Code of Practice on the Design and Construction of Tower Working Platforms

ELECTRICAL AND MECHANICAL SERVICES DEPARTMENT
1997

CONTENTS

PART 0 : INTRODUCTION

This Code is established under Section 11 of the Builders' Lifts and Tower Working Platforms (Safety) Ordinance (the Ordinance). This Code, unless the Director of Electrical and Mechanical Services (the Director) states otherwise, is applicable to all tower working platforms subject to the Ordinance. Figures 1(a) shows one typical layout of a tower working platform of fixed type with base enclosure and figure 1(b) shows one typical layout for a tower working platform of mobile type with the fence omitted for clarity.

Because of the varying operating conditions on sites, the great versatility of some extending structures, the multipurpose and mobility of the machinery, the code has been drawn up based upon the following requirements:

(a) The operation of the platform is carried out by competent operators.
(b) The horizontal transfer of the tower working platform within working area is carried out by competent workers.
(c) The extension of outriggers is carried out by competent workers.
(d) The tower working platform is maintained, inspected, cleaned, oiled and adjusted periodically by registered contractors.
(e) The tower working platform is checked and inspected daily by competent operators for its function before operation.
(f) The tower working platform, including any lifting equipment on the platform, is tested and examined by registered examiners before use.
(g) The construction and design of any lifting equipment erected on the platform shall be approved by the Director. The lifting equipment shall only be operated by competent operator having received sufficient and relevant training on the equipment.
(h) The emergency lowering/raising operation shall only be carried out by competent operators fulfilling either of the followings:
    - The competent operator has undergone relevant training on the operation of the emergency lowering/raising device of the type concerned and the working principle of the safety gear for tower working platforms equipped with safety gears.
    - The competent operator has undergone relevant training on the operation of the emergency lowering/raising device of the type concerned and the working principle of the speed controlling device which shall be installed to tower working platforms not equipped with safety gears.
(i) The safety gear shall not be reset by competent operators after tripping.

Tower working platforms are not primarily designed for conveyance of persons. They are used as a temporary working place for supporting workers, materials, tools and equipment for building refurbishment, renovation, repairs and other construction works at a construction site or at an existing building. Special precautions should be taken when carrying out construction work using flammable materials or liquid on platform. No excessive quantity of combustible materials or flammable materials/liquid shall be placed on the platform to minimise the risk of fire.

Incidentally, the platform conveys the workers, materials, tools and equipment to and from different levels. Workers shall board and alight the platform at one location only, usually at the base enclosure. Materials can be loaded on the platform manually or by lifting equipment integrated with the platform.

The lifting equipment integrated with the platform may be used for lifting work as well as to facilitate installation, alteration of mast height or dismantling of the tower working platform. For some models, tower working platforms are supported on a chassis which can be towed or self propelled on the ground or rails.

PART 1 : SCOPE

This Code specifies the safety requirements for tower working platforms as defined in the Ordinance.

The following configurations of tower working platform are included in the Code:

- the platform is supported on at least one vertical mast,
- the tower working platform may be of mobile or fixed type,
- the mast may be fixed to the adjacent structure with wall anchorages,
- the mast is of a standing type and supported at the base,
- the chassis of a mobile tower working platform may be towed, pushed or self-propelled on the ground or rails,
- the platform is elevated by rack and pinion,
- the platform may be counterbalanced by a counterweight,
- the platform is allowed to be boarded and alighted at one location only.

This Code shall not apply to:

- suspended working platforms as defined in Factories and Industrial Undertakings (Suspended Working Platforms) Regulation, Chapter 59,
- mobile elevating working platforms not having a mast, guides, or control on the platform,
- fire fighting personnel lifting appliances,
- receptacles lifted by crane under the Construction Sites (Safety) Regulations, Chapter 59,
- platforms not supported on a vertical mast,
- elevated platforms mounted on sea going barges or vessels.

The objective of this code is to enhance the reliability and safe use of a tower working platform without placing undue limitation on the general design, construction and installation of the tower working platform.

PART 2 : DEFINITIONS

The following definitions are used to indicate precisely the technical terms that are used in this Code in conjunction with all the interpretations as stipulated in Section 2 of the Ordinance. Cross-reference should be made to Figures 1 for the terms provided.

Auxiliary Platform
The part of the platform which is built up using secondary structural elements, whose support and location is dependent upon the primary structural elements of the primary platform. They are used to extend the primary platform, usually along its longitudinal working edge, and may form irregular shapes which conform with the work site. The auxiliary platforms may be above or below the primary platform level. They are designed and constructed for support of persons and their tools and equipment only.

Base Frame
A structural part upon which the mast, platform and other appendages are supported.

Buffer
A resilient stop at the end of travel, and comprising a means of braking using fluids, springs, elastomers, or other similar means.

Chassis
A trolley with a structural frame for supporting the mast, platform and other appendages. The trolley may be pulled, pushed, or self-propelled.

Counter Roller
A roller used to counter-react the separating force created by the meshing rack and pinion.

Counterweight Way
The total space within which the counterweight of a tower working platform travels.

Driving Machine
This comprises the electrical or hydraulic motor, driving machine brake and the reduction unit if applicable.

Driving Machine Brake
A device used to decelerate and arrest a moving platform in the event of interruption of the power supply to the device.

Fence
Fixed rails used to prevent persons falling from a height.

Guide
A rigid element provided for guiding the direction of vertical travel of the platform (and the counterweight if provided).

In-service Condition
An operating condition in which the laden or unladen platform can be either travelling or stationary in any position in the liftway.

Load Chart
A diagram indicating the allowable number of persons, allowable material loads with their distributions on the platform for a particular configuration of a tower working platform.

Mast
A structure used to support and guide the platform (and the counterweight when provided).

Mast Section
Individual sections which are joined together to form the mast.
Out-of-Service Condition
A non-operating condition in which the unladen platform is placed in such a position that it is least affected by wind. This is usually laying on the base frame or chassis.
Outriggers
Extensible parts used to maintain or increase the stability of a tower working platform and that may be capable of supporting or levelling the tower working platform.
Overspeed Governor
A device which, when the platform attains a predetermined speed in either upward or downward direction, causes the platform to stop and, if necessary, causes the safety gear to apply.
Pitch Circle
It is the imaginary circle that rolls without slippage with a pitch circle of a mating gear.
Platform
It means the platform of a tower working platform and includes the primary platform and the auxiliary platform if provided.
Primary Platform
The platform which is designed and constructed for support of materials, persons, tools and equipment, upon which the auxiliary platform is built.
Rated load
The maximum load that a tower working platform has been designed to carry in service as stated in the load chart.
Rated Speed (raising/lowering)
The vertical travel speed of the platform that has been designed for.
Rated Speed (transfer operation)
The horizontal travel speed of the mobile tower working platform that has been designed for.
Registered Professional Engineer
A person who has been registered under the Engineers Registration Ordinance, Chapter 409.
Safety Gear
A mechanical device for stopping and maintaining the platform on the mast(s) in the event of overspeeding.
Speed Controlling Device
A device used to automatically control the lowering/raising speed of the platform during emergency lowering/raising operation.
Stopping Distance
The distance travelled by the platform from the instant when the control circuit is interrupted until the platform has been arrested.
Tooth Module
It is equal to the pitch circle diameter of a gear divided by the number of teeth.

Tower Working Platform

It means a fixed or mobile tower containing a lifting machine

(a) that has a platform, the dimensions and design of which permit the conveyance of persons;

(b) the operating controls of which lifting machine are located on the platform; and

(c) the direction of movement of which is restricted by a guide or guides.

It is used for construction work, and includes the supports, liftway and enclosures, the platform and the whole of the mechanical and electrical apparatus required in connection with the operation and safety of the tower working platform.

Transfer Operation

The horizontal movement of the tower working platform, which is in transfer state, from one position to another on the same working site.

Transfer State

The configuration of a tower working platform supported on wheels and with the platform at the fully lowered position.

Wall Anchorage

A structural member, connected between the mast and an adjacent building or other structure, used to prevent lateral movement of the mast.

PART 3 :

TECHNICAL REQUIREMENTS

SECTION A : STRUCTURAL DESIGN

1 GENERAL DESIGN CONSIDERATIONS

The design and stability calculations shall conform to the laws and principles of applied mechanics and strength of materials. All components and structural members shall be properly designed and made of sound materials that are free from defects and shall have sufficient strength and specified quality. The construction and reliability of the tower working platform, in whole or part, shall be appropriate to its intended use, operating environment and design life. Materials used in the fabrication of the tower working platform shall not support combustion and emit toxic gases or fumes upon burning. If the plywood or wood panels are used as platform floor, they shall meet the minimum requirement of Class 3 Surface Spread of Flame of BS 476 Part 7 or other equivalent international standards.

Wall anchorages between the mast and the adjacent structure or building are considered to be part of the structure of the tower working platform. Structural support and concrete foundation for supporting the base frame are not included in this Code. They should be designed and checked by registered professional engineers in structural or other appropriate disciplines. Figure 1(a) illustrates one typical layout of a tower working platform of fixed type. Figure 1(b) illustrates one typical layout of a tower working platform of mobile type with the fence omitted for clarity.

2 CONSIDERATION OF FORCES AND LOAD COMBINATIONS

2.1 General

The structure as a whole of the tower working platform with all allowable configurations shall be so designed, calculated and constructed that its strength is sufficient under all conditions, including normal operation, transfer operation, application of safety gear, emergency lowering/raising, impact of the platform on its buffer, installation and dismantling and adverse weather conditions.

2.2 Forces and load combinations

Any possible combination of the following forces and loads shall be taken into consideration when designing the structure of a tower working platform.

2.2.1 Static load

Static loads include the masts, wall anchorages and other appendages excluding the platform, rated load and parts that travel with the platform.

2.2.2 Dynamic load

Dynamic loads include the loads due to moving components, e.g. dead weight of the unladen platform, rated load, trailing cables, and parts that travel with the tower working platform.

Dynamic forces shall be calculated by multiplying the moving load by a dynamic factor. This dynamic factor shall not be less than 1.15.
When a tower working platform is being transferred, the dynamic forces due to inertia effects on starting, transferring and stopping on level ground or gradient shall be taken into consideration.

2.2.3 Rated load

In designing the rated load of the platform, it shall be calculated in accordance with the following formula:

$W = n \times w_p + W_m + 2 \times w_t$

where
- W - rated load in kg
- w_p - weight of each person (minimum 80kg per person),
- w_t - maximum allowable personal tools and equipment carried by each person (minimum 40kg per person for the first two persons only)
- W_m - maximum allowable weight of materials on platform (excluding the weights of persons and their tools and equipment)
- n - maximum allowable number of persons on platform (including the competent operator)

The loads due to persons, their tools and equipment, and materials shall act on the platform at the same time.

(a) The minimum number of persons (including the competent operator) shall be 2 for single-mast platforms and 4 for multiple-mast platforms.

(b) The weight of each person (w_p) shall be considered acting at a point on the platform 0.1m from the uppermost inner rail of the fence. The separate distance between persons shall be 0.5m. Figure 2(a) illustrates the distribution of persons on the platform.

(c) The weight of personal tools and equipment carried by each person (w_t) shall be considered acting on the same point as the weight of the person.

(d) The weight of materials shall be considered as uniformly distributed on the platform, and w_m is given by W_m/L (where L is the total length of the primary platform). w_m shall be considered acting eccentrically on the platform at 0.15b (where b is the width of the primary platform) from the longitudinal centre line of the primary platform.

(e) The combination of the weights as specified in the preceding subsections (b), (c) and (d) shall give the most unfavourable loads or moments on the tower working platform.

(f) The bending moment (M) on the mast(s) and platform due to weight of material shall be calculated as follows:

i. For single-mast tower working platform: (refer to Figure 2(b))

$M_{max} = w_m \times L_m^2 \times 1.15/2$ (Formula 1)

where L_m is the greater of L_1 and L_2

ii. For multiple-mast tower working platform: (refer to Figure 2(c))

$M_1 = w_m \times L_1^2 \times 1.15/2$ (Formula 2)

$M_2 = w_m \times L_2^2 \times 1.2/8$ (Formula 3)

$M_3 = w_m \times L_3^2 \times 1.15/2$ (Formula 4)

The factors 1.15 and 1.2 are introduced to cater for situations where a concentration of the same load may be placed anywhere within the individual length.

For the bending moments due to these loads, reference shall be made to Section A2.2.3(b) and Section A2.2.3(c).

(g) Calculations must allow for the possibility of having half-load situated on one end of the platform which may create an unbalance condition and exert higher stresses in some parts of the tower working platform than the full-load situation.

2.2.4 Wind loads

The wind load shall be determined by:

$F = A \times q \times C_f$

where F is the wind load in N
q is the dynamic wind pressure in N/m^2
A is the effective frontal area in m^2
C_f is the force coefficient

The dynamic wind pressure q is given by:

$q = V^2/1.6$

where V is design wind speed in m/s

To determine the force coefficient, reference shall be made to the Code of Practice on Wind Effects Hong Kong - 1983.

In calculating wind loads on the tower working platform, the following three wind conditions shall be taken into account:

(a) In- service condition

The minimum value for wind pressure and the corresponding wind speed under in service condition shall be as indicated in Table 1:

Table 1:

Installation	Wind Speed (m/s)	Wind Pressure (N/m^2)
tower working platform (free standing)	12.5	100
tower working platform secured with wall anchorages	15.5	150

(b) Out-of-service condition

The wind pressure for out of service condition shall depend on the height above ground and the location where the tower working platform is installed.

Table 2 is extracted from the Code of Practice on Wind Effects Hong Kong - 1983 which provides the minimum design pressures with respect to heights.

Table 2:

Height Above Ground Level	Wind Pressure in N/m^2	
	General Terrain	Built-up Area
0-10m	1,200	1,200
10-30m	2,200	1,200
30-50m	2,500	1,900
50-100m	3,000	2,400
100-150m	3,500	3,000
150-200m	3,800	3,400
200-250m	4,100	3,700
250-300m	4,300	4,000
above 300m	4,300	4,300

(c) Erection and dismantling wind pressure

The minimum design wind pressure during erection or dismantling shall be $100N/m^2$ which corresponds to a wind speed of 12.5m/s.

2.2.5 Wind forces on persons and materials

The wind forces acting on persons and materials on the tower working platform shall be assumed to act horizontally in any direction.

(a) The wind force on each person on a platform exposed to wind shall be calculated as acting on an area of $0.7m^2$ (0.4m average width × 1.75m height) with the centre of area at 1.0m above the platform floor, for persons fully exposed; or an area of $0.35m^2$ with the centre of area at 1.45m above the platform floor, for each person standing behind an imperforated fence. The force coefficient for each person exposed to wind shall be 1.0.

(b) The number of persons directly exposed to wind shall be calculated as:

i. the length of the side of the platform exposed to wind, rounded to the nearest 0.5m and divided by 0.5m; or

ii. the number of persons allowed on the platform if less than the number in the subsection (i).

If the number of persons allowed on the platform is greater than that in this subsection (i), a coefficient of 0.6 may apply to the extra number of persons.

(c) The wind force on exposed materials on the platform shall be taken as 3% of the material load (W_m), acting horizontally at a height of 1.0m above the platform floor.

2.2.6 Erection and dismantling load

The load exerted during erection and dismantling shall be considered.

2.2.7 Loading and unloading force

The tower working platform shall be capable of sustaining forces during loading and unloading of persons and materials. The loading force due to lifting, lowering or suspension of materials with the lifting equipment integrated with the platform shall be taken into consideration. Any side forces induced on the platform during loading/unloading shall be taken into consideration.

2.2.8 Operation of safety gear at overspeed

Forces due to operation of the safety gear shall be considered. To determine the forces produced by operation of the device, the sum of all moving masses must be multiplied by a dynamic factor given by:

Safety gears of progressive type	2
Safety gears of instantaneous type	5

A lower dynamic factor can be used provided that the factor is derived from actual testing in the following ways:

i. The tower working platform is tested with load on platform of value up to 1.5 times the rated load, whichever the load generating the greatest dynamic force.
ii. The dynamic force so generated upon application of the safety gear is divided by the static force resulted from rated load condition to obtain the dynamic factor.
iii. However, the dynamic factor shall not be less than 1.2 in any case.

2.2.9 Manual force at platform

The minimum value for the manual force at the platform is assumed to be 200N for each of the first two persons on the platform and 100N for each additional person. It is assumed that the force is applied at a height of 1.1m above the floor of the work platform and act in any horizontal direction. If a force greater than this is permitted, it shall be stated by the manufacturer.

2.2.10 Special loads and forces

Special loads and forces that are created by special working methods and conditions of use of the tower working platform shall be taken into account. Such special considerations shall include:

- Weather protection screen and roof

- Effect of any item which significantly increase the wind area
- Use of slightly raised outriggers during transferring in order to avoid instability from failure of one tyre
- Transportation
- Objects carried outside the platform
- Wind forces on large objects carried on the platform
- Loading due to lifting equipment integrated with the platform

2.3 Other considerations

2.3.1 The design of the tower working platform shall allow for a vertical misalignment of at least 0.5° introduced during erection of mast.

2.3.2 In calculating the loading and stability on tower working platform supported on rubber tyres during transfer operation with the platform in the transfer state, the design shall take into account the effect of one tyre failure.

2.3.3 When any non-standard configurations are used, these shall be approved before installation.

2.4 Safety factors

The structure as a whole and each part of the tower working platform including the wall anchorages, outriggers and the chassis shall be designed by taking into account the combination of loads and forces.

The allowable stress of a stressed member shall be given by:

$\sigma_0=\sigma_y/S_y$

where σ_0 is allowable stress
σ_y is yield strength of the material
S_y is the factor of safety with respect to yield strength

The factors of safety, S_y, for structural steel is shown in Table 3.

2.5 Stability of tower working platforms

When a tower working platform is in a free standing mode during erection, dismantling, in operation, transfer operation, emergency lowering/raising or out of service condition, the stability of the tower working platform shall be considered.

2.5.1 The maximum overturning moments and the corresponding stabilising moments shall be calculated about the most unfavourable tipping lines.

2.5.2 The calculation shall be made with the tower working platform in the most unfavourable extended and/or retracted positions with the maximum allowable inclination of the chassis or base frame as defined by the manufacturer. All loads and forces, which can act simultaneously shall be taken into account in their most unfavourable combinations. An allowance of 0.5° for inaccuracy in setting up the tower working platform shall be added to the maximum allowable inclination of the chassis or base frame.

