

National University of Singapore
Department of Building
BU3107 Construction Technology IV

Discuss the erection of tower cranes. Justify the selection in terms of size, location, and erection methods.

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COMMON CRANES IN SINGAPORE

Cranes are commonly used for vertical transport in building operations though they are generally capable of moving objects in all directions. Common generic crane types that can be found on sites include:

- Truck mounted crane
- Climbing crane
- Mobile crane
- Tower crane
- Gantry crane

Truck mounted crane

These are cranes normally used for loading/unloading purposes or for jobs involving “hook-up” of materials. They may also be attached with telescopic or lattice arms, slewing or fixed.



Mobile Crane

Difficulties in accurate positioning of components such as cooling towers at top of building and limited site coverage are some major drawbacks of mobile cranes. Mobile cranes are normally fitted with strut (lattice) or hydraulic jibs but it is common for them to come with a flying jib as well (figure on the right below). This may be either parallel to or offset at an angle to the main jib. Its function is to extend the radius, height and reach of the crane when handling light loads, since the introduction of an extra joint will inevitably decrease its capacity.



Climbing Crane



Cranes are climbing in the sense that they can climb up a shaft within a building using a limited number of mast sections. Since they are normally located in the lift core at the center of the building, they allow for strategic coverage yet maximizing land use in congested sites.

Gantry Crane

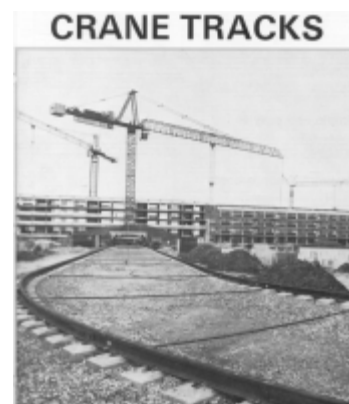
A gantry crane is a crane with a jib supported on a 4-legged portal carried on rails with adjustable height for flexibility. It is normally used to handle cartons and machinery in aircraft, automobile and marine applications as well as to function in warehouse and loading areas. Applied in the construction sector, they are normally used for material handling in the construction of caissons.



Special Design 8 Ton Motorized Travel Gantry

Tower Crane

Tower cranes are normally employed for their ability to transport materials quickly across the site due to their extensive coverage. However, their low capacity (as compared to mobile cranes) as a result of their slenderness and their need for support to adjacent structures often calls for the use of mobile cranes to supplement the “blind spots” i.e. areas that are beyond the coverage of tower cranes. Tower cranes may be mounted on special rails or tracks. In such cases, they are known as goliath cranes and consist of a portal frame and main beam from which a hook or grab hangs and travels along. The frame of the portal usually has four legs supported on wheels running on a pair or sets of rails.



TYPICAL COMPONENTS OF A TOWER CRANE

All tower cranes consist of the same basic parts:

- The **base** is bolted to a large concrete pad that supports the crane (fig. 1)
- The base connects to the **mast** (or **tower**), which gives the tower crane its height.
- Attached to the top of the mast is the **slewing unit** – the gear and motor that allows the crane to rotate (fig. 2)



On top of the slewing unit are three parts:

1. The long horizontal **jib** (or **boom arm**), which is the portion of the crane that carries the load. A trolley runs along the jib to move the load in and out from the crane's center (fig. 3)
2. The shorter horizontal **boom arm**, which contains the crane's motors that lift the load, the control electronics that drive it and the cable drum as well as the large concrete **counter weights**.
3. The operator's **cabin**.



VARIATIONS TO THE TYPICAL COMPONENTS

As can be seen from the photos above, a tower crane is typically fitted with a fixed horizontal (saddle or hammerhead) jib with little room for slewing. Counter weights are generally slotted into shorter horizontal section of the boom arm. Such arrangements however, may be varied.



Counter weights may be fixed at the ground level. This is normally done in situations where the load to be lifted by the tower cranes changes frequently. By having the counter weights at ground level, the counter weights can be easily changed to balance the varying loads.



Instead of using a fixed horizontal jib, tower cranes may be fitted with a derricking (or luffing) jib. These cranes are conceived for work on exceptionally tall buildings or in very restricted spaces. They can avoid obstructions within the working area, and slew through 360° under load at only 8m slewing radius.

Due to their compact slewing radius and steep jib angle (between 15° and 70°) even when not operating, these cranes are particularly suitable for use on confined sites where several cranes have overlapping slewing radii.

Tower cranes may also be fitted with not one, but two horizontal jibs of different jib lengths thus making them extremely mobile. Hook clearances and vertical positioning are quickly adaptable and they can even be driven fully extended into the most narrow of construction spaces.

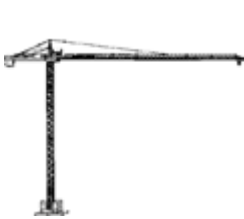




For unusual jobs such as the construction of cooling towers or TV masts, additional joints may be introduced to the luffing jib. Such cranes have immense advantages. The jib, for instance, can be accurately repositioned as the diameter of a cooling tower changes. Tower sections are saved, since excess operating radius can be converted into height under the hook. Costs as well as working time are cut, as these cranes need fewer anchorages to the building and reduced rope guying.

COMPARISON BETWEEN CRANE TYPES

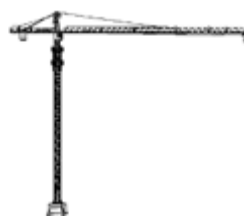
The working characteristics of different crane types vary to suit different applications. Even within the same crane type, there are a variety of models of varying capacity, lifting height and working radius to suit the unique requirements of each site. The diagrams below summarize show the series of tower cranes usually supplied by manufacturers.



[The H series](#)



[The TT series](#)



[The K series](#)

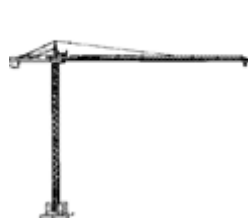


[The A series](#)

The H, TT and K series of bottom-slewing cranes are designed as fast-erecting cranes and are ideal for small, narrow building sites. Lifting capacities of up to 120 metric ton can be handled with hook heights of up to 34m. The A series are similar to the H, TT and K except that they are equipped with luffing jibs.



