in use
(c) Details of the steps to be taken in order to eliminate hazards for employees who are not involved in lifting operations, and where necessary, prevent their entry into the danger zone, for example by closing the road if necessary

(d) The requirements for pre-use inspection are completed
(e) Clear statement of responsibility to all personnel involved in lifting operations

The lifting operation is control by lifting supervisor who has the power to stop the work if the surroundings are unsatisfactory. Lifting supervisor should ensure that all employees involved in lifting operations are directed in the precautionary situation and specific features of the control method at the begining of the work.

A copy of the risk control method and the tower crane operation manual should be provided to all members involved in the lifting operation plan. Risk control methods should be enough to provide a basis briefing or induction for each employee. Lifting supervisor or representative from main contractor should take the opportunity during induction on site to give a opinion of the lifting team regarding safety.

For an effective risk control method, a clear role determination of each team member should be made. Guidelines for effective communication among teams (and where necessary with nearby crane operators in danger) should be provided. Among the risk controls in tower cranes opreration are as follows:

(a) Avoid risk
(b) Assess the risks that are inevitable
(c) Reducing existing risks
(d) Adapting work to individuals, such as workplace design, selection of work equipment, work methods, production and others
(e) Adapt to technological advances in machinery or systems
(f) Develop an overall risk prevention policy covering technology, work organisation, working conditions, social relationships and the influence of factors related to the work environment
(g) Prioritise the collective protection measures from individual protection measures
(h) Provide appropriate and easy-to-understand instructions to employees

(i) Inspection of switches/devices and safety limit movements, lifting equipment, and critical components such as jib, pulley, wire rope and others should be monitored and evaluated periodically, eg. monthly, quarterly or annual

(j) Medical check up for employee should be monitored and evaluated periodically, for example, on a monthly, every three months or annually

(k) Project managers should ensure that each employee involved in the lifting operation has attend proper training of safety courses and related techniques (command instructions, rigging etc.) and pass the exam

(l) Clear and easy-to-understand communication between crane operators, signalmans or riggers such as using a walkie-talkie or phone or hand instruction

(m) The responsibilities of each employee must be cleared and determined as the person who manages the lifting operation, maintenance person, safety supervisor, or other person related to the use and crane operation

7.4 Risk Planning and Coordination of Tower Crane Operations

Careful risk planning is important for ensuring the safe operation of tower cranes. Effective planning will help to identify ways to protect persons who:

(a) Erect, climb and dismantle tower cranes, as well as raise, lower and shift loads

(b) Are directly involved in the lifting operations such as the crane operator

(c) Inspect areas adjacent to the tower crane, including public places

(d) Ensure the safe installation and use of electricity and electrical equipment, especially for those working in the vicinity of the power supply

(e) Determine the requirements of the crane, including the space for loading and unloading, and access to the lifting site, at the preparatory stage of the project

(f) Cut down on the number of tower cranes at the project site so as to reduce the possibility of collisions between the crane and other objects

(g) Ensure that each tower crane is installed at a safe distance from other cranes

In addition, the lifting supervisor must plan the following matters during the operation of the crane or lifting work:

(a) Selection of the crane placement

(b) Use of other cranes (if necessary)

(c) Route and location when raising or lowering a load (if across people/public place, ensure there are no major hazards)

(d) Selection of lifting equipment that is appropriate for the material/load to be lifted

(e) Determine a suitable location/place for the loading or unloading

(f) Determine the location/place for a loading bay

(g) The material to be lifted daily (must be clearly stated in the lifting plan, and the number of loads to be lifted must also be recorded)

(h) Assess and plan the number of operators, riggers and signalmen that will be required (for example: have more signalmen if the lifting work is not clearly visible/obstructed from view)

7.5 Emergency Response Plan

The project owner/client or contractor must develop and document an emergency response plan (ERP), and test it by conducting an ERP exercise for all workers who are involved in lifting works. The ERP exercise must also be documented and recorded as part of the safety system at the workplace. This plan must identify the accident potential, emergency situations and prevention of risks in relation to crane operations or lifting works. The ERP must include the following:

(a) Details of the personnel managing emergencies

(b) Flowchart for the communication of an emergency

(c) Roles and responsibilities of the emergency management team

(d) Contact details for emergency services and medical treatment (such as the police, fire or ambulance services)
(e) Location of the first aid kits and fire extinguishers
(f) Safe place for the evacuation of workers
(g) Emergency training procedures that are relevant for the workers who are involved
(h) Procedures for those who are in the vicinity of the crane as well as crane operators (for example, procedure for a change of operators in case of an emergency)
(i) Warning signs should be put up at disposal sites and these must be visible to the workers and other people
(j) Management of injured persons
(k) Frequency of training and the type of training that should be conducted

All lifting works should have an emergency response procedure that is documented and covers all operational aspects. This emergency response plan will clearly and accurately identify the requirements and actions that must be taken in the event of any emergency. Among the emergencies that can occur are:

(a) Failure of the lifting equipment
(b) Failure of the crane structure such as a fractured boom
(c) A shift in the suspended load
(d) Lifting a load that is close to an adjacent structure
(e) Rescue of an injured worker from a confined space such as the cabin of the tower crane
(f) Electric power cut off during crane operation (need to refer to the crane manufacturer's manual)

Lifting works can also be carried out from ground level or at a high place like a multi-storey building or in a confined area such as in a tunnel or factory. Hence, the lifting supervisor must ensure that the ERP is prepared by the project owner/client or contractor and is implemented properly. The lifting supervisor must also identify all access points to where the crane is operating to

facilitate medical support and immediate evacuation in case of an emergency. A sample of the information form for an emergency response plan is shown in Figure 7.7.

EMERGENCY RESPONSE PLAN					
Project:					
Project Address:					
Date Prepared:					
Emergency Personnel Names and Phone Numbers					
Designated Responsible Official (Highest ranting manager at: _____site, such as _____, or _____					
Name:	Phone:				
Emergency Coordinator:					
Name:	Phone:				
Area/Floor Monitors (if applicable):					
Area/Floor:		Name:		Phone:	
Area/Floor:		Name:		Phone:	
Assistant to Physically Challenged (if applicable)					
Name:	Phone:				
Name:	Phone:				
Date:					

Figure 7.7 Information form for an emergency response plan

Bibliography

Bakri, A., Zin, R. M., Misnan M. S. & Mohammed, A. H. 2006. Occupational Safety And Health (OSH) Management Systems: Towards Development of Safety and Health Culture. *Proceedings of the 6th Asia-Pacific Structural Engineering and Construction Conference (APSEC 2006)*, 5 – 6 September 2006, Kuala Lumpur, Malaysia, pg. 1-10.

Chong, H. Y. & Low, T. S. 2014. Accidents in Malaysian Construction Industry: Statistical Data and Court Cases. *International Journal of Occupational Safety and Ergonomics (JOSE)* 20(3): 503–513.

Crane Safety Inspection and Lifting Gears, Beruntung Skills Training Centre (BSTC), Malaysia.

Crane Safety Inspection and Lifting Gears, Gamuda Plant Operator School (GPOS), Malaysia.

David V. MacCollum, Crane Hazards and Their Prevention, American Society of Safety Engineer, 2005.

Guidebook for Lifting Supervisors, Workplace Safety and Health Council, Ministry of Manpower, Singapore, 2011.

Guidelines for Creating Lifting Plan for Lifting Operations In Workplaces, Workplace Safety and Health (WSH) Council, Singapore, 2014.

http://www.rockwoodcasualty.com [10 Oktober 2017]

MS 1803:2008 Cranes-Safety-Tower Cranes.

Safe Lifting, Occupational Safety & Health Council, Hong Kong, 2002.

Saifullah, N. M. & Ismail, F. 2012. Integration of Occupational Safety and Health during Preconstruction Stage in Malaysia. *Procedia - Social and Behavioral Sciences* 35: 603-610.

Tower Crane Reference Manual, National Commission for the Certification of Crane Operators, 2014.

Zakaria, N. H., Mansor, N. & Abdullah, Z. 2012. Workplace Accident in Malaysia: Most Common Causes and Solutions. *Business and Management Review* 2(5): 75 – 88.

CHAPTER 8

LIFTING EQUIPMENT

8.1 Introduction

Lifting equipment can be divided into three categories as follows:

1. Mechanical equipment that can raise and lower loads. For example, cranes, hook blocks, hoisting ropes and so on.
2. Equipment that connects loads to mechanical equipment for the purpose of raising and lowering. For example, ropes, slings, hooks, shackles and so on.
3. Equipment that combines the two categories of equipment mentioned above.

8.2 Selection of Lifting Equipment

The following steps are important during the selection of lifting equipment namely:

(a) All lifting equipment must be made of materials that are suitable for their use. They should be tested according to the prescribed standards or conditions, and the test certificate must be identified before they can be used.

(b) All lifting equipment should have a safety factor that corresponds to its design.

(c) It is very important for the manufacturer/supplier to provide information regarding the suitable use of the equipment before it is put into operation.

(d) All equipment must have the SWL or WLL mark or label.

(e) It is necessary to select the appropriate equipment according to the compatibility of each load that is to be lifted. There are several different grades of quality of materials for the equipment, especially for hooks, links, rings and shackles. Their size also varies according to the capacity and the grade of the material.

8.3 Type and Uses of Lifting Equipment

8.3.1 Wire rope

Wire ropes are classified according to their size, construction, quality, structure and type of core. The main components in wire ropes, the structure of the wire rope and to measure the wire rope are shown in Figure 8.1-8.3. There are three core types used in wire rope, namely steel core, strand core and fibre core as shown in Figure 8.4.

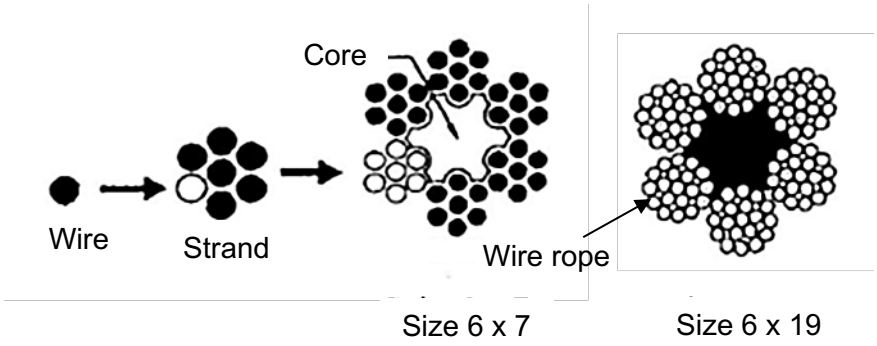


Figure 8.1 Forms and classes of wire ropes

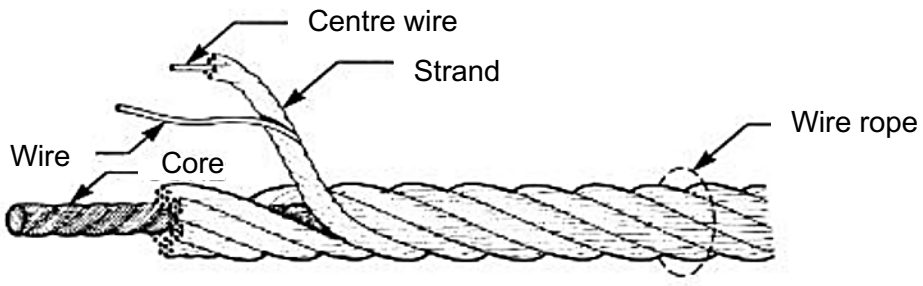


Figure 8.2 Structure of a wire rope (www.edwardswirerope.com)

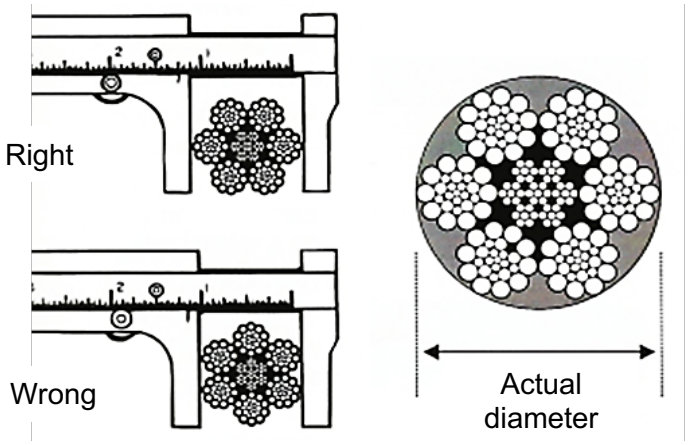
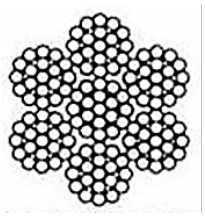


Figure 8.3 Measuring the wire rope diameter correctly
(www. portcityindustrial.com)

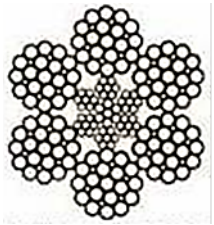
Core type : Fibre
Classification : 6 x 19

(a)



Core type : Strand
Classification : 6 x 19

(b)



Core type : Steel
Classification : 6 x 19

(c)

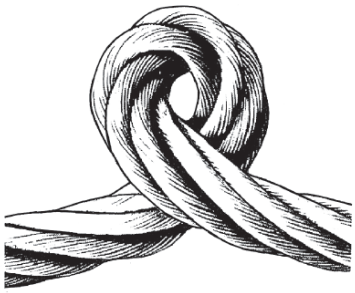
Figure 8.4 Wire ropes with different cores: (a) fibre core, (b) strand core, (c) steel core

Based on the production of iron wires from Australia, the international specifications for the classification of the strength of iron is shown in Table 8.1.

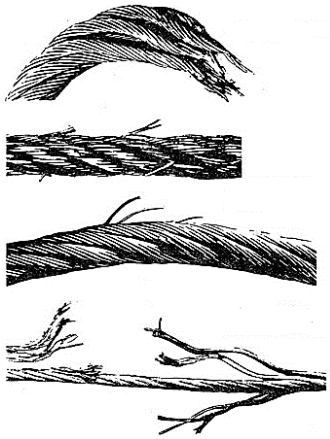
Table 8.1 Classification of the strength of iron (Iron wires from Australia)

Type	Minimum Tensile	Abbreviated Description
Black 8Bright, non-galvanished) wire	1770 Mpa	1770 grade
Galvanished wire	1570 MPa	G1570 grade

G 1770 (Galvanised 1770 MPa) is the standard iron recommended for making FSWRs. The FSWRs are produced with sizes of 6 x 7, 6 x 19, 6 x 24 and 6 x 37, based on the construction of the FSWR. Figures 8.5 shows several examples of damage or defects that commonly occur. A sling cannot be used if the following defects are identified. Figure 8.6 show the correct and wrong way of handling wire ropes.