Table 3: Factors of safety (S_y) for structural steel

Load Case	Combination of Loads and Forces	S_y
Tower working platform in service without wind, static	structural loads, rated load, horizontal forces and inaccuracy in setting up	1.5
Tower working platform in service without wind, dynamic	structural loads, rated load, dynamic forces and inaccuracy in setting up	1.5
Tower working platform in service with wind, static	structural loads, rated load, horizontal forces, in service wind loads and inaccuracy in setting up	1.33
Tower working platform in service with wind, dynamic	structural loads, rated load, dynamic forces, in service wind loads and inaccuracy in setting up	1.33
Tower working platform during erection or dismantling	structural loads, dynamic forces, in service wind loads, load and force during transfer operation, erection and dismantling loads and inaccuracy in setting up	1.33
Tower working platform during transfer operation	structural load, dynamic forces, in service wind loads, load and forces during transfer operation and inaccuracy in setting up	1.33
Tower working platform striking the buffer while in service	structural load, rated load and buffer force	1.25
Tower working platform during action of safety means while in service	structural loads, rated load and action of safety means	1.25
Tower working platform out of service	structural loads and out of service wind loads	1.25

Notes:

(a) The static structural loads are the masses of the components of the tower working platform when they are not moving. The dynamic structural loads are masses of the components of the tower working platform when they are moving.

(b) Factors of safety for other materials shall follow the relevant international standards.

2.5.3 The following influences shall be taken into account in the calculations:

- Distortions due to inaccuracies in the manufacture of the components
- Play in the connections of the structure
- Elastic deflections due to effects of forces
- Inertia force while the tower working platform is being transferred
- Manual forces exerted by persons on platform causing an overturning moment
- Failure of rubber tyres

2.5.4 When calculating the stability of a tower working platform, the sum of overturning moments multiplied by the respective overturning factors shall be less than the sum of the stabilising moments. The overturning factors shall be as in Table 4:

Table 4:

Overturning Moment Created By	Overturning Factor
static loads	1.1
dynamic loads	1.2
wind loads	1.2
manual forces	1.2
others	1.2

2.5.5 While the tower working platform is being transferred, the application of the brake shall not induce instability.

2.6 Design details of steel structure

The design of steel structures shall require a general stress analysis, including buckling and crippling, and fatigue stress analysis. If metals other than steel, e.g. aluminium alloys or other materials are used for structural components, the design shall comply with relevant international standards.

2.6.1 General stress analysis

The general stress analysis is the proof against failure by yield or ductile fracture. The analysis shall be made for all load bearing components and joints.

2.6.2 Elastic stability analysis

The elastic stability analysis is the proof against failure by elastic instability (e.g. buckling, crippling). The analysis shall be made for all load bearing components subjected to compressive loading.

2.6.3 Fatigue stress analysis

The fatigue stress analysis is the proof against failure by fatigue due to stress

fluctuations. The analysis shall be made for all load bearing components and joints which are critical to fatigue taking into account the constructional details, the degree of stress fluctuation and the number of stress cycles. The number of stress cycles may be multiple of the number of load cycles.
The number of load cycles for a tower working platform is normally 2×10^4-intermittent duty (e.g. 10 years, 40 weeks per year, 25 hours per week and 2 cycles per hour).

2.7 Tower working platform support conditions

The ground or foundations, temporary supporting structure and anchorages for tower working platforms shall be of sufficient strength to withstand the maximum load imposed in-service and out-of-service without failure, and settlements or deflection which may endanger the stability or safety of the machine. The support of the tower working platform, the assessment of maximum loads and the design of foundations, supporting structures and ancillary details should be checked by a registered professional engineer in structural or other appropriate disciplines. Particular care should be taken to ensure that the imposed loads are not underestimated and also a careful assessment of probable wind pressure shall be made, taking into account the degree of exposure of the site and any other special factors. Tower working platform manufacturer's data relating to the dead weight of the tower working platform and the dynamic forces which can occur during operation of the tower working platform should always be obtained.

Under in-service conditions, the loads imposed on the tower working platform support are usually due to the combined effects of:

- the dead weight of the tower working platform
- the dead weight of the load
- dynamic forces caused by movements of the tower working platform and the load during operation
- wind loading, resulting from operation in wind speeds up to a maximum permitted for in-service conditions, acting in any direction on the tower working platform and load
- loads due to lifting, lowering or suspension of materials by the lifting equipment

When the tower working platform is in the out-of-service condition, the loads imposed on the tower working platform support are due to the dead weight of the tower working platform combined with the wind load, acting in any direction, due to maximum wind pressure anticipated on the particular site as specified by a registered professional engineer in structural or other appropriate disciplines. Particular care shall be taken to estimate loads arising during operation for which data should be obtained from the manufacturer of the tower working platform.
The overall stability and safety of a tower working platform shall be carefully checked particularly when the tower working platform must operate close to excavations or embankments, or on bridge decks, or partially completed building frames or other structural supports.

The analysis of the forces imposed by a tower working platform on its support is a vitally important matter which should always be checked by a registered professional engineer in structural or other appropriate disciplines. The vertical and horizontal forces imposed are not uniformly distributed; their magnitude may be much greater than the loading which cause them and will vary according to the position and movement of the tower working platform and load and direction and speed of the wind. On tall tower working platforms, wind forces will have a considerable influence on the strength requirements of the supports and foundations and the greatest care is necessary in the fitting-up and fixing of any holding-down devices, rail clamps, temporary connections or anchorages.

SECTION B : MATERIALS AND MANUFACTURING

1 MATERIALS

Material of structural parts (excluding others which are not subject to structural calculation) and mechanical parts shall be steels listed in Section B1.1 or steels having mechanical property equivalent or superior to them. The guides shall be made of steel and shall be rigid. Wire ropes or chains shall not be used as guides.

1.1 Structural steel shall be of grade 43, grade 50 or grade 55 of BS 7613, BS 7668, BS EN 10029, BS EN 10113 : Parts 1-3, BS EN 10155 and BS EN 10210-1 or of other equivalent international standards. Other grades of structural steels may be used provided that they are suitable for use and comply with relevant international standards.

1.2 Welding electrodes for joining structural steel shall be in compliance with the requirements of BS EN 499 or other equivalent international standards.

1.3 Bolts and nuts shall comply with relevant international standards. High friction grip bolts shall conform to BS 4395 : Parts 1 and 2 and their use shall conform to BS 4604 : Parts 1 and 2. High friction grip bolts of other equivalent international standards may also be used. Plain washers shall be made of steel.

2 MANUFACTURING

Structural parts shall be manufactured by welding, bolt or pin joint.

2.1 Welding

2.1.1 All welding on loaded parts shall be carried out according to BS 5135 or other equivalent international standards. The following calculations of weld strength shall apply:

(a) Butt welds shall be treated as parent metal with a thickness equal to the throat thickness (or a reduced throat thickness for certain types of butt welds) and the allowable stress shall not be greater than those allowed for the parent metal.

(b) When electrodes appropriate to a lower grade steel is used for welding together parts of material of higher grade steel, the allowable stresses for the lower grade steel shall be used.

(c) When a weld is subject to a combination of stresses, the value of the combined stress shall not exceed that permitted for the parent metal.

2.1.2 Welded joints shall be free from defects that will impair the service performance of the construction. Such acceptance requirements, covering both surface and subsurface defects, shall be in accordance with Tables 18 and 19 of BS 5135. A higher requirement of acceptance shall apply for welded joints under fatigue

loading.
All welded joints shall be visually inspected in accordance with BS 5289. Butt welds in main structural members shall be examined by either radiographic or ultrasonic examination. The extent of these tests shall be set by the manufacturers having taken into consideration the required performance of the welds and the complete structure.

2.1.3 A weld subject to visual inspection would be acceptable if

- the weld is free from surface cracks
- the weld exhibits full fusion between parent metal and weld
- no craters are found
- the required size and profile of welds are exhibited
- no excessive undercuts and/or overlaps are found

The following non-destructive testing methods and standards are applicable:
Radiographic examination shall be in accordance with BS 2600 : Parts 1 and 2. Welds subject to radiographic examination shall be free from cracks and lack of fusion defects. In the case of ultrasonic testing, the calibration, sensitivity and scanning technique employed shall be in accordance with BS 3923 : Parts 1 or 2 as appropriate. Magnetic particle inspection of welds shall be carried out in accordance with BS 6072. Dye penetration tests shall be in accordance with BS 6443.

2.1.4 A report on all of the non destructive tests on butt welds and fillet welds of the tower working platform including the masts, platform, wall anchorages, landing gates, chassis, base frame etc., shall be provided by the manufacturer.

2.2 Bolt joint

Bolt holes shall be drilled and free from burrs. Precision bolts shall be turned or cold finished and fitted into reamed or drilled holes. Black bolts other than friction grip bolts shall not be used in main members in shear, for joints in stress-bearing members, or in joints subjected to fatigue. Whenever there is a risk of nuts becoming loose due to vibration or alternation of stresses, they shall be securely locked.
Pre-loaded bolts shall be grade 8.8 or grade 10.9. They shall be tightened by controlled means.

2.3 Pin Joint

When pins are used for connection, they shall fit to the holes and be secured from displacement by a positive means.

3 SURFACE TREATMENT OF STEELWORK

All surfaces which require a protective coating applied shall have a surface preparation to a standard compatible with the protective system to be adopted.

SECTION C : PLATFORM

1 BASIC REQUIREMENTS

Every platform shall consist fundamentally of a frame, a floor and a fence on all sides above the floor. The frame, floor and fence shall have sufficient strength. The whole assembly shall be able to withstand the forces specified in Section A. The platform shall be securely supported on the mast(s). Auxiliary platforms may be provided along the sides of the primary platform as shown in Figure 3.

2 GUIDING OF PLATFORM

The platform shall have rigid guides to prevent disengagement or jamming. The following measures shall be adopted:

(a) The platform shall be provided with effective devices which shall retain the platform to the guides in the event of failure of the guide shoes, blocks or rollers.

(b) The platform shall be provided with effective mechanical means to prevent it from coming off the guides. These means shall be effective during operation, emergency lowering/raising, operation of safety gear, erection, dismantling and maintenance.

3 PLATFORM FLOOR

3.1 The platform floor shall be slip-resistant and self draining. It shall be fixed so that it cannot be accidentally displaced. Any opening in the floor or between the floor and the toe board or platform gate shall be dimensioned so as to prevent the passage of a sphere of 15mm in diameter.

3.2 The platform floor shall be able to withstand a static force of at least 2kN exerted on any part of the floor having an area of 0.1m×0.1m without yielding.

3.3 The platform of a tower working platform of single or multiple mast configuration shall remain in a horizontal position (better than ±2°) during normal movement of the platform and under the application of rated load and other forces exerted during normal operation.

3.4 During operation of the safety gear and emergency lowering/raising, the maximum permitted variation of the platform floor level from the horizontal shall be ±5°.

3.5 For auxiliary platforms of telescopic type, they shall be securely fixed and prevented from inadvertent movement after extension or retraction. A positive means shall be provided to prevent this type of auxiliary platforms from coming off

at their extremities. Markings shall be provided to indicate the maximum allowable extension.

3.6 The auxiliary platform floor shall be within 150mm above or below the primary platform floor. Any gap between the primary and auxiliary floors shall be dimensioned so as to prevent the passage of a sphere of 15mm in diameter. The height of the fence shall be not less than 1,000mm and not more than 1,150mm with respect to primary or auxiliary platform floor whichever is higher. The clearances between the top rail and the intermediate rail, the intermediate rail and the platform floor shall be not more than 600mm.

3.7 Trapdoors in the platform floor shall be used for maintenance, service or emergency lowering/raising purposes only. They shall be securely fixed and fastened against inadvertent opening. The trapdoor shall either slide sideways or hinge upwards. It shall not be possible for the trapdoors to open downwards. A safety switch shall be provided for each trapdoor which shall interrupt the control circuit and prevent the movement of the platform if the trapdoor is not properly closed and positioned.

3.8 When the free movement of the auxiliary platform positioned between the mast and the building may be obstructed by the building structure or wall anchorage, a safety switch shall be provided to interrupt the safety circuit and prevent movement of the platform unless the auxiliary platform is properly retracted and positioned in such a way that its free movement is guaranteed This is to prevent the auxiliary platform from being struck by object protruding into the liftway.

3.9 When the platform is fully laden, the static deflection of any part of the platform between two consecutive masts with span S shall not exceed S/360 and the static deflection of any part of the cantilevered end with length L shall not exceed L/180. The static deflection does not include the displacements of the platform due to play between the platform guide rollers/shoes and the mast(s) or the mast deflection.

3.10 The clear width of the primary platform shall not be less than 600mm.

3.11 The maximum extension of the auxiliary platform for tower working platforms of fixed type shall not be more than 1,800mm as shown in Figure 3 and shall be subject to the structural design requirements in Section A and manufacturers' recommendations. The extension of the auxiliary platform can be extended beyond 1,800mm if it is provided with an overload and overmoment sensing device in additional to the one specified in Section J. This additional overload and overmoment sensing device shall give an audible and visual (continuous red light) alarm and interrupt the safety circuit when the auxiliary platform or the primary platform is overloaded or overmoment.

3.12 In the case of tower working platforms of mobile type, the maximum extension of the auxiliary platform shall not be more than 1,000mm.

4 FENCE

The platform shall have fences on all sides to prevent persons and materials from falling off.

4.1 The height of the fence shall not be less than 1,000mm and not more than 1,150mm with intermediate rails at the middle. Toeboards of 200mm high shall extend from the platform floor. If wire mesh is provided between the top rail of the fence and the toeboard, intermediate rails will not be required but the size of perforation shall be less than 25mm.

4.2 The fence shall be constructed to withstand concentrated forces of 300N for each person allowed on the platform. The forces shall apply outwards in horizontal direction at 500mm intervals. The top rail of the fence shall also be constructed to withstand without permanent deformation a single vertical load of 1kN applied in the least favourable position but not simultaneously with the horizontal load.

4.3 Chains or ropes shall not be used as fence.

4.4 The sides of the primary platform and any auxiliary platform adjacent to the mast(s) or counterweight way, if counterweight is provided, shall be protected with walls to a height of at least 2m to prevent any part of a person being trapped or struck. If perforated walls are used, the size of perforation shall fulfil Table 5.

Table 5: Size of perforation or opening related to clearance

Maximum Size of Perforation or Opening X(mm)* in square	Minimum Clearance From Adjacent Moving Parts (mm)
$X \leq 10$	22
$10 < X \leq 13$	50
$13 < X \leq 32$	100
$32 < X \leq 38$	125
$38 < X \leq 150$	850

* When the opening is in the form of a slot the length of the slot may be longer than these maximum sizes, provided its width does not exceed the maximum size stated in the table. In no case the maximum size of perforation shall exceed 150mm.

5 PLATFORM GATE

There shall have at least one platform gate for each platform for normal access of passengers.

5.1 Each platform gate which forms part of the fence shall not open outwards and shall be electrically interlocked such that the platform shall be prevented from operation unless all platform gate(s) is/are properly closed and locked.

5.2 Inadvertent opening of the access gate shall not be possible.

5.3 The platform gate shall be provided with a mechanical lock designed in accordance with Section F 4.

6 LIGHTING

The platform shall be provided with electric lighting that can produce a light intensity of at least 50 lux at each control station and the platform floor.

7 USE OF SAFETY BELTS

Workers on the platform shall be prohibited from leaning over the fence to reach out. If it is not reasonably practicable to do so, the workers leaning over the fence shall wear a safety belt or safety harness with its lanyard attached to a secure point of the platform. The platform shall be provided with clearly identified and conveniently located attachment points of adequate strength for securing safety harness. The number of attachment points shall be not less than the maximum number of passengers including the operator allowed on the platform.

8 FIRE HAZARD ON PLATFORM

Portable fire extinguishers of appropriate type should be provided on the platform for emergency use.

8.1 A clear notice in both Chinese and English on how to use the fire extinguisher should be either displayed on the platform near the extinguisher or attached to the fire extinguisher.

8.2 Wording in both Chinese and English particular to the type of portable extinguisher indicating appropriate and suitable uses and precautions should be provided.

8.3 Mounting brackets should be provided to fix the portable fire extinguishers on the platform.

8.4 The use, maintenance and testing of portable fire extinguishers should be referred to the relevant requirements and regulations laid down by the Fire Services Department.

8.5 When flammable materials or liquid is used, no excessive quantity is allowed to be placed on the platform or stored inside the base enclosure.

SECTION D : BASE FRAME AND CHASSIS, MAST AND GUIDE, WALL ANCHORAGE, COUNTERWEIGHT

1 BASE FRAME, CHASSIS AND OUTRIGGERS

Tower working platforms can be of fixed or mobile type. For tower working platform of fixed type, the mast shall be supported at the base with a base frame which shall be anchored or supported on the ground or other structures. In the case of tower working platforms of mobile type, the mast shall be supported on a chassis equipped with wheels for transfer operation and outriggers for increasing the stability of tower working platform for raising/lowering of the platform.

1.1 Base frame for fixed type

1.1.1 The base frame shall be able to sustain any loading during normal operation, erection, dismantling, emergency lowering/raising and out of service condition.

1.1.2 The base frame shall transfer the loading to the support or foundation effectively.

1.1.3 The plumb of the mast shall be capable of being adjusted with suitable pads or liners.

1.2 Chassis for mobile type

1.2.1 The raising and lowering of the platform should not be allowed before the suspension of the chassis is rigidly locked. A device shall be provided to prevent operation of the platform unless the suspension is locked rigidly. It shall not be possible for the locked suspension from loosening when the platform is in elevated position.

1.2.2 Springs, elastomers, pneumatic or cushion tyres used for transferring the loading to the rails or ground are not allowed when the platform is in an elevated position.

1.2.3 Every tower working platform shall have a level indicator to indicate whether the inclination of chassis is within the limits permitted by the manufacturer. The level indicator shall be so positioned that it is protected against damage wherever possible.

1.2.4 The chassis shall be equipped with fixings for safe and secure attachment to other parts of the platform, such as the mast and outriggers.