[The LC series](#)



[The EC / EL series](#)

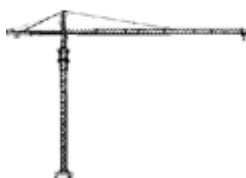


[The EC-B series](#)



[The EC-H series](#)

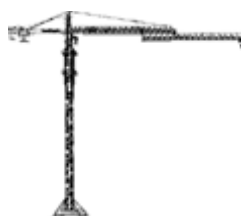
The LC and EC / EL- top-slewing cranes are particularly easy to transport and assemble. The construction series ranges from 30 to 100 metric ton, with trolley jib extensions from 30.0 to 52.5m.



[The HC series](#)



[The HC-L series](#)



[The HC-T series](#)



[The HC-K series](#)

The top-slewing cranes in the HC series are general-purpose cranes for use in medium- to large-scale construction projects of all kinds. The series covers capacities from 800 to 5,000 metric ton with luffing or telescopic jib lengths of up to 100m; maximum loads of 80 ton and free traveling hook heights of up to 110m.

The table below shows some figures for various working characteristics for the different series of tower cranes. For comparison purposes, the corresponding figures of mobile and truck-mounted crane are also included.

Series	Size category (metric ton)	Max Hook Height (m)	Max Lifting Capacity (kg)	Max Working Radius (m)	Lifting Capacity (kg)
H	13-26	17-21	1200-2000	20-28	600-800
TT	24-32	14-24	2500	24-30	1000
K	26-120	26-34	4000-8000	33-50	1100-1450
A	660-1500	107-160	45000-110000	76-80	6000-9000
LC	30-100	31-53	2000-3000	30-50	1000-1600
EC / EL	45-100	52-71	3000-6000	45-53	1050-1700
EC-B	80-180	62-73	6000-10000	45-60	1500-2000
EC-H	112-630	61-93	6000-50000	55-80	1400-4800
HC	800-5000	79-110	20000-80000	80-100	5000-42000
HC-L	800-800	79-110	20000-80000	80-100	5000-42000
HC-T	100-300	48-53	6000	50-60	1800-4500
HC-K	~140	80	12000	55	2000

Type	Max Lifting Capacity (ton)	At the radius of (m)	Max Lifting Height (m)	Max Radius (m)
Truck Mounted	35 - 800	Ave 3	45 - 146	40 - 126

Type	Max Capacity (ton)	Max Main Boom (m)	Max Flying Jib (m)	Max Combination (m)
Mobile Crane	90-250	65-96	18-70	Ave 55 + 46

LEGISLATIONS GOVERNING THE USE OF TOWER CRANE IN SINGAPORE

CP 62: 1995 Code of Practice for safe use of tower cranes

Section 1

- Scope
- Description of Cranes
- Definitions

Section 2

Operational Conditions

a) Sitting and General Safety Considerations

The safe use of a crane is very much affected by where it is sited and should not encroach upon public areas. Cranes that are perched on high-rise buildings will be subjected to stronger winds and higher wind load thus adequate allowance should be made when designing the supports

Additions of billboards on jib will add to the surface area and increasing the wind load, thus it is best to avoid attaching billboards.

Cranes must not be in the way of aircraft flight path.

The ground below the crane must have adequate soil bearing capacity to support and any change in the soil bearing capacity caused by the weather must be taken into account.

Cranes should not be sited on grounds that pose as a hazard to its foundation and it should not be placed near excavations, embankments, buried pipes and if it is needed to be sited near such areas, enough reinforcement and shoring must be provided.

Tower cranes should be adequately grounded and protected against lightning.

Aircraft warning lights and checkered red and white flags should be fitted.

b) Stability

The manufacturer or crane supplier should provide data on the maximum forces acting at the crane's base such as crane's dead weight, weight of attachments and the maximum dynamic forces that result when the crane is in operation. Estimates on wind load on the crane should also be provided.

The crane should be plumped and remain so throughout as tilts will impose stress on crane which can eventually lead to failure of crane structure.

c) Proximity Hazards

When the crane is in operation, the load should not be allowed to oversail outside the site boundaries

Slewing limits switches could be used to restrict jib movements to be within site boundaries and trolleying limits switches may be installed to prevent the trolley from being moved beyond site boundary or warning alarms should be installed

Care must be taken not to collide the crane with nearby structure and if the structure is lower than the crane, trolleying limits switches may be installed to prevent the crane's hoisting rope from fouling with the structure.

When two or more cranes are used, the cranes should be separated with the lowest elements of the jib of the higher crane at least 2m above the highest component of the lower crane that is in the interference zone.

Possible interference of jib or counter-jib with the mast of another crane is prohibited and should be prevented by using slewing limit switches.

d) Erection and Dismantling

Before the crane is erected or dismantled, the area must be cleared of personnel not involved with erection work and there should be sufficient working space.

A competent engineer should inspect parts and components of a tower crane before it is erected.

Crane's load capacity chart in relation to its operating radius is to be fitted in the operator's cabin that is visible to the operator

Workers should be trained and competent and after it is erected the erectors should give a written declaration that the crane is erected in accordance with the manufacturer's specification

After the crane has been erected it should be first be checked and tested by the erector to check all bolts and locking devices are correctly positioned and secured; all wire ropes are thoroughly checked for defects; indicators, alarms and other safety devices are correctly fitted; and ladders, platforms, walkways, handrails and other accesses and its attachments are in position and secured.

Crane should be inspected visually and tested under no load conditions, suitable load and maximum load conditions.

Competent person from relevant authorities must inspect Crane.

For static crane, anchorages should be used when the crane's height exceeds the specified freestanding height.

On cranes that are capable of height extension, care should be taken to ensure that there is always a minimum number of 3 turns on the hoist drum.

Use of radius indicator is mandatory for all cranes and it should be set to correctly indicate the horizontal distance between the center of the hook to the center of the rotation.

Load limit switch should be fixed.

Operator's cabin should be made of fire resisting material and equipped with a fire extinguisher.

e) Operation and Control

Tower cranes should not be used for dragging and pulling of load, carrying of inclined load, piling work and carrying swing ball for demolition. It should not be used for tandem lifting with any other crane and should not transport people.

Operator should carry out pre-operational checks on all parts, components and switches and to make sure all devices are operational.

The load to be lifted in relation to its distance from the center of rotation should be within the safe working load as shown in the load capacity chart.

When the operator has no visual contact with load, a signaler should guide him. Only low speed movement is allowed in such a case. Voice communication devices should be used.

Loads that are of considerable surface areas as to be affected by wind shall be controlled using tag lines.