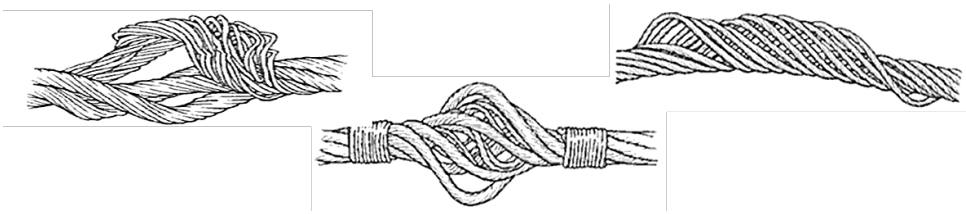


(a) Kinks (www.work.alberta.ca)



(b) Strain (www.nasdonline.org)

(c) Wear and corrosion (www.maintworld.com, www.wisc-online.com)



(d) Bird cage (www.work.alberta.ca)

Figure 8.5 Examples of damage to wire ropes

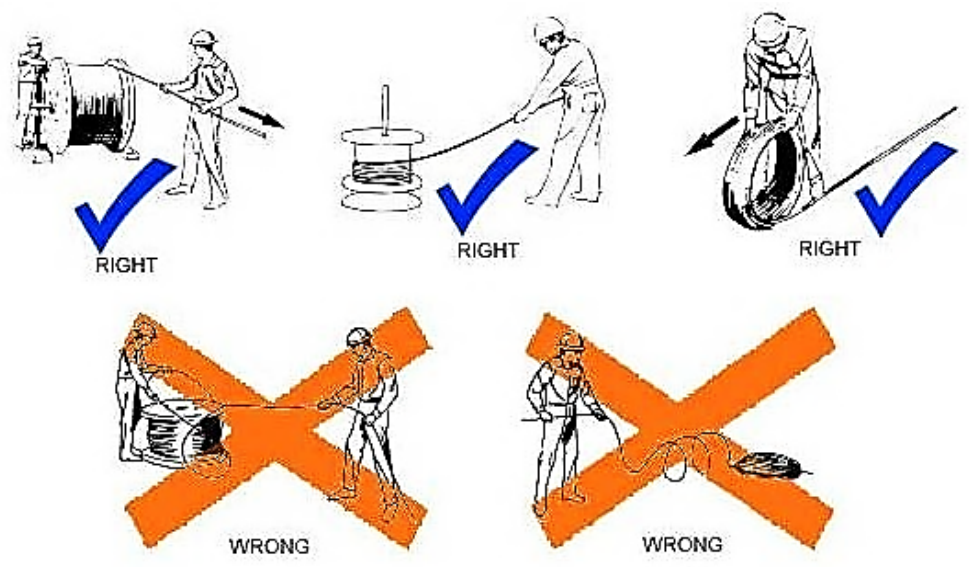


Figure 8.6 Correct and wrong way of handling wire ropes (www.practicalmaintenance.net)

8.3.2 Fibre rope

Fibre ropes are made from waste materials, and equipment can be damaged or destroyed if they are exposed to high temperatures, fire and chemical substances. Therefore, such equipment needs to be inspected frequently. Fibre ropes are used as taglines to control or stabilise loads that are being hoisted to prevent them from swinging is shown in Figure 8.7. They are suitable as taglines because they are flexible and are non-conductors.

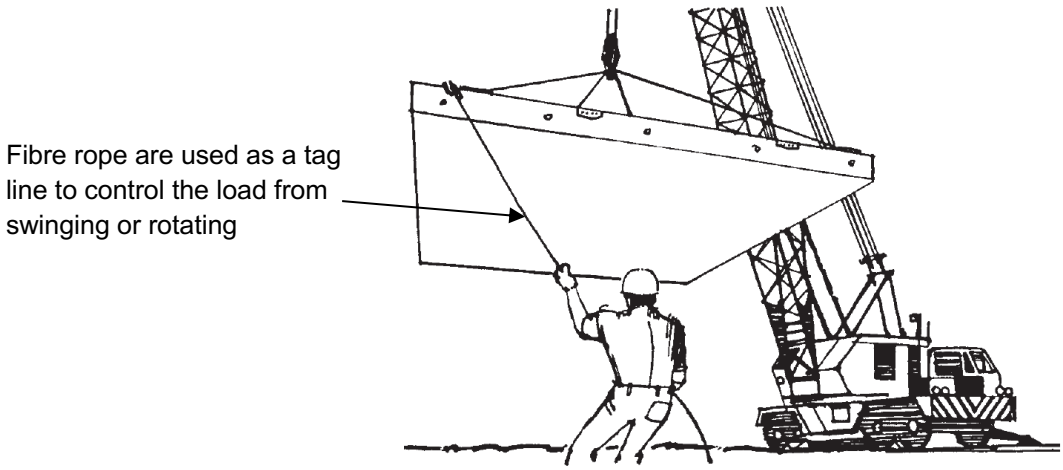


Figure 8.7 Use of fibre rope to control loads (Hoisting and Rigging Safety Manual 2012)

8.3.3 Synthetic fabric slings

Figure 8.8 shows a few synthetic fabric slings that are used for hoisting works. There are several types of such slings, as shown in Figure 8.9. The materials and colour codes that are normally used for these slings are nylon slings are marked with a green code, polyester slings are marked with a blue code and polypropylene slings are marked with a red/brown code. Minimum diameter for these sling is 12 mm.

Figure 8.8 Synthetic fabric sling (www.craneinstitute.com)

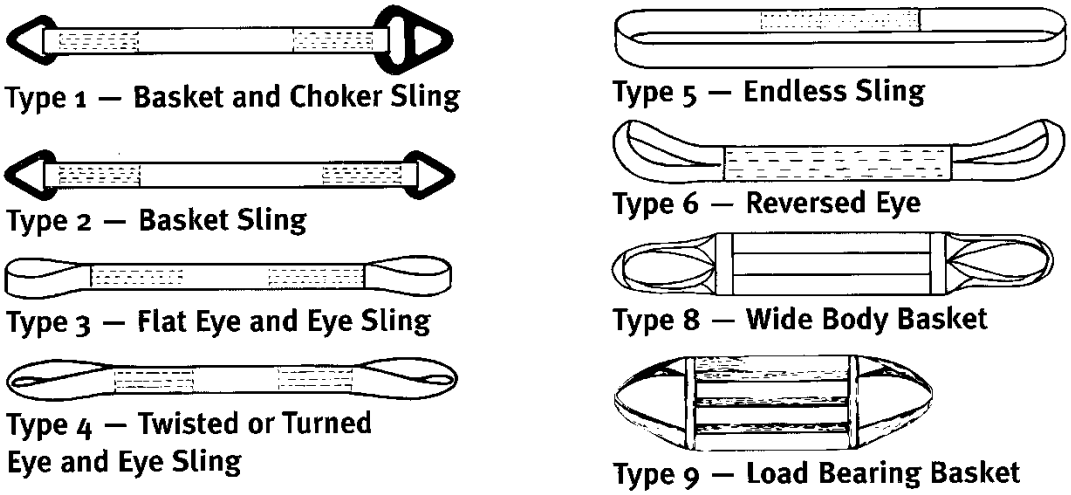


Figure 8.9 Some types of synthetic fabric slings (www.totaltool.com)

Damage to synthetic fabric slings

Figures 8.10 shows several examples of damage or defects that commonly occur. A sling cannot be used if the following defects are identified.

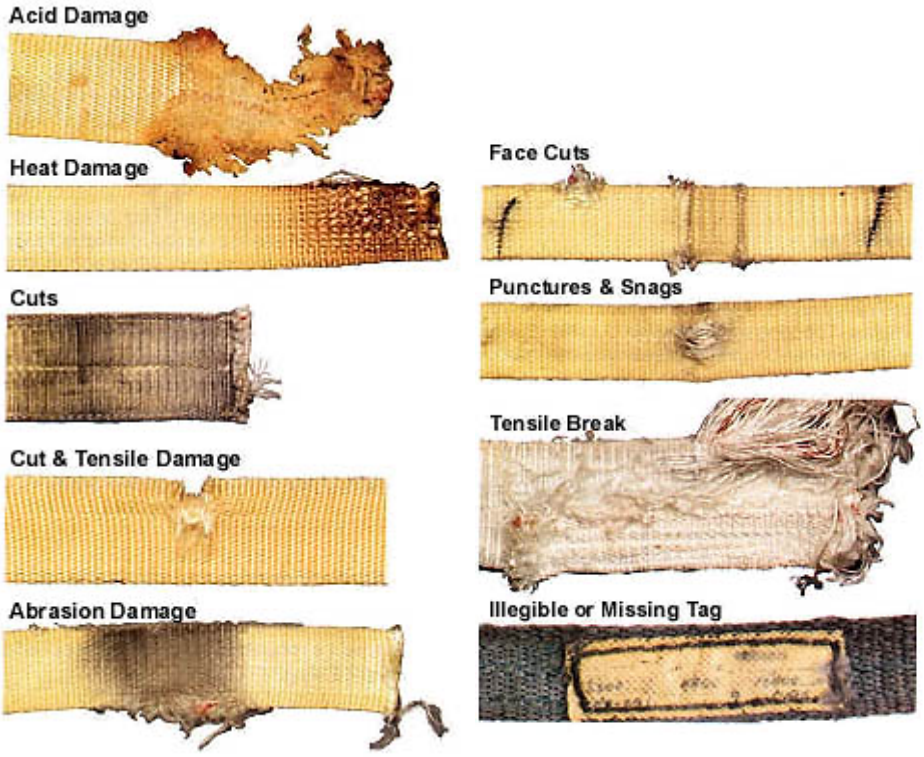


Figure 8.10 Damage to a synthetic fabric sling (www.stren-flex.com)

8.3.4 Chain slings

A grade T 800 Herc-Alloy chain is normally used, with its specifications being according to the Australia 2321-1979 standard. There are also other types of chains used in the lifting work as shown in Table 8.2. The short-link chain that is used as a sling has the following features:

(a) Minimum tension of 800 MPa to the destruction of strength for a breaking load

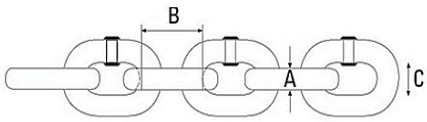
(b) Minimum tension of 400 MPa for a load test approval

(c) Total minimum elongation limit of 17%

Meanwhile, the working load limit (WLL) according to the same standard is as follows:

- Tension of 200 MPa at the working load limit

Table 8.2 Types of chains and their uses

Type of Chain	Use
Short Link  (Source: www.qdacsco-rigging.com)	Lifting Loads
Long link  (Source: www.suncorstainless.com)	Hitching Loads
Stad link  (Source: www.zszhongnan.com)	Hitching Loads
Calibrated   (Source: www.seagoyachting.com)	For chain blocks
Bush Roller  (Source: www.tsubaki.eu)	For motorcycles that involve gears or sprockets

The use of a single-leg short link chain is shown in Figure 8.11, while the use of a four-leg short link chain is shown in Figure 8.12.

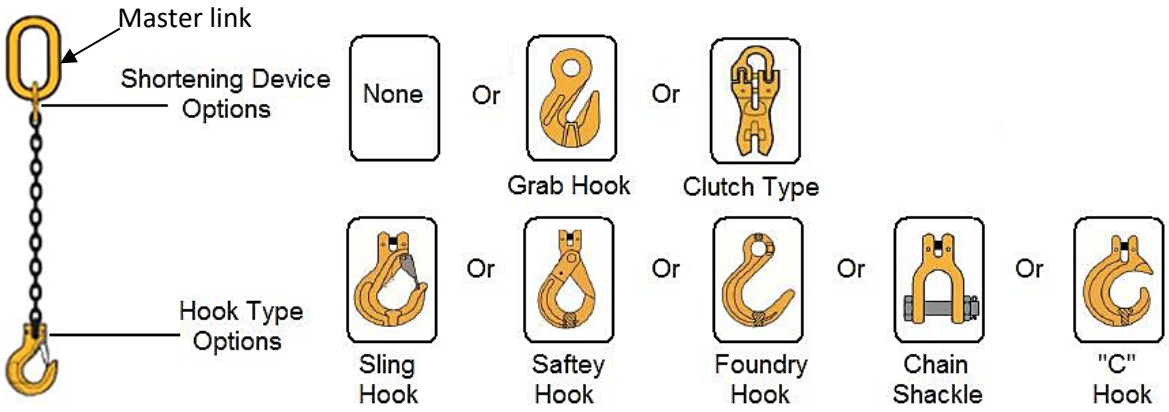


Figure 8.11 Single-leg short link chain with a master link and hook (www.liftsolution.co.uk)

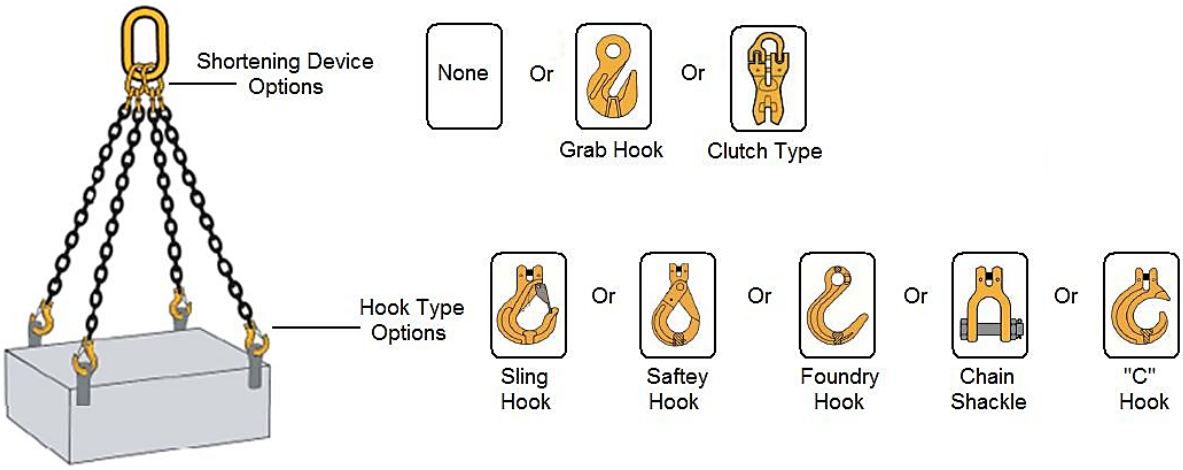


Figure 8.12 Four-leg short link chain with master link and hook (www.liftsolution.co.uk)

Chains must be checked before use. A chain that is damaged or defective cannot be used because it can cause accidents. Figure 8.13 below shows several examples of damaged chains.

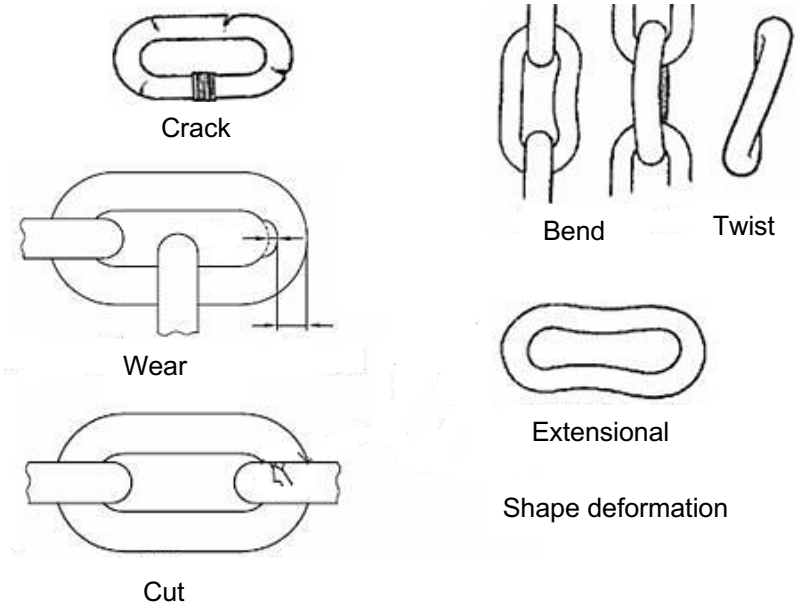


Figure 8.13 Damage to chains (www.suggest-keywords.com)

8.3.5 Procedure for selecting the right sling

(a) Determine the weight of the load that is to be hoisted beforehand.

(b) Determine the hoisting method that is to be used, whether it is to be by a single sling, double sling or the use of a sling together with other tools (spreader beam, etc.)

(c) Determine the required size of the sling based on the safe working load (SWL), whether from a table or by calculations.

(d) Determine the length of the sling and take into account the sling angle if the hitch is to be at an angle according to the hoisting method.

(e) Ensure the distance between the sling and the load is measured accurately according to the required angle.

(f) Select the type of sling that is appropriate for the material to be hoisted.

(g) Follow all the instructions for the sling with regard to its SWL/WLL and the suitability of its use.

8.3.6 Storage of slings

(a) Before or after a sling is used, it must be cleaned with high-pressure air.

(b) Do not keep slings in a store with acids, alkalis, chemicals and other liquids that can damage the slings.

(c) Do not mix slings that can be used with slings that are already damaged and cannot be used (store them separately).
(d) Before storing after cleaning, rub some grease or oil on FSWR slings.