1.2.5 There shall be a brake for each chassis. The chassis shall be capable of being stopped and held stationary with a braking device under all ground conditions and also the worse combination of horizontal speed and a maximum gradient specified by the manufacturer. The brakes shall only be released and kept released by an intended action. The brake shall be of fail proof type. After being applied, the means of braking shall not depend on an exhaustible energy source.

1.2.6 Chains shall only be used in propelling system for transfer operation when means to prevent inadvertent movements of the chassis are provided for the failure of a chain. These chains shall be effectively guarded to prevent injury to persons. Belts used for transmission are not allowed.

1.2.7 If powered and manual drive systems are provided for the same movement, interlocks shall be provided to prevent both systems from being engaged at the same time.

1.2.8 On starting, or on restoration of the power after failure of the power supply, no inadvertent movement shall occur.

1.2.9 Means shall be provided to prevent instability of the tower working platform when any one of the tyres in the chassis failed.

1.2.10 For rail mounted chassis, means shall be provided to stop the machine safely at the limits of travel. To absorb the energy of the travel movement suitable buffers or other appropriate devices shall be provided. The wheels shall be guided on the rails to prevent derailment.

1.2.11 If axles are detachable, the chassis shall be equipped with fixings for safe and secure attachment of the axles when they are in use.

1.2.12 If towbars are left in a raised position when not in use, the towbar shall not obstruct the free movement of the platform and an automatic device shall be provided to hold and secure the bars in this position. Unintentional release shall not be possible. Towbars shall be designed to prevent handling hazards to the user.

1.2.13 Steering system shall be reliably constructed and manufactured. It must be easy to inspect and maintain.

1.2.14 The recommended air pressure in tyres shall be stated next to the pneumatic rubber tyres if the platform equipped with rubber tyres. Only pneumatic rubber tyres of the type and specification stated by the manufacturer of the tower working platform shall be used.

1.2.15 The chassis shall be capable of sustaining the loading during normal operation of platform, erection, dismantling, emergency lowering/raising, transfer operation and out of service condition.

1.3 Outriggers

1.3.1 Outriggers shall be capable of carrying all possible loads imposed on it, including the operation of the tower working platform and its own dead weight. Special loads due to unintentional movements (for example due to operation of the safety gear) shall also be considered. Inclination and operation on a gradient permitted by the

manufacturer shall also be considered.

1.3.2 The feet of the outriggers shall be free to pivot in all planes to an angle of at least 10° from maximum gradient specified by the manufacturer.

1.3.3 A notice shall be displayed on the outrigger to remind the user to check the applied ground pressure from the outrigger.

1.3.4 Movement of the outrigger beams shall be limited by mechanical stops at fully extended and retracted positions. It shall be possible to lock them in their extreme position. Locking pins for preventing movement of outriggers in extended positions shall be secured against unintentional disengagement or loss.

1.3.5 The outriggers shall be designed so that unintentional movement is prevented.

1.3.6 Outriggers relying on a permanent pneumatic pressure to provide support during the operation of the platform shall not be used.

1.3.7 Any hydraulic outriggers shall be equipped with a load securing valve mounted directly to the cylinder. This valve shall prevent unintended flow of oil to or from the cylinder, even in case of pipe or hose rupture. The closing of this valve shall not cause any dangerous movement.

1.3.8 When central supports are provided directly beneath the mast(s), these shall also comply with the relevant requirements in this section.

1.3.9 Power operated outriggers shall be fitted with interlocking devices to prevent from operation and raising of platform unless all outriggers are properly extended and the platform is at the lowest position. For manually operated outriggers, outrigger beams shall be clearly and durably marked to show when they are fully extended. The extension of the outriggers shall at all time be carried out by competent workers.

1.3.10 For tower working platforms with powered outriggers, the indication of the inclination shall be clearly visible from each control position of the outriggers.

1.3.11 When the manufacturer of the tower working platform has specified intermediate extension of the outriggers the following conditions shall be fulfilled:

(a) The intermediate extension positions shall be clearly and durably marked;
(b) The manufacturer shall provide a load chart indicating the correct rated loads applicable to the relevant outrigger extensions;
(c) Provisions shall be made in the overload and overmoment sensing device to accommodate the specified intermediate extensions.

2 MAST AND GUIDE

The maximum height of the mast and maximum height of travel of the platform shall be considered at the design stage.

2.1 The platform shall be guided by at least two rigid guides throughout the travel. The guides can be part of the mast. Flexible elements such as wire ropes or chains shall not be used as guides. The strength of the guides, their attachments and joints shall be sufficient to withstand the forces imposed due to the operation of the safety gear and deflections due to uneven loading of the platform.

2.2 Guides or masts shall be so designed that they are able to sustain all loads specified in Section A2.2. Horizontal forces acting transverse to the guides shall be considered when calculating the lateral rigidity of the guides and their fastenings. Joints between individual mast sections and guide sections shall be effective to transfer the loads, maintain the alignment and resist loosening.

2.3 The mast sections shall be provided with a means of identification which shall be able to prevent the use of inappropriate mast sections.

2.4 Protective measures shall be provided to prevent excessive corrosion of structural members of the mast sections including both inner and outer surfaces. The figure of minimum allowable thickness of the structural members of the mast shall be provided by the manufacturer.

2.5 Attachments of the rack to the guide/mast shall ensure that the driving element is kept in a correct position. Also, the stipulated loads so generated can be transferred to the mast.

2.6 Mast sections shall be designed to facilitate manual handling. When the permissible weight for manual handling is exceeded, suitable lifting equipment shall be provided to assist erection.

3 WALL ANCHORAGE

3.1 The wall anchorages shall be able to withstand all loads generated under normal operation, erection, dismantling, addition of mast sections, emergency lowering/raising and out of service condition.

3.2 The wall anchorages shall be adjustable in length to cater for variation in distance between the mast and the adjoining building or structure.

3.3 Information regarding the magnitude of the load exerted by the wall anchorages on the adjoining structure or building shall be provided by the manufacturer. The strength of fixing bolts, sockets and the mounting on the building side should be

checked by a registered professional engineer in structural or other appropriate disciplines.

3.4 The maximum and minimum distances between two consecutive wall anchorages shall be given by the manufacturer. The length of the overhang of the mast above the highest wall anchorage shall also be provided.

3.5 If the separation between the mast and the adjoining building is very large, any extension or cantilever constructed from the adjoining building side, used to connect to the wall anchorages, should be designed and checked by a registered professional engineer in structural or other appropriate disciplines. No extensions or cantilevers shall be allowed to directly connect to the mast except via properly designed wall anchorages.

3.6 The wall anchorages shall provide sufficient torsional rigidity to the mast, which is normally achieved by triangulation of the anchorage members.

3.7 Wire ropes shall not be used as wall anchorages. Anchorage by means of guy ropes shall not be allowed.

4 COUNTERWEIGHT

If counterweight is used in the tower working platform suspension system, the following requirements shall be observed:

4.1 If the counterweight is constructed with materials filled in a retainer, the following measures shall be considered:

- the fillers shall be effectively retained within a rigid frame;
- the filler materials shall be homogeneous inside the retainer and shall be properly maintained and protected against damage.

4.2 To prevent the displacement of the counterweight from its guides, the guides shall be equipped with a permanent anti-disengagement device in addition to rollers or shoes. The counterweight shall be guided by suitable guides, shoes or rollers situated near the upper and lower extremities of the counterweight frame.

4.3 A notice shall be displayed stating the total weight of the counterweight required and each individual block shall have its own weight marked on it.

4.4 The counterweight shall be equipped with a safety gear if there is an accessible space underneath the ground which is below the counterweight way.

4.5 Allowance shall be made for counterweight overrun at the top end of the counterweight way.

4.6 The platform shall not be used as a counterweight to counterbalance another platform.

SECTION E : BUFFER, OVERRUN, LIFTING EQUIPMENT

1 BUFFER

1.1 Buffers shall be placed at the bottom limit of travel for the platform and counterweights, if provided.

1.2 The total possible stroke of the buffers shall be at least equal to the gravity stopping distance corresponding to the maximum possible speed which can occur in service, emergency lowering/raising speed or the tripping speed of the overspeed governor whichever is the greater. Buffers shall be designed in such a way that the average deceleration of the platform during action of the buffers shall not exceed 1g (where g is the gravitational acceleration which is equal to 9.81m/s^2) with no peak exceeding 2.5g for more than 0.04 second.

1.3 If the buffers travel with the platform, or counterweight if provided, they shall strike against a pedestal at least 0.5m high at the end of the travel.

1.4 Hydraulic buffers shall be constructed so that the fluid level may be easily checked. An electric safety switch shall be provided to check whether the buffers have been returned to their extended position after operation. The platform cannot be driven by the normal operating means until the buffers are fully extended.

1.5 The characteristics of the buffer (such as buffer's stiffness, damping effect, energy absorption, etc.) shall also be considered when calculating the buffer force.

2 OVERRUN

The overrun of the platform at the top end of mast or liftway, i.e. the vertical distance the platform may travel after actuation of the top final limit switch and before meeting any obstruction to its normal travel or upper guide rollers reaching the end of the guides, shall not be less than 250mm.

3 LIFTING EQUIPMENT

3.1 Any lifting equipment integrated with the tower working platform shall be designed and constructed not to impose loads on the structure of tower working platform for which it was not designed for. If the lifting equipment is power operated, means shall be provided to prevent simultaneous operation of the platform and the lifting equipment.

3.2 The lifting equipment shall be designed and calculated in accordance with BS 2573 : Part 1 and Part 2 or other relevant international standards.

3.3 The safe working load of each lifting equipment shall not exceed 1,000kg. A load

limiting device, which cut the lifting motion when the load exceeds the overload setting, shall be provided. The overload setting shall be set between 100% and 110% of the safe working load.

3.4 The lifting equipment shall be tested and examined by a registered examiner before it is put into service. Further tests shall be required following repairs or substantial alteration, or at intervals not more than 6 months.

3.5 For the testing and examination of the lifting equipment, the structural, electrical and mechanical parts of the lifting equipment shall be inspected and thoroughly examined. Load tests shall be conducted with 125% of the safe working load. If the working radius can be varied, load tests shall be conducted at the minimum and maximum working radii.

3.6 A tensile test shall be carried out for every lifting wire rope by a registered examiner. The tensile testing force shall not be less than twice the safe working load of the wire rope. The safe working load of a wire rope shall not be greater than 20% of the minimum breaking strength of the wire rope.

3.7 The lifting equipment and the lifting gear shall be clearly marked with their safe working load with respective to the working radius in both Chinese and English and shall not be overloaded, except by a registered examiner for the sole purpose of testing.

3.8 The lifting equipment shall be operated by those competent operators who have undergone adequate training in the operation of this type of lifting equipment.

3.9 Routine maintenance of the lifting equipment shall be carried out at intervals not exceeding 7 days. Systematic maintenance, repairs and renewals shall be carried out and recorded.

3.10 No lifting appliances, other than the lifting equipment integrated with the platform, which exert loading on the platform, the mast or any part of the tower working platform, shall be allowed to be attached to any part of the tower working platform, unless they have been designed by the manufacturer for the purpose.

3.11 The lifting equipment, including the hook and wire rope when not in use, shall be securely stowed.

3.12 When the lifting equipment is used only for erection/dismantling of masts for extension/reduction of height of travel of the platform and the safe working load is less than 300kg, the load limiting device is not required.

3.13 No load shall be suspended by the lifting equipment during travelling of the platform or transferring of the tower working platform.

SECTION F : LIFTWAY AND ACCESS GATE

No obstruction of free movement of the platform shall be allowed. Trapping and shearing points between parts of the structure, chassis and platform shall be avoided by the provision of safe clearances or adequate guarding. Those areas within reach of persons on the platform or persons standing adjacent to the tower working platform at ground level, or at other points of access, shall be considered. If safe clearance or adequate guarding is not possible, then a device giving audible and visual warning alarms shall be provided to the platform to warn persons nearby of the movement of the platform.

1 LIFTWAY PROTECTION

Every tower working platform shall have a base enclosure of its own. There shall be only one location for boarding and alighting of passengers to the platform. This access shall be at the base enclosure or any other designated location.

1.1 Base enclosure

1.1.1 The base enclosure shall have walls at all sides to a height of at least 2.0m. The size of any perforation or opening in the enclosure related to the clearances from adjacent moving parts shall conform to Table 5 in Section C4. The enclosure shall be constructed to withstand the atmospheric conditions in the environment that they are exposed. The strength of enclosure walls shall be designed without permanent deformation when a thrust of 300N applied normally by rigid square or round flat face of 500mm^2 at any position and also it shall not sustain an elastic deflection more than 30mm.

The enclosure shall possess structural strength such that when a force of 1kN is vertically applied at any point along the top member of the enclosure, the enclosure shall sustain without permanent deformation.

1.1.2 If the counterweight is within the base enclosure, a rigid partition wall of 2.0m high measured from the ground shall be constructed to separate it from the main area.

1.1.3 An electrically interlocked access gate shall be provided at the base enclosure for access of services staff or passengers if the base enclosure is for normal access. The access gate shall comply with Section F3.

1.1.4 In order to provide safe access beneath the platform for maintenance purposes, a prop or equivalent device shall be provided to support the platform so as to create a minimum vertical clearance of at least 2.0m. The clearance shall extend under the entire area of the platform. This prop or equivalent device shall be capable of supporting a fully laden platform and shall not cause damage to any part of the tower working platform. It shall be possible to erect and dismantle the prop or equivalent device without any person working underneath the platform.

1.1.5 No persons shall be inside the base enclosure, except on the platform, during normal operation of platform.

1.1.6 An "Emergency Stop" device of press and non-resetting type in red which is easily and conveniently accessible inside the base enclosure for tower working platforms of fixed type shall be provided. In the case of tower working platforms of mobile type, the device shall be at the chassis.

1.1.7 A safe means of access shall be provided for access to the platform. When the distance between the access level and the platform floor exceeds 500mm, an access ladder or staircase shall be provided. The steps or rungs shall be not more than 300mm apart, and spaced equally over the distance between the access level and the platform floor. Each step or rung shall be at least equal in width to the access gate, at least 25mm deep and shall have a slip-resistant surface. The front of steps or rungs shall be located to give at least 150mm toe clearance. Hand holds shall be provided to facilitate climbing the access ladder to the platform.

1.1.8 In the case of tower working platforms of mobile type, i.e. installed with a chassis for transferring on site, a base enclosure is not required. However, a fence shall be provided to enclose the working area of the platform. The fence shall meet the following requirements:

(a) The height of the fence shall not be less than 1.1m with intermediate rails at the middle.
(b) The fence shall be constructed to withstand concentrated forces of 300N at 500mm intervals acting horizontally at the top rail. The top rail shall be capable of withstanding a single vertical load of 1kN in the least favourable position but not simultaneously with the horizontal load.
(c) A gate shall be provided for access of passengers to the platform. This gate, which forms part of the fence, shall not open inwards to the platform. The gate shall be provided with a lock.

1.2 Liftway protection

Any part of the liftway of a tower working platform that is accessible to persons shall be properly enclosed according to subsection 1.2.1 or fenced according to subsection 1.2.2 so as to prevent persons from being struck by the platform.

1.2.1 Provision of enclosures

For enclosures provided for wall openings on the building side to prevent persons from being struck by any part of the moving platform, the following requirements shall be complied with:

(a) If the safety separation between any point of access (other than the landing gate opening to the liftway) and any adjacent moving part of the tower working platform is less than 1.0m, a liftway enclosure shall be provided and it shall have a minimum of 2.0m height or extend to the full length

from the access floor to ceiling where this is less than 2.0m.

(b) If the safety separation is 1.0m or more, a fixed enclosure to minimum height of 1.5m shall be provided.

The size of perforation of the liftway enclosures shall conform to Table 5 and the strength of liftway enclosure shall have the equivalent strength of the base enclosure.

1.2.2 Provision of fences

For wall openings on the building side which are provided with fences only for preventing persons from being struck by any part of the moving platform, the following requirements shall be complied with:

(a) i. A safety trip bar/wire installed along and underneath the platform shall be provided to prevent movement of the platform in the downward direction if it comes into contact with any obstruction. The operation of safety trip bar/wire shall override the normal lowering control; or

ii. Flashing or rotating warning light and audible warning alarm shall also be provided on the platform and be activated while the platform is being moved. The sound level of the audible warning alarm shall be sufficient to alert any person from being struck by the moving platform. The flashing or rotating warning light shall be installed at both ends of the platform and at intervals not more than 9m along the platform;

(b) Fences shall be installed or fixed on the building structure. They shall comply with Sections F1.1.8(a) and (b). Toeboards of at least 200mm high shall be provided.

(c) Warning notices in Chinese and English with letters and characters as shown below shall be displayed conspicuously at areas accessible to the platform from the building side to warn any person working on the building floor adjacent to the liftway of the danger of being struck by the moving platform on each floor. The size of Chinese letters and characters shall be not less than 50mm in height and that for English letters and characters shall be not less than 30mm in height.

PLATFORM IN MOTION
DO NOT REACH OUT THE BUILDING FACE
工作平台在移動中
切勿攀越外牆

2 ACCESS ON OTHER LEVEL

If access to a platform is not at the base enclosure, an access provided with access gate at other designated location shall be provided. The horizontal separation between the closed platform gate and the closed access gate shall not be greater than 100mm.

3 ACCESS GATE

3.1 The access gate shall be rigid and shall not open towards the liftway.

3.2 Horizontally sliding gates shall be guided at both top and bottom. Vertically sliding gates shall be guided at both sides.

3.3 Vertically sliding gate panels shall be supported by at least two independent wire ropes. Wire ropes may only be stressed up to 1/8 of their breaking strength and means shall be provided for retaining them in their pulleys.

3.4 Pulleys used in connection with vertical sliding gate shall have a diameter of at least 15 times the wire rope diameter. The ends of wire ropes shall be cast, spliced, swaged or fitted with wedge grips. U-bolt wire rope grip is not permissible.

3.5 The access gate shall not be opened or closed by a device which is mechanically operated by the movement of the platform.

3.6 The access gate shall be securely fixed.

3.7 The clear height of the access gate opening shall be not less than 2.0m. The width shall not be less than 650mm.

3.8 The access gate shall have the following mechanical strength:

(a) The panel of the access gate shall be designed without permanent deformation when a thrust of 300N applied normally by rigid square or round flat face of 500mm^2 at any position and also it shall not sustain an elastic deflection more than 30mm.