Crane operator should be:

- 1) Over 18 years of age
- 2) Medically and mentally fit for the job
- 3) With good eyesight
- 4) Trained and competent in tower crane operation
- 5) Trained to judge distances, height and clearance
- 6) Trained in the operation of types of crane he is to operate
- 7) Expressly authorized by the owner to use the crane
- 8) Conversant with the duties of the slinger and signaler and familiar standard operational signals

Appendix 1 shows a copy of the test to be taken to qualify as a crane operator.

Signaler/slinger

- 1) Must be familiar with slinging methods, estimate weights and center of gravity
- 2) Able to select proper lifting gears
- 3) Familiar with standard crane operational signals

Crane owner should ensure that the operator and slingers are competent to carry out their responsibility.

When the crane is to be left unattended, all suspended loads should be removed, the control set to neutral and power switched off, locking devices applied with the hook raised to highest position and moved to its minimum radius.

When the crane is unattended overnight, in addition to the above, the crane must be moved to storage area with rail clamps. Boom should be slewed back to a safe location and locked.

Section 3

Maintenance, inspection and repair

A record in the form of logbook should be maintained for each crane giving details such as dimensions and its parts, hours worked, renewal of parts, thorough examinations and repairs and it should follow the crane from site to site.

Routine inspection should be made on parts of the crane that are subjected to deterioration through wear, structural elements of the crane and means of access periodically.

All cranes are required by section 31(2) of the Factories Act to be thoroughly examined by an approved person at least once in every 12 months.

Any parts of the crane which is damaged and worn should be repaired or replaced without due delay and should comply with manufacturer's specification.

Code of Practice, Safety and Health of Construction Worksites Part I, 1985

Chapter 9 - Lifting appliances and Equipment

This chapter sets the guidelines for ascertaining the maximum safe working load that a lifting equipment can lift. Clause 5.1.3, specifically written for tower cranes, states that for a crane fitted with a derricking jib, the safe working load at various radii of the jib should be marked upon it, or otherwise clearly indicated. The crane must not be loaded beyond the safe working load or left unattended. In addition, no one should stand directly below the crane when it is hoisting.

Section 5.3 and 5.6 states all the regulation on tower cranes in order to protect the safety of the workers. Some important aspects are discussed below:

a) Structure

- Crane should be made from materials that absorb shock such as mild steel
- Cabin should be made of fire resisting material and provided with a fire extinguisher
- Access to the cabin should be from a safe place in the crane

b) Erection/Inspection/Operation of crane

- Should be supervised by competent persons
- Cranes should be inspected at least once a week and also after any experiences of earth tremors, blasting or after any lengthy idle period

c) Anchorage and ballast

- Every fixed crane should either be securely anchored or be adequately weighed by suitable ballast firmly secured to ensure stability
- Counterweights should be so arranged that they do not subject the backstays, sleepers or pivots to excessive strain

d) (i) Jib crane

- Means such as a stirrup piece should be provided to prevent the rope from coming off the pulley at the end of the jib
- When the jib is fixed and cannot be lowered to the ground, access to the pulley should be provided by a ladder protected by guard-rails and toe-boards
- When the jib of a jib crane is at the maximum radius there should not be less than two dead turns of rope on the derricking drum.

(ii) Slewing crane

- Slewing cranes that slew on wheels should be equipped with means that prevent them from overturning if a wheel breaks.
- Precautions should be taken to prevent workers from being crushed between rotating parts of cranes and the carriage.
- Tower slewing cranes with power-driven slewing mechanism should have a brake for the slewing motion
- Tower slewing cranes should be equipped with loud warning devices
- Counterweight jibs that are loaded with ballast after erection should be provided with a suitable walkway
- When tower cranes are being erected, the area of operations should be fenced off or guarded; and the erection crew should wear safety belts
- Tower cranes should not be erected in high winds
- If the ballast and counterweight vary with the heights of the tower and the radius of the jib, a table should be provided on the crane indicating the ballast and counterweight required for different tower heights and jib radii

e) Power control on electric cranes

- Electric cranes should be equipped with at least one switch by which power for all movements can be cut off on all poles from the operator's stand
- The hoisting mechanism should automatically stop if even only one phase of the power fails
- Electric cranes should be equipped with overload protection devices that act on the hoisting mechanism, jib raising and lowering mechanism and the jib crab
- After the overload prevention device has acted, it should be possible to lower the load and pull in the crab
- It should only be possible to switch on the power when all the controls of electric cranes at zero

f) Load and radius indicator

- Power-driven jib cranes should be fitted with an automatic indicator which indicates clearly to the operator when the load being moved approaches the maximum safe working load of the crane at any inclination of the jib and gives an efficient signal when the load being moved is in excess of the maximum safe working load of the crane at any inclination of the jib
- No crane with either a fixed jib or a derricking jib should be used unless a plate has been fixed in the driver's cabin which indicates to the driver the safe working loads that correspond to the following conditions when the crane is standing on a firm horizontal base: the length of the jib; the radius of operation with or without stabilizing screw-jacks.

- The maximum permitted angle of inclination of the crane jib must be clearly marked on the crane.

g) Inspection and testing

- No crane should be used unless an Approved Person has inspected and tested it; and furnished a certificate specifying the maximum safe working load at the various radii at which the jib can be worked; and in the case of a crane with a derricking jib, the maximum radius at which the jib may be worked.
- Before being put into use for the first time, jib cranes with a variable radius should undergo tests of stability and of all movements such as travel, slewing, raising and lowering the load, braking the crane and braking the load
- Cranes should be tested for anchorage by the imposition on each anchorage of the maximum uplift or pull exerted either by a load of 25 per cent above the maximum load to be lifted by a crane as erected; or by a lesser load arranged to exert an equivalent pull on the anchorage

h) Operation

- Jib cranes should not be moved or operated in dangerous proximity to electric power lines
- Where more than one crane is required to lift or lower one load: arrangements should be such that none of the cranes will at any time be loaded beyond its safe working load or be rendered unstable in the hoisting or lowering of the load; and a person should be specially appointed to co-ordinate the operation of the cranes working together