8.3.7 Safety practices when using slings

The strength of a sling during hoisting work depends on:

(a) The weight and shape of the object to be hoisted
(b) The type of equipment used
(c) The method of rigging a load

Therefore, to ensure safety when a sling is being used to lift a load, the following criteria should be complied with:

(a) The sling must be inspected before it is used
(b) A sling cannot be knotted or damaged
(c) A sling cannot be shortened by knotting it or by tying it between other lifting gear components
(d) Clear away all obstacles when hoisting loads
(e) The sling must be hitched safely and correctly to the load
(f) The legs of the sling cannot be twisted
(g) The sling cannot be used to lift loads that exceed the SWL/WLL
(h) The sling must be shielded from sharp objects
(i) Loads with a basket hitch must be balanced
(j) Do not allow loads to be dragged.
(k) Do not pull on a sling that is caught beneath a load
(l) It is prohibited to lift persons using a sling
(m) All lifting equipment must be inspected before and after hoisting a load, and a report must be made of any damage
(n) All lifting equipment must have the SWL/WLL mark
(o) Do not use a hard object to tighten the hitch on a sling
(p) The load should be covered, especially if it has sharp edges, to avoid damaging the sling

(q) Ensure that all the sling legs are in place and that the master link is inserted in the latched hook

(r) Check each sling hitch to ensure that it is correct

8.4 Lifting Gear

Lifting gear is one of the important components used in hoisting works involving tower cranes. Each lifting gear has its own features and specifications to ensure that it is not used wrongly or with excessive loads. The tool concerned must also be checked each time it is to be used, and proper care and maintenance should be provided to ensure that it will be safe for use as well as to prolong the life of the tool.

Below are some examples of lifting gear:

(a) Shackles

(b) Eye bolts

(c) Hook blocks

(d) Pulleys

(e) Turnbuckles

(f) Spreader beams

(g) Plate clamps

8.4.1 Type fo lifting gear

(a) Shackle

A shackle is a hitching component that is comprised of a U-shaped steel piece with a pin through the open end. Shackles are used together with other hitching components such as wire ropes or chain slings for fixed lugs or fittings. There are two types of shackles, i.e. D shackles and bow shackles, as shown in Figure 8.14 Both types of shackles come with a screw pin or a round pin.

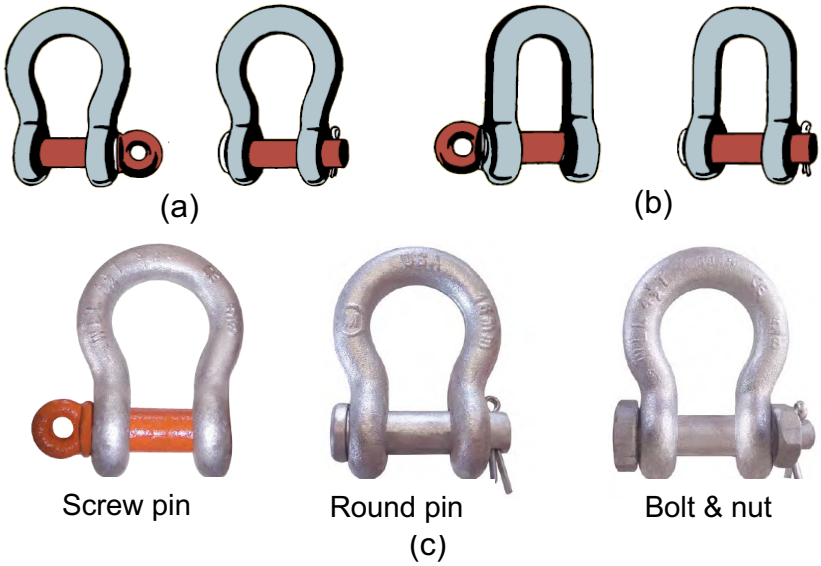


Figure 8.14 Types of shackles: (a) bow shackle, (b) D shackle (Occupational Safety & Health Council, Hong Kong, 2002), (c) types of pins on shackle (www.cmindustrial.com)

The surface of each shackle should be marked by the manufacturer to indicate the following information, which are name or trademark of the manufacturer, loading rate (WLL or SWL) and size. Methods for attaching slings to shackles are shown Figure 8.15.

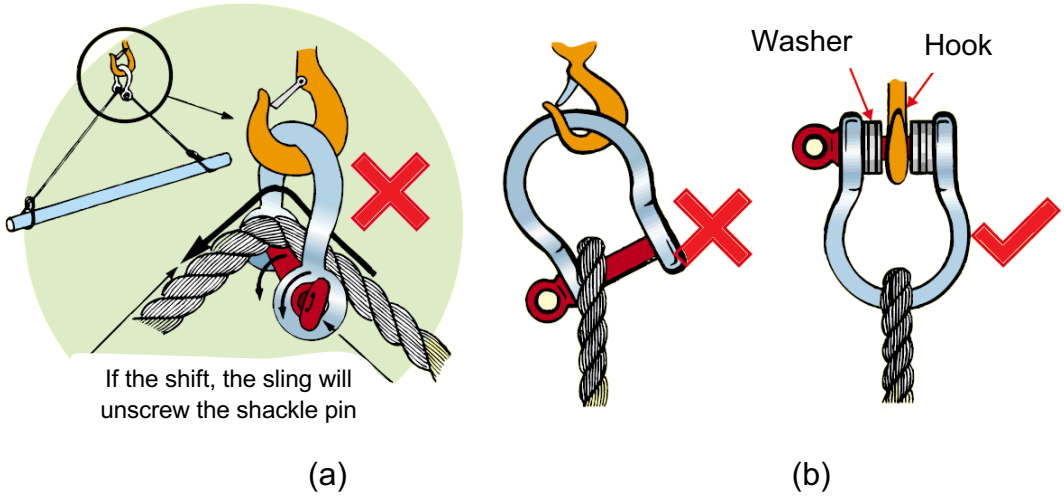
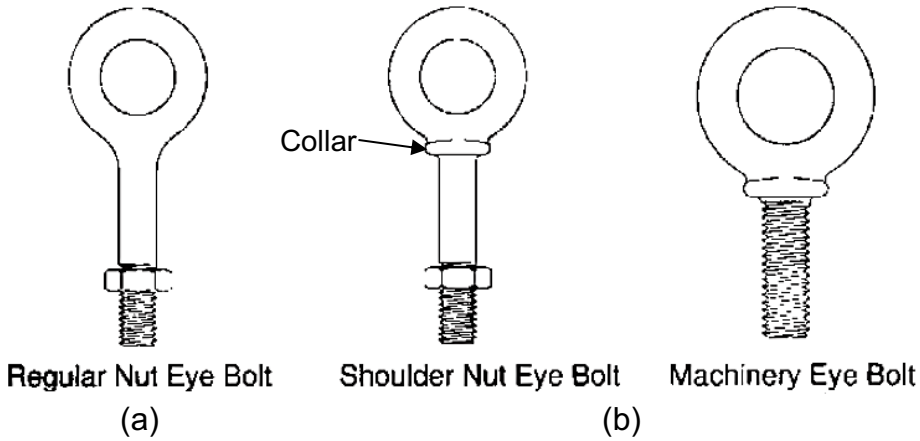


Figure 8.15 Methods for attaching slings to shackles: (a) wrong way, (b) correct way (load perpendicular to pin) (Safe Lifting, 2002)

(b) Eyebolt

Eye bolts can be classified into two types, namely those with a collar and those without a collar (normal type), as shown in Figure 8.16. It is recommended that only eye bolts with a collar be used for hoisting works.



8.16 Types of eye bolts: (a) without a collar, (b) with a collar (Bechtel Equipment Operations Rigging Department Bechtel Rigging Handbook, 2002)

Eye bolts with collars are used for vertical and angled hoisting where, for the latter, the SWL of the tool concerned must be noted. An angle of less than 45º is prohibited. Figure 8.17 and 8.18 shows how to use eye bolt when lifting work.

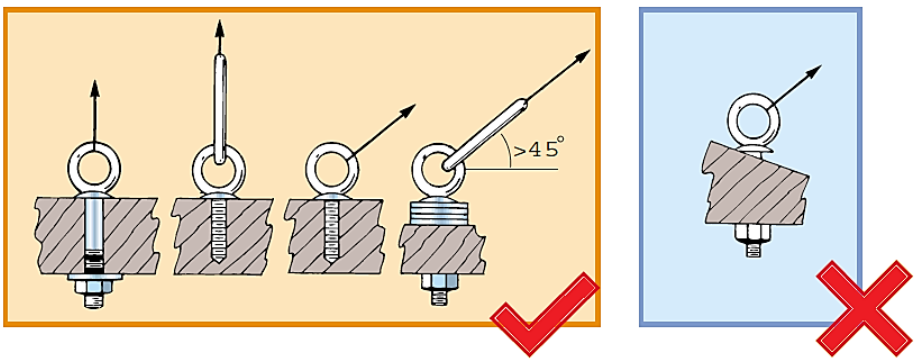


Figure 8.17 Correct and wrong way of hitching: (a) an eye bolt without a collar, (b) an eye bolt with a collar (Occupational Safety & Health Council, Hong Kong, 2002)

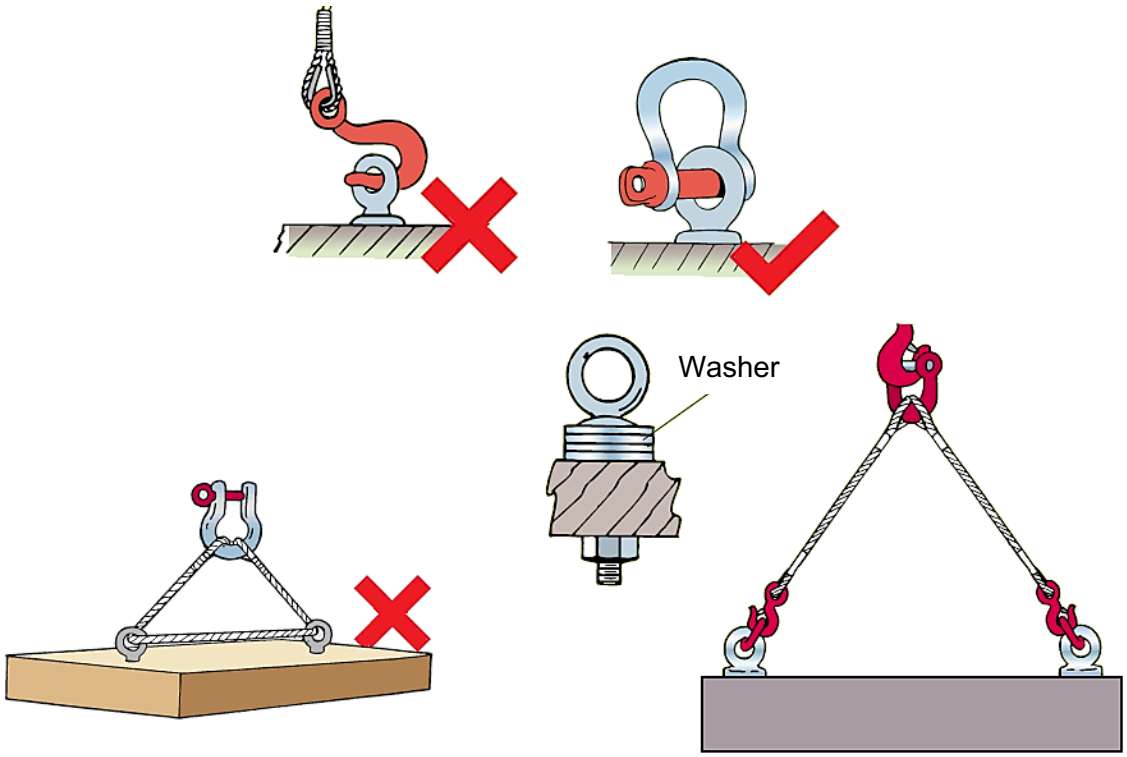


Figure 8.18 Correct and wrong way of hitching and slinging using eye bolts (Occupational Safety & Health Council, Hong Kong, 2002)

(c) Hook block

A hook is connected to a hook block assembly, and it is also installed with sheaves and pulleys carrying ropes. Hook blocks are designed in different shapes and sizes to fulfil various hoisting requirements. They can be classified as oval or diamond-shaped, or as snatch blocks, which are also known as gate blocks as shown in Figure 8.19. While a Figure 8.20 shows the details design of a hook block.

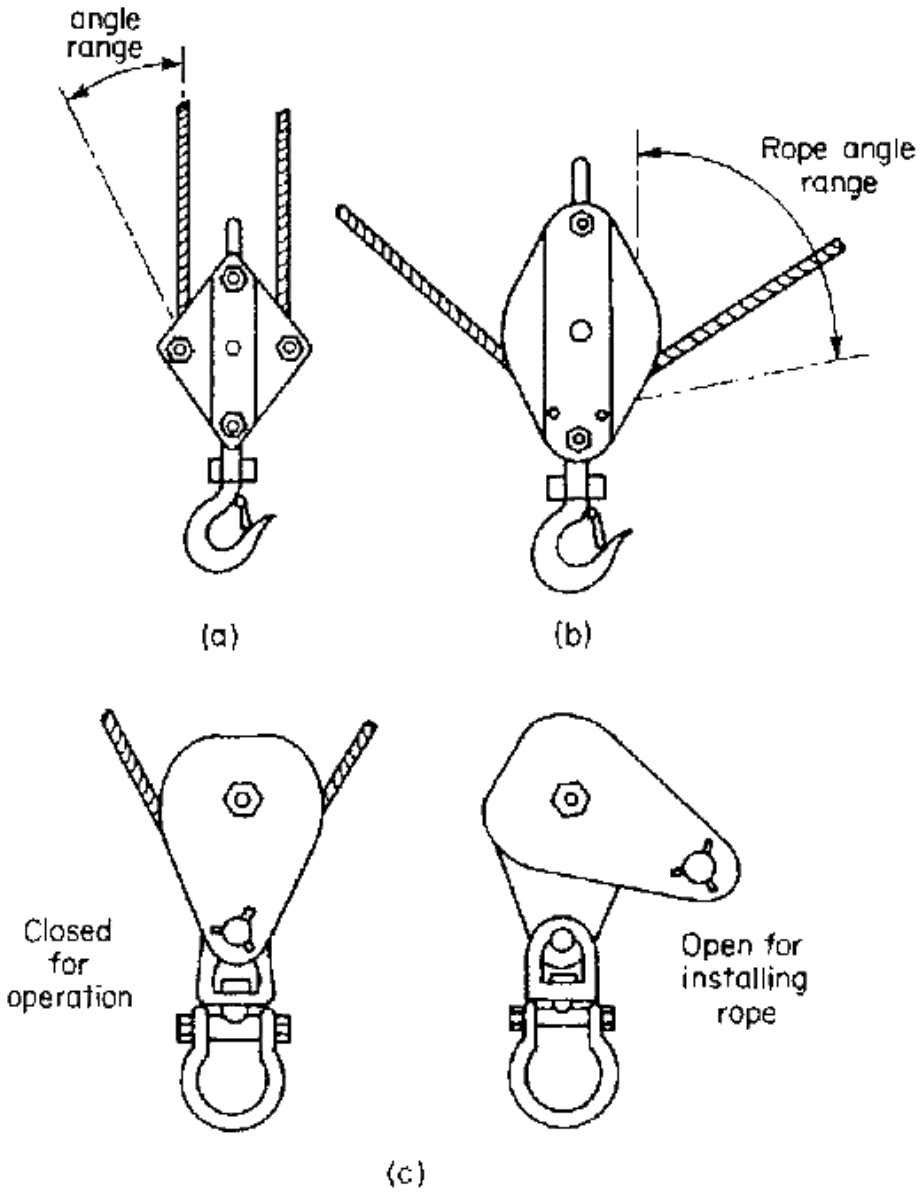


Figure 8.19 Types of blocks: (a) rhombic shape, (b) oval shape, (c) retractable block (Lawrence K. et. al, 2011; Cranes and Derricks, 2011)