(b) The access gate shall possess structural strength such that when a force of 1,000N is vertically applied at any point along the top member of the access gate, the gate shall sustain without permanent deformation.

3.9 The access gate shall be provided with a key operated lock. It shall require a key to open the gate from the building side and it shall be capable of being opened from the platform side without a key. A spare key shall be readily available at site for emergent use.

3.10 The access gate shall have a mechanical lock in accordance with Section F4. The

gate shall be electrically interlocked so that the control circuit will be interrupted and the platform will not operate when the access gate is not properly closed and locked.

4 MECHANICAL LOCK

4.1 The mechanical lock specified in Section F3.10 shall be securely fixed by means of fastenings. The fastenings shall not become loosened in the course of operation.

4.2 The locking component shall engage fully by not less than 10mm at right angles to the direction of movement of the part to be locked. For flap type locks, the flap shall engage with the gate leaves over the entire width by an amount sufficient to prevent the gate from opening. It shall not be possible for the locking flap to engage with leaf or leaves while the gate leaf or leaves are in any position other than the closed position.

4.3 The operation of the electrical safety device to ensure locking of gate before platform operation shall be by means of positive separation of the contacts and this shall be independent of gravity. The electrical contacts of this device shall be actuated by the movement of the lock.

4.4 The mechanical lock together with any associated actuating mechanism and electrical contacts shall be so situated or protected to prevent inadvertent operation.

4.5 The mechanical lock shall be capable of resisting a force of 1kN at the level of the lock in the opening direction of the gate.

4.6 The mechanical lock and the electrical safety device shall be designed to allow for servicing. Electro-mechanical locks and electrical parts sensitive to water, deleterious dust and other contaminants shall be enclosed within sealed housings with a minimum protection of IP54 of BS EN 60529.

4.7 The locking components shall be retained in the locked position by springs or weights. Where springs are used, they shall be of compression type and the failure of a spring shall not lead to unsafe operation.

4.8 The electrical contacts of the electrical safety device shall be safety contacts.

4.9 The removal of any detachable cover of the mechanical lock and electrical safety device shall not disturb any of the lock mechanism or the wiring. All detachable covers shall be retained by captive fastenings.

4.10 It shall not be able to keep the platform in motion unless all locking elements are engaged by not less than 7 mm.

SECTION G : DRIVING MACHINE FOR RAISING/LOWERING OF PLATFORM

1 BASIC REQUIREMENTS

1.1 A tower working platform equipped with a safety gear attached to its platform frame shall have at least one driving machine of its own for each mast. In the case of tower working platforms not equipped with safety gears, there shall be at least two independent and identical driving machines for each mast.

1.2 Each driving motor shall be fitted with a driving machine brake which operates immediately to arrest the platform when the operating circuit or safety circuit of the tower working platform is interrupted.

1.3 The output shaft of the driving machine shall be coupled to the drive pinions by a positive means according to Section G1.11 that they cannot be disengaged from each other.

1.4 The platform shall, during normal operation, be power driven upwards and downwards at all times. Lowering under gravitational force by alternatively applying and releasing the driving machine brake or alternatively opening and closing the flow control valve is not allowed during normal operation.

1.5 During normal operation, the upward speed of the empty platform and downward speed of platform with rated load shall not exceed 115% of the rated speed.

1.6 The driving machine and its associated moving parts shall be so positioned or guarded to protect persons from injury and guarded against damage from falling objects. Effective guards shall be provided for gears, chain-wheels, chains, moving shafts, flywheels, guide rollers, couplers and similar revolving components. These moving parts shall be designed to permit easy access for routine inspection and maintenance work. Perforated guards shall have openings conforming to Table 6. The thickness of metal guards shall not be less than 1.2mm. Any machine enclosure door or gate shall be provided with a lock.

Table 6:

Minimum Distance Between Opening and Point of Operation (mm)	Maximum Size of Opening (mm)
40	10
65	12
90	15
140	20

Size of openings means the greatest dimension of the opening. The maximum size of the opening shall not be greater than 20mm.

1.7 Belts or chains shall not be used in the driving machine including the driving machine brake for transmission of power.

1.8 Stress concentration shall be minimised by forming adequate fillets where shafts and axles are shouldered. Pulleys or sprockets and their shafts shall be so supported and retained as to prevent them from becoming displaced.

1.9 Keys shall be effectively secured against movement.

1.10 The driving machine brake, motor, gear case and any bearings shall be mounted and assembled so that proper alignment of these parts is maintained under all conditions.

1.11 Any separate sheave, spur gear, worm wheel or brake drum shall be fixed to its shaft or other drive unit by any one of the following positive means:
- sunk keys;
- splines or serrations;
- secured by means of machined fitting bolts to a flange forming an integral part of the shaft or driving unit.

1.12 Manual drive systems shall not be allowed except during emergency lowering/raising.

1.13 Measures shall be taken to prevent the uppermost guide rollers or shoes from running off the top of the guides during normal operation. Further measures shall be taken to ensure that under no circumstance including erection and dismantling the overspeed safety device pinion could come out of mesh with the rack.

1.14 The maximum rated speed for raising and lowering the platform shall not be greater than 0.2m/s.

1.15 Measures shall be taken to ensure the continued stability of the tower working platform in the case of failure of any guide roller.

1.16 The platform shall be raised and lowered by rack and pinion suspension system.

2 RACK AND PINION SUSPENSION SYSTEM

2.1 General

2.1.1 All rack and pinion shall be manufactured in accordance with the dimensional requirements of BS 436 : Part 2 or other equivalent international standards.

2.1.2 The rack and pinion tooth module shall be not less than -

(a) 4 where the forces between the counter rollers (or other means) and the rack are inter-reacted directly without any other elements of the mast in between.
(b) 6 where the forces between the counter rollers (or other means) and the rack are inter-reacted indirectly via other elements of the mast in between.

2.1.3 When there is more than one drive pinion in mesh with the rack, then either there is a self-adjusting means effectively spread the loading equally to each drive pinion, or the drive system is designed to accommodate all conditions of load distribution between the pinions.

2.1.4 The overspeed governor pinion shall be at a position lower than the drive pinions.

2.1.5 Visual examination of the pinions shall be possible without the removal of the pinions or major disassembly.

2.1.6 Information regarding the wear limits of the drive pinion, safety gear pinion and rack shall be provided by the manufacturer.

2.2 Pinion

2.2.1 Each of the drive pinion, overspeed governor pinion and other pinions engaged with the rack shall be machined from wear resistant material and shall have a safety factor of not less than 4. The safety factor is equal to the ultimate tensile stress of the pinion material divided by the maximum stress exerted on the pinion. The maximum stresses exerted in the pinion teeth shall be the total suspended load which includes the weight of the platform, rated load, weight of the lifting equipment, weight of materials suspended by the lifting equipment and weight of suspended trailing cables.

2.2.2 Undercutting of the teeth shall be avoided.

2.2.3 The pinion shall be affixed to the output shaft by positive means. Methods involving friction and clamping shall not be used.

2.2.4 During erection and dismantling, the drive pinion shall have a safety factor of at least 4 with respect to ultimate tensile stress of the material. This safety factor shall not be lowered under all circumstances, e.g. by taking into account the advantage of a counterweight.

2.2.5 A pinion shall not be used as a guide roller.

2.3 Rack

2.3.1 The rack shall be made of material having properties matching those of the pinions in terms of wear and impact strength and shall possess an equivalent safety factor.

2.3.2 The rack shall be securely attached to the mast particularly at their ends. Joints in the rack shall be accurately aligned to avoid faulty meshing or damage to teeth.

2.3.3 The load imposed upon the rack by the pinion shall not cause permanent deformation of the rack.

2.4 Rack and pinion engagement

2.4.1 Means shall be provided to maintain the rack, all the drive pinions and any safety gear constantly in mesh under all conditions and even in the event of failure of counter rollers or other meshing control feature including platform or local deflection of the mast. Such means shall not rely solely upon the platform guide rollers or shoes. The correct mesh shall be when the pitch circle diameter of the pinion is coincident with, or not more than one-third of the module out beyond the pitch line of the rack. See Figure 4(a).

2.4.2 Further means shall be provided to ensure that in the event of failure of the means provided in Section G2.4.1, the pitch circle diameter of the pinion shall never be more than two-thirds of the module out beyond the pitch line of the rack. See Figure 4(b).

2.4.3 Means shall be provided to restrict the disengagement of the drive pinion from the rack in such a way that at least 90% of the width of a rack tooth is always engaged with the drive pinion in the event of failure of a roller or shoe. The maximum disengagement is shown in Figure 4(c).

2.4.4 The pinion teeth and the rack teeth shall be square to each other in all planes, within a tolerance of ± 0.5°. See Figure 4(d).

2.5 Guarding

Effective guarding shall be provided to prevent the rack or pinion from being damaged by the entry of any material to the teeth.

3 HYDRAULIC SYSTEM FOR DRIVE PINION

When the drive pinion of the platform is driven by hydraulic motor, the hydraulic system shall comply with the following requirements:

3.1 Each hydraulic pump or pump group shall be provided with a pressure relief valve to limit the maximum pressure of the hydraulic system.

3.2 Isolation of the pressure relief valve from the hydraulic system by means of a device shall not be allowed.

3.3 The pressure relief valve shall be set at a pressure not greater than 120% of the maximum operating pressure of the hydraulic system.

3.4 The designed flow rate of the pressure relief valve shall not be less than the maximum flow delivered by the pump without building up excessive pressure in the hydraulic system.

3.5 Pressure relief valves shall have a means to prevent unauthorised adjustment after setting.

3.6 When the speed and direction of rotation of the motor are controlled by the flow rate and flow direction of the variable displacement pump, means shall be provided to stop the pump delivering fluid to the motor when the control is in the neutral or off position.

3.7 An effective means shall be provided to cool the hydraulic fluid.

3.8 Hydraulic valves shall not be used as the only means for stopping and arresting of the platform. An electro-mechanical or hydro-mechanical brake shall always be provided for stopping and arresting the platform.

3.9 Pipes and hoses shall be protected against damage by proper fixing and cover and shall be designed to withstand a pressure equal to 4 times the pressure setting of the pressure relief valve. Flexible hoses shall be protected against damage, in particular of mechanical origin. The installation of hoses shall be such as to avoid the use of sharp bends and chaffing by moving parts of the machine.

3.10 Pressure parts of the hydraulic system which may be subjected to the maximum pressures permitted by the pressure relief valve shall be designed to withstand at least twice the pressure without permanent deformation.

3.11 Piping shall be so supported that undue stresses are eliminated at joints, bends and fittings, and particularly at any section of the system subject to vibration.

3.12 Sufficient pressure gauges and/or gauge connectors shall be provided to allow checking for pressures of all hydraulic circuits.

3.13 The design of the hydraulic system shall enable entrapped air to be vented via vent ports and hydraulic fluid to be drained off via drain ports. A hydraulic tank open to the atmosphere shall be equipped with an air inlet filter. An oil filter shall be provided with the hydraulic fluid tank.

3.14 A temperature sensor shall be provided to measure the temperature of the hydraulic fluid. This sensor shall stop the machine and keep it stopped when the temperature of hydraulic fluid exceeds a pre-set value.

3.15 Each hydraulic tank shall be installed with a level indicator to indicate the fluid level and marked with the maximum and minimum levels. The type of oil used shall be specified by the manufacturer.

3.16 Means shall be provided to prevent the movement of the platform due to the external leakage of the fluid, bursting of flexible hoses or rigid pipe, and internal leakage of hydraulic components or motors.

3.17 The driving machine brake shall remain in the applied position until the normal operating pressure has been reached and the movement of the platform is initiated.

3.18 Pilot operated hydraulic valves shall return to the neutral position in the event of failure of the pilot signal.

3.19 The braking system shall not operate pneumatically.

3.20 Information regarding the minimum volumetric efficiency of the hydraulic pump and the hydraulic motor at maximum working pressure and temperature shall be provided by the manufacturer.

4 WIRE ROPE CONNECTION BETWEEN PLATFORM AND COUNTERWEIGHT

4.1 The wire ropes shall be of steel wire ropes. Wire ropes shall conform to BS 302 or other equivalent international standards.

4.2 Not less than two wire ropes, independent of one another, shall be provided for suspension of counterweight. Means shall be provided to ensure loads are evenly distributed between the wire ropes.

4.3 The nominal diameter of the wire ropes shall not be less than 8mm. The tensile strength of the wires shall be between 1,570N/mm^2 and 1,960N/mm^2. The number of individual wires shall not be less than 144. The other characteristics of the wire rope shall correspond to those specified in BS 302 : Part 4 or other equivalent international standards.

A certificate of the wire rope shall be provided by the manufacturer.

4.4 The factor of safety of suspension wire ropes shall not be less than 6 for the suspension of counterweights, if it is independent of the suspension system of the platform.

The factor of safety is the ratio between the minimum breaking load of the wire rope and the maximum static force imposed on this wire rope.

The minimum breaking load of a wire rope is the product of the cross-sectional area of the wire rope and the tensile strength of the wires and a coefficient appropriate to the type of wire rope construction conforming to a relevant international standard.

4.5 In case of abnormal relative extension, slackening or breakage of any one of the wire ropes, an electric safety device of non-resetting type shall be provided to interrupt the safety circuit and causes the platform to stop.

4.6 Termination of wire rope

4.6.1 The strength of the wire rope termination shall not be less than 80% of the minimum breaking load of that of the wire rope.

4.6.2 Wire ropes shall be terminated by any one of the following methods:

- metal or resin filled sockets
- thimbles with a ferrule secured end terminal
- swaged or pressed terminals with ferrules
- a wedge and socket anchor
- eye splices with thimbles

Hand spliced and U-bolt grip fixing methods shall not be used.

4.6.3 Visual examination of wire rope terminations shall be possible without the removal of wire ropes or major disassembly of the wire systems.

4.7 Wire rope shall be suitably protected by anti-corrosive coating or lubricant to prevent corrosion and wearing. Zinc coated or corrosion resistant wire ropes are recommended for corrosive environment.

4.8 BS 6570 shall provide guidance for examination and discard criteria of wire ropes.

4.9 Pulley

4.9.1 The diameter of the pulleys and sheaves shall not be less than 30d measured at the bottom of the groove where d is the nominal diameter of the rope.

4.9.2 All grooves shall be smoothly finished and their edges rounded. The contour of the grooves shall be circular over an arc of not less than 120° and have a radius of not more than 7.5% nor less than 5% in excess of the nominal radius of the wire rope.

4.9.3 The groove depth shall be not less than 1.5 times the nominal diameter of the wire rope. The angle of flare on the side of the groove shall be 52°.

4.9.4 Pulleys having wire ropes leading upwards shall be protected against the ingress of foreign objects. Effective precautions shall be taken to avoid wire ropes coming off their grooves.

4.9.5 The fleet angle between the wire rope and a plane normal to the axis of a pulley shall not exceed 2.5°.

5 ROPE SUSPENSION SYSTEM

The raising and lowering of the platform of a tower working platform by means of a rope suspension system including traction drive and drum drive is not allowed. The provision of counterweight, together with a driving system other than rope suspension system, does not fall into this category.

SECTION H : DRIVING MACHINE BRAKE FOR PLATFORM

1 The platform shall be provided with driving machine brake. The driving machine brake shall operate to stop and arrest the platform automatically:

- in case of loss of power supply,
- in the event of the loss of supply to the control circuit.

If two or more masts are used to support the platform, there shall be a driving machine brake for each mast.

2 The driving machine brake system shall have at least one electro-mechanical brake or hydro-mechanical brake, but may have additional means of braking or stopping the machine. The driving machine brake shall be of friction type.

3 Band brakes shall not be used.

4 The driving machine brake(s) of a tower working platform shall be capable of bringing the platform to rest under 125% of rated load and at its rated speed in the downward direction and maintaining the platform stationary. Under all conditions, the retardation of the platform shall be between 0.2g and 1g. In addition, the driving machine brakes on their own shall be capable of bringing the platform to rest under rated load and at the tripping speed of the overspeed governor.

5 No toggle or positive locking devices shall be used to hold off the driving machine brake.

6 In case of only one driving machine brake, at least two brake shoes, pads or callipers on the brake drum or disc shall be provided. All mechanical parts of the driving machine brake shall be so designed that if any one of them fails, the platform with rated load would still be arrested.

7 The driving machine brake shall not be released in normal operation unless a continuous electric/hydraulic power is applied to the driving motor.

In the case of an electrically/hydraulically operated brake, the electric/hydraulic supply shall be interrupted by at least two independent electrical devices/hydraulic valves, whether or not integral with those that cause the interruption of the electric/hydraulic supply feeding the motors and the driving machine brakes.

8 If when the platform is stationary, one of the devices (i.e. electrical devices or hydraulic valves) has not interrupted the supply to the driving machine brake, further movement shall be prevented at the latest at the next change in direction of movement.

9 In the case of an electrically/hydraulically operated brake, when the motor may function as a generator/pump, it shall not be possible for the electric/hydraulic device which operates the driving machine brake to be fed by the motor.

10 Compression springs shall be used to apply the driving machine brake. These shall be adequately supported and shall not be stressed in excess of 80% of torsional elastic limit of the material. Fatigue life calculation shall be considered when there is an adverse effect resulting from failure of compression spring.

11 Brake linings shall be asbestos free and of incombustible material and shall be so secured that normal wear does not weaken their fixings. The wearing surface of brake drums or discs shall be machined and shall be smooth and free from defects.

12 Braking shall become immediately effective after the power supply to the driving machine brake is cut off (the use of diode or capacitor connected directly to the terminals of the driving machine brake coil is not considered as a means of delay).

13 No earth fault, circuit malfunction or residual magnetism shall prevent the driving machine brake from being applied when the supply to the motor is interrupted.

14 The components of the driving machine on which the driving machine brake operates shall be positively coupled to the sprocket or drive pinion. Belts, chains or friction clutches for coupling the motors to the components on which the driving machine brake operates are not permitted.

15 Driving machine brakes shall be provided with means of adjustment to cater for the wear of the friction surfaces. The driving machine brake shall be self-compensating whenever practicable.

16 Every driving machine brake shall be capable of being released manually and shall require a constant force to maintain the driving machine brake open. The driving machine brake shall reapply as soon as the force is released.

17 The driving machine brake shall have a degree of protection not less than IP23 of BS EN 60529 and be designed to prevent the ingress of lubricants, water, deleterious dust or other contaminants by means of cover or enclosed housing.