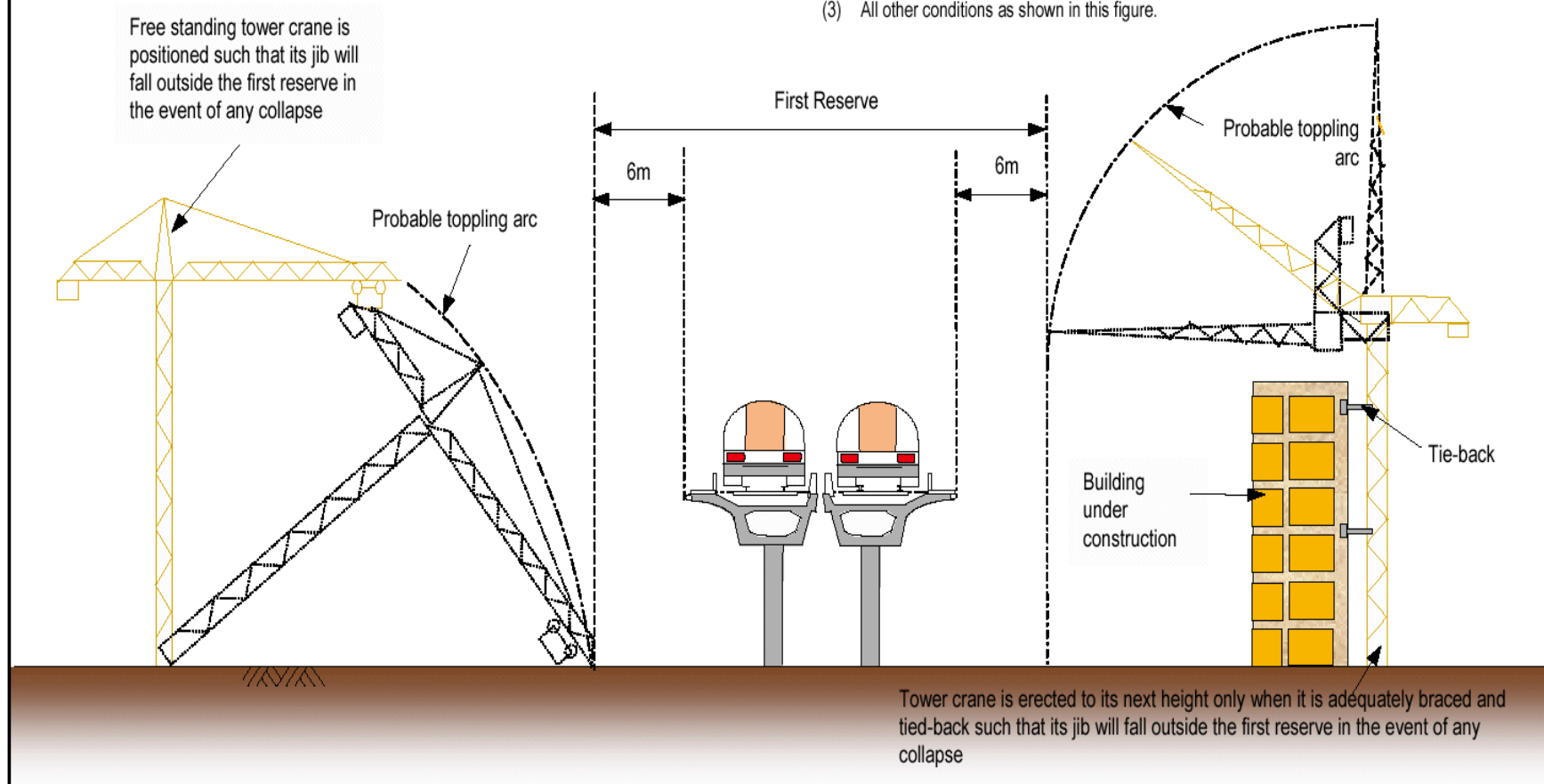
i) Bucket

- Concrete buckets positioned by crane or aerial cableways should be suspended by safety hooks.

Guide to Carrying out Restricted Activities within the Railway Protection and Safety Zones

Conditions

- (1) All lifting operations must be carried out by a competent crane operator and supervised by qualified lifting supervisor and safety officer.
- (2) In special case where crane may encroach into the first reserve, the following must be adopted :
 - (a) PE(Mech) shall inspect and certify at monthly interval that mechanical equipment, lifting appliances and accessories are in good working condition; and
 - (b) PE(Civil) shall be full time on site to provide standing supervision of all crane operations.
- (3) All other conditions as shown in this figure.



THE ERECTION AND DISMANTLING PROCEDURE (Self Jacking Crane)

1. Establishing a concrete base for the basic mast of the crane.



2. Assemble the telescopic cage mast of section on top of the mast.



3. Assemble the top mast section just the mast cabin on top of cage section



4. Erect the section of top tower under (cat head) containing the mast cabin above top mast section.



5. Install the counter-jib perpendicular to the vertical tower using the counter-jib tie.



6. Hang the counterweights at the end of the counter-jib



7. Fixing the main jib with the main jib tie.



8. Installing horizontal lever element to crane tower for accommodating extra mast sections for telescoping.



9. Lifting extra mast section with monorail for installing on lever element.



10. Introducing extra mast section to crane tower for telescoping.



Note:
Steps 9 & 10 are repeated until the desired height is reached.