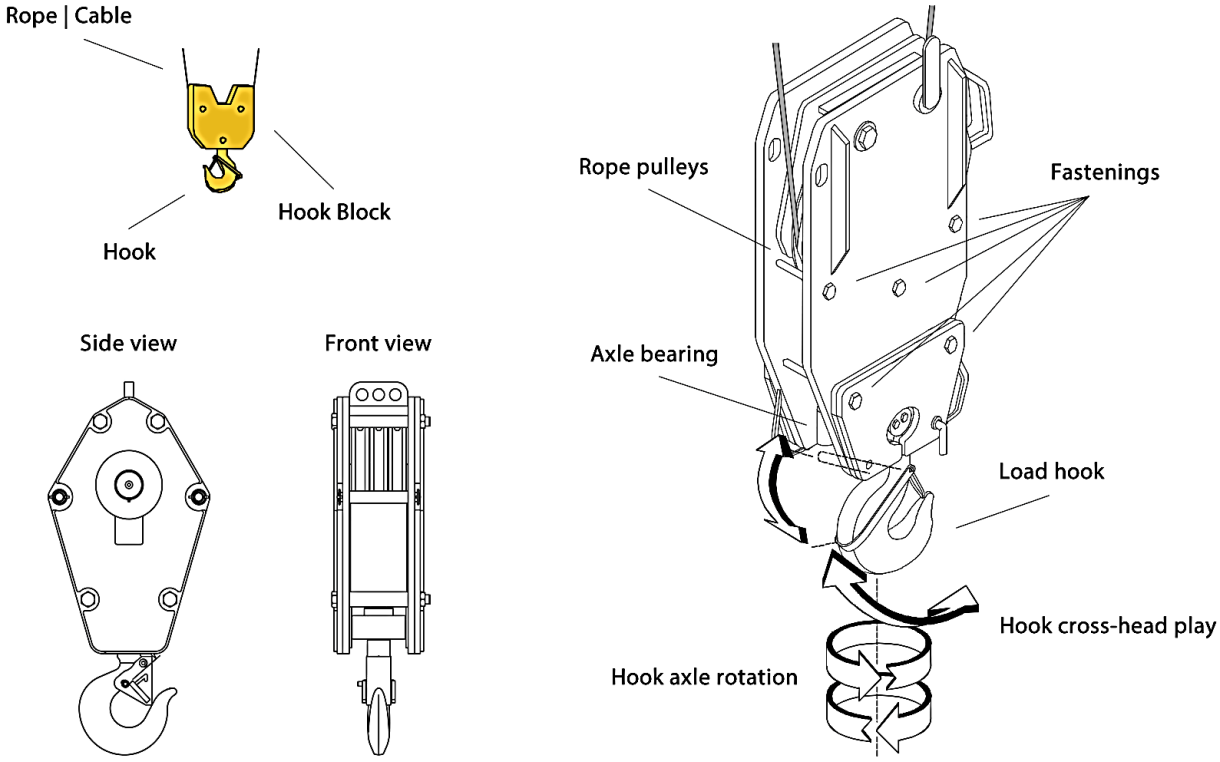


Figure 8.20 Design of complete hook block
(www.morrow.com/crane101)

(d) Pulley

Pulley is used for lifting, pulling, moving, change direction and reduce friction. There are two pulley configurations (Figure 6.14) as follows:

(a) Fixed pulleys, known as change of direction (COD) pulleys, that allow for a change in the pull direction.

(b) Movable pulleys that are rigged to the load and move when the load is pulled, dragged or raised.

Tower cranes use fixed and movable pulleys to hoist loads. The size and clearance between the wire rope and the groove should refer to the manufacturer's specifications to ensure the lifting work is safe.

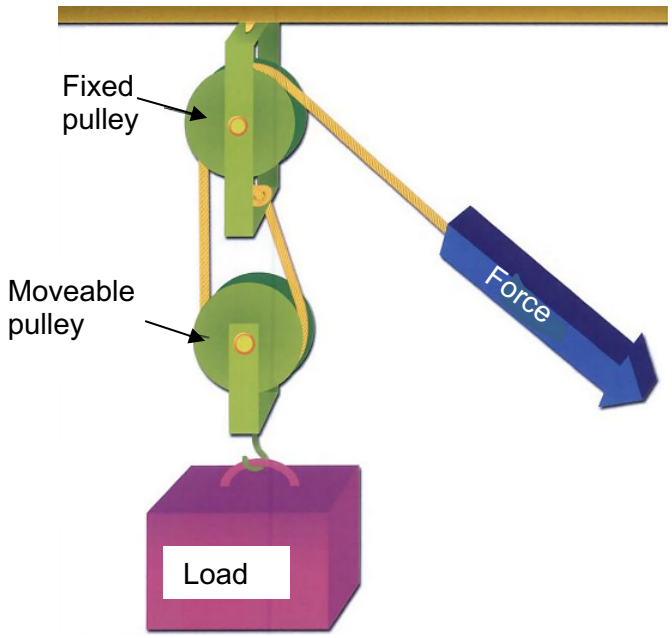


Figure 8.21 Use of pulleys for hoisting (Anne Welsbacher 2001)

(e) Turnbuckle

Turnbuckles are used to eliminate slack in pendent ropes. They come with hooks, rings or shackles as shown in Figure 8.22.

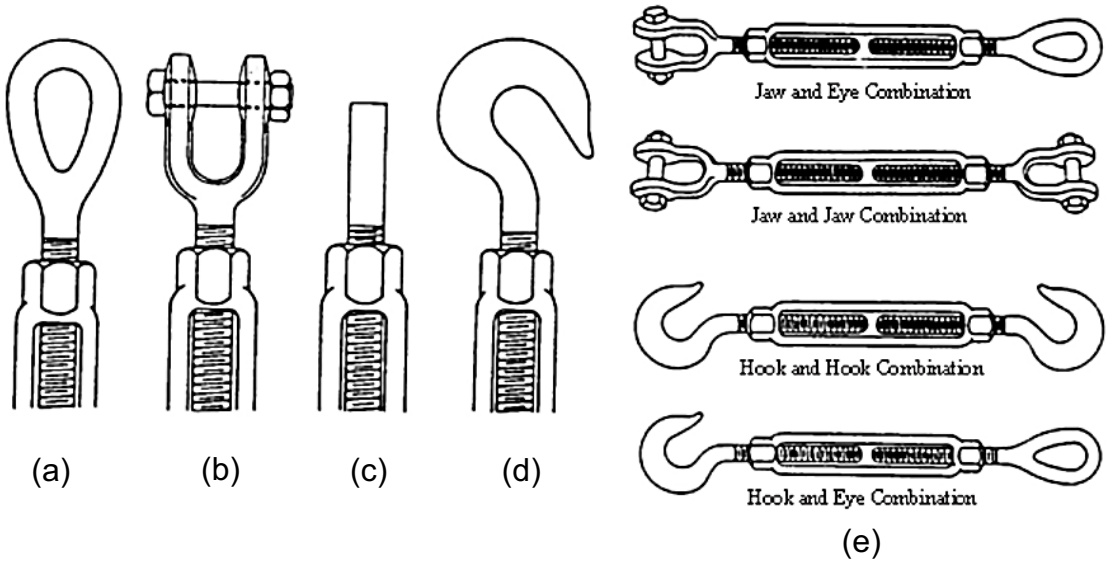


Figure 8.22 Types of turnbuckles (a) eye, (b) jaw, (c) stub, (d) hook (reduced capacity), and (e) combinations of turnbuckles (Hoisting and Rigging Fundamentals for Riggers and Operators, 2002)

(f) Spreader beam

Spreader beams come in various capacities and are either the fixed or adjustable type. They can also be designed with configurations for hooks or special shackles as shown in Figure 8.23. Spreader beams are usually used to hoist long loads. The weight of the spreader beam is included as part of the load to be hoisted.

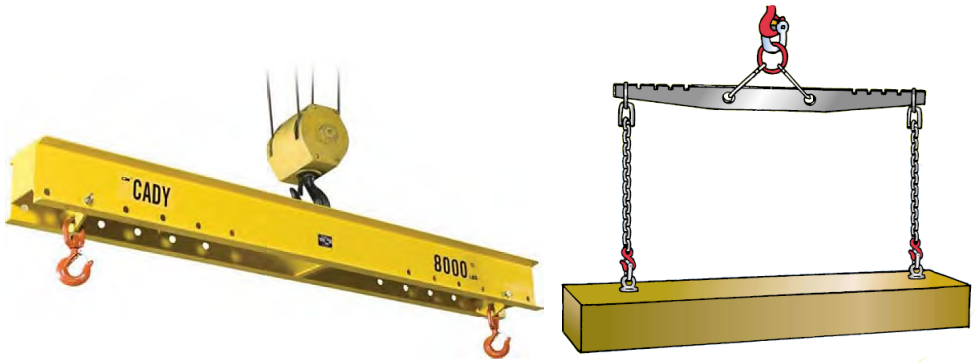


Figure 8.23 Spreader beam design (Columbus Mckinnon Corporation 2009; Lifting Accessories, Safety 2007)

(g) Plate clamp

Hoisting operations using plate clamps cannot be carried out on critical and high-pressure equipment. The use of plate clamps to secure loads must be according to the instructions manual, and they cannot be used to fasten inappropriate loads. Plate clamps cannot be used to lift more than one plate at a time for vertical hoists (Figure 6.19). Example of plate clamp design and clamping method are shown in Fig 8.24 dan 8.25.

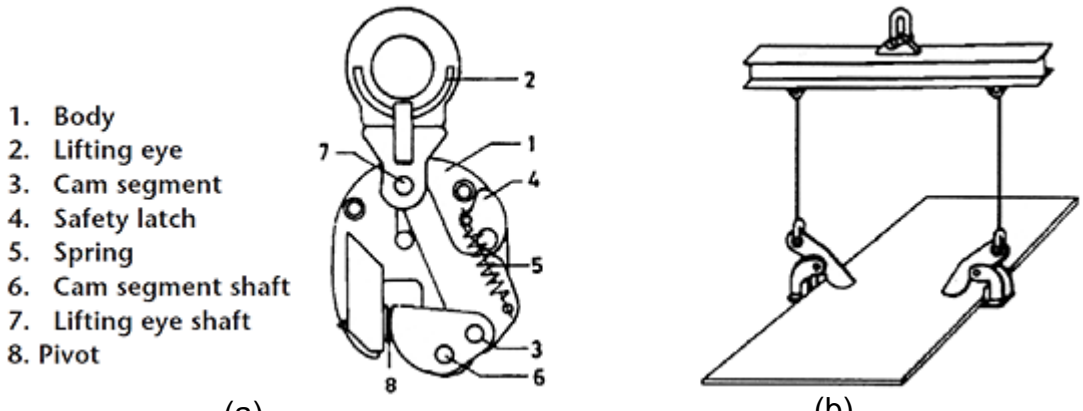
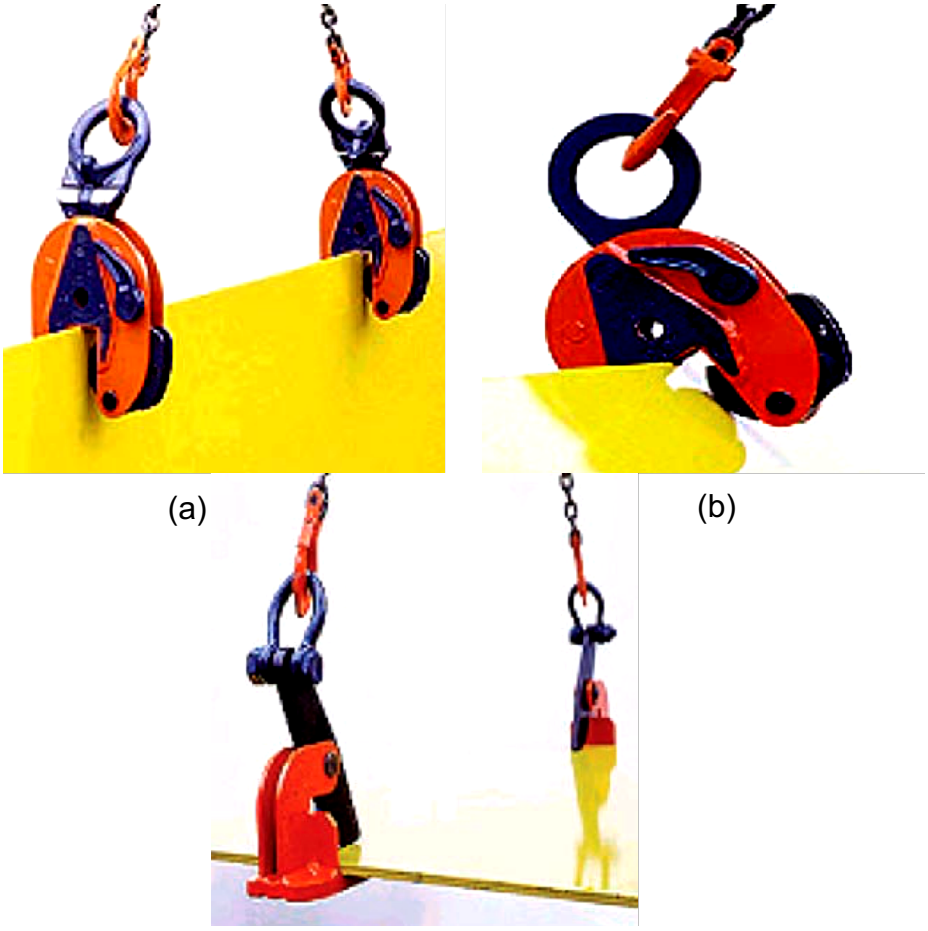


Figure 8.24 (a) Design of plate clamps for hoisting, and (b) a horizontal hoist (Lifting Equipment Operation 1997)



(a) (b)

(c)

Figure 8.25 Method of clamping (a) vertical hoist, (b) angled hoist, (c) horizontal hoist (Technical Advisory for Safe Operation of Lifting Equipment 2009)

8.4.2 Selection of lifting gear

(a) The tool concerned must be suitable, strong and stable enough for a particular use, and it should be marked with the safe working load.

(b) Every lifting aid and its components should be identified by its working load limit (WLL) and safe working load (SWL).

(c) The position of the tool and the type of tool to be installed can reduce any risk of injury/accident.

(d) To ensure the safe use of lifting gear, the work must be planned, organised and implemented by competent persons.

(e) A lifting gear tool that does not display/bear the WLL/SWL mark should not be used.

8.4.3 Inspection of lifting gear

(a) Employers can appoint someone in their service or an outsider with expertise in the structure, use and inspection of lifting equipment to carry out inspections.

(b) The inspector must be able to detect faults and defects, and estimate their impact on occupational safety.

(c) The instructions of the manufacturer must be taken into consideration in the inspection.

(d) The inspections usually involve visual assessments to determine the effects on the safe operation due to wear, change of shape or damage. If necessary, the inspection can include non-destructive inspection methods

(e) Inspection marks must be made on every tool to avoid the use of equipment that has not been checked and to facilitate the carrying out of the inspection.

(f) An effective way of preventing accidents from occurring due to the use of lifting gear that failed inspections and cannot be repaired is to dispose of them completely. After overloading or damage, a thorough inspection of the lifting gear must be conducted before they can be used once again.

(g) Before a new lifting tool is used, it must be checked to confirm that it complies with all aspects of the operating requirements and is suitable for use.

(h) Users need to check all lifting gear tools that are used daily on a continuous basis. Tools that are used less frequently must be checked each time the equipment is taken for use.

8.4.4 Care and maintenance of lifting gear

(a) The safe and correct care and storage of lifting tools can protect them from damage and extend their service life.

(b) Overloading is strictly prohibited. Check the WLL to verify the work load.

(c) Lifting gear must be well-maintained in reference to the manufacturer's manual.

(d) The weight of the load to be lifted must be accurate. This weight must include every part that is involved including the hook block, ropes, beams, shackles, slings and so on.

(e) Ensure that every lifting operation is controlled and free from unplanned movements, and that the centre of gravity is known.

8.4.5 Repair and disposal of lifting gear

If there is a lifting tool that shows signs of damage, defects or any uncertainty as to the integrity of the tool, it should not be used, and should be marked with the "**Not Usable**" tag.

The tool concerned must be referred to the hoisting supervisor, who will conduct a lifting assessment, and has the authority to decide whether the damaged tool is to be repaired or disposed of. Any lifting gear that is cracked, broken or bent cannot be repaired and must be replaced.