SECTION I : DEVICE OR MEANS TO PREVENT PLATFORM FROM FALLING

1 GENERAL

All tower working platforms shall be provided with a device, or means attached to the platform frame which prevents the platform from falling in the event of any failure (other than a structural failure of the mast or platform) and which operates before a speed of 0.5m/s is exceeded. This device or means shall automatically arrest and sustain the platform with 110% of rated load.
This shall be achieved by either:

(a) a safety gear activated by an overspeed governor or
(b) two or more independent and identical driving machines, each of which shall have its own driving machine brake, fitted for each mast.

These devices or means shall, when tripped, cause a deceleration between 0.005g and 1.0g where g is the gravitational acceleration.
Adjustable components which have a safety related function shall either require tools for their adjustment or be capable of being sealed against unauthorised adjustment.

2 SAFETY GEAR

2.1 The safety gear shall be tested and issued with a certificate and shall have a permanent label marked with the following data:

- maker's name and address;
- model;
- serial number;
- tripping speed;
- permitted load;
- stopping distance;
- year of construction.

Note : The stopping distance is the distance which the platform with rated load will fall measured from the point of release of the stationary platform to the point of arrest.

2.2 During erection or dismantling, when workmen carry out lift work on the platform, the safety gear shall be operational at all times unless the platform is supported by a means, such as a prop, with a factor of safety of not less than 4.

2.3 Any movement of platform by means of normal control shall automatically be prevented by a non-resetting type electric safety device as soon as the safety gear is applied. The motor control and driving machine brake control circuits shall be opened automatically.

2.4 When the safety gear has tripped, it shall not be possible to release or reset the safety gear by raising the platform by means of normal control. After the tripping of the safety gear, it shall require a competent worker to reset the safety gear and return the platform to normal operation. Clear and concise instructions for the release of the safety gear shall be provided at the point of release.

2.5 Testing the function of safety gear shall only be possible at a distance from the platform using a remote control. No person is allowed on or under the platform during the testing of safety gear.

2.6 Pulleys used to carry overspeed governor wire ropes shall be mounted independently of any shaft that carries the suspension wire rope pulleys.

2.7 Where there is relative movement between the gripping surface and the braking surface, the surfaces shall be held clear of each other during normal operation of the platform.

2.8 A safety gear designed to grip more than one guide shall operate on all guides simultaneously.

2.9 Suitable provision and protection shall be made to prevent the safety gear from becoming inoperative due to the accumulation of extraneous materials or due to atmospheric conditions.

2.10 Where safety gear of the gripping type is fitted on the platform or the counterweight, no component of the safety gear shall be used for both guiding or braking.

2.11 Jaws, blocks or pinions of the safety gear shall not be used for guiding the platform under normal operating conditions.

2.12 In safety gear where braking action is achieved by means of coil springs, the springs shall be in the form of compression spring which shall be guided and in the non-loaded condition having a coil pitch of less than twice the nominal wire rope diameter.

2.13 When the safety gear operates, the load (if any) being uniformly distributed, the floor of the platform shall not incline more than 5% with respect to its normal position and shall recover without deformation after such test.

2.14 If a platform has more than one overspeed governor, then they shall be of the same design and shall apply simultaneously.

2.15 The device that sets the tripping speed of the overspeed governor shall be located, as far as possible, to prevent unauthorised alteration and shall be properly sealed.

2.16 If wire ropes are used to actuate the safety gear, the wire ropes, wire rope attachment etc. shall be of dimensions and design as laid down in Section G4. The nominal diameter of the wire rope shall not be less than 8 mm. The bending diameter of the wire rope shall be at least 30 times of the nominal diameter of the wire rope for pulleys idling in normal service. Pulleys and drums that rotate only when the safety gear operates shall have a diameter of at least 20 times the nominal diameter of the wire rope.

During the assembly of the tower working platform, a wire rope to an overspeed governor shall be supported directly by the mast.

The tensile force in the overspeed governor wire rope produced by the overspeed governor when triggered shall not be less than 300N or twice that necessary to engage the safety gear whichever is the greatest.

2.17 For overspeed governors driven by a wire rope, the direction of rotation, corresponding to the operation of the safety gear, shall be marked on the overspeed governor.

2.18 The tripping of the overspeed governor shall be activated by a mechanical device.

2.19 When there is an access underneath the counterweight, the counterweight shall be provided with a safety gear which shall operate in the downward direction upon overspeeding of the counterweight.

2.20 A safety factor of at least 2.5 shall be used for the design of the safety gear based on the ultimate strength of the material and the highest force which can occur in the device at rated load and maximum possible speed.

2.21 The platform shall be provided with safety gear attached to the platform frame and triggered by overspeed governor.

2.22 The ratio between the minimum breaking load of the wire rope and the highest line pull occurring in the wire rope shall not be less than 8.

2.23 The safety gear shall be independent of the driving machine other than the rack.

2.24 In the case of a platform suspended on more than one mast, the suspension system of the platform at each mast shall be provided with a safety gear to arrest on each mast or its guides.

2.25 Adjustable components which have a safety related function shall either require a tool for their adjustment or be capable of being sealed against unauthorised adjustment.

3 SYSTEM INVOLVING TWO OR MORE DRIVING MACHINES FITTED FOR EACH MAST

If safety gear is not provided, two or more independent and identical driving machines fitted to the platform for each mast shall be used to prevent falling of the platform in the event of failure of any one of the driving machines.

3.1 Each driving machine shall have a driving machine brake and each driving machine brake shall be completely independent of each other and shall be connected positively but separately to the rack and pinion suspension system.

3.2 Each driving machine brake on its own shall be capable of stopping and sustaining the platform with 110% rated load at the maximum possible speed, even under conditions of emergency lowering/raising. Each driving machine brake shall also be capable of stopping and sustaining the platform with 125% rated load at rated speed.

3.3 The driving machine brake shall be operational during normal use, erection, maintenance and dismantling.

3.4 The driving machine and the driving machine brake shall be accessible for inspection, maintenance and testing without major dismantling. Each driving machine brake shall be tested individually by a registered examiner.

3.5 This driving machine shall have the driving machine brake and the means of suspension positively connected.

3.6 This system shall fulfil the requirements of electrical circuits as in Section K, where appropriate, if it is dependent on energising or maintaining of an electrical circuit.

3.7 Each driving machine shall have a safety factor of at least 2.5 calculated by comparing the highest force which can occur in the driving machine with rated load and maximum possible speed and the ultimate strength of the material.

3.8 There shall be means to detect any influence or malfunction in each driving machine which endangers proper functioning. The detection device shall provide an audible and visual alarm when anyone of the following influences or malfunctions is detected:

- failure of one phase,
- a loss of mechanical integrity which results in a differential in the current demand between each driving machine, exceeding 25% of the full load current or
- a loss of braking capacity which exceeds 25% of the manufacturers intended value.

SECTION J : OVERLOAD AND OVERMOMENT SENSING DEVICE

Every tower working platform shall be installed with an overload and overmoment sensing device to give clear visual and audible signals on the platform in case of overload/overmoment. The overload and overmoment sensing device shall measure all loads including the passengers, tools, equipment and materials on the platform (primary and auxiliary if provided) and loads suspended with the lifting equipment integrated with the platform. It shall also detect those moments due to these loads that are likely to lead to overturning or failure of the tower working platform. The device shall at least detect:

- bending and torque moments on cantilevered primary platforms
- bending and torque moments on the central part of simply supported primary platforms
- bending moment on the mast(s)

1 Overload and overmoment alarm system

An overload and overmoment alarm system shall be provided for every tower working platform complying with the following requirements:

(a) The setting of the overload and overmoment alarm system shall be greater than the rated load/moment and less than 110% of the rated load/moment of the tower working platform.

(b) When the load/moment reaches or exceeds the overload and overmoment setting, the alarm system shall give a continuous audible and visual (in red light) alarm. Simultaneously, the platform and the lifting equipment, if installed, shall be prevented from movement by interrupting the control circuit. When the load/moment is reduced to below the overload and overmoment setting, the alarms shall be interrupted.

(c) An additional pre-warning alarm initiated at a setting below the overload and overmoment setting is allowed provided that the pre-warning alarm is distinguishable from the audible alarm at the overload and overmoment setting. However, the pre-warning alarms shall not be activated at a setting below 90% of the rated load/moment of the tower working platform and any pre-warning audible alarm shall be activated for not more than 5 seconds.

2 The audible alarm shall be clearly distinguishable from other sounds emitted from pagers, wireless telephones, audible emergency alarm and bells for calling of lift service. The visual warning shall be clearly distinguishable under all conditions. Visual warning shall be positioned to allow persons on the platform to see it with a full view.

3 All visual alarms, information displays, switches and controls shall have clear markings on or adjacent to them, with symbols or words in both Chinese and English to indicate their function and mode of operation.

4 Any faults or abnormalities of the overload and overmoment sensing device shall interrupt the movement of the platform and the lifting equipment and activate the overload and overmoment alarm system.

5 The overload and overmoment sensing device shall be designed to operate in ambient temperatures between -4°C and +40°C. The design should be taken into account that under the circumstances described a temperature higher than +40°C can be reached inside the housing.

6 The overload and overmoment sensing device shall be protected against rain, water spray, frost, snow, dirt, dust, condensation or other adverse conditions. The degree of protection shall be at least IP55 of BS EN 60529.

7 The overload and overmoment sensing device shall not be liable to electromagnetic interference giving false alarm signals.

8 An overmoment sensing detection may not be required if the moment exerted by the load is covered by stability and stress calculations together with the overload sensing device.

9 The design and construction of the overload and overmoment sensing device shall take into consideration the inaccuracy and variation of characteristics and parameters of the components used. Having taken into account of the asymmetric load distribution and inaccuracy of the components used, the overload and overmoment alarms shall still be activated when the load-moment is between 95% and 110% of the rated load/moment.

10 The overload and overmoment sensing device shall be able to detect the load during loading/unloading of the platform and lifting/lowering/suspension of any load with the lifting equipment. The overload and overmoment sensing device shall be consistent with the loads and their distribution as specified in the load chart specified by the manufacturer.

11 The overload and overmoment sensing device shall function:

(a) automatically for different possible platform configurations or

(b) by selecting the platform configuration with a selector which has a clear sign of the respective platform configuration or a code for identifying the respective platform configuration. This shall be carried out by a competent worker only.

Adjustment of the overload and overmoment sensing device by unauthorised persons including the competent operators shall be prevented.
The number of possible selections permitting use of the platform shall not exceed the number of configurations for the platform. The selector shall be so situated or protected so as to be inaccessible to unauthorised persons.

12 If power supply is interrupted, the data, information, selected rated load/moment and calibration of the overload and overmoment sensing devices shall not be changed.

13 No provision shall be made for unauthorised persons to cancel the overload and overmoment alarms when the load/moment has exceeded the overload and overmoment setting.

14 The design and construction of the overload and overmoment sensing device shall take into account the need to test the system without substantial disassembly. The performance of the overload and overmoment system device shall not be affected after such test. The overload and overmoment sensing device shall be capable of sustaining a load on the platform not exceeding 125% of the rated load/moment.

15 The overload and overmoment devices shall be capable of sustaining loading from shock and vibration, loading encountered during transportation, erection, operation, dismantling and maintenance as well as influences from environment such as rain and wind.

16 The overload and overmoment sensing device shall be arranged so that their operation (not necessarily their accuracy) can be checked without applying loads to the platform.

17 Assurance of system safety integrity of the overload and overmoment sensing device shall be achieved by:

(a) causing the overload and overmoment sensing device to fail to a safe condition in the event of an open circuit, short circuit or earth fault on all external wiring and devices;

(b) carrying out periodic functional checks to verify that warnings and displays are operating correctly.

Note : Manufacturers should use components which comply with BS 9000 or other equivalent international standards that provide an equivalent integrity. Components should be conservatively rated to achieve a high mean time between failures.

18 The power supply for an overload and overmoment sensing device shall have a nominal voltage not exceeding 50V A.C. or 120V D.C. The recommended power supply voltage should be as low as reasonably practicable.

19 The overload and overmoment sensing device shall be designed to operate correctly for supply voltages in the range +20% to -15% of the nominal voltage. The overload and overmoment sensing device shall continue to function correctly or fail to a safe condition if the supply voltage is outside this range. It shall operate correctly in the event of voltage recovery from the minimum value. Protection against voltage variations, surges and supply voltage reversal (in the case of D.C.) shall be provided.

20 The overload and overmoment sensing device shall be designed to operate correctly for supply frequency variations (in the case of A.C.) as follows:
- ±2% for power supplies derived from the mains;
- ±5% for power supplies derived from engine driven generators.

It is important that the power supply to the system to be so arranged that the overload-moment sensing device is energised before movement of the platform could be initiated.

21 All signals and power supplies transmitted between units of the overload and overmoment sensing shall be by means of discrete insulated conductors. The structure of the platform shall not be used to transmit power, signals or the functional signal return.

22 Electrical signals which initiate continuous audible and visual alarms shall be separated from those used to drive visual displays if provided and other circuits to minimise common cause failures.

23 The operation of transducers, associated conductors and connections shall be monitored for out of range condition due to temperature or humidity variation. Should a fault occurs, the overload and overmoment sensing device shall fail to a safe condition.

24 An instruction manual written clearly and precisely in English or Chinese shall be provided with every overload and overmoment sensing device.
The instruction manual shall contain all the information to permit the correct installation, calibration, testing, inspection, maintenance and use of the overload and overmoment sensing device. It shall also contain any information about special procedures to be followed during erection, dismantling, maintenance, cleaning, repair and overload testing of the tower working platform.

SECTION K : ELECTRICAL INSTALLATIONS AND APPLIANCES

1 ELECTRICAL DESIGN AND CONSTRUCTION

1.1 General provisions

Electrical installations and appliances shall be in compliance with the Code of Practice for the Electricity (Wiring) Regulations issued by the Electrical and Mechanical Services Department. For electronic components, the related field and possible temperature in use shall be considered.

1.2 Protection against electric faults

1.2.1 General provisions

Any one of the faults, envisaged in Section K1.2.2(a) in the electric equipment of the tower working platform shall not cause a dangerous malfunction of the tower working platform.

1.2.2 Electrical faults

(a) The following faults may be envisaged in the electrical equipment of a tower working platform:
   i. absence of voltage;
   ii. voltage drop;
   iii. insulation fault in relation to the metalwork or the earth;
   iv. short circuit or open circuit, changing in parameters of an electrical component such as resistor, capacitor, transistor, lamp;
   v. non-attraction or incomplete attraction of the moving armature of a contactor or relay;
   vi. non-separation of the moving armature of a contactor or relay;
   vii. non-opening of a contact;
   viii. non-closing of a contact

(b) The non-opening of a contact in Section K1.2.2(a)vii need not be considered in the case of safety contacts conforming to Section K1.2.6.

1.2.3 Phase reversal and failure

(a) Tower working platforms connected to polyphase A.C. power supplies shall incorporate means to prevent the motor being energised in the event of a phase reversal.

(b) In the event of a phase failure the machine shall not start, and may stop immediately if the platform is moving. In the case of one of the phases of the supply to the directional control device failing, the machine shall stop.
If any failure of one phase occurs, it is allowable that the platform continues to run at the most to the next restart provided that the driving machine(s) has sufficient driving capacity to drive the platform with rated load and also sufficient braking capacity to arrest the platform as specified in Section H4. The effect of excessive overheating of the driving motor(s)

shall be considered and prevented by means of thermal protective devices in the motor windings.

1.2.4 Earthing protection

When a circuit with an electric safety device in conformity with Section K1.2.5 is short-circuited to earth, it shall:

(a) either cause the immediate stopping of the machine, or

(b) prevent restarting of the machine after the first normal stop.

The return to service shall not be possible except by a competent worker.

1.2.5 Electric safety devices

During operation of one of the electric safety devices listed in Table 7, movement of the machine shall be prevented or it shall be caused to stop immediately as indicated in Section K1.2.8. The electric safety devices shall consist either:

(a) one or more safety contacts (satisfying Section K1.2.6) directly cutting the supply to the contactors, their relay contactors, or the electrical devices (referring to in Section K3) or

(b) be a safety circuit (satisfying Section K1.2.7) consisting of either:

i. One or more safety contacts (satisfying Section K1.2.6) not directly cutting the supply to the contactors (referring to Section K3) or their relay contactors, or

ii. Contacts not satisfying the requirements of Section K1.2.6.

Table 7: Conditions for use of electric safety devices

closed position of access gates	safety switch, self resetting
closed position of access gate locking device	safety switch, self resetting
closed position of platform gate	safety switch, self resetting
closed position of trapdoor	safety switch in a safety circuit
operation of safety gear	safety switch in a safety circuit
terminal limit switch	without any conditions
buffer switch	safety switch in a safety circuit
final limit switch	safety switch in a safety circuit
slack rope switch in suspension of counterweight	safety switch in a safety circuit
tripping bar/wire	safety switch, self resetting
emergency stopping device	safety switch, not self resetting

Apart from the exceptions permitted in this Code, no electric equipment shall be connected in parallel with an electric safety device.

1.2.6 Safety contacts

(a) Positive separation of contacts

The operation of a safety contact shall be by positive separation of the circuit breaking devices. This separation shall occur even if the contacts have welded together.

Positive opening is achieved when all the contact-breaking elements are brought to their open position and when for a significant part of the travel there are no resilient members (e.g. springs) between the moving contacts and the part of the actuation to which the actuating force is applied.

The design shall be such as to minimise the risk of a short-circuit resulting from component failure.

(b) Types of safety contacts

The safety contacts shall fulfil Section K1.2.2(b) and shall be provided for a rated insulation voltage of 250V minimum.

The safety contacts shall belong to the categories as defined in BS EN 60947-5-1 or other relevant international standards:

i. AC-15 for safety contacts in A.C. circuits

ii DC-13 for safety contacts in D.C. circuits

The clearances shall be at least 3mm, the creeping distances at 4mm and the distances for the breaking contacts at least 4mm after separation.

In case of multiple breaks, the distance after separation between the contacts shall be at least 2mm.

Abrasion of conductive material shall not lead to short circuiting of contacts.