Other procedures to be done on ground

1. Securing basic mast section by bolting to the ground support of crane base.



2. Placing steel reinforcement to crane base.



3. Workers connecting the jib components.



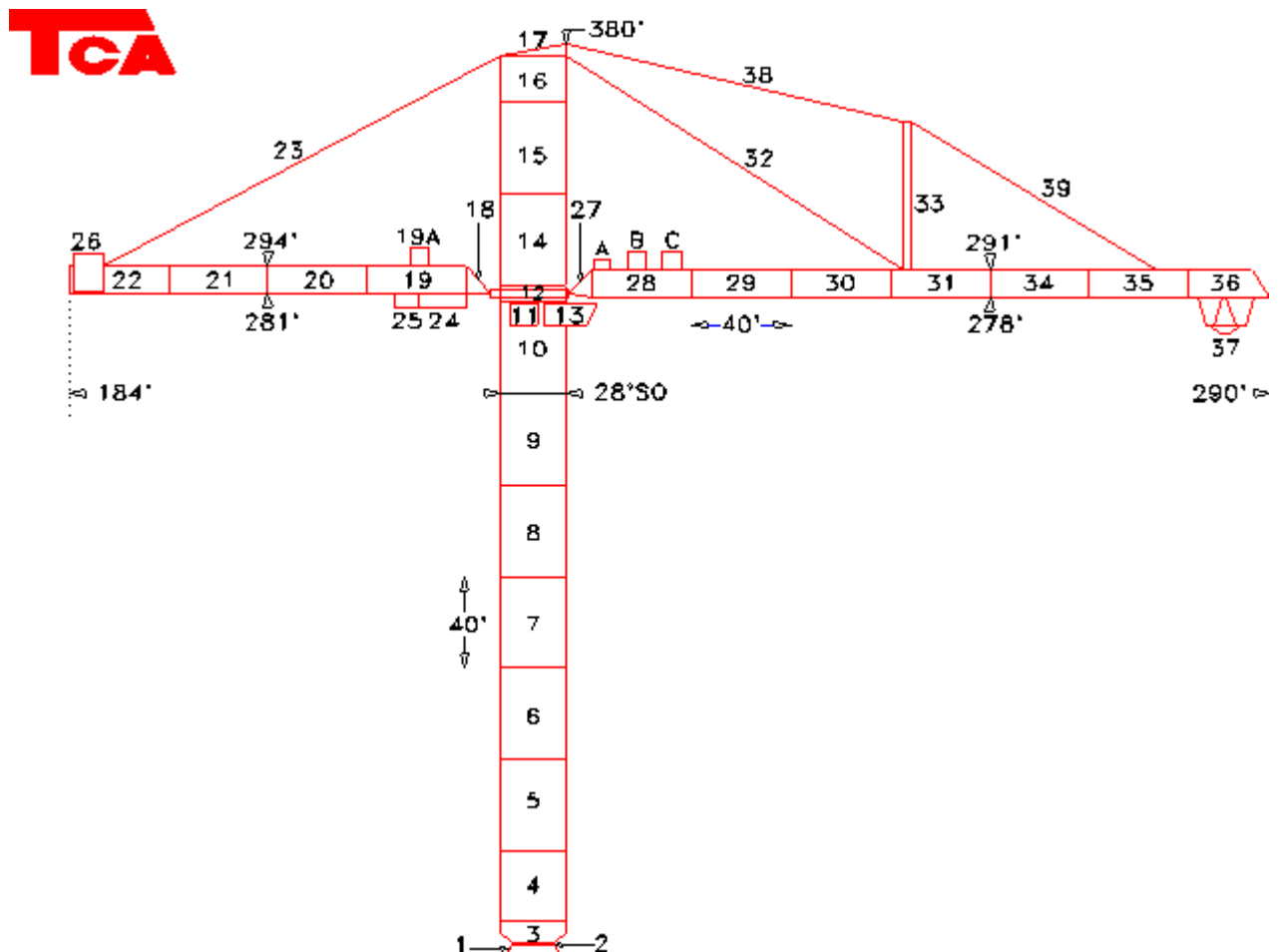
Note:

Dismantling of the tower crane takes place in the same manner except in the reverse order.

Dismantling of Tower Crane

(NB. To keep this word file small enough, Pls refer to the powerpoint and video clip for a comprehensive guide on the dismantling procedures of a self-jacking, telescopic tower crane)

A Schematic Summary



The erection sequence is as summarized below:

1. The Component Reference Numbers, #1-39, represent the general overall Erection Sequence.
2. #19-22, #28-31 and #34-36 are generally pre-assembled on the ground.
3. If the overall height makes a Service Crane required or desired, it could be installed after three sides of #14 have been installed. The Service Crane would then finish #14 and brings up #15, 16 and 17.

#	COMPONENT DESCRIPTION	LENGTH (FT)	WEIGHT (1,000 lbs)	PRE-ASSEMBLY
1	Anchor Bolt Base Ring		29.5	
2	Swing Ring Bearing		22.0	
3	Rotating Swing Chassis		151.0	
4	Tower Section, M80 S	30	38.0	
5	Tower Section, M80 S	40	51.0	
6	Tower Section, M80 S	40	51.0	
7	Tower Section, M80	40	45.0	
8	Tower Section, M80	40	45.0	
9	Tower Section, M80	40	45.0	
10	Tower Section, M80	40	45.0	
11	Elevator, incl. Mast		46.0	
12	Jib Support Frame		61.7	
13	Operator's Cabin, incl. Support		16.5	
14	Tower Section	30	42.1	
15	Tower Section	40	54.8	
16	Tower Section	20	29.4	
17	Tower Head		10.3	
18	CW Jib Foot	10	8.3	
18A	CW Trolley Winch		3.4	
19	CW Jib Section	40	16.6	Counterweight Jib
20	CW Jib Section	40	16.6	#18 - #22
21	CW Jib Section	40	16.6	80,500 LBS
22	CW Jib Section	40	19.0	
23	CW Jib Tie Bars		24.2	
24	Inner CW Trolley, w. CW		182.6	
25	Outer CW Trolley, w. CW		88.2	
26	Fixed CW		220.0	
27	Jib Foot	10	11.5	
28	Jib Section	40	27.0	
28A	Trolley Winch		5.3	
28B	Ultra Hoist Winch, excl. Rope		27.5	Inner Jib Half
28C	Hoist Winch, excl. Rope		27.5	#27 - #31
29	Jib Section	40	27.0	180,700 lbs
30	Jib Section	40	27.0	
31	Jib Section	40	27.9	
32	Jin Tie Bars, Lower+B4		17.0	
33	Strut Tower	60	9.0	
34	Jib Section	40	27.0	
35	Jib Section	40	27.9	Outer Jib Half
36	Jib Section	30	12.2	#34 - #37
37	Load Trolleys, incl. Truss		28.4	95,500 lbs
38	Jib Tie Bars, Upper		14.9	
39	Jib Tie Bars, Outer		10.2	
40	Hoist Cable		12.5	
41	Ultra Hoist Cable		12.0	

FACTORS AFFECTING THE SELECTION OF TOWER CRANES

Carrying Capacity

In every construction project, it is important that sufficient load carrying capacity is available within the operating radius to pick up and deposit the loads. The various loads to be lifted and the maximum load for the whole construction have to be determined. Apart from this, the load capacity profile over the jib length should also be identified.

Maximum Coverage

One of the major criteria is to ensure that the tower crane covers 100% of the required building area. The length of the jib should be chosen so as to reach the furthest point of delivery. Any excess length will result in the jib being underutilized and jeopardize the safety of the public.