Repairs

a) All repairs must be conducted by the supplier or an experienced person by referring to the original manufacturer's specifications and any applicable standards.

b) All slings and lifting gear that undergo repairs must be marked according to the relevant standard and then tested to fulfil the following criteria:
   - the tool that is repaired complies with the original strength requirements;
   - the tool has been marked to identify who carried out the repairs; and
   - all tools with cracked, broken or bent parts are replaced and not repaired.

c) If the identification tag and marking have been separated or cannot be read, the lifting tool can be returned after an assessment by a qualified inspector. If the tool is found to be in good condition, it must undergo tests

to verify the WLL or SWL, and it will be marked once again after the process is completed.

Disposal

All lifting gear tools that are damaged or defective must be assigned the "**Not Usable**" status before they are disposed. If a sling shows signs of defects, it cannot be used and must be disposed of immediately. The registration of lifting gear must be coordinated.

(Note: Detail informations on lifting equipment and lifting gear can be found in the Training Module for Rigger)

Bibliography

Anne Welsbacher, Pulleys, Bridgestone Books, Amerika Syarikat, 2001.

Bechtel Equipment Operations Rigging Department Bechtel Rigging Handbook, Second Edition, Bechtel Equipment Operations, Inc., 2002.

CM Complete Lifting Systems, Columbus Mckinnon Corporation, 2009.

Hoisting and Rigging Fundamentals for Riggers and Operators, TR244C, Rev. 5, 2002.

Hoisting and Rigging, Safety Manual, Infrastructure Health & Safety Association, Canada, 2012.

http://www.cmindustrial.com [2 Februari 2017]

http://www.craneinstitute.com [2 Februari 2017]

http://www.edwardswirerope.com [2 Februari 2017]

http://www.liftsolution.co.uk [2 Februari 2017]

http://www.maintworld.com [5 Februari 2017]

http://www.morrow.com/crane101) [5 Februari 2017]

http://www.nasdonline.org [5 Februari 2017]

http://www.portcityindustrial.com [2 Februari 2017]

http://www.practicalmaintenance.net [5 Februari 2017]

http://www.stren-flex.com [5 Mei 2017]

http://www.suggest-keywords.com [5 Februari 2017]

http://www.totaltool.com [5 Februari 2017]

http://www.wisc-online.com [5 Februari 2017]

http://www.work.alberta.ca [5 Februari 2017]

Kempsey Shire Council, Selection, Use, Inspection and Maintenance of Lifting Equipment, Work Health and Safety Policy, 2015.

Lawrence K. Shapiro, ans Jay P. Shapiro, 2011, Cranes and Derricks, Fourth Edition, McGraw-Hill, ISBN: 978-0-07-162558-6).

Lifting Accessories, Safety, Occupational Safety and Health Administration, 2007.

Lifting Equipment Operation, Norsok Standard, 1997.

Nota Operator Kren Menara, Institut Kemahiran Tinggi Belia Negara (IKTBN), Kementerian Belia dan Sukan, Bachok, Kelantan, 2004.

Nota Operator Kren Menara, Institut Kemahiran Tinggi Belia Negara (IKTBN), Kementerian Belia dan Sukan, Chembong, Negeri Sembilan, 2003.

Nota Tower Crane Operator, Gamuda Plant Operator School (GPOS), Shah Alam, Selangor, 2002.

Safe Work Australia, General Guide for Cranes, 2015.

Technical Advisory for Safe Operation of Lifting Equipment, Workplace Safety and Health Council, Ministry of Manpower, 2009.

MS 2093:2008 Cranes and Lifting Appliances - Selection of Wire Rope-Part 1: General (ISO 4308-1:2003, MOD)

CHAPTER 9

METHODS FOR THE RIGGING OF LOADS

9.1 Introduction

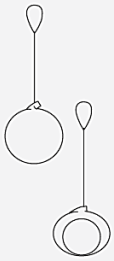
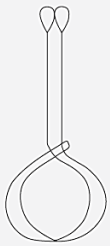
A sling is defined as a tool that is used for rigging something so that it can be suspended. In the construction sector, a sling is used for rigging loads when works to hoist, lower or suspend are being carried out by a tower crane as well as a travelling crane. There are several types of slings, and the use of each sling depends on the kind of load to be hoisted Among the slings that are commonly used at construction sites are wire rope slings, chain slings, synthetic fabric slings and fibre slings. Figure 4.1 below shows some of the slings that are usually used at construction sites, while Table 9.1 show the mode factor used for selecting a sling and rigging.

(a) Wire rope sling (b) Chain sling

(c) Fibre sling (www.shutterlock.co.za) (d) Synthetic fabric sling (www.craneinstitute.com)

Figure 9.1 Types of slings that are usually used at construction sites (www.uscargocontrol.com)

Table 9.1 Factor mod chart for types of slings and rigging

MODE FACTORS Maximum load to be lifted = mode factor x SWL marked on the sling Key: NP = non preferred, NA = not applicable								
1	2	3	4	5	6	7	8	9
Material	Single leg in line 	Single leg choked 	Single leg basket 	Single leg back hooked 	Single leg halshed 	Endless in line 	Endless choked 	Endless basket 0-90° 
Chain	1	0.8	1.4	1	NP	NP	1	NP
Wire rope	1	1	1.4	1	2	NP	1	1.4
Webbing	1	0.8	1.4	NA	NP	1	0.8	1.4
Fibre Rope	1	0.8	1.4	1	1.6	1	0.8	1.4
Roundsling	NA	NA	NA	NA	NA	1	0.8	1.4

Source: Lifting Supervisor Guidebook (2014)

9.2 Type of Sling for Rigging the Load

9.2.1 Direct hitch

This type of sling is hitched directly with a single-leg without any bending or stretching towards the load. It is tied to the load using hooks at every place where there is a bow or eye bow attached to the load. When a sling with more than one leg is used, i.e. a 2-leg, 3-leg or 4-leg sling, and if it is not folded to become two or more slings, and is not stretched, it is still categorized as a single sling, as shown in Figure 9.2.

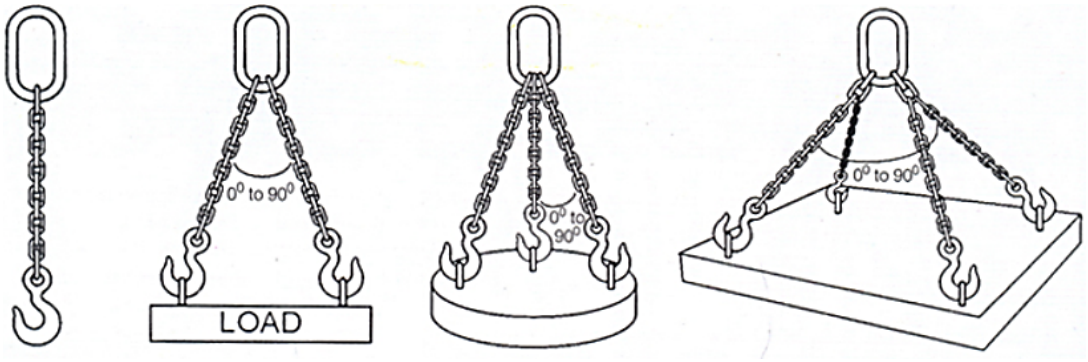


Figure 9.2 From left, direct hitch sling with one leg, two legs, three legs and four legs (www.lifttechnique.com)

9.2.2 Choke hitch/reeved hitch

In this method, the load is wrapped or choked using the same sling. This type of sling has an eye at its end, whether it is a single sling or more than one sling (Figure 9.3). When the load is hoisted, the sling that is wrapped around the load will become tighter and will experience strain. The sling can also be double-wrapped around the load to prevent the load from slipping out of the sling or being pulled out from the rigging, for example, when lifting a large number of cylindrical pipes. This type of hitch can also be used to shorten the sling.

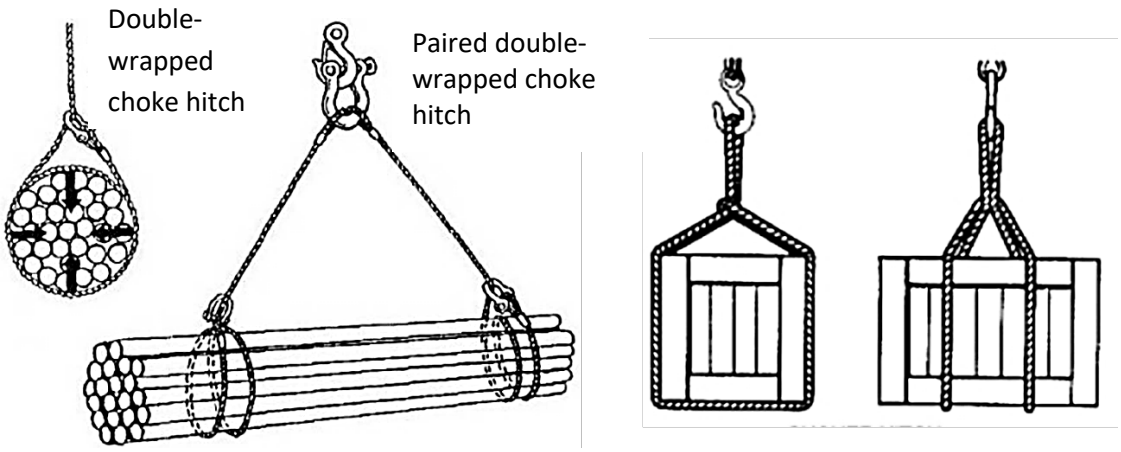


Figure 9.3 Choke/reeved hitch sling (www.practicalmaintenance.net, www.globalsecurity.org)

9.2.3 Basket hitch

This type of sling is passed around the load and both ends of the sling are joined to a hook in the hook block of a tower crane or added to the hoist beam as shown in Figure 9.4.

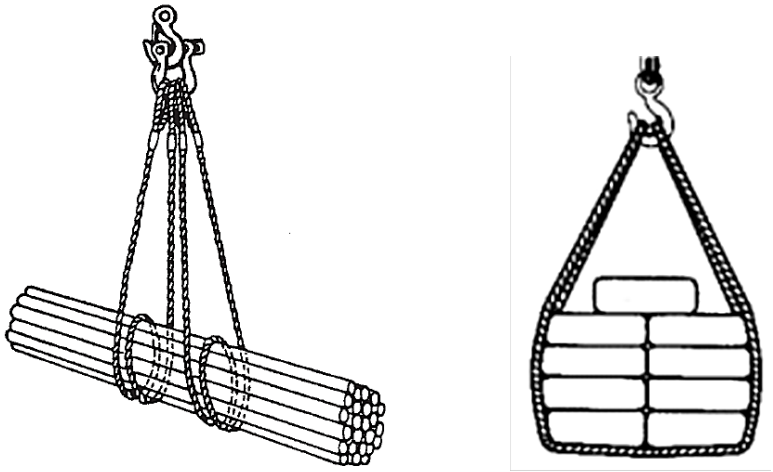


Figure 9.4 Basket hitch sling (www.practicalmaintenance.net; www.globalsecurity.org)

9.3 Selection of Sling

To ensure safety during hoisting works, the appropriate sling must be selected based on the following matters:

(a) Type of load to be hoisted
(b) Weight of the load
(c) Size of the load. Large-sized loads require longer slings
(d) Shape and orientation of the load
(e) Whether the load is provided with points to connect to a sling or not
(f) Whether the load can be easily damaged or not
(g) Whether the load is an individual load or is comprised of several loads hitched together
(h) Double hitches must be used with long slings
(i) Whether the load is in the form of ingots or bricks

The main factors in the selection of sling for lifting work are as follows:

(a) Working load lomit

The working load limit (WLL) is the maximum load that can be applied to a lifting equipment or lifting aid to prevent damage. Every lifting equipment has its own WLL. Therefore, the lowest WLL value should be used as a reference for hoisting work if the equipment or lifting gear used has different WLL values.

(b) Safe working load

The safe working load (SWL) is the old term that was used before the introduction of the WLL to determine the maximum load to prevent damage to the equipment. Most lifting equipment or lifting gear now uses the WLL label.

(c) Breaking strength

The breaking strength (BS) is the actual force required to cause damage to lifting equipment.

(d) Proof loading

Proof loading is the load failure limit that is determined by testing the material concerned. The safe working load value must be below the proof loading value. The sling that is used to hoist the load should have this test certificate issued by the manufacturer.

(a) Safety factor

The safety factor (SF) is used to prevent any failure in all areas, especially in the engineering design. The value of the SF varies according to the lifting equipment, and it is used to calculate the WLL/SWL. Table 9.2 shows the SF values for several types of lifting equipment.

Table 9.2 Safety Factor according to type of sling

Sling type	Safety factor
All types of slings when used to lift persons	10
Synthetic fabric	8
Fibre rope	6
Wire rope	5
Chain (steel)	4

(b) Angle factor and load factor

There are two main factors that can have an effect on the strength of the sling during operations, namely, the Angle Factor and the Load Factor.

(i) The angle of the sling to the load can affect the strength of the sling. When the sling angle is increased, the tension in the sling also increases as shown in Table 9.3. When the tension in the sling increases, the strength capacity of the sling will be reduced.

Table 9.3 Increase in the sling tension with an increase in the sling angle angle factor

Sling angle	Percentage of increasing in sling tension	Angle factor
30°	3%	1.93
45°	7%	1.85
60°	15%	1.73
90°	41%	1.41
120°	100%	1.00

Figure 9.5 shows the same load being hoisted using a single 2-leg chain sling at 5 different angles. The sling angle was changed from 0° to 120° and the load on the sling legs was changed from 5 tons to 10 tons. This clearly proved that the angle influences the tension as well as the strength of the sling.

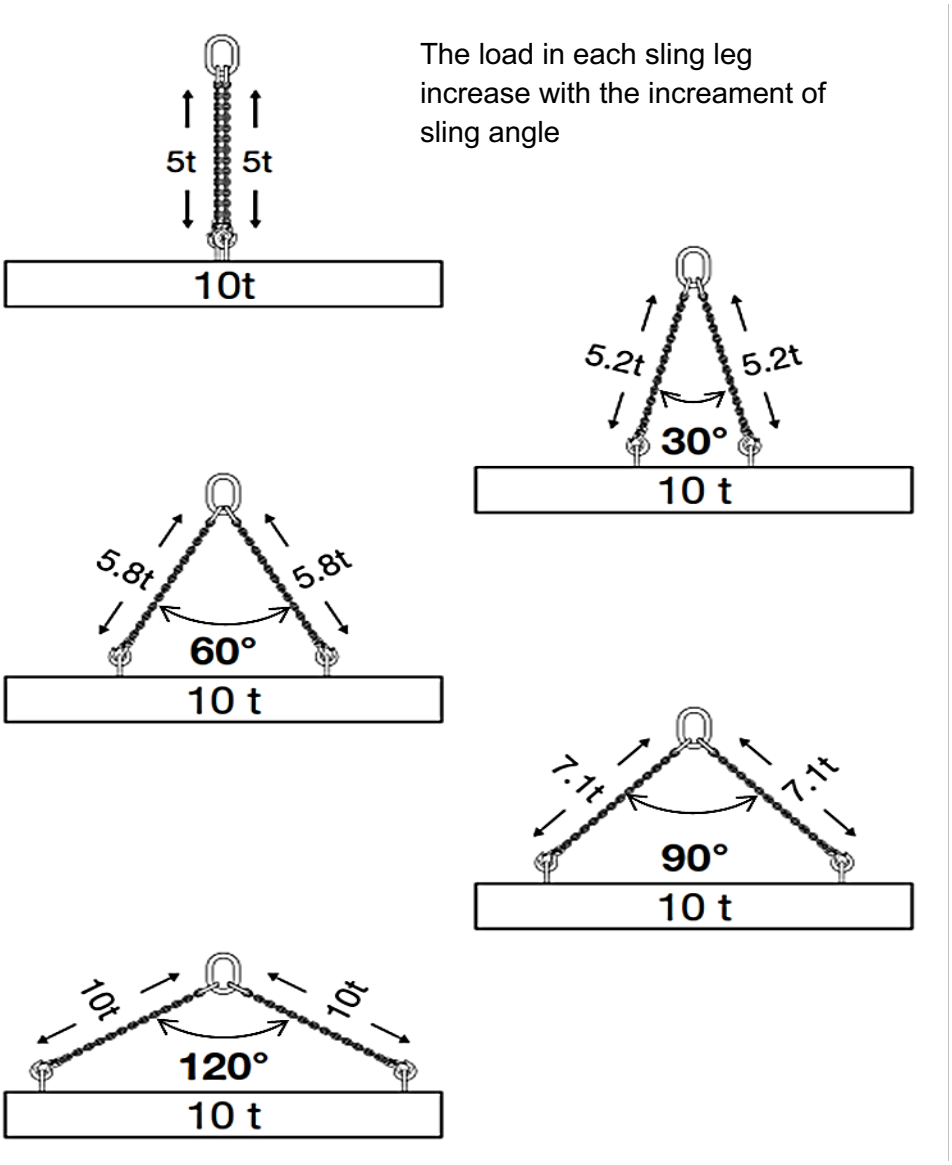
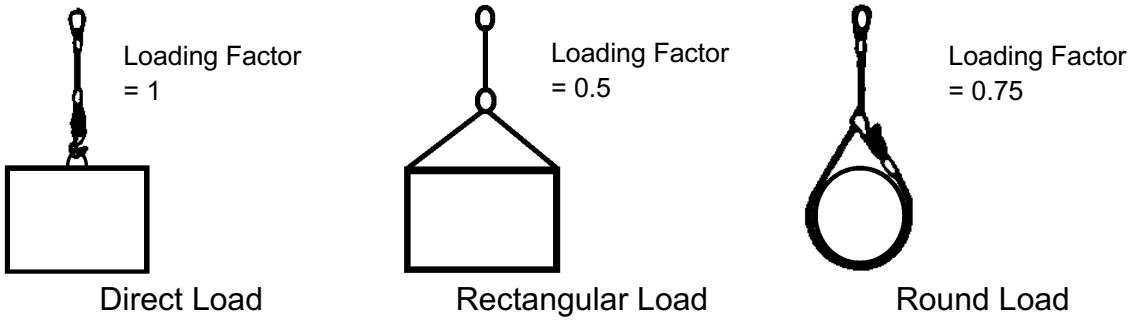