1.2.7 Safety circuits

Safety circuits shall comply with the requirements of Section K1.2.1 relating to the appearance of a fault. In addition, they shall be designed such that:

(a) If one fault combined with a second fault can lead to a dangerous situation, the tower working platform shall be stopped at the latest at the next operating sequence. All further operation of the tower working platform shall be impossible as long as this fault persists.

(b) If a dangerous situation can only occur through the combination of several faults, the stopping and maintaining in a stopped position of the tower working platform shall be brought about at the latest before the possible appearance of the fault, would lead to the dangerous situation.

(c) On restoration of the power supply after it has been disconnected, maintenance of the tower working platform in the stopped position is necessary.

(d) In redundancy-type circuits, measures shall be taken to limit the risk of defects occurring simultaneously in more than one circuit arising from a single cause.

1.2.8 Operation of electric safety devices

To ensure safe operation, an electric safety contact shall be provided to prevent the motion of the machine or initiate immediately its stopping. The electric supply to

the driving machine brake shall likewise be broken.
The electric safety contacts shall act directly on the equipment which controlling the supply to the machine in accordance with the requirements of Section K3.
If because of the power to be transmitted, relay contractors are used to control the machine, these shall be considered as equipment directly controlling the supply to the machine for starting and stopping.

1.2.9 Control of electric safety devices
The components controlling the electric safety switches shall be built so that they are able to function properly under the mechanical stresses resulting from continuous normal operation. If the devices for controlling electrical safety devices are through the nature of their installation accessible to persons, these electrical safety devices cannot be rendered inoperative by simple means. A magnet or a properly designed bridge piece is not considered a simple means.

1.2.10 Safety switches
All gate switches, stopping switches, final limit switches, slack rope switches, overspeed safety device switches etc., shall be safety switches. They shall contain safety contacts which comply with Section K1.2.6. During operation of one of the electric safety switches listed in Table 7, movement of the platform shall be prevented or it shall cause to stop immediately.

1.3 Main isolating switch

1.3.1 For each tower working platform there shall be a manually operated main isolating switch or circuit breaker capable of isolating every pole of the supply network. The switch or breaker shall be capable of disconnecting the drive motor starting current. It shall have stable open and close positions.

1.3.2 The main isolating switch shall be positioned at the chassis for tower working platforms of mobile type or outside the base enclosure for tower working platforms of fixed type in an easily accessible position. Where this switch is housed in a cabinet, the operating handle shall be accessible outside the cabinet.
The handle shall open the contacts positively and the handle shall be capable being locked in the off position. The “ON” and “OFF” positions of the switch shall be clearly marked in both Chinese and English.

1.3.3 The main isolating switch shall cut off all electric power to the tower working platform including the safety switch at the access gate of the base enclosure.

1.4 Cables and wiring

1.4.1 The size of all cables supplied with the tower working platform shall be such that the rating is adequate for the maximum current under all conditions of operation in service, including starting.

1.4.2 The mains cable for connecting the tower working platform to the supply network shall be such that the rating and size comply with Section K1.4.1.

1.4.3 All cables and wiring for the tower working platforms shall be located and installed to provide protection from mechanical damage that may be caused during the use of the tower working platform.

1.4.4 Terminals shall be adequately shrouded and incoming power terminals shall be covered and marked "LIVE TERMINAL" in both Chinese and English.
Power and control circuits shall be grouped and, where necessary, separated by insulating barriers; they shall also be marked according to the designation of the circuits.

1.4.5 When positioning a cable, allowance shall be made for the stresses to which the cable can be subjected as a consequence of mechanical action. When the cable is led in to motors, apparatus, connection boxes, etc., this shall be done in an appropriate manner for each type of cable and in such a way that the cable is protected against the stresses occurring.

1.4.6 Trailing cables and flexible cables shall be protected against wear, breakage or tearing. The outer sheath of the cable shall be led in and securely fixed at the lead-in point so that the cores are not subjected to harmful tension or twisting in the connection space. Normal sealing glands with packing are not regarded as meeting the requirement for relief from pulling and twisting.

1.4.7 Cables shall be connected and branched in permanently mounted enclosed terminal blocks or by means of strong connectors intended for the purpose. Loose clamps or jointing of cables, e.g. flexible cables, shall not be used.

1.4.8 Special attention shall be paid to electric cables which hang from the platform with regard to cable strength and the effects of climates. Precautions shall be taken to ensure the free and safe movement of the trailing cable throughout the full range of travel of the platform.

1.4.9 The control gear cabinet shall contain such drawings or documentation as are necessary to aid maintenance and fault finding, e.g. a circuit diagram and a wiring diagram.

1.5 Contactors and relay-contactors, components of safety circuits

1.5.1 The main contactors (i.e. those necessary to stop the machine according to Section K3) shall belong to the following categories defined in BS EN 60947-4-1 or other relevant international standards:

(a) AC-3 for contactor for A.C. motor

(b) DC-3 for contactor for D.C. motor
These contactors shall in addition allow 10% of starting operations to be made as inching.

1.5.2 If, because of the power they carry, relay contactors must be used to operate the main contactors, those relay contactors shall belong to the following categories as defined in BS EN 60947-5-1 or other relevant international standards:

(a) AC-15 for controlling A.C. electromagnets

(b) DC-13 for controlling D.C. electromagnets

1.5.3 Both for the main contactors referred to in Section K1.5.1 and for the relay contactors referred to in Section K1.5.2, it may be assumed in the measures taken to comply with Section K1.2.2, that

(a) if one of the break contacts (normally closed) is closed, all the make contacts are open;

(b) if one of the make contacts (normally open) is closed, all the break contacts are open.

1.5.4 Components of safety circuits

(a) When devices as per Section K1.5.2 are used as relay in a safety circuit, the assumption of Section K1.5.3 shall also apply.

(b) If relays are used which are such that the break and make contacts are never closed simultaneously for any position of the armature, the possibility of partial attraction of the armature (see Section K1.2.2(a)v) can be disregarded.

(c) Devices (if any) connected after electric safety devices shall meet the requirements of Section K1.2.6(b) as regards the creep distances and the air gaps (not the separation distances).
The requirement does not apply to the devices mentioned in Section K1.5.1, K1.5.2 and K1.5.4(a) and which themselves fulfil the requirements of BS EN 60947-5-1, BS EN 60947-4-1, or other relevant international standards.

1.6 Control circuit

Guidance on the design of control circuit is given in BS 5304 or other equivalent international standards.

1.6.1 The voltage of the tower working platform control and operating circuits shall be not exceeded 130V with respect to earth. It shall be connected to an alternating current network via an isolating transformer with separate primary and secondary windings, and also with the primary windings earth screened.
One pole of the secondary winding, or if a rectifier is connected to it one D.C. pole, shall be directly connected to earth.

1.6.2 Control circuits shall be so arranged that any faults, except open circuit faults, will be faults to earth. Any faults, or the discharge or failure of any circuit component, shall not set up an unsafe condition, e.g. starting or continuing platform motion when any safety contact has opened or is opening.

1.6.3 All safety circuits shall be designed to prevent an inter-circuit fault.

1.6.4 Control circuits shall be protected by fuses or equivalent devices, independently of the protection provided for the main circuits. In the event of an earth fault in control circuit of the tower working platform, the circuit shall be disconnected as a result of rupturing a fuse or similar protective device.

1.6.5 Switches shall not be connected between the earth and the control circuit operating coils.

1.7 Electrical control panels and cabinets

1.7.1 The control panels for the electrical equipment shall be arranged outside the danger area of moving parts.

1.7.2 To prevent unauthorised access during normal use of the platform, doors or covers that are provided for maintenance and inspection shall be secured by devices that required a spanner, key or special tool to remove or loosen them. Should threaded fasteners be used, they shall be of the captive type.

1.8 Control equipment, relays and contacts

1.8.1 The control panel or their supporting frames shall be constructed of materials that do not support combustion.

1.8.2 The main and auxiliary resistors shall be adequately supported and ventilated.

1.8.3 Interlocking shall be provided, where necessary to ensure that the relays and contactors operate in proper sequence.

1.8.4 Contactors for reversing direction of travel shall be mechanically and electrically interlocked.

1.8.5 Every electric motor shall be protected from overcurrent.

1.9 Protection against the effects of external influences

All electrical apparatus excluding that installed in control gear cabinets shall be protected from the harmful or hazardous effect of external influences. Where appropriate to the design, it shall be positioned to provide protection against rain, mortar, concrete, dust and other dirt i.e. have a degree of protection at least equal to that which corresponds to IP54 of BS EN 60529.

1.10 Earthing

The mast structures, machine frames, chassis, controller frames, governor frames, casing of electric safety devices, and other similar exposed metallic parts, including guide rails, of the tower working platform which carry electrical equipment, shall be bonded to the main earthing terminal of the main isolating switches by supplementary bonding through protective conductors. Due to the tendency for

tower working platform to operate in exposed positions, consideration shall be given to a possible need for the provision of protection against lightning.

2 CONTROL DEVICES

2.1 Travel limit switches

The permitted combinations of travel limit switches shall comply with Table 8 below:

Table 8:

terminal limit switch	top	yes
	bottom	yes
final limit switch	top	yes
	bottom	yes

2.1.1 Terminal limit switches

Terminal limit switches shall be provided to each liftway or platform and shall be positively operated and of self-resetting type. The switches shall be so arranged that their operation will result in the platform being automatically stopped from rated speed at the highest and lowest levels before contacting the final limit switch.

2.1.2 Final limit switches

(a) Top final limit switches

A top final limit switch of positively operated and non-resetting type shall be provided to interrupt the power supply to the motor and the driving machine brake on all phases before contact is made with any mechanical stop, e.g. a buffer. If there are no buffers the top final limit switch shall be positioned such that the platform will come to a stop before reaching the end of the liftway. After triggering the top final limit switch, all movements of the tower working platform shall be prevented and it shall be reset by a competent worker.

(b) Bottom final limit switches

A bottom final limit switch of positively operated and non-resetting type shall be provided to interrupt the power supply to the motor and the driving machine brake on all phases such that the platform is not driven against the buffers. After triggering the bottom final limit switch, all movements of the tower working platform shall be prevented and it shall be reset by a competent worker.

The top and bottom final limit switches must not be actuated by same operating elements as the terminal limit switches. The switches shall be directly operated by the movement of the platform or its related parts.

2.2 Electrically operated locking device

When a safety switch forms part of the electrical interlocking of the access gate of liftway and the platform gates, the safety switch shall be electrically coupled so that it cannot close the circuit while the gate is open.

2.3 Trapdoor safety switch

The switch shall be so positioned that any movement to open the trapdoor during normal operation of the tower working platform would result in the control circuit of the platform being interrupted.

2.4 Slack rope device

Tower working platforms with counterweight connected with wire rope shall be incorporated with a slack rope device of non-resetting type. The switch shall be so arranged to interrupt the control circuit of the control equipment in the event of any wire rope breakage or becoming slack. After triggering the slack rope switch all movements of the platform shall be prevented until the device is reset by a competent worker.

2.5 Stopping devices

The stopping devices shall consist of electric safety devices in conformity with Section K1.2.5. They shall be bi-stable such that a return to normal operation cannot be resulted from an involuntary action. They shall stop and maintain the level of the tower working platform when it is out of service. All stopping devices including emergency stopping devices shall be clearly identified.

3 STOPPING THE MACHINE

3.1 The stopping of the machine by means of an electric safety device in conformity with Section K1.2.5 shall be achieved by the interruption of the supply to the motor and driving machine brake, by either:

(a) the safety switch itself or

(b) actuated by two independent contactors, the contacts of which shall be in series in the supply circuit.

Use of devices other than contactors is not covered by this standard. Other devices can be used provided that the same level of safety is ensured.

3.2 If, whilst the platform is stationary, one of the contactors has not opened the main contacts, further movement of the platform shall be prevented at the latest at the next change in the direction of motion.

4 CONTROL MODES

4.1 Normal operation on platform

The raising and lowering of the platform shall be controllable on the platform only.

4.1.1 Every control station on the platform shall be provided with the minimum "Up", "Down", and "Emergency Stop" controls. An indelible inscription indicating the "UP", "DOWN" and "EMERGENCY STOP" of the controls in both Chinese and English shall be prominently displayed adjacent to the controls. The controls shall be placed in a position:

(a) which give the competent operator ample room for operation and a clear view of the landing level; and

(b) that it is impossible to reach them by hand from outside a closed access gate.

4.1.2 The "Up" and "Down" controls shall be of deadman control type. That means the platform shall stop from moving after the "Up" or "Down" controls return to neutral or off position upon release of the lever or switch in the actuated positions. The "Emergency Stop" control, which shall stop and arrest the platform when actuated, shall be a red press button of non resetting type.

4.1.3 If several control stations are provided on the platform, these controls shall be interlocked such that control is possible only at one pre-selected control position.

4.1.4 The controls, excluding the "Emergency Stop" control, shall be prevented from accidental actuation. On switching on the power, or restoration after power failure, the platform shall not move without the actuation of the controls.

4.1.5 During normal operation, it shall not be possible to control the platform from other control stations except on the platform.

4.1.6 On starting or restoration of power failure, no further movement shall occur without the intervention of the competent operator.

4.1.7 A device shall be provided to prevent the platform from movement for at least two seconds after the platform has been stopped if the restarting or re-connection of the power or control circuit may have an adverse effect such as surging on the circuitry.

4.1.8 A switch to render the control circuit inoperative shall be fitted in the platform as a means of preventing unauthorised operation of the tower working platform. The switch shall be of a type that cannot be turned to the "ON" position until a key has been inserted, the key being trapped when turned and not removable until returned to the "OFF" position.

4.1.9 While moving the platform vertically the positioning of the control station has to be arranged in a way to provide the competent operator with the best possible view of the travel area and to ensure safe movement of the platform (e.g. pendant lead, remote control, etc.). A warning sign shall be mounted on the movable station stating that it is not allowed to operate the platform from other places than the platform itself.

4.1.10 It must not be possible to move the platform if the free travel of the platform is obstructed by parts of the platform itself, e.g. extensible platforms, trailing cable or mast lifting equipment.

4.2 Inspection and erection operations

4.2.1 All safety devices controlling the movement of the platform shall remain in operation.

4.2.2 If the running of the platform is obstructed by parts of the platform itself (e.g. lifting equipment on the platform or trailing cable) during the course of travel, the platform shall be prevented from moving.

4.2.3 “Emergency Stop” switches shall not be bridged during erection, dismantling and maintenance.

4.2.4 When the top final limit and terminal limit switches are not incorporated or functioning, alternative means shall be provided to prevent the platform coming off the top end of the guides.

4.2.5 Remote control shall be provided only to facilitate testing of the platform.

4.3 Control for transfer operation of tower working platform

On tower working platforms with a self-propelled chassis, it shall not be possible to operate the horizontal movement of the chassis and vertical movement of the platform simultaneously. The transfer control station for horizontal movement of chassis shall not be situated on the platform.

4.3.1 The transfer control station shall be provided with the minimum "Forward", "Backward” and "Emergency Stop" controls. An indelible inscription indicating the "FOWARD", "BACKWARD", and "EMERGENCY STOP" of the controls in both Chinese and English shall be prominently displayed adjacent to the controls.

4.3.2 The “Forward” and “Backward” controls shall be of deadman type. The “Emergency Stop” control shall be of non resetting and pressure type. The transfer control station shall be placed in a position which give the competent worker ample room for operation and a clear view of the ground.

4.3.3 A bi-stable selector switch or other means shall be provided to select whether the tower working platform is in raising and lowering operation or transfer operation.

4.3.4 The selector or means in the preceding paragraph shall be prevented from unauthorised and inadvertent operation.

SECTION L : EMERGENCY AND TRANSFER OPERATIONS

1 EMERGENCY ALARM

In order to call for outside assistance, there shall be provided on the platform an audible alarm device easily recognisable and accessible to the competent operator. The device shall be a bell or similar devices installed on the platform. The device shall be capable of functioning for at least 60 minutes after power failure to the platform.

When the audible emergency alarm is not effective in alerting the rescue personnel because of the long distance away, an additional means such as an intercom, a walkie-talkie or a communications system shall be provided inside the platform for the competent operator to communicate with the rescue personnel stationed on the construction site.

The push-button or switch for actuating the audible emergency alarm shall be clearly marked "ALARM" in both English and Chinese. In the case of more than one tower working platform, it shall be possible to identify the platform from which the call is being activated.

2 EMERGENCY LOWERING/RAISING

Every tower working platform shall be provided with a manual emergency lowering/raising device on the platform. If there is a power failure or failure of controls, the emergency lowering/raising device shall be possible to bring the platform to a place where the passengers and the competent operator can safely leave the platform.

The emergency lowering/raising device shall comply with the following requirements:

(a) The manual emergency lowering/raising of the platform shall be capable of being operated by hand requiring a constant effort of no more than 400N.

(b) Operation of the emergency lowering/raising device shall require the temporary release of the braking system of the driving machine.

(c) The emergency lowering/raising device shall be protected from misuse, e.g. by a protective cover capable of being broken in the event of an emergency.

(d) The emergency lowering/raising device shall only be operated by the registered examiner, competent worker or competent operator.

(e) The manual emergency lowering/raising device shall not be operated by the competent operator/competent worker unless either one of the following requirements is met:

  i. The platform is equipped with a safety gear and the competent operator/competent worker has undergone training on the operation of the manual emergency lowering/raising device of the type concerned and the working principle of the safety gear; or

  ii. The platform is equipped with a speed controlling device specified

in Section L2(k) for emergency lowering/raising and the competent operator/competent worker has undergone relevant training on the operation of the emergency lowering/raising device of the type concerned and the working principle of the speed controlling device.

(Note : The detailed requirements and training of competent operators are specified in Annex II.)

(f) Precautions shall be taken that when emergency lowering/raising is carried out when there is more than one driving machine. As some of the driving machine brakes may be made ineffective (e.g. the driving machine brakes are released by wedging) to facilitate the emergency lowering/raising, the remaining effective driving machine brake(s) in exercising the emergency lowering/raising must be capable of arresting the platform with a capacity as described in Section H4.

(g) The emergency lower/raising device shall be operated from a safe, but easily accessible location on the platform which also permits the best possible view of the travel area.

(h) The emergency lowering/raising device shall be able to lower/raise the platform with 110% of rated load on the platform.

(i) For multiple mast machines, emergency lowering/raising shall be possible to be carried out from each mast individually.

(j) No parts of the platform shall exceed 5 degrees from the horizontal during emergency lowering/raising.