Sufficient Space

The proposed tower crane position must be reachable by the mobile crane of an appropriate size. Apart from this, space for staging and assembly of components is also required. At the end of construction, access must also be provided for the mobile crane to disassemble the tower crane. If the tower crane is expected to climb down at the completion of its work, room must be left for it to clear away from any adjacent structure.

Ability to Weathervane Freely

As far as possible, the tower cranes must be able to turn 360° freely without any obstruction. They must also be able to “luff” vertically, especially for congested site surrounded by existing buildings. The luffing boom crane is also frequently the most viable choice when two or more tower cranes are employed at close proximity within the same site. Alternatively, tower cranes installed with hammerhead jibs and overlapping working radii may be set at different working heights as precautionary measures.

Building Height

The height of the tower crane depends on the height of the building and the adjacent structure over which the crane jib passes, or the height of the tallest crane over which the crane jib passes. The height at which a climbing crane is preferred to an external one is where either the extra cost of the mast sections is outweighed by the additional building structure, jacking up costs and extra dismantling costs, or the building is higher than the supported height to which a crane can stand.

Cost of Acquisition

Tower cranes, like any other mechanical part or machinery incur substantial capital investment. However, crane selection should not be based solely on acquisition price, because the true cost of a tower crane includes many other items that can dwarf the differences in prices. All the various factors such as the company's financial status, size and duration of the project, and also the types of projects handled should be considered before a decision is made.

Availability of Crane

After the maximum radius and critical lift for the crane have been calculated, it is necessary to check whether tower crane with such the chosen jib length and capacity is available.

FACTORS AFFECTING THE LOCATION OF TOWER CRANES

Site Area

The ideal location of a tower crane is outside the building footprint to which there is vehicular access to within at least 10 metres for the assembly and dismantling operations. Erection and dismantling costs are then kept to the minimum. It is common that the delivery of all materials, plants and equipment to be lifted by the tower crane would be within 10-15 metres from the crane base.

In sites with limited space such as when the building footprint is taken right to the boundary line, it would be better for the tower crane to be located within the building. This is because the use of an internal climbing crane is undoubtedly the most strategic since its center position allows for the use of a shorter jib for full coverage relative to an external tower crane located at the perimeter of the building. With a shorter jib for a given task, bending moment decreases thus the crane structure is lighter and cheaper.

Soil Condition

A static tower crane is similar to a rail-mounted type without its wheeled undercarriage. The tower or mast is fixed to a ballasted framework or to a specially designed reinforced concrete foundation that helps to transfer the load to the soil.

The maximum pressure exerted on the soil by the tower crane footing is the combined effect of the vertical loads and moments. The soil condition will therefore have a direct effect on the location of a tower crane. This is especially true when a site uses track mounted tower crane for the construction. On poor soil, track differential settlements may cause track elevations to go beyond permitted tolerances and endanger operations.

Building Height

To erect an external fixed tower crane for a tall building is not considered cost efficient. A climbing crane has similar advantages as that of a static model used within a building but the mast height of the internal climber can be just of the maximum height necessary. Hence, there will be no extra cost incurred for the additional mast sections, regardless of how tall the building is.

Maximum Coverage

The primary consideration for a tower crane is to ensure that it can cover the whole plan area and the pick up zone for materials. The tower crane must be located at such locations where it is possible to provide 100% lifting coverage over the plane area of the building.

Usually, it is insufficient for a single tower crane to cover the whole site. Hence, it is common to supplement the “blind spots” with mobile cranes or additional tower cranes. When multiple cranes are in operation, it is necessary to section off the building in accordance with the physical characteristics of the project so as to establish the locations of the multiple cranes.

Location of Existing Structure and Underground Hazards

Temporary facilities for the construction must be in position before the crane location is determined so that there would not be any restraints on the location of the crane. There is always the threat of location a tower crane above buried pipes and mains. A tower crane is usually not positioned near existing buildings, as this would restrict the slewing of the crane's boom.

CASE STUDIES

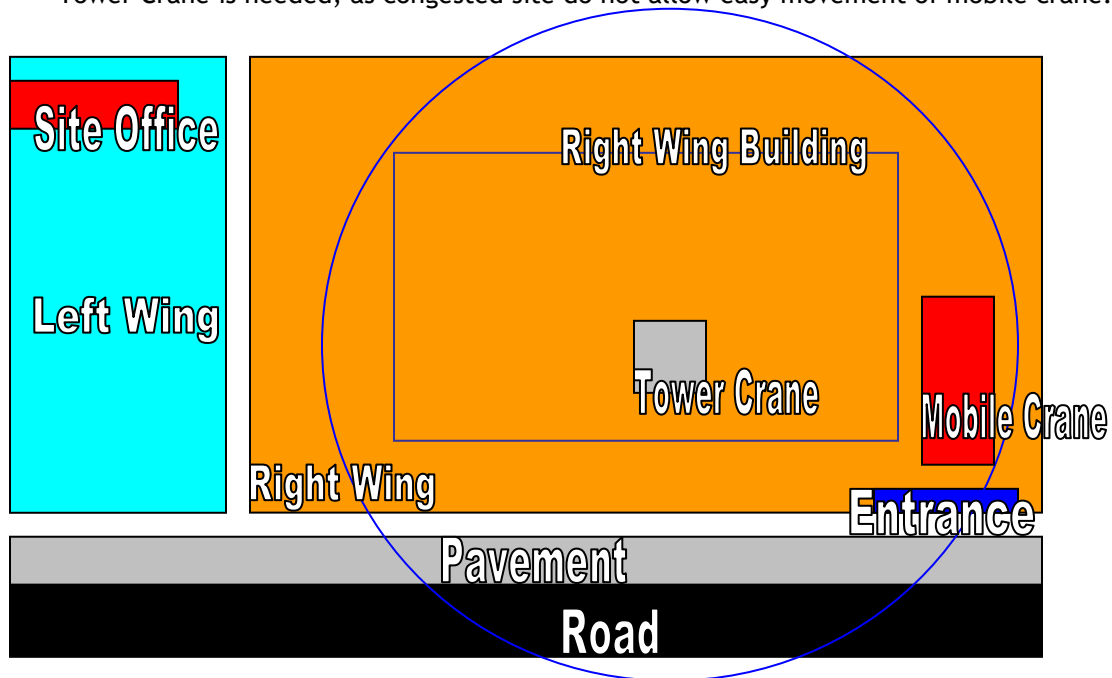
Case Study #1: Scotts Road (2 Extension Blocks for Royal Plaza)

Project Name: Scotts Walk

Need for Tower Crane?