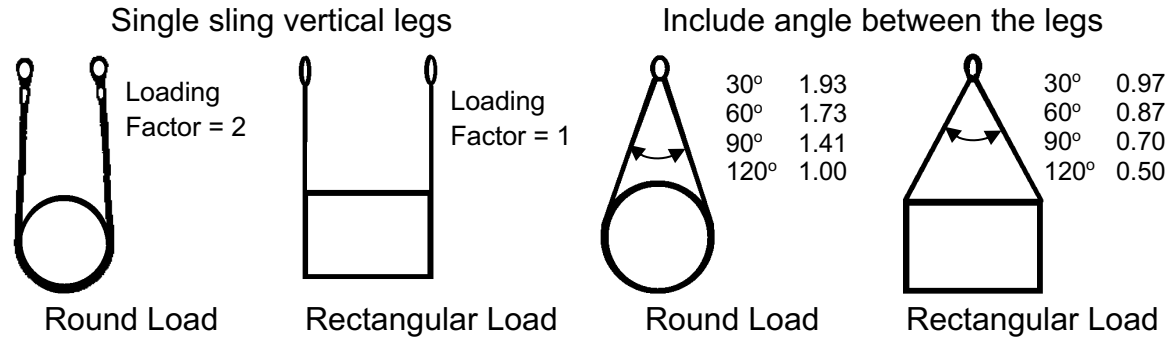
Figure 9.5 Angle factor on sling tension (Laing O`Rourke 2008)

(ii) The load factor (LF) also influences the strength of the sling, where it is used to calculate the WLL/SWL. The load factor depends on the type of sling hitch as well as the shape of the load to be hoisted as shown in Figure 9.6.

SINGLE SLING



BASKET HITCH



ENDLESS SLING OR GROMMET

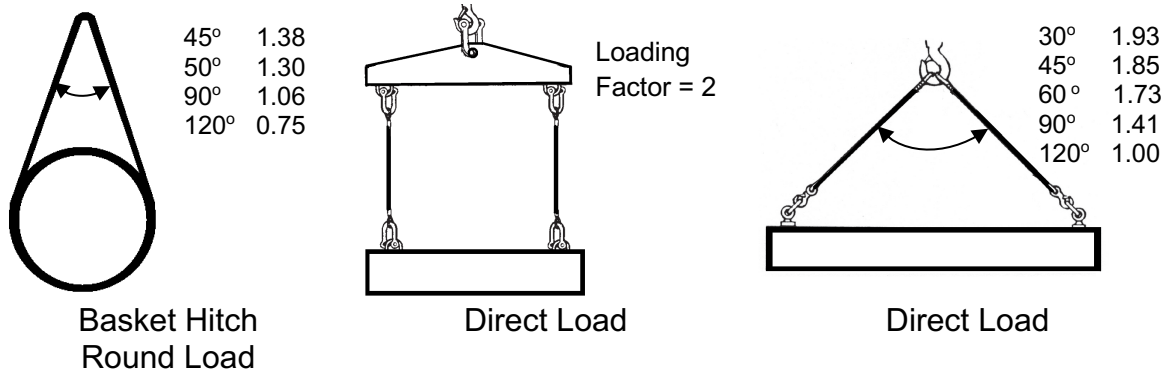


Figure 9.6 Load factors for various sling hitches and different load shapes (www.cranecrew.com)

Figure 9.7 below shows the correct and wrong ways of using a sling to ensure that the load is safely hoisted.

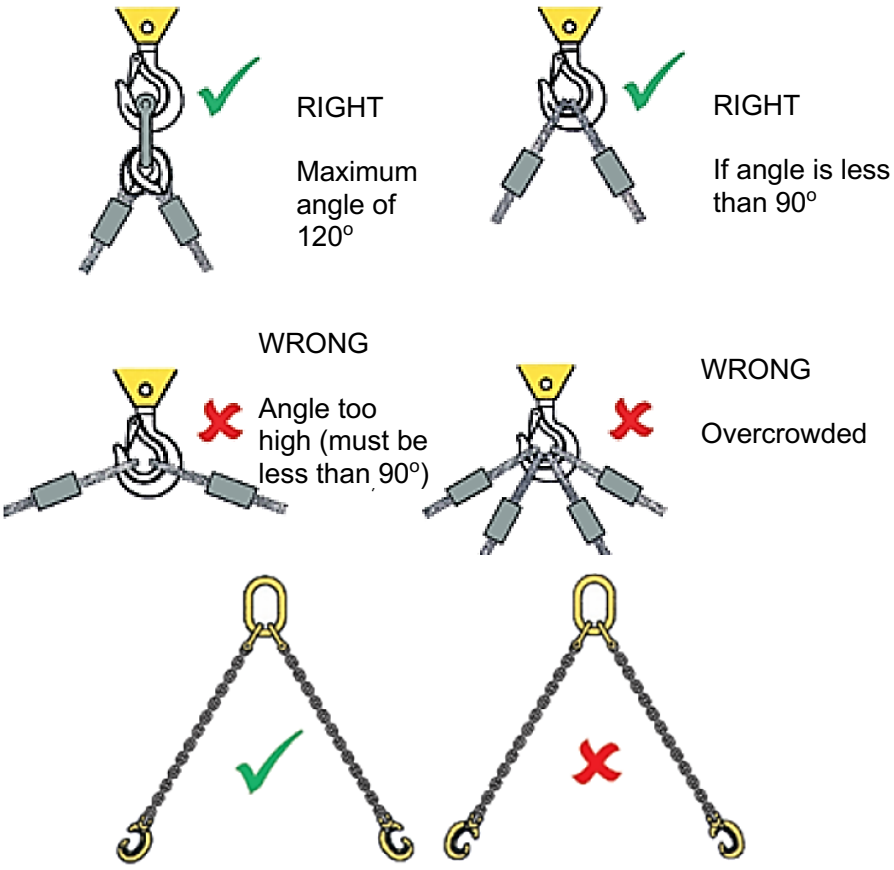


Figure 9.7 Correct and wrong ways of using a sling
(Laing O'Rourke 2008)

9.4 Calculation of the SWL Based on the Angle Factor and Load Factor

The relationship between the angle factor, load factor and SWL/WLL is shown in Equation (9.2):

$$\text{WLL} = \text{Weight of load} \div \text{Angle factor} \div \text{Load factor} \quad (9.2)$$

From Equation (4.2), the maximum load can be calculated using Equation (9.3) below if the value of the WLL is known:

$$\text{Maximum load} = \text{WLL} \times \text{Angle factor} \times \text{Load factor} \quad (9.3)$$

(Note: Detail informations on lifting equipment and lifting gear can be found in the Training Module for Rigger)

Bibliography

http://www.cranecrew.com [12 March 2017]

http://www.craneinstitute.com [12 March 2017]

http://www.globalsecurity.org [12 March 2017]

http://www.lifttechnique.com [20 March 2017]

http://www.practicalmaintenance.net [20 March 2017]

http://www.shutterlock.co.za [20 March 2017]

http://www.uscargocontrol.com/Lifting-Slings [20 March 2017]

J. Clausaen, S. O. Hansson, F. Nilsson, “Generalizing the safety factor approach, Reliability Engineering & System Safety, 2006, Vol. 9(8), pp. 964-973.

Laing O’Rourke, 2008. Guide to safe slinging and signalling.

Nota Operator Kren Menara, Institut Kemahiran Tinggi Belia Negara (IKTBN), Kementerian Belia dan Sukan, Bachok, Kelantan, 2004.

Nota Operator Kren Menara, Institut Kemahiran Tinggi Belia Negara (IKTBN), Kementerian Belia dan Sukan, Chembong, Negeri Sembilan, 2003.

Nota Tower Crane Operator, Gamuda Plant Operator School (GPOS), Shah Alam, Selangor, 2002.

Guidelines for Creating Lifting Plan for Lifting Operations In Workplaces, Workplace Safety and Health (WSH) Council, Singapore, 2014.

CHAPTER 10

TOWER CRANES ACCIDENTS AND PREVENTIVE

10.1 Tower Cranes in Malaysia

With reference to the statistics by DOSH (2017), the states with a high number of tower cranes are Kuala Lumpur, Selangor, Johor and Penang. To date, there are 1434 tower cranes and 1614 registered and active tower crane operators in Malaysia. A large number of these tower cranes (1120) are being used in Kuala Lumpur, Putrajaya, Selangor and Johor.

10.2 Factors Giving Rise to Accidents Worldwide

From the year 2000 until now, more than 1125 tower crane accidents have occurred involving 780 deaths worldwide. According to the data from surveys, many accidents go unreported, and these are estimated to be twice as many as the reported cases. In 2009, there were 188 cases involving 78 deaths, while a total of 154 accidents with 113 deaths were reported in 2010. The statistics on the number and causes of such accidents are shown in Figures 10.1 and 10.2.

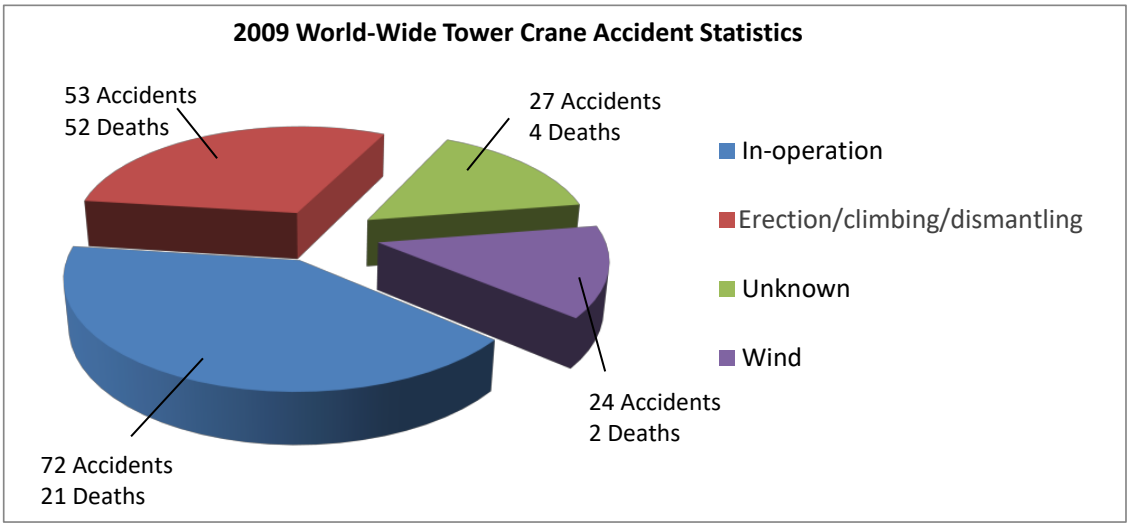


Figure 10.1 Statistics on the number of tower crane accidents worldwide (www.towercranesupport.com)

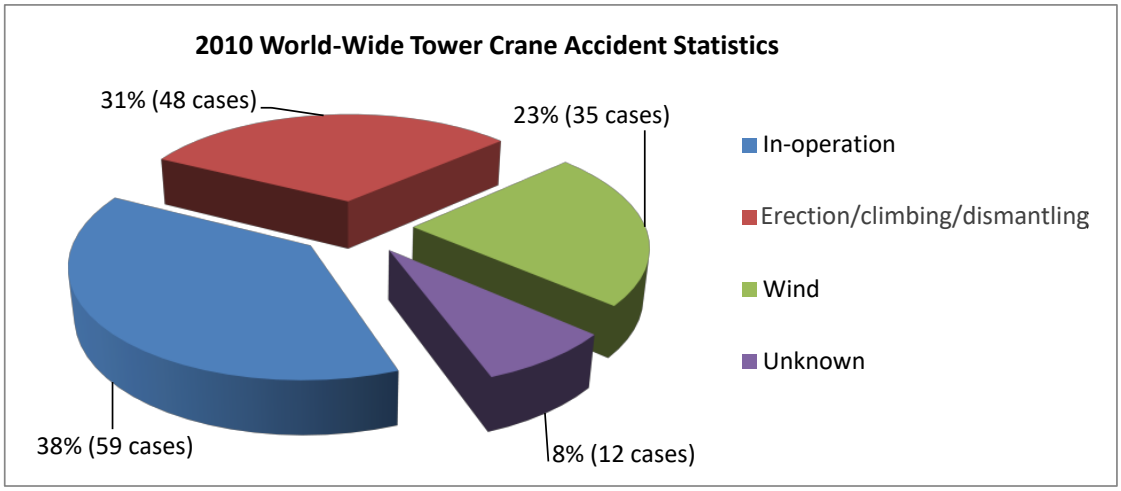


Figure 10.2 Statistics on the percentage of factors that are the causes of tower crane accidents (www.towercranesupport.com)

10.3 Statistics on Tower Crane Accidents

Based on surveys that have been conducted, the accident statistics show that deaths and hazardous incidents at the workplace involving tower cranes and hoisting equipment are increasing every year (see Figure 10.3). Among the causes of the accidents are:

(a) failure of the crane structure or components

(b) failure of the hoisting equipment (such as the wire rope, pulley, hook block, etc.)

(c) falling objects

(d) swinging object during the hoisting of a load

Based on the causes of accidents mentioned, it is necessary for the construction industry to improve its practices for the safe operation of tower cranes. Therefore, the stakeholders in the operation of tower cranes (such as crane manufacturers, crane contractors, engineers and designers, project managers, lifting supervisors, operators, signalmen, riggers and construction workers) should play their respective roles and carry out their responsibilities to ensure that the hoisting operations are conducted safely.