(k) For tower working platforms not equipped with safety gears, the emergency lowering/raising speed shall be automatically controlled by a speed controlling device to not more than 0.3m/s. The speed controlling device shall have a safety factor of not less than 2.5 with respect to the ultimate tensile strength of the material and the highest force which can occur in the speed control device when the platform is travelling at 0.3m/s with rated load. The speed controlling device may be part of the drive unit or an independent unit.

(l) The emergency lowering/raising device shall not affect the operation of the safety gear for platform equipped with safety gear.

3 TRANSFER OPERATION

3.1 Prior to transfer operation, means shall be provided to ensure, or at least to give proper warning, that the tower working platform is in the proper transfer state, i.e. the platform is at its lowest position for transferring. This means shall be an electric safety switch for a self-propelled chassis which shall allow the transfer operation of the platform only when the platform is in the proper transfer condition. In the case of a chassis of non self-propelled type, a device shall be provided to warn that the platform is not yet lowered to the proper transfer state before the operation.

3.2 No person shall be allowed on the platform while the tower working platform is

under transfer operation. The base enclosure or fence may be dismantled to facilitate transfer operation. The transfer operation shall be carried out by competent workers.

3.3 Acceleration and retardation during transferring must be within the manufacturer's stability criteria.

3.4 Horizontal travelling shall only be carried out from the control station if there is good visibility over the route and working area. The control station for transfer operation shall not be on the platform.

PART 4 : USER INFORMATION

1 GENERAL

Every tower working platform shall be supplied with an instruction manual which provides technical data concerning the platform. The manual shall be suitably protected and kept at site.

2 CONTENTS OF THE INSTRUCTION MANUAL

2.1 Technical description and information

- a description of the major components of tower working platform
- name and address of maker
- load carrying capacity, giving both the maximum number of persons, rated load and the distribution of loads (the load chart shall be in both Chinese and English)
- vertical travel speed of platform
- horizontal transfer speed of tower working platform
- outdoor/indoor installation
- maximum manual force
- type and model
- dimensions of the primary platform and auxiliary platforms (width, length, height)
- maximum lifting height without wall anchorage
- maximum lifting height with wall anchorages
- minimum/maximum distance between wall anchorages
- minimum/maximum distance between the bottom anchorage and the base frame
- allowable overhang of mast above top wall anchorage
- maximum allowable inclination of the chassis
- outrigger arrangements for tower working platform
- platform arrangements
- in-service, out-of-service and erection wind speeds
- a description of the driving machine for raising and lowering the platform which shall include:
  - (a) power
  - (b) electric power supply (voltage, frequency, no. of phases)
  - (c) full load current
  - (d) starting current
  - (e) the type of the driving machine brake
  - (f) a description of the driving machine
    - type and position of the control station
    - type of landing gate
    - details of lifting wire rope or counterweight rope
      - i. number of ropes

ii. construction of rope
iii. diameter
iv. minimum breaking strength
v. number of parts
vi. factor of safety

- details of terminal and final limit switches and buffers
- full information on the operation and maintenance of safety gear, including method of assessing wear
- full information including safe working procedures for the installation, testing, operation of outriggers, alteration of height of travel, extension of platform, serving and dismantling of the tower working platform, transfer operation, rescue procedures and emergency lowering/raising
- full information to enable foundations, wall anchorages and wall anchorage fixings to be designed
- specification of bolts for assembling the structure
- electrical and hydraulic circuit diagrams showing the operation of the electrical and hydraulic components
- operation of emergency audible alarm
- safe working loads at different working radii of the lifting equipment, size, strength and construction of the lifting wire rope

2.2 Foundation

- loading on foundation
- dimensions of concrete block for anchorage if possible
- construction and design of reinforcing bars if possible

2.3 Erection and dismantling

Only competent workers and workers under their direct supervision shall erect and dismantle the tower working platform. The following information shall be provided:

- weights of components or assemblies of the tower working platform
- capacity of lifting appliance required for the erection and dismantling work
- operation of lifting equipment integrated with the platform (if applicable)
- procedures including safe work methods, for erection and dismantling of the tower working platform.

2.4 Operation

2.4.1 A separate section shall be included in the instruction manual which gives all users of the tower working platform clear information regarding the safe operation, such as:

- field of application
- loading of the platform and possible restrictions regarding load position and concentration and securing of the load

- rated load and maximum number of persons, allowable manual force
- outrigger spread and configuration
- operation of access gate and platform gate
- control of tower working platform
- emergency procedures
- transfer of tower working platform on site including maximum gradient
- use of safety belts with safety harness attached to platform
- wearing of safety helmets
- operation of lifting equipment

2.4.2 A separate section shall be included which provides the competent worker the information regarding the handling of emergency situations and safe working procedures such as:

- special controls
- safety gear
- reacting to failures
- environmental conditions
- circuit diagram
- emergency lowering/raising device

3 MARKINGS AND NOTICES

Markings and notices must be easily legible and permanently attached to the tower working platform.

3.1 Rating plate

- name and address of the manufacturer
- year of manufacturer
- type designation
- serial number or manufacturer number
- rated load and maximum number of persons
- maximum height of travel
- wire rope data
- rated speed

3.2 Mast section identification label

Each individual mast shall be marked with an identification or serial number enabling the date of manufacture to be determined.

3.3 Notice on the platform

(a) Notice on primary platform

An indelible notice in both English and Chinese with letters and characters not less than 30mm in height shall be prominently displayed on the platform as shown below.

MAXIMUM NUMBER OF PERSONS INCLUDING OPERATOR : 最多可載人數(包括操作員)：
MAXIMUM WEIGHT : **in kg** 最高載重： 千克
MAXIMUM IN-SERVICE WIND SPEED : **in m/s** 最大工作風速： 米/秒
WARNING : 警告：
THE PLATFORM SHALL BE OPERATED BY A COMPETENT OPERATOR ONLY. 祇許由合資格操作員操作此工作平台

The notice shall be kept legibly at all times.
In addition, if the rated load of tower working platforms depend on configurations of the platform and outriggers. The restrictions regarding the load position and concentration with respect to that configuration of the platform and outriggers shall also be displayed.

(b) Notice on auxiliary platforms

An indelible notice in both English and Chinese with letters and characters not less than 30mm in height shall be prominently displayed on the auxiliary platform as shown below.

THIS FLOOR IS USED FOR SUPPORT OF PERSONS ONLY 此地台只用作承托工人
NO MATERIAL SHALL BE PLACED ON THIS FLOOR 不准擺放任何物料在此地台

3.4 Notice at ground level

A notice in both English and Chinese with letters and characters, as shown below, shall not be less than 50mm in height and shall be displayed at the base enclosure or fences at ground level.

ACCESS BY AUTHORISED PERSONNEL ONLY
嚴禁非工作人員內進

For tower working platforms of mobile type, a notice in both English and Chinese with letters and characters not less than 30mm, as shown below, shall be displayed at the chassis.

WARNING :
警告：

ELEVATING THE PLATFORM IS NOT ALLOWED UNLESS ALL OUTRIGGERS ARE FULLY EXTENDED AND SUPPORTED.
除支撐腳適當地伸展及支撐，否則不能提升此工作平台

TRAVELLING ON SITE IS NOT ALLOWED UNLESS THE PLATFORM IS FULLY LOWERED.
除完全降下工作平台，否則不能在工地上移動

3.5 Label at safety gear

The following information shall be displayed in the nameplate of the safety gear.

- maker's name and address
- model
- serial number
- tripping speed
- permitted load
- stopping distance
- year of construction

3.6 Driving motor

The following information shall be provided in the nameplate of the driving motor of the driving machine.

- name and address of manufacturer
- type designation
- year of construction and serial number
- operating speed
- rated load

ANNEX I

FIGURES 1(a), 1(b), 2(a), 2(b), 2(c), 3, 4(a), 4(b), 4(c) and 4(d)

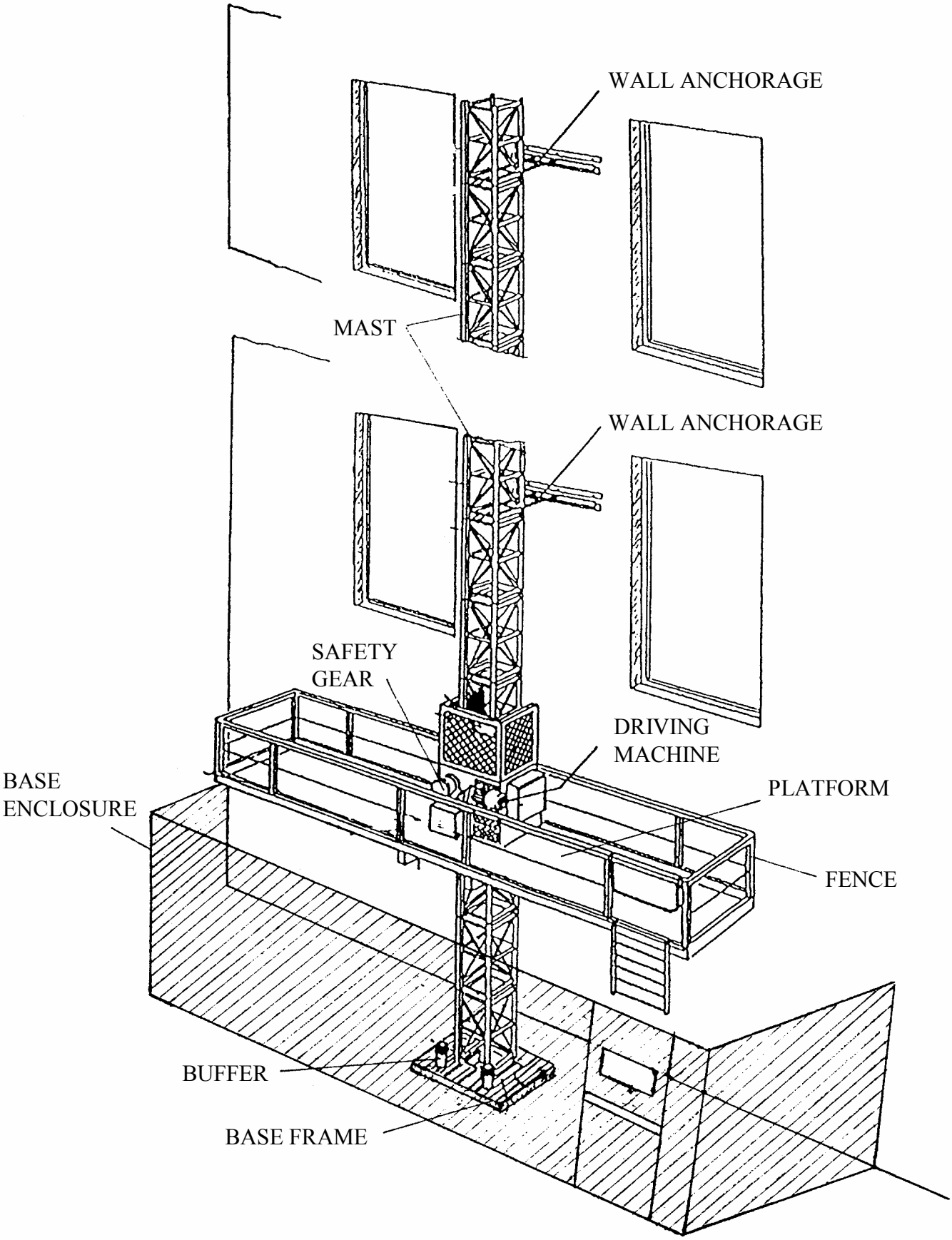


FIGURE 1(a) : ONE TYPICAL LAYOUT OF A TOWER WORKING PLATFORM OF FIXED TYPE

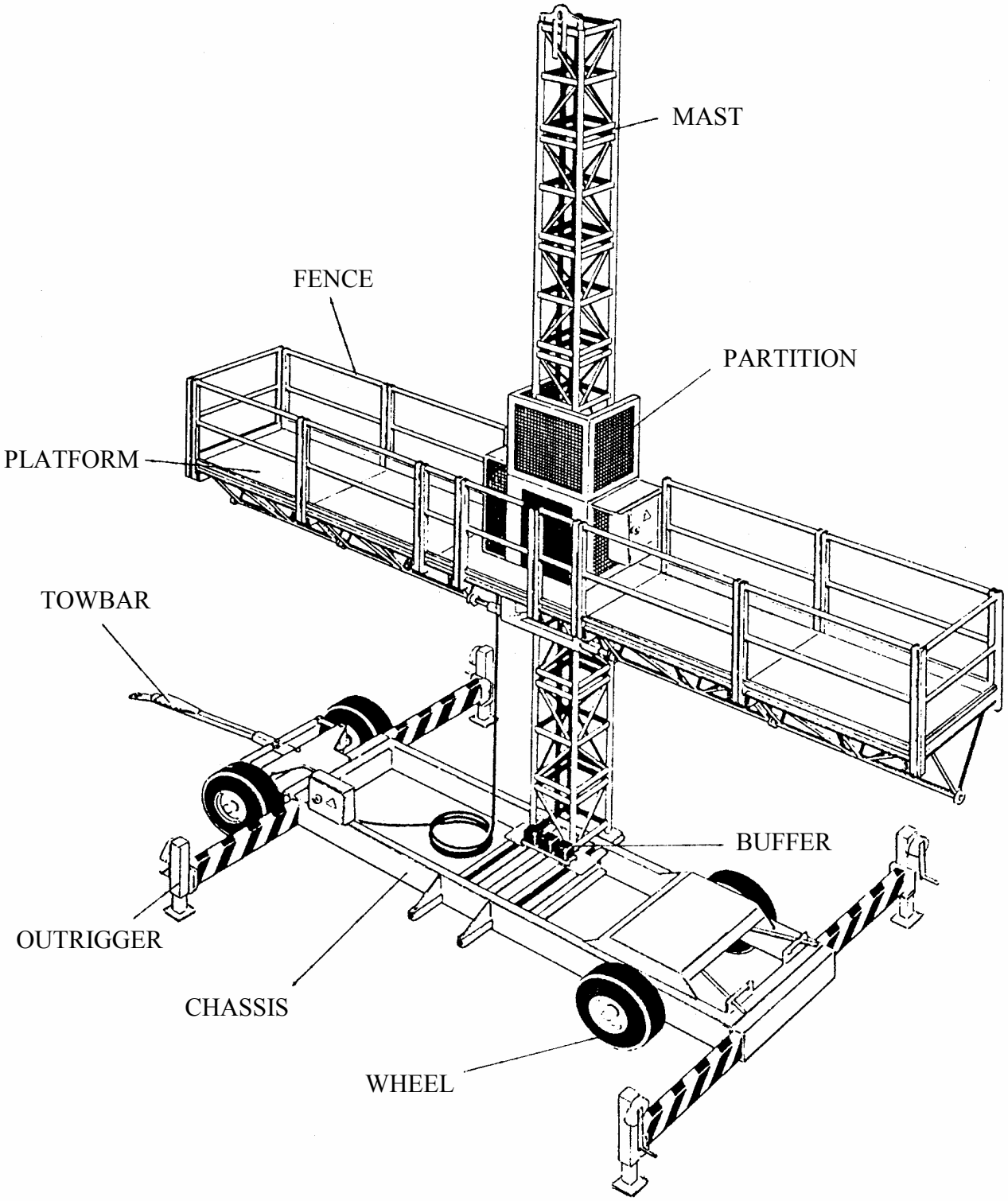


FIGURE 1(b) : ONE TYPICAL LAYOUT OF A TOWER WORKING PLATFORM OF MOBILE TYPE

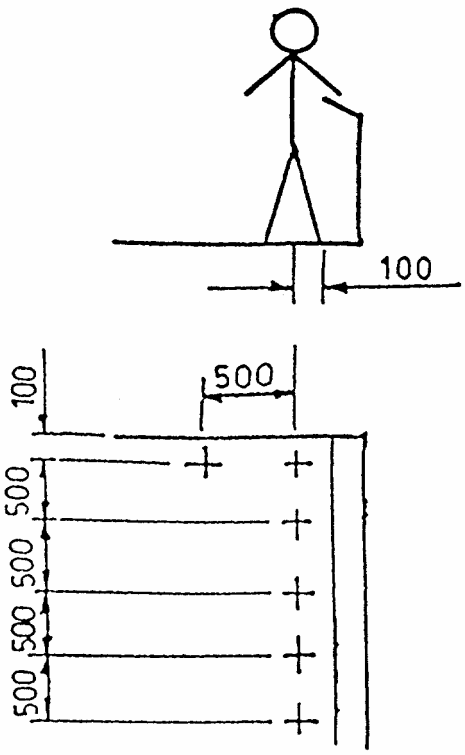
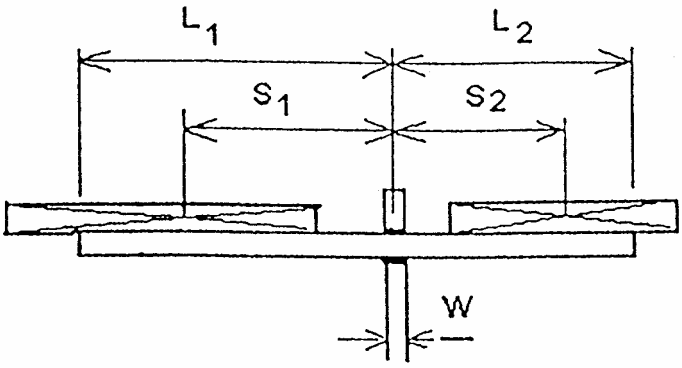
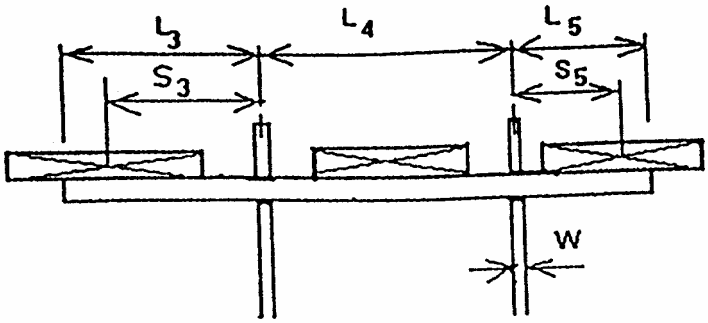