Facts and figures:

- The extension of the Royal Hotel is on the right wing of the site.
- Left wing is for A&A.
- Right wing had been demolished for a new 5-storey extension of the Royal Hotel.
- Site dimension approx 40m by 30m.
- Piling had already been done.
- Congested Site.
- Tower Crane is needed, as congested site do not allow easy movement of mobile crane.



Thus a Tower Crane is needed.

Type of Tower Crane?

From the congested site situation, a saddle head crane is not suitable for the job. A luffing jib will be much better as the slewing radius is not so rigid and it will help to comply with the Railway Code of not intruding into the MRT reserves lines. Also, the luffing jib can withstand and carry higher loadings than the saddle head cranes. Of course, all these factors must work in hand with the availability of the crane in the market. In this case, the proposed building is not comparatively tall and the loads to be lifted by the crane are not very heavy. Thus it is rather easy to find such tower cranes in the market. In contrast, it is believed that there are less than 4 sets (in Singapore) of the K-4 slewing jib tower crane used in the Serangoon HDB site. In conclusion, a luffing jib tower crane is being chosen for this project.

Location of Tower Crane?

Due to the proximity of the underground MRT tunnel near the Left Wing, the position of the tower crane is being placed on the Right Wing. Coupled with the fact that only the right wing needed more construction for expansion as compared to the Left Wing A&A, the tower crane had been positioned near the slightly off the center right of the Right Wing. It is also near to the Site Entrance that complies with the Code of Practice that the crane should be within 10-15m from the site entrance to facilitate transportation of materials.

It must also be taken into account that the soil conditions must also be good enough to withstand the load of the tower crane.

The tower crane, in this situation is actually being positioned within the proposed building. The mast will be within the proposed lift shaft due to the congested site conditions.

Erection of the Tower Crane?

The tower crane is actually being assembled within one day after casting the tower crane concrete pad overnight. The crane was assembled on a Saturday, from morning till night, in one full day. Assembling details has been covered in another section of this report.

Dismantling of the Tower Crane?

After the proposed building has been erected. The mobile crane will dismantle the tower crane from top to bottom via the lift shaft in an opposite manner from the erection procedure.

Salient Points?

When the building is constructed, there will not be the luxury of space for the dismantling process, as the jib must be dismantled piece by piece. This is unlike the erection procedure in that the entire jib was assembled before installing onto the mast.

Because of the congested site nature, mobile cranes are not being employed for the entire process. The mobility of a mobile crane will not be used to its fullest advantage. For example, a mobile crane being positioned at the entrance for the entire duration of the construction will not be able to reach out to the far ends of the site. Also, adjustments of counterweights will be a main problem, coupled with the fact that it will be blocking the only site opening for vehicular access.

Floodlights are very important as CBD construction takes place very often during the night. During the day, human and vehicular traffic are heavy and land space is very expensive, therefore considerations for night construction are crucial.

Also, lateral wind pressure is usually higher at night and thus care must be taken especially during night construction.

A good feature of the Scotts Walk tower crane is that the mast is being encompassed within the building. Load transfer will be assisted by the building structure and thus the slenderness of the mast will not pose too much problems regarding lateral wind loads.

Case Study #2: Grange Residences, Tanglin Road

Justifications for selection/location of tower crane (refer to Appendix 2)

The first decision to make is to choose the appropriate type of crane for the project. From the site plan, it can be seen that an extensive coverage is necessary. To employ the use of mobile cranes would result in too many cranes than economical. Climbing cranes are not considered due to their high cost of acquisition and complexities in erection and dismantling. In addition, their availability of site space does not justify their selection. Thus, tower cranes were deemed to be the most suitable crane type for this project.

With the decision to use tower cranes made, the next step is to decide on the number of tower cranes necessary for maximum coverage of the proposed site layout. For economic reasons, the use of one tower crane was first considered. Logically speaking, it should be placed at the center of the site (i.e. the current position of TC2) to maximize coverage. This would mean that a large working radius would be required in order for it to serve the extreme faces of block A & C. This would inevitably result in an excessive long jib length. Consequently, the load-carrying capacity at the end to the boom arm might be insufficient to lift the required loads at the furthest point of delivery. Renting a tower crane of higher load-carrying capacity might result in even higher costs than having more than one tower crane on site. In addition, having only one tower crane on site would mean that vertical lifting operations of all three blocks are dependent on it. The limitations in crane time might slow down operations since simultaneous construction of all three blocks may not be possible.

Thus, with all the above considerations, the option of having two tower cranes was evaluated. Again, the most logical positions would be points X1 and X2, since choosing an appropriate working radius for both cranes will cover the working areas of all three blocks. However, this would mean that the crane bases of both tower cranes are more than 30 metres away from all the 3 entrances. As discussed before, it is common that the delivery of all materials, plants and equipment to be lifted by the tower crane would be within 10-15 metres from the crane base. Hence, having such location arrangements for two tower cranes will result in inefficiencies in the unloading process. Also, the position of X1 will obstruct the possible simultaneous construction of the basement with the superstructure.

Finally, the use of three tower cranes at the respective positions as shown in the site plan was decided. In this particular arrangement, a working radius of 45m for each crane would cover 100% of the working area for all three blocks. The delivery of materials from any of the 3 entrances will also be within 10-15 metres from the crane base of either TC1 or TC3. Having three tower cranes each serving each block will also speed up construction activities since there will be no restraints on crane time.

As can be seen from the site plan, TC1 and TC3 are at close proximity to TC2 with working radii overlapping with the latter. Thus, installing luffing boom arms for TC1 and TC3 are the most viable choices to ensure that all three jibs are able to weathervane freely without obstruction. In addition, all three tower cranes are set at different working heights to serve as further precautionary measures. Moreover, luffing jibs are more suited for TC1 and TC3 because they serve primarily block A and C, which are taller in building height (18 storeys). A hammerhead is sufficient for the vertical transportation requirements of the 8-storey block B.