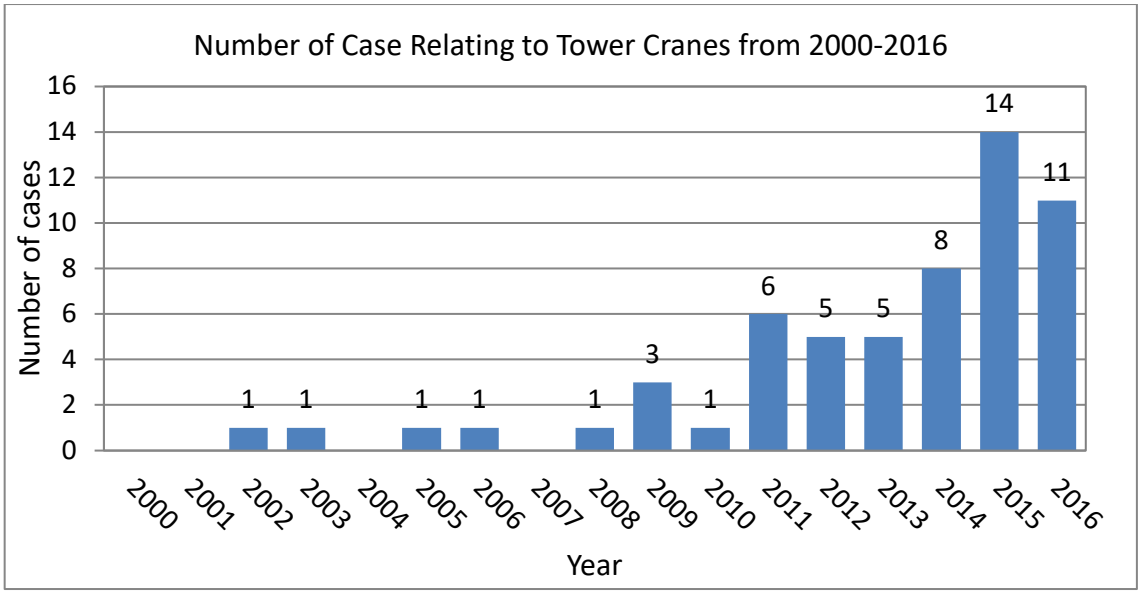


Figure 10.3 Statistics on accidents involving tower cranes

Among the factors identified as being the cause of accidents during hoisting operations are the following:

(a) damage to a single mechanical system (such as the hoisting system, hook block, electronic system and the brake system)
(b) the lackadaisical attitude of the hoisting crew
(c) unsafe working environment for cranes
(d) defective lifting equipment or tools
(e) abnormal load types and shapes
(f) improper rigging and slinging methods

More than 80% of the respondents to a questionnaire agreed that crane accidents were due to the negligence of the crane operator, poor communication, mechanical issues and the lifting of excessive loads, as shown in Figure 10.4. Referring to reports from the Department of Occupational Safety and Health (DOSH) from 2000-2017, among the main factors that contributed to tower crane accidents were mechanical or structural issues, and those that occurred during the operation of the crane, as shown in Figure 10.5.

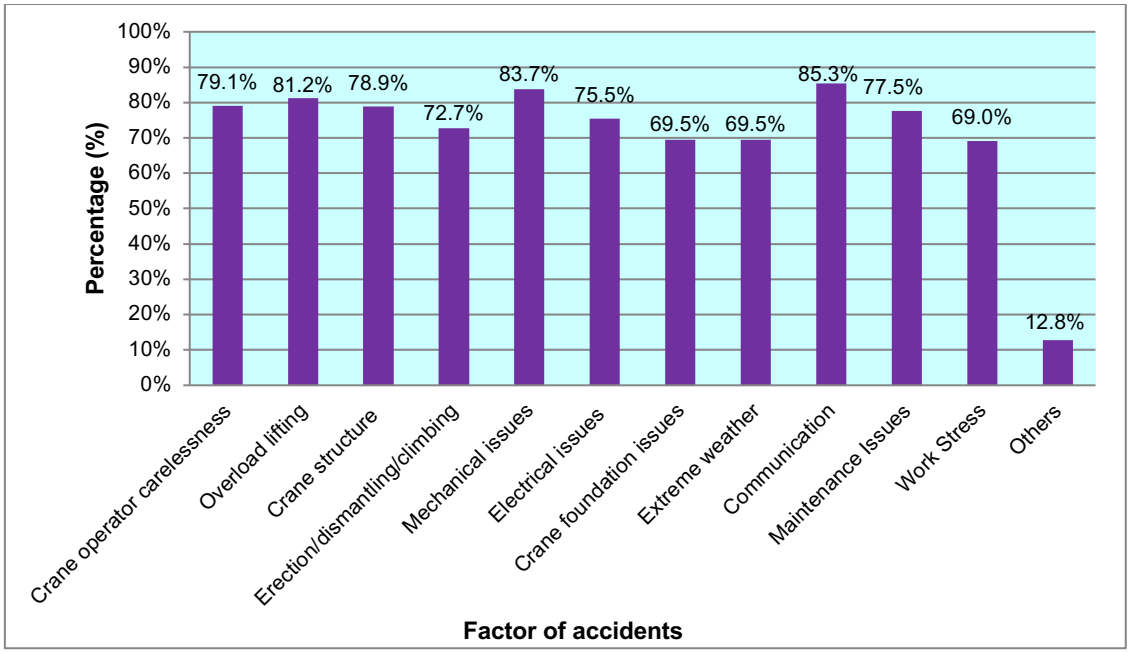


Figure 10.4 Percentage of causes of tower crane accidents (through surveys)

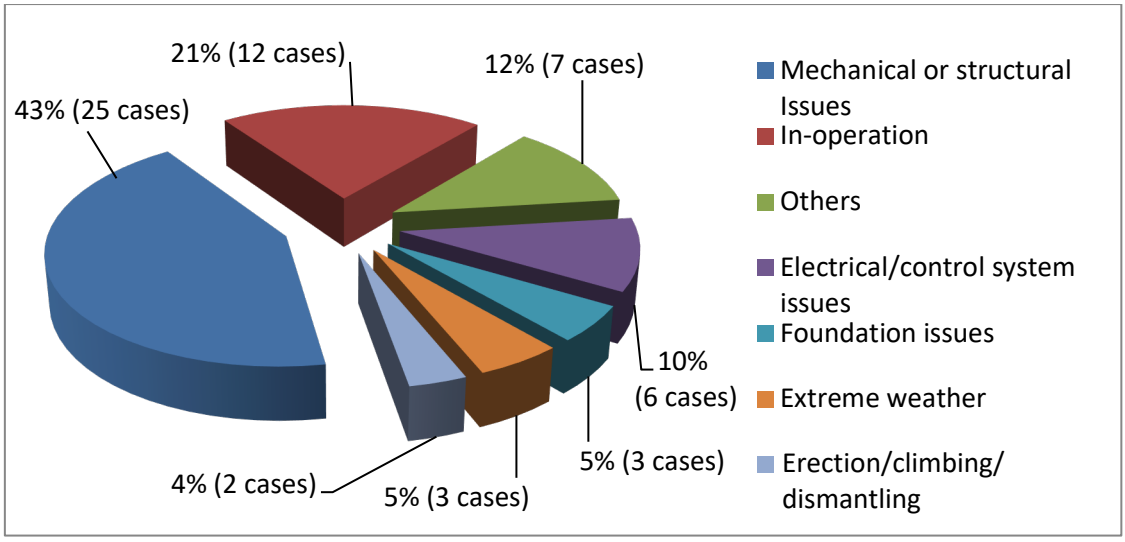


Figure 10.5 Percentage of factors that cause tower crane accidents (Abdullah & Wern 2010; Fail siasatan JKKP; www.dosh.gov.my)

With reference to Figure 10.5, out of 58 accidents that occurred, 43% were due to mechanical or structural issues with the crane, i.e. damage to the crane components, such as:

(a) bent boom

(b) snapped crane cable

(c) broken pin/bolt, and slewing table

(d) snapped luffing wire rope

(e) broken or cracked boom pin
(f) gear/brake problems
(g) hoisting drum problems
(h) snapped wire rope hoist
(i) bent or cracked crane mast

The factors that occurred during the operation of the crane contributed to 21% of the accidents, and these were due to the negligence of crane operators and signalmen, and the failure of the management in ensuring that the hoisting team comprised members who were competent. The other factors were electrical or control system issues, where 10% of the accidents were due to failure in the crane control system, such as:

(a) hoist limit switch
(b) hoisting system
(c) failure of the luffing system

In addition, crane accidents were also caused by the failure of the tower crane base, where 4% were due to the installation/mounting/dismantling of tower cranes, 5% to extreme weather (wind and lightning), and 12% to other factors/unknown causes. Among the factors that affected safety during the installation, mounting or dismantling of tower cranes were:

(a) inadequate knowledge and skills of the installer/dismantler
(b) incomplete instructions or manuals regarding safe work procedures
(c) damage to tower crane parts due to improper storage
(d) poor supervision at the workplace
(e) work pressure, space and time constraints

To control hazards associated with hoisting equipment and operations, the members of the hoisting crew should take note of the following:

(a) the selection of the hoisting equipment
(b) the position of the hoisting equipment
(c) the determination and identification of a safe work load for each hoisting equipment
(d) safe storage of hoisting aids

(e) maintenance of hoisting equipment
(f) planning of hoisting operations
(g) slinging and rigging methods
(h) adequate training for personnel involved in hoisting

10.4 Previous Accident Cases

Examples of Cases

Case 1:

The incident occurred on 15 April 2016 at a construction site at Lot 422, Jalan Bangsar, Section 96, Kuala Lumpur. At approximately 11:50 a.m., a tower crane at the construction site adjacent to Dataran Maybank toppled over, where the tip of the crane fell onto the road in front of Dataran Maybank (as shown in Figure 10.6). No fatalities were reported. The details of the accident were as follows:

(i) the luffing tower crane was manufactured in 1994
(ii) according to the logbook, it was first used at the construction site in November 2015
(iii) the crane was lifting an iron elbow weighing 1.5 tonnes, where the boom was lifted up to 82 degrees (according to the meter reading, it had exceeded the permissible safe limit). The boom then toppled over in the opposite direction, while the tip of the boom dropped off and fell on the adjacent road, causing damage to a lorry
(iv) The cause of the accident was the failure of the luffing limit switch

Figure 10.6 Luffing tower crane accident in Bangsar

Case 2:

The incident took place in Johor Bahru, Johor on 24 July 2016. The tower crane became unstable when it was lowering sand, and the front part of the boom broke first, followed by the jib balancer. The boom toppled over and got stuck on the 13th floor, as shown in Figure 10.7. The details of the accident were as follows:

(i) the tower crane was unloading sand using a bucket with a capacity of approximately 1 m^3 from ground level to the 10th floor

(ii) when the load was at a height equivalent to the 5th floor and the trolley was at the mid-point of the boom, the crane suddenly experienced failure

(iii) this failure caused the boom to fall backwards and the buffer weight to fall to the ground

(iv) from the results of the preliminary investigation and based on the surrounding evidence, it was found that the accident probably occurred when the bucket got caught on the scaffolding

(v) the cause of the accident was the wire rope hoist, which got caught on the scaffolding

Figure 10.7 Condition of the tower crane after the incident

Case 3:

The incident involving a luffing tower crane occurred in Bukit Bintang, Kuala Lumpur on 25 August 2016, as shown in Figure 10.8. The details of the accident were as follows:

(i) the hook block of the crane, weighing more than 300 kg, fell from a height of more than 100 metres, and crashed onto a car on the road, resulting in the death of a 24-year-old woman

(ii) members of the public claimed that they saw the boom moving across the road beyond the operating boundary of the crane before the hook block fell and crashed onto the victim's car

(iii) the position of the crane also violated the rules of safety because it was operating beyond the site fence for the building project

(iv) the incident could have been caused by the lifting limit switch being diverted when lowering or raising the hook, thereby causing the hook to jerk on the tip of the boom and to cause the wire rope to snap

Figure 10.8 (a) Luffing tower crane and (b) iron hook of crane that fell on the victim's car

10.5 Measures to Prevent Accidents

Preventive measures must be taken by the responsible parties to ensure that such accidents involving tower cranes are not repeated. Among the preventive measures that can be taken are the following:

(a) When encountering difficulties in hoisting a load, the crane operator must avoid using force, and the hoisting work must be stopped immediately. An inspection should be carried out, and the parties concerned should be informed so that further action can be taken

(b) Ensure the pulley sheave is in good condition, without any defects or damage

(c) Ensure the luff wire rope that is used is according to the specifications set by the manufacturer,

(d) Conduct inspections from time to time to ensure that the crane is being handled safely by the operator

(e) Perform regular checks on the luff wire rope, and if it is damaged, defective or a few strands of the wire rope have given way, change the rope immediately

(f) Carry out checks on safety devices such as the overload limit switch and the hoisting speed limit before use

(g) Carry out a risk assessment around the area of operation of the crane and take the appropriate steps to reduce such risks

(h) The crane operator should handle the crane in the correct manner, and comply with the procedures outlined in the operating manual

(i) The crane operator should identify the inherent risks around the crane when lifting or lowering a load

(j) Periodic inspections should be carried out on the crane structure

(k) Regular inspections and maintenance of the pulley and trolley should be performed at frequent intervals

(l) Owners must ensure that all tower cranes are handled by competent and registered operators

(m) Crane owners must ensure that the cranes are safe for use

(n) Crane owners must ensure that cranes are maintained and checked regularly

(o) Contractors should conduct a risk assessment of every work activity that is carried out using a tower crane

(p) The brake components should be carefully inspected. Among the brake components requiring attention are:

  (i) brake lining

  (ii) hydraulic oil supply

  (iii) electrical wiring or related component of the brake system, etc

(q) If the crane stops operating for a short period of time, the crane operator must comply with the procedure concerning 'leaving a crane unattended' by ensuring:

  (i) the load has been removed from the hook

  (ii) the electricity supply has been switched off

  (iii) the brake lock has been engaged

The boom should be parked according to the angle outlined in the crane manufacturer's manual.

Bibliography

Abdullah, D. N. M. A. & Wern, G. C. M. 2010. An Analysis of Accidents Statistics in Malaysian Construction Sector. 2010 International Conference on E-business, Management and Economics, IPEDR vol.3 (2011) © (2011) IACSIT Press, Hong Kong, pg. 1-4.

Laporan dan fail kemalangan Jabatan Keselamatan dan Kesihatan Pekerjaan.

http://www.towercranesupport.com [21 March 2016]

http://www.dosh.gov.my [23 Ogos 2017]

CHAPTER 11

PRACTICAL TRAINING

The skills and knowledge required by the personnel involved in the safe lifting work can be improved through practical training. For lifting supervisors, practical training can be done at the existing training centers registered with DOSH such as Gamuda Plant Operator School (GPOS), Institut Kemahiran Tinggi Belia Negara (IKTBN), Akademi Bina Malaysia and others.

The steps that are required for safe working on lifting practical training are:

(a) Prepare to supervise safe lifting operations

(i) Comply to risk assessment

(ii) Check to ensure adherence to legislations and organisational safe work procedures

(iii) Participate in lifting plan, risk assessment and safe work procedure briefing for lifting operations as a supervisor

(iv) Check to ensure proper use of appropriate personal protective equipment and tag line for personnel in lifting operations

(v) Interpret load charts to verify the intended lift is within the safe working load of the crane

(vi) Verify pre-lift inspection of crane, lifting equipment and accessories

(vii) Check to ensure proper selection of rigging equipment, lifting equipment and accessories for lifting load

(viii) Check to ensure proper rigging of load

(ix) Check to ensure proper set up of communication equipment serviceability and functionality of radio channels for safe lifting operations (between crane operator, signalman dan liftign supervisor)

(x) Report and resolve any defects in the crane, lifting equipment and communications equipment according to organisational procedures

(xi) Apply preventive measures and hazard control of lifting accidents according to organisational procedures

(a) Carry out supervision of safe lifting operations

(i) Implement safety practices and hazard control measures in workplace when carrying out Lifting Supervisor tasks

(ii) Identify hazards during lifting operations

(iii) Coordinate and supervise safe lifting operations involving cranes in a safe and proper manner

(iv) Coordinate and supervise lifting according to lifting plan

(v) Respond to lifting accident and emergencies according to organisational emergency response procedures

(b) Supervise reinstatement of safe lifting operations

(i) Supervise the dismantling and restoring of rigging equipment, lifting equipment and accessories

(ii) Supervise good housekeeping of equipment and work area

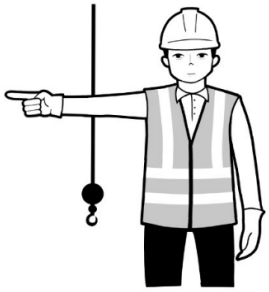
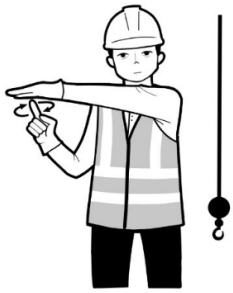
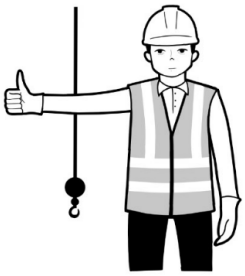
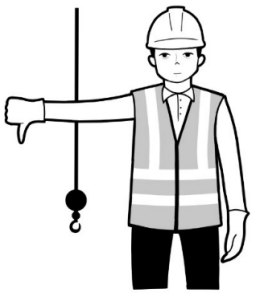
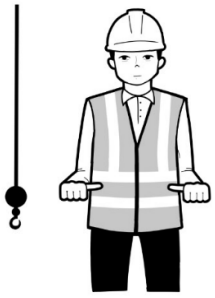
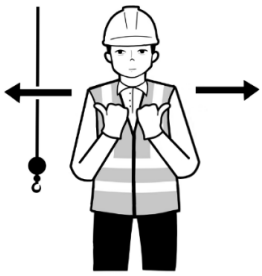
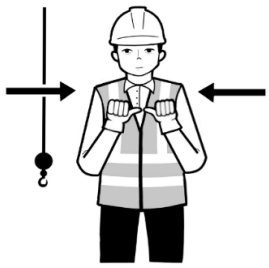
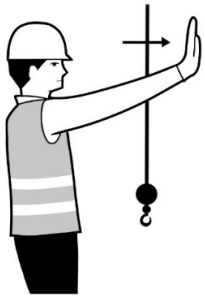
(iii) Supervise post-operational checks on communication equipment crane, lifting equipment and accessories

(iv) Check to ensure reporting of any damage and defects on communication equipment, crane, lifting gear and accessories

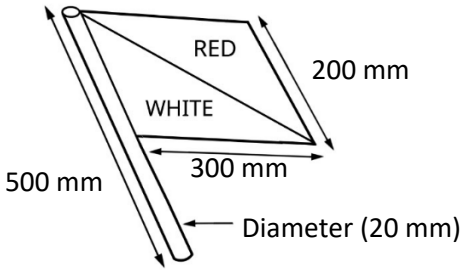
(v) Conduct accident investigation and analysis process of lifting accidents (where necessary)

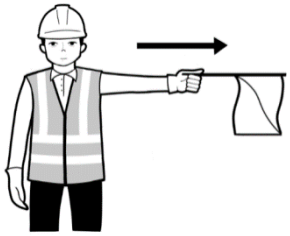
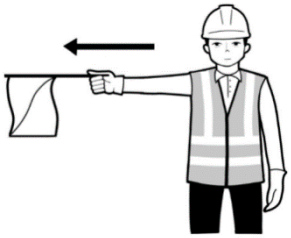
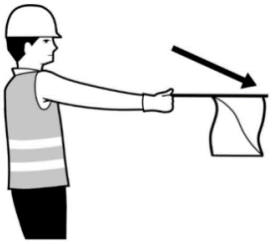
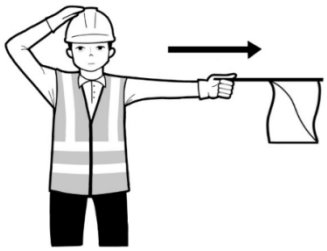
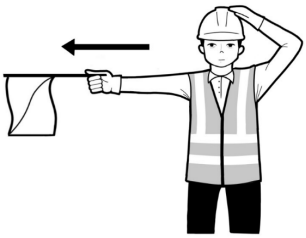
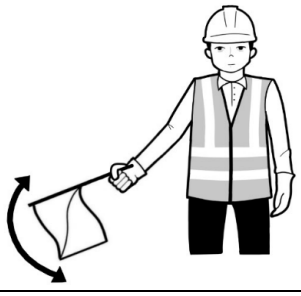
ANNEX A

Hand Signal

			
Turun ke bawah (Hoist down)	*Angkat ke atas* (Hoist up)	*Memusing* (Swing)	*Angkat ke atas perlahan-lahan* (Hoist up slowly)
			
Naik bum (Boom up)	*Turun bum* (Boom down)	*Pengurangan bum* (Retract boom)	*Pemanjangan bum* (Extend boom)
			
Gunakan cangkuk utama (Apply mian hook)	*Troli ke arah luar* (Trolley in)	*Troli ke arah dalam* (Trolley out)	*Guna alat bantu angkat tambahan* *(*Use whipline)
			
Dog everything *(Berhenti seketika apabila berlaku risiko bahaya seperti hujan, angin, dan lain-lain faktor)*	*Bergerak* (Move)	*Berhenti* (Stop)	

Hand signal with flag



		
Memusing ke kanan (Slewing right)	*Memusing ke kiri* (Slewing right)	*Menunjuk kedudukan* (Indicationg position)
		
Luf-mengangkat ke atas (Luffing-boom up)	*Luf-menurun ke bawah* (Luffing-boom down)	*Berhenti kecemasan* (Emergency stop)
		
Mengangkat (Hoisting)	*Berhenti* (Stop)	*Panggilan* (Call)
		
Bergerak (Travel)	*Merendah* (Lowering)	*Mengangkat secara perlahan* (Hoist slowly)

	
Merendah secara perlahan (Lower slowly)	*Terima kasih* (Thank you)

ANNEX B

Exmple of Permit To Work (PTW) Form

Job Name & Description of Work:		Document Control No: (PERMIT-Date-Initials) PERMIT-
Weight of Load: Estimated or Known?	Method by Which Weight was Determined:	Center of Gravity determined by: Estimated or Calculated?
Date/Time Permit Requested:	Date/Time Permit Issued:	Date/Time Permit Expires:

CONTACT INFORMATION

	Name	Company	Phone Number
Designated Lift Leader (Issuing Authority)			
Qualified Crane Operator (Performing Authority)			
Designated Rigger			

SAFETY REVIEW

	Yes	No	NA
CRANE If the answer to any of the following questions is "NO", lifting operations shall not proceed.			
1. Was a pre-lift operations meeting held?			
2. Is the yearly crane/hoist inspection current? (Is it documented?)			
3. Has the daily visual inspection been completed?			
4. Are safety devices installed and tested?			
5. Is the wind speed below 30 mph? *(Wind speed >20 mph require reassessment of Work Risk Assessment and TSEA, if wind speed >30 mph, lifting operation shall not proceed.*			
6. Have precautions been taken to keep other personnel out of the area?			
7. Was the need to protect the swing area and lift/landing zones considered?			
8. Has the ground stability been assessed, and is the ground stability adequate for this lift?			
RIGGING If the answer to any of the following questions is "NO", lifting operations shall not proceed.	Yes	No	NA
9. Has the rigging been inspected? (shackles, chains, wire, rope, etc.)			
10. Is the rigging attached to the pole at the proper angle?			
LOAD If the answer to any of the following questions is "NO", lifting operations shall not proceed.	Yes	No	NA
11. Has the need for taglines been evaluated?			
12. Is the load to be lifted stable? *(no liquid or other resulting load)*			
13. Have the lifting lugs and pad eyes been inspected?			
CRITICAL LIFT ASSESSMENT If the answer to any of the following questions is "YES", a critical lift plan must be completed.	Yes	No	NA
14. Are people being lifted? If yes, refer to Section 5.7 of the *Lifting Operations Defined Practice.*			
15. Are power lines within twice the maximum boom swing radius plus the equaled clearance?			
16. Are two or more lifting machines being used to simultaneously lift one load?			
17. Is this a lift that presents a risk of significant property damage or high potential of personal injury?			
18. Will the crane or hoist operator lose sight of the lead original person at any time during the lifting operation?			
19. Is the weight of the load more than 80% of the dynamic or static capabilities of the lift equipment?			
20. Is the lift being conducted over energized or pressurized equipment?			

LIFT DETAILS	
Crane Make & Model	
Total weight of required rigging	
Total weight of planned load	
Additional weight to be added to load	
TOTAL WEIGHT OF THE LIFT:	
Maximum operating boom radius	
Planned operating boom radius	
ALLOWABLE LOAD (from load chart):	
RATIO OF LIFT TO ALLOWABLE LOAD:	

Rigging Diagram:	Crane Setup Diagram

	Yes	No	NA
1. Does this lift involve lifting personnel? *If "YES", attach manbasket inspection checklist.*			
2. Are there nearby power lines that are closer than twice the distance of the maximum length of the boom?			
3. Are the power lines energized? *If "YES", then stop the job and contact the Electrical Service Provider (ESP) to request the power turned off.*			
4. Do you have documentation from the ESP that all electrical power lines have been de-energized?			
5. Is there sufficient clearance to de-energize power lines?			
6. Is there a spotter?			
7. Will there be a representative of the ESP on site during the lift? Name:			
NOTE: *There may be instances that require lifts that are closer than twice the boom radius to be made near a live electrical power line. These must be very carefully planned and require approval from the Area Lift Champion and a Regional Manager or Deputy Regional Manager.*			

AUTHORIZING SIGNATURES

I certify the total weight of the lift is less than the allowable load (from the load chart) at the planned boom radius.

TITLE	NAME	SIGNATURE	DATE/TIME
Designated Lift Leader (Issuing Authority)			
Qualified Crane Operator (Performing Authority)			
Designated Rigger			
Signaler			

ANNEX C

Examples of Crane Safety Certificate (Annual) Form

CERTIFICATION OF TOWER CRANE (YEARLY)	
Crane Information	
Certificate no.:	
Crane type:	
Crane manufacturer:	
Crane serial no.:	
Design registration no.:	
Owner's name:	
Address:	
Inspection date:	
Competent Person	
Name of competent person:	
Address of competent person:	
Telephone number:	
Qualification of competent person (e.g. professional engineering qualification, membership of professional organisation, crane industry experience or other tertiary qualifications or trade qualifications):	
Crane Inspector	
Inspector identification number:	
Competent person statement:	
I hereby certify that the crane, serial number: _____, has received its manual safety inspection in accordance with the instructions of the crane designer and manufacturer, and with relevant Malaysian Standard and the Code of Practice for Safe used of Tower Crane 2017, and is safe to use.	
Competent person signature:	
Date:	
Comments:	

ANNEX D

Example of Lifitng Plan, Risk Assessment and Method Statement Form

Project		**Date**			
Site/location		**Client**			
Document Ref.	/ /	**Rev**	**0**	**Issued by**	
Appointed Person carrying out the Assessment:				**Date of Assessment:**	
Contact:		**Phone:**		**Fax:**	
Site contact:		**Phone:**		**Fax:**	
Description of lift:					

Details of Loads	**Load Position 1**	**Load Position 2**	**Load Position 3**
Weight:			
Dimensions:			
Position of C of G:			
Height of lift (worst case only):			
Max. radius (worst case only):			
Date of lift:			
Time of lift:			
Monetary value of load:			

Details of Cranes	**1st**	**2nd**	**3rd**
Make & model:			
Capacity:			
Jib length:			
Outrigger spread:			
Outrigger load:			
Max. ground bearing capacity:			
Counterweight:			
Weight of crane:			

Alternative Crane Details

Make & model:			
Capacity:			
Jib length:			
Outrigger spread:			
Outrigger load:			
Max. ground bearing capacity:			
Counterweight:			
Weight of crane:			

Ground Conditions (Visual assessment)

Access/Egress for crane & transport:			
Lifting position:			

Lifting Accessories

Slings (wire rope):	Slings (webbing):
Slings (chains):	Shackles:
Other Accessories:	

Identification of Hazards

Proximity Hazard	Present?
Overhead power lines	
Other overhead obstacles	
Underground services	
Excavations	
Unstable/ Soft ground	
Hazardous chemicals/materials	
Confined working area	
Restricted access - width	
Restricted access - height	
Other vehicles	

Proximity Hazard (cont.)	Present?
Other hazards identified	
Load Hazard	**Present?**
Slinging difficulties	
Top heavy	
Sharp edges	
Other hazards identified	

Assessment of Risk

Hazard Present	Risk	Action to Avoid or Reduce Risk
Operational Requirements:		
Site Provisions:		

Notes

ANNEX E

Checklist Form for Cranes Handling (Before and After)

BUKU LOG OPERATOR KREN

Tarikh Mula (Minggu):_____ Operator: _____
Nombor PMA: _____ Model Kren: _____

PEMERIKSAAN KEADAAN	I	S	R	K	J	S	A	CATATAN
Struktur kren								
Cuaca								
Kerosakan								
Kerosakan yang sedang diperbaiki								
Kemalangan atau kejadian berbahaya								
PEMERIKSAAN ITEM	**I**	**S**	**R**	**K**	**J**	**S**	**A**	**CATATAN**
Asas tapak (termasuk bol dan anchor)								
Suis ELCB dan pendawaian bumi								
Kabel eletrik								
Tangga memanjat (termasuk bol dan nat)								
Pelantar rehat								
Bahagian mast (termasuk pin, bol dan nat)								
Jib pengimbang								
Pelantar slu								
Berat timbal								
Motor angkatan (hoisting motor)								
Puli								
Troli								
Tali dawai								
Bongkah cangkuk								
Semua suis pengehad								
Lampu signal dan lampu amaran								
Amaran audio dan visual								
Kebersihan kabin								
Alat pemadam api								
Brek slu								
Pengelap cermin (wiper)								
Hon								
Carta beban								
Penunjuk beban/jarak/jejari								
Buku manual								
Minyak gear (semua komponen yang perlu)								
Minyak gris (semua komponen yang perlu)								
Komen umum dan catatan								

KEMALANGAN, KEJADIAN BERBAHAYA ATAU MAKLUMAT BERKAITAN

TARIKH	MAKLUMAT	TANDATANGAN

ANNEX F

Examples of Lifting Equipment Inspection Report

LIFTING ACCESSORY INSPECTION REPORT No.

NAME OF LIFTING ACCESSORY: _____

DEPARTMENT AND PRECISE LOCATION:_____

MANUFACTURER / SELLER_____

PURPOSE OF USE:_____

WORKING LOAD LIMIT: CE MARKING Y ☐ N ☐

SERIAL NUMBER: _____

INSPECTION INTERVAL:_____

0°
kg
45°
kg
60°
kg

SERIAL NUMBER

INSPECTION INTERVAL

PARTS LIST

PHOTOGRAPH

DRAWING

TECHNICAL DESCRIPTION

	INSPECTED BY	DATE	FAULT(S) OBSERVED	
COMMISSIONING			Y	N
ANNUAL INSPECTION			Y	N
ANNUAL INSPECTION			Y	N
ANNUAL INSPECTION			Y	N
ANNUAL INSPECTION			Y	N
ANNUAL INSPECTION			Y	N
ANNUAL INSPECTION			Y	N

ANNEX G

Examples of Conformity Declarations and Certificates for the Use of Lifting Equipment

Supplier

[redacted]

We herewith declare that the following indicated equipment meets the fundamental health and safety requirement concerning the EU - guide line(s), due to their design and manufacture. In case of an uncoordinated modification of the equipment, without consultation with us, this declaration automatically expires.	

To.	*Cert. no.*	
	Buyers ref.	
	Order no.	
	Works order no.	

Manufacturer's Name and Address (if different from above) :

Identification Marks and/or Serial No.	*Name / type of Equipment*	*Quantity*	*Nationally applied standard and/or Drawing No. specifications*	*Batch No. Test Cert. No.*	*Test Report No.*	**WLL**

Remarks, major concessions, deviations, etc. If applicable, Name and Address of Approved Body. Relevant EU - Guideline(s) an EU type certificate no.

Certified that the equipment detailed hereon, have been inspected, tested and unless otherwise stated above, conform in all respects with the requirements of the contract or order. The quality control arrangements adopted in respect of these supplies have complied with our quality control system.	

place. : Date :

Sign. : *position :*

For and on behalf of (supplier)