Figure 2(a) : Load Distribution for Platform



$BM_{max} = t \times L_{max} \times S_{max}$

Figure 2(b)



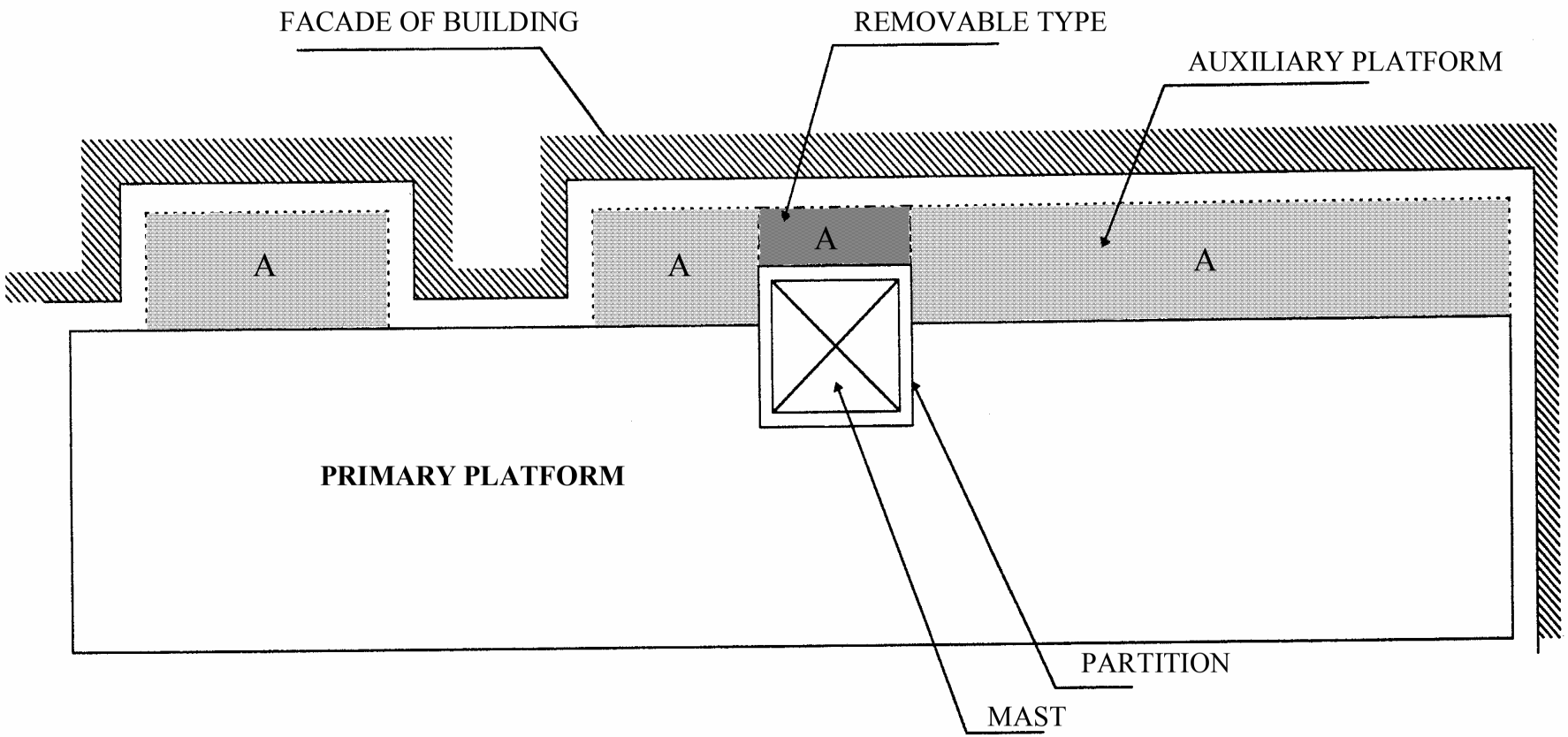
$$t = \frac{T}{\Sigma L}$$

W = width of mast

$$Sx = \frac{Lx}{2} \times 1.15$$

Figure 2(c)

x = 1, 2, ... 5



A : AUXILIARY PLATFORM

FIGURE 3 : LAYOUT OF PLATFORM

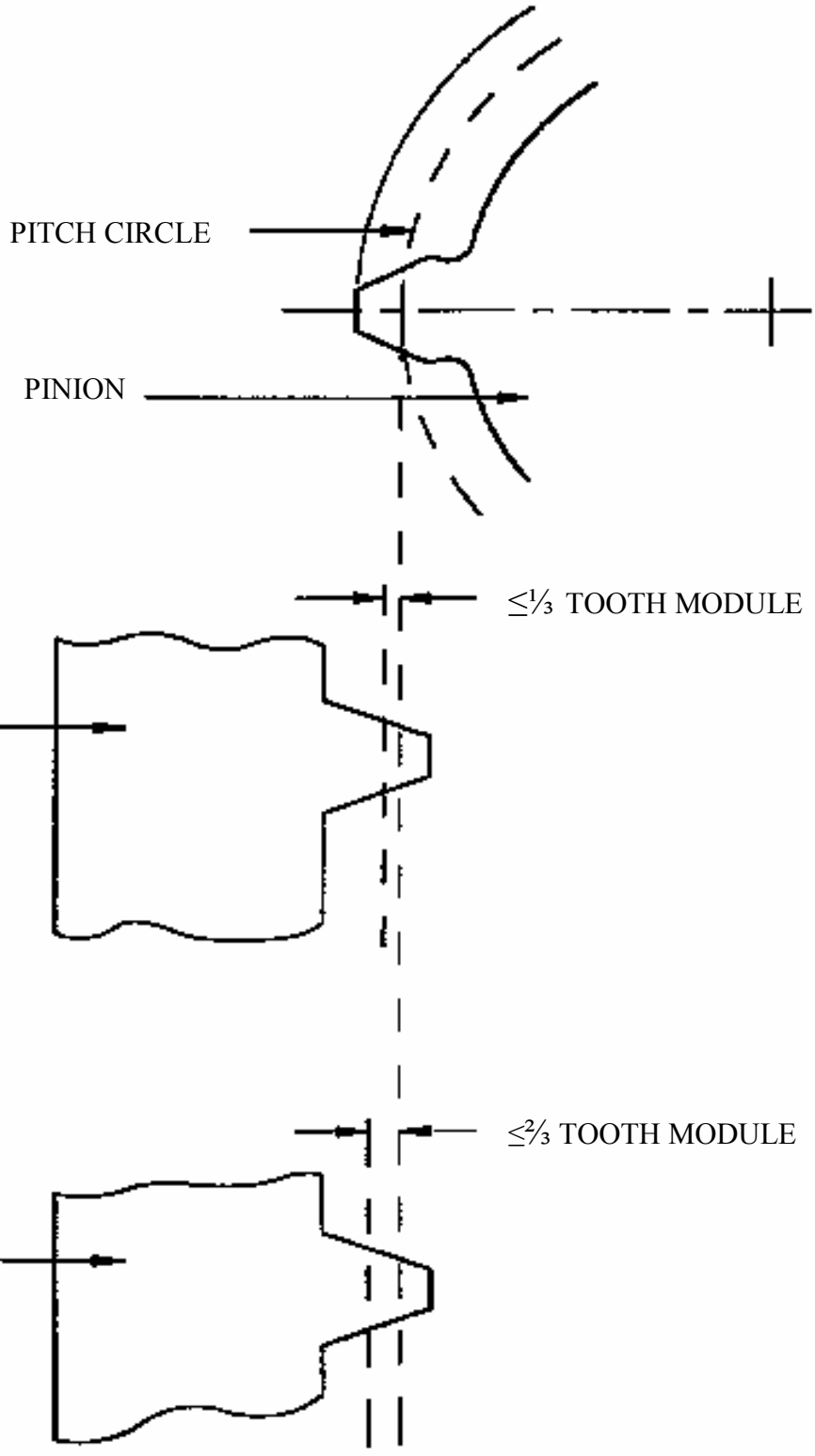


FIGURE 4(a)

FIGURE 4(b)

FIGURES 4(a) & 4(b) : SEPARATION OF PINION FROM RACK

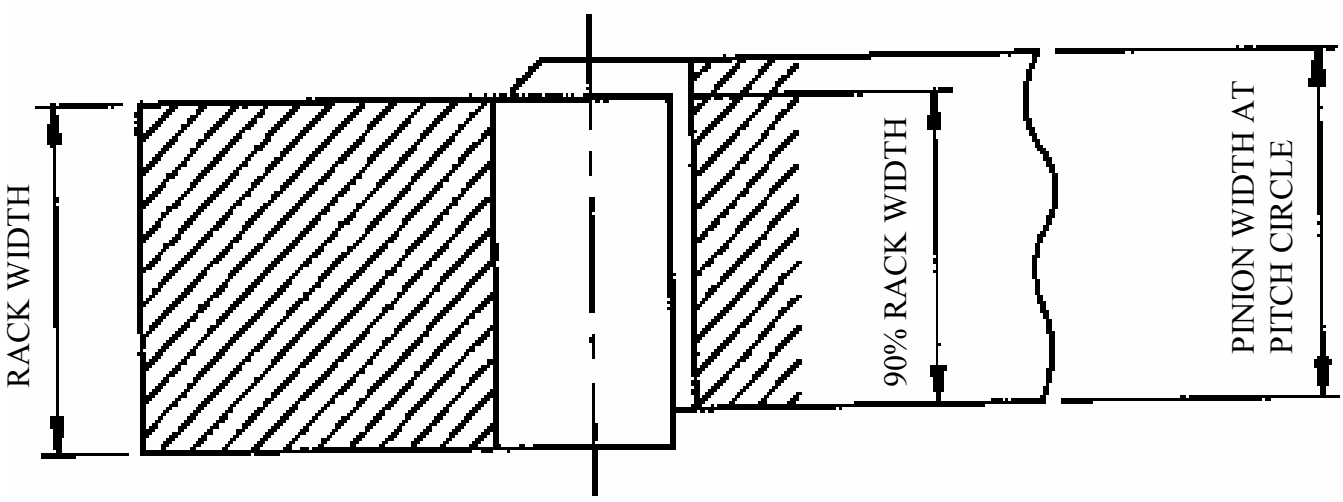


FIGURE 4(c) : RACK / PINION ENGAGEMENT

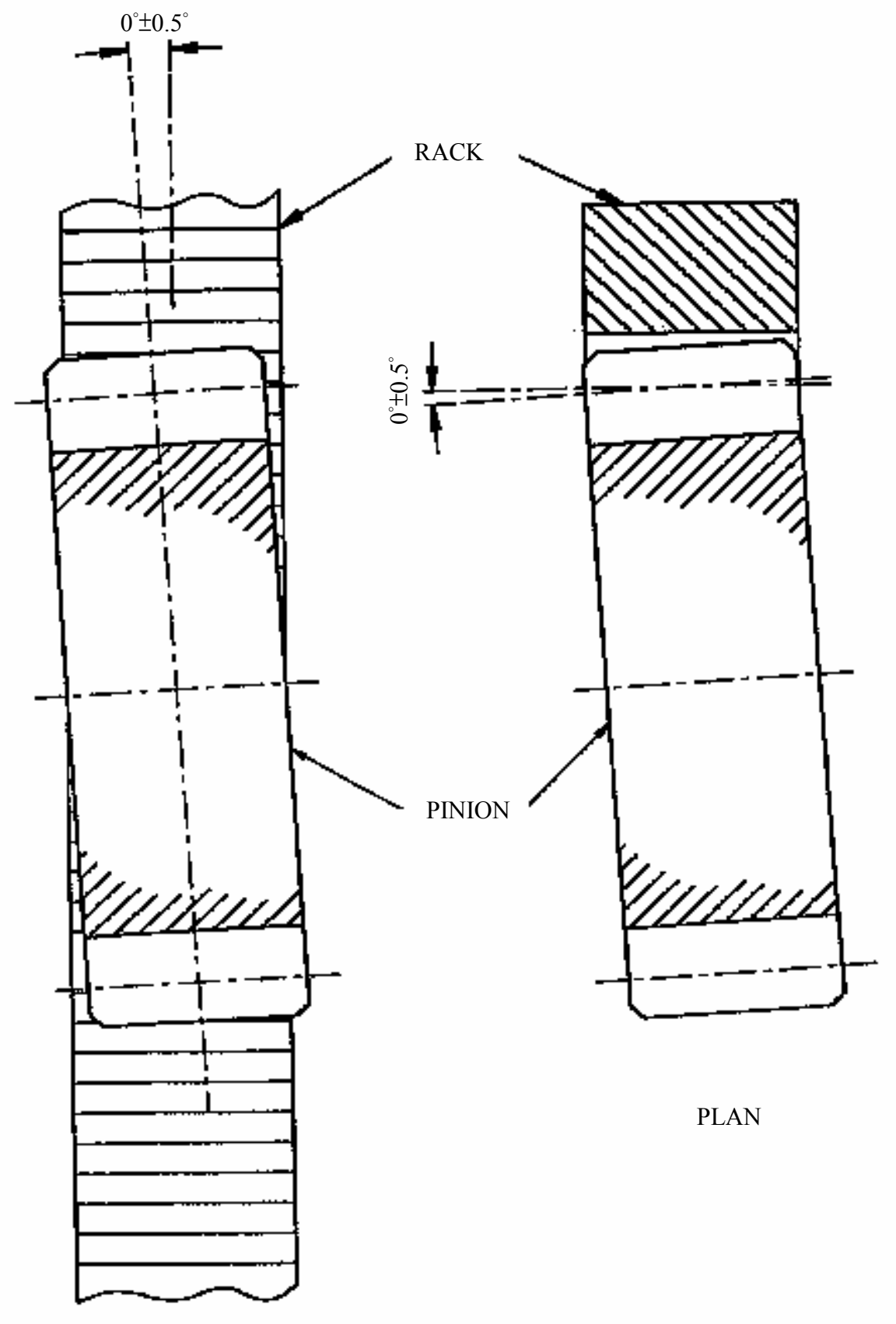


FIGURE 4(d) : RACK / PINION ENGAGEMENT

ANNEX II : COMPETENT OPERATORS

1 REQUIREMENTS OF COMPETENT OPERATORS

The competent operators for the operation of platforms shall:

(a) be medically fit for operation of tower working platform and carrying out daily checks;
(b) have been adequately trained in the operation and working principles of tower working platforms;
(c) have been authorised to operate the tower working platform by the owner;
(d) have sufficient knowledge of the working of the tower working platform to enable him/her to carry out daily checks.

The competent operator shall not operate the lifting equipment installed on the platform unless he/she:

(a) has the stature to enable him/her to operate the lifting equipment safely;
(b) has been adequately trained in the operation and working principles of the lifting equipment concerned;
(c) fully understands the safe working load(s) prescribed in the load chart;
(d) has sufficient knowledge of the working of the lifting equipment to enable him/her to carry out daily checks.

The competent operator shall not operate the emergency lowering/raising device unless either of the following is met.

i. he or she has undergone relevant training on the operation of the emergency lowering/raising device of the type concerned and the working principle of the safety gear for tower working platforms equipped with safety gears.
ii. he or she has undergone relevant training on the operation of the emergency lowering/raising device of the type concerned and the working principle of the speed controlling device for tower working platforms not equipped with safety gears.

2 TRAINING REQUIREMENTS

The training for competent operators shall include the following aspects:

2.1 <u>Basic construction and working principles including:</u>

(a) the electrically operated locking device of the gates;
(b) the overload and overmoment sensing device;
(c) the audible emergency alarm;

2.2 <u>Operational aspects including:</u>

(a) the allowable lifting capacities and maximum permitted numbers of passengers to be carried for different platform arrangements, outrigger arrangements and load distributions;

(b) operation of the control levers and switches installed on the platform;
(c) the use of audible emergency alarm;
(d) the use of emergency communication systems when fitted;
(e) the use of safety belts or safety harnesses and the proper anchorage for them when working on a platform;
(f) the training on the operation and daily checks of lifting equipment integrated with tower working platform, if the competent operator is required to operate the lifting equipment;
(g) the training on the operation of the emergency lowering/raising device if the competent operator is required to operate the device;
(h) checking of settlement of the foundation or supports.

Note : The horizontal transfer operation of tower working platforms of mobile type, the extension and retraction of outriggers, resetting of safety gear shall be operated by competent workers and not by competent operators.

2.3 Daily checks including:

(a) general visual inspection of platform for irregularities;
(b) inspection of liftway for any obstruction that will endanger the operation of the platform;
(c) inspection of the electrically operated locking devices for platform gate and access gate;
(d) inspection of fencing and platform gate for any signs of loosening or insecure fixing;
(e) checking of operating control;
(f) checking the outriggers and any timber or other packing for security;
(g) inspection of personal protective equipment provided, such as the safety belts or harness to ascertain their condition for use;
(h) checking of notices and warning signs.

If the platform is provided with lifting equipment and the operator is required to operate the lifting equipment, the following daily checks shall be included:

(a) visual inspection of the wire rope of lifting equipment;
(b) inspection of lifting hook;
(c) inspection of structure of lifting equipment for signs of deformation, cracks and corrosion.

ANNEX III : REFERENCES

(a) BS 4465, Design and Construction of electric hoists for both passengers and materials

(b) Code of Practice on the Design and Construction of Builders' Lifts issued by Electrical and Mechanical Services Department, 1996

(c) Code of Practice on the Design and Construction of Lifts and Escalators issued by Electrical and Mechanical Services Department

(d) Code of Practice for the Electricity (Wiring) Regulations issued by Electrical and Mechanical Services Department

(e) Code of Practice on wind effects Hong Kong-1983 by Building Development Department

(f) Electricity Ordinance, Chapter 406

(g) Factories and Industrial Undertakings Ordinance, Chapter 59

- i. Construction Sites (Safety) Regulations
- ii. Factories and Industrial Undertakings (Lifting Appliances and Lifting Gear) Regulations
- iii. Factories and Industrial Undertakings (Guarding & Operation of Machinery) Regulations
- iv. Factories and Industrial Undertakings (Suspended Working Platforms) Regulation
- v. Factories and Industrial Undertakings (Electricity) Regulations

(h) Lifts and Escalators (Safety) Ordinance, Chapter 327

(i) U.K. Health & Safety Executive Guidance HS(G) 23 : Safety at Power Operated Mast Working Platforms (1985)