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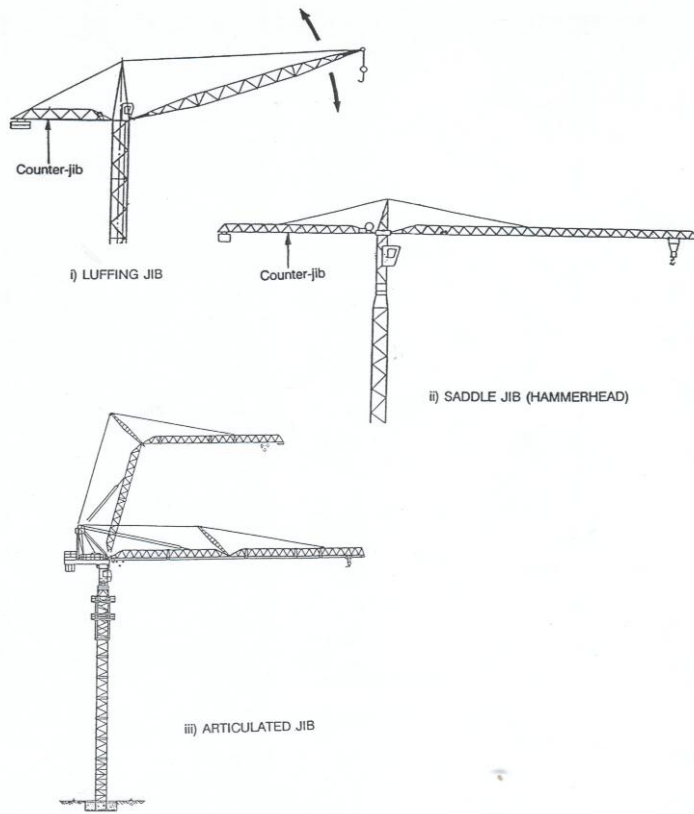


Figure 3. Types of jib

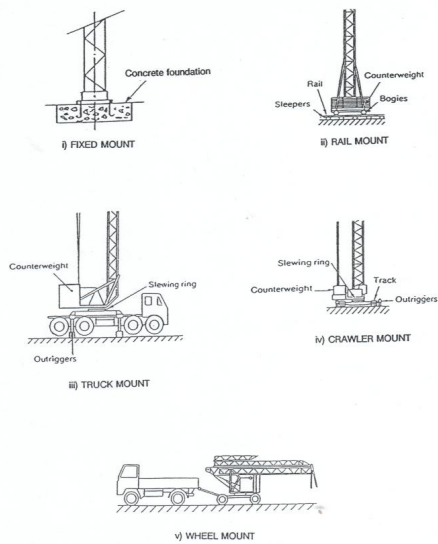


Figure 1. Types of mount

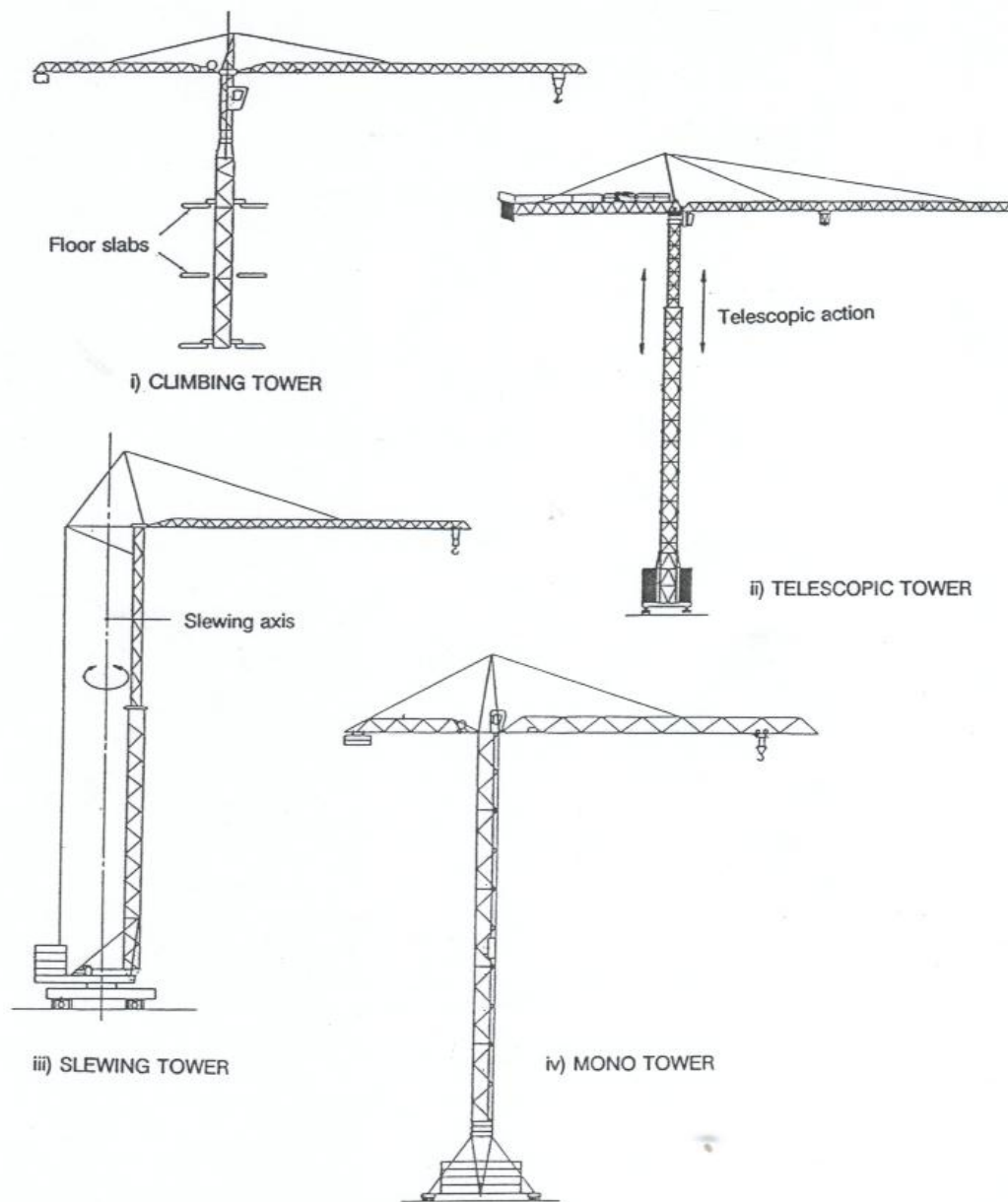


Figure 2. Types of